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GEOTECHNICAL DESIGN REPORT - CULVERTS
ROUTE 26 IMPROVEMENTS
MAINEDOT WIN 018767.00
WOODSTOCK, MAINE

by Haley & Aldrich, Inc.
Portland, Maine

for Maine Department of Transportation
Augusta, Maine

File No. 130458-002
August 2020

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Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016

Attention: Kate Maguire, P.E.
Senior Geotechnical Engineer

Subject: Geotechnical Design Report - Culverts
Route 26 Improvements
MaineDOT WIN 018767.00
Woodstock, Maine

Ladies and Gentlemen:

We are pleased to submit herewith our report entitled, "Geotechnical Design Report - Culverts, Route 26 Improvements, MaineDOT WIN 018767.00, Woodstock, Maine," prepared in accordance with our proposal, dated 18 July 2017 and executed by your Bradford Foley on 7 August 2017.

This Geotechnical Design Report (GDR) presents the results of design phase subsurface explorations and geotechnical evaluations, and provides geotechnical design recommendations that are specific to the large diameter and/or box culverts that are planned for the project. The work was completed by Haley & Aldrich, Inc. (Haley & Aldrich) in support of the Maine Department of Transportation's (MaineDOTs) development of the 100 percent plans, specifications and engineer's estimate (PSE) package. Please note that geotechnical evaluations and design recommendations for the roadway and retaining wall that are planned for the project were previously provided in the report entitled "Geotechnical Design Report– Roadway," dated 19 August 2020 (Roadway Report).

It is our understanding that this report may be included as a reference document in the package of information (i.e., Contract Documents; CDs) that will be provided to the prospective Contractors for bidding. Please note that the recommendations included herein are superseded by the information contained in the CDs and that the information contained in the CDs takes precedence over the information provided in this GDR.

Horizontal Coordinate System and Elevation Datum

Plan locations of test borings were determined in the field by MaineDOT and were provided to Haley & Aldrich as northing and easting coordinates relative to the Maine State Plane Coordinate System, North American Datum of 1983 (NAD 83), Maine 2000 West Zone. As-drilled test boring locations were related to station and offset distance/direction relative to the baseline stationing by MaineDOT. The baseline stationing for the project extends from approximately Sta. 11+00 (east; project beginning) to Sta. 147+50 (west; project end).

The project elevation datum and elevations referenced herein are in feet and reference the North American Vertical Datum of 1988 (NAVD 88).

Project Location and Proposed Improvements

U.S. Route 26 (Route 26) carries traffic northbound and southbound through the Town of Woodstock, Maine, as shown in Figure 1, Project Locus.

In general, the project site is located along an approximate 2.6-mile long segment of Route 26 in Woodstock, Maine. This section of roadway was originally constructed in the 1930s or 1940s and is situated between two segments of roadway that were more recently reconstructed by MaineDOT. It is our understanding that MaineDOT will be rehabilitating the 2.6-mile long section of roadway, which includes the following key elements:

- Replacement of an existing, skewed (relative to the roadway) 4 ft x 3 ft box culvert with a 48-in. diameter, 84-ft long reinforced concrete pipe (RCP) culvert at Sta. 13+42 (approximate).
- Replacement of existing twin, skewed (relative to the roadway) 36-in. diameter corrugated metal pipe (CMP) culverts with a 6 ft x 10 ft x 126-ft long precast concrete box culvert at Sta. 24+93 (approximate).
- Replacement of an existing, skewed (relative to the roadway) 36-in. diameter RCP culvert with 60-in. diameter, 88-ft long RCP culvert at Sta. 123+85 (approximate).
- Modification to the existing horizontal and/or vertical profile and widening of the roadway between Sta. 52+00 and 61+50 (approximate). Along this portion of the alignment, the roadway is situated on an embankment that extends up to 25 ft (approximate) above the St. Lawrence and Atlantic Railroad (railroad), which is located near the toe of the embankment and immediately south of the roadway. In addition, steep mountainous terrain exists immediately north of the roadway and an existing 225-ft long (approximate) soil nail wall is present.

As noted above, this GDR is specific to improvements to the existing drainage infrastructure (i.e., first three bullet items shown above). Geotechnical information and recommendations for the proposed modifications to the existing roadway (i.e., fourth bullet item shown above) are included in a separate report.

Subsurface Exploration Program

GENERAL

Haley & Aldrich completed a design phase subsurface exploration program at the site in August and September 2017. A total of 16 test borings, designated HB-WOOD-201 through BB-WOOD-216, were drilled along the proposed alignment, including two test borings at the extreme ends (upstream and downstream) of the three proposed culverts. Only six of the test borings (HB-WOOD-201 through HB-WOOD-204 and HB-WOOD-215 and HB-WOOD-216) that were drilled for the proposed drainage improvements (i.e., culverts) are included in this GDR and are discussed herein.

The test boring locations were laid out in the field by Haley & Aldrich prior to the start of drilling. "As-drilled" exploration locations and ground surface elevations at test boring locations were determined in the field by MaineDOT upon the completion of drilling. The coordinate location and station/offset information provided by MaineDOT for each test boring is shown on Table I. Please note that only station/offset information is provided on the test borings logs included in Appendix A. The plan locations of the test borings are shown on Figures 2 through 4, Site and Subsurface Exploration Location Plan and Interpretive Subsurface Profiles.

A Haley & Aldrich geotechnical engineer monitored the drilling, logged and conducted visual inspection/classification of the soil and rock samples collected, prepared test boring logs documenting the conditions encountered, and confirmed that all drilling and sampling was performed in accordance with MaineDOT requirements.

TEST BORINGS

The test borings were drilled by New England Boring Contractors of Hermon, Maine using a Mobile Drill B-59 truck-mounted drill rig. Test borings were advanced into or through the naturally-deposited overburden soils to depths ranging from approximately 21 to 27 ft below existing ground surface (BGS) using 3-in. (NW-size) or 4-in. (HW-size) outside diameter (OD) steel casing. Please note that the upper portion of each test boring was drilled with a solid-stem auger prior to setting the steel casing, as shown on the test borings logs in Appendix A.

Soil samples were generally collected continuously through the fill soils and at standard, 5-ft intervals thereafter, by driving a 1-3/8-in. inside diameter (ID) split-spoon sampler with a 140-lb hammer dropped from a height of 30 in., as indicated on the test boring logs. The number of hammer blows required to advance the sampler through each 6-in. interval was recorded and is provided on the test boring logs. The uncorrected SPT N-value (N-uncorrected) is defined as the total number of blows required to advance the sampler through the middle 12 in. of the 24-in. sampling interval. The drill rig was equipped with a calibrated automatic hammer per MaineDOT requirements. The energy-corrected SPT N-values (N_{60}) shown on the test boring logs are equal to the uncorrected N-value multiplied by the hammer efficiency factor (0.869) divided by 0.6.

A photoionization detector (PID) was used in the field to screen for the presence of volatile organic compounds (VOCs) in the overburden soil samples. No elevated PID readings were detected in the soil samples collected in the overburden soils. PID readings are provided as part of the individual soil sample descriptions shown on the test boring logs provided in Appendix A.

Two test borings (HB-WOOD-215 and HB-WOOD-216) were advanced approximately 5 ft into bedrock using a 2.0-in. (NQ-size) ID diamond-tipped core barrel.

All soil and bedrock samples were collected and preserved in glass jars and wooden boxes, respectively, and are available for review upon request. The available soil and bedrock samples (i.e., those that were not submitted for laboratory testing) are currently being stored at the Haley & Aldrich laboratory facility in Portland, Maine.

Generalized Subsurface Conditions

The subsurface conditions encountered in the test borings generally consisted of man-placed fill soils overlying naturally-deposited marine silt/clay, glacial till and bedrock. Considering that the subsurface conditions are variable, a brief description of each soil unit encountered is presented in order of increasing depth below ground surface for each of the proposed culverts.

Detailed soil and bedrock descriptions are provided on the Haley & Aldrich test boring logs included in Appendix A. Please note that the soil descriptions provided on the test boring logs and summarized below do not represent actual field conditions other than at the specific test boring locations. The actual conditions may vary from those described and shown herein and may not become apparent until construction begins.

The generalized subsurface conditions present at each of the three proposed culvert locations are presented separately, below.

CONDITIONS @ STA 13+42 (PROPOSED 48 IN. DIA. REINFORCED CONCRETE PIPE CULVERT)

Soil Unit	Approximate Range in Encountered Thickness (ft)	Generalized Description *(refer to test borings HB-WOOD-201 and HB-WOOD-202)*
Fill	4 to 8	A 1.4-ft thick layer of bituminous concrete was encountered at the ground surface in test boring HB-WOOD-201. Medium dense to very dense, fine to coarse SAND with variable amounts of silt and gravel with occasional cobbles; dense, Sandy GRAVEL with variable amounts of silt *(encountered in both test borings)*
Alluvial	0 to 3	Very loose to loose, fine to medium SAND with variable amounts of silt (occasional laminae up to 1/8-in. thick) and gravel, oxidation staining was observed. *(encountered in test boring HB-WOOD-202)*
Wetland Deposit	5 to 6	Very loose to loose, fine to medium SAND with variable amounts of silt and coarse sand and gravel, contains roots, wood, trace amounts of peat and has a strong organic-like odor. *(encountered in both test borings)*
Glacial Lacustrine Deposit	8 to 13	Loose to medium dense, fine to medium SAND with variable amounts of coarse sand and fine gravel; loose, fine Sandy SILT with variable amounts of medium and coarse sand and fine gravel. *(encountered in both test borings)*
Bedrock		Bedrock was not encountered in either test boring.

SOIL CONDITIONS @ STA 24+93 (PROPOSED 6' RISE X 10' SPAN PRECAST CONCRETE BOX CULVERT)

Soil Unit	Approximate Range in Encountered Thickness (ft)	Generalized Description *(refer to test borings HB-WOOD-203 and HB-WOOD-204)*
Fill	6.5 to 7	A 0.7-ft thick layer of bituminous concrete was encountered at the ground surface in test boring HB-WOOD-204. Medium dense to very dense, Gravelly SAND and fine to coarse SAND with varying amounts of silt and gravel, well graded. *(encountered in both test borings)*
Wetland Deposit	2 to 3	Very loose to loose fine SAND with variable amounts of medium and coarse sand and gravel and silt, contains roots and trace amounts of peat and has a strong organic-like odor. *(encountered in both test borings)*
Glacial Lacustrine Deposit	11.5 to 15	Very loose to medium dense fine SAND with variable amounts of silt (occasional laminae up to 1/8-in. thick), and medium and coarse sand. *(encountered in both test borings)*
Glacial Till	1 to 3	Medium dense Sandy GRAVEL and Gravelly SAND with variable amounts of silt, loosely bonded and well graded. *(encountered in both test borings)*
Bedrock		Bedrock was not encountered in either test boring.

SOIL CONDITIONS @ STA 123+85 (PROPOSED 60 IN. DIA. REINFORCED CONCRETE PIPE)

Soil Unit	Approximate Range in Encountered Thickness (ft)	Generalized Description *(refer to test borings HB-WOOD-215 and HB-WOOD-216)*
Fill	3 to 5	Very loose to medium dense, fine to coarse SAND with variable amounts of silt and gravel *(encountered in each test boring)*
Topsoil/Root Mat	3	Very loose fine SAND with variable amounts of medium and coarse sand, silt and gravel, contains roots and wood and has a strong organic-like odor. (*encountered in each test boring*)
Glacial Lacustrine Deposit	5 to 8	Very loose to medium dense fine SAND with variable amounts of silt and medium and coarse sand and gravel. *(encountered in each test boring)*
Glacial Till	3	Very dense Gravelly SAND with variable amounts of silt, well graded *(encountered in each test boring)*
Bedrock	Top of bedrock surface encountered at depths ranging from approximately 16 to 18 ft BGS (El. 741 to El. 739). Bedrock conditions are summarized in subsequent sections of this GDR.	

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GROUNDWATER CONDITIONS

Observation wells were not installed in any of the completed boreholes. As a result, long term static water levels at test boring locations were not determined at any of the culvert locations. The following general observations were made relative to groundwater conditions during drilling:

- Sta. 13+42 - collected soil samples were visually observed to be “wet” between approximately 4 and 5 ft below ground surface (BGS). Water levels measured in the completed boreholes upon the completion of drilling and sampling ranged from approximately 7 to 13 ft BGS.
- Sta. 24+93 – collected soil samples were visually observed to be “wet” between approximately 5 and 8 ft BGS. Water levels measured in the completed boreholes upon the completion of drilling and sampling ranged was approximately 5 ft BGS.
- Sta. 123+85 - collected soil samples were visually observed to be “wet” between approximately 3 and 8 ft BGS. Water levels measured in the completed boreholes upon the completion of drilling and sampling ranged from approximately 5 to 6 ft BGS.

Please note that the visual observations made during drilling and water levels taken in the completed boreholes may have been affected by drilling means/methods and may not be representative of actual static water levels at the site. In general, groundwater levels can be expected to fluctuate, subject to test boring drilling means/methods, seasonal variation, local soil conditions, topography and precipitation. Groundwater levels encountered during construction may differ from those observed in the test borings.

BEDROCK CONDITIONS

As stated previously, approximately 5 ft of bedrock was sampled in test borings HB-WOOD-215 and HB-WOOD-216. The sampled and recovered bedrock generally consisted of the following:

- Very hard, fresh, medium to coarse grained GRANODIORITE of the Songo Granodiorite Formation. Primary joints dip at low angles (parallel to foliation) and are widely spaced. Joints are open, and joint surfaces are discolored, planar and rough.

Rock quality designation (RQD) is a common parameter that is used to help assess the competency of sampled bedrock. RQD is defined as the sum of pieces of recovered bedrock greater than 4 in. in length divided by the total length of the bedrock core run. RQD values for bedrock encountered at the site ranged from 78 to 100 percent indicating good to excellent rock quality.

Photographs of the sampled bedrock are provided for reference in Appendix A.

Laboratory Testing Program

A laboratory testing program was undertaken on soil samples collected during the field investigation to assist in soil classification/identification. In general, laboratory testing was performed on disturbed soil samples collected during SPT sampling. All laboratory soil testing was performed by the State of Maine, Department of Transportation Laboratory in Bangor, Maine. Geotechnical laboratory testing was performed in accordance with applicable American Society for Testing Materials (ASTM) testing procedures. A summary of laboratory test results is provided below.

Laboratory Test	ASTM Test Designation	Soil Unit	No. of Completed Tests	Range in Test Results
Grain Size[1]	ASTM D 422	Fill	10	AASHTO Classification: A-1-a, A-1-b USCS Classification: GW-GM, SW-SM, SP-SM, SM
		Alluvial Deposit	2	AASHTO Classification: A-2-4 USCS Classification: SM
		Topsoil/ Root Mat	2	AASHTO Classification: A-2-4 USCS Classification: SP-SM, SM
		Wetland Deposit	8	AASHTO Classification: A-4, A-2-4, A-3 USCS Classification: SP-SM, SM
		Glacial Lacustrine Deposit	12	AASHTO Classification: A-3, A-2-4, A-4 USCS Classification: SP-SM, SM, CL
Organic Content[2]	ASTM D 2974	Topsoil/ Root Mat	1	MC = 45% OC = 23%
		Wetland Deposit	8	31% < MC < 166% 2% < OC < 55%
		Glacial Lacustrine Deposit	2	21.3% < MC < 25.5% 0% < OC < 2%

Notes:
1. Refer to the Key to Soil and Rock Descriptions and Terms in Appendix A for USCS definitions.
2. MC = moisture content; OC = organic content

Laboratory test results are provided in Appendix B and can be found in the test boring logs in Appendix A.

Geotechnical Design Recommendations

Technical evaluations used as the basis for development of geotechnical design recommendations were coordinated with MaineDOT. Engineering calculations that support the recommendations outlined in this section are provided for reference in Appendix C.

ANTICIPATED SUBGRADE CONDITIONS

Based on the subsurface conditions encountered in the test borings and the design culvert invert elevations provided by MaineDOT, the soil units present at the design subgrade level will vary along the length of culvert and at each culvert location. The anticipated soil units present at the design subgrade level for each culvert is summarized below and shown graphically on Figures 2 through 4.

Approximate Culvert Location	Approximate Range in Invert Elevation (ft, NAVD 88)	Anticipated Soil Unit(s) at Subgrade Level[1]
Sta. 13+42	El. 715 to El. 716	Alluvial Deposit, Wetland Deposit
Sta. 24+93	El. 696 to El. 697	Wetland Deposit, Glacial Lacustrine Deposit
Sta. 123+85	El. 748 to El. 749	Glacial Lacustrine Deposit

Notes:
1. Refer to previous sections of this report and the test boring logs in Appendix A for a more detailed description of the soil units that are anticipated to be present at subgrade level.

Please note that the actual subgrade conditions will vary from those summarized above and shown on Figures 2 through 4 and may not become apparent until construction begins.

We recommend the following bedding materials at each culvert:

- Sta. 123+85: The culvert should be bedded on a 2-ft thick (minimum) layer of Underdrain Backfill Material, Type C (MaineDOT Pay Item 203.55 Culvert Bedding Stone) that is fully encapsulated in Separation Geotextile (MaineDOT Standard Specification 722.04) with a layer of geogrid at the center consistent with MaineDOT standard practice.

- Sta. 13+42: The culvert should be bedded on a 2-ft thick (minimum) layer of Underdrain Backfill Material, Type C (MaineDOT Pay Item 203.55 Culvert Bedding Stone) that is fully encapsulated in Separation Geotextile (MaineDOT Standard Specification 722.04) with a layer of geogrid at the center consistent with MaineDOT standard practice. Based on the nature and consistency of the Wetland Deposit and Topsoil/Root Mat soils that are anticipated to be present at the design subgrade level along some portions of the culvert at Sta. 13+42, it is our opinion that they are not suitable for direct culvert support. As a result, we recommend that where encountered, the Wetland Deposit and Root Mat/Topsoil soils be over-excavated from within the zone of influence (ZOI) of the culvert down to the top of naturally-deposited inorganic soils (i.e., Glacial Lacustrine Deposit) and replaced with the bedding material described above.

- Sta. 24+93: The culvert should be bedded on a 2-ft thick (minimum) layer of Underdrain Backfill Material, Type C (MaineDOT Pay Item 203.55 Culvert Bedding Stone) that is fully encapsulated in Separation Geotextile (MaineDOT Standard Specification 722.04) with a layer of geogrid at the center consistent with MaineDOT standard practice. Based on the nature and consistency of the Wetland Deposit and Topsoil/Root Mat soils that are anticipated to be present at the design subgrade level along some portions of the culvert at Sta. 24+93, it is our opinion that they are not suitable for direct culvert support. As a result, we recommend that where encountered, the Wetland Deposit and Root Mat/Topsoil soils be over-excavated from within the zone of influence (ZOI) of the culvert down to the top of naturally-deposited inorganic soils (i.e., Glacial Lacustrine Deposit) and replaced with the bedding material described above.

The ZOI is defined as the area below proposed culverts and below imaginary lines that extend 1 ft laterally beyond the edge of the culvert and down on a one horizontal to one vertical (1H:1V) slope to the top of the Glacial Lacustrine Deposit. Based on the subsurface conditions encountered in the test borings, we anticipate the following ranges of over-excavation and replacement will be required (below the bedding material):

- Sta. 13+42 0 ft (south) to 6 ft (north)
- Sta. 24+93 0 ft (south) to 2 ft (north)

We also recommend that all topsoil, organic matter, and other unsuitable material (if present) be over-excavated (removed) from within the ZOI of culverts prior to subgrade preparation and placement of the bedding material described above.

Recommendations regarding subgrade preparation and protection and backfill placement and compaction recommendations are provided in the Construction Considerations section of this report.

BEARING RESISTANCE

Bearing resistance calculations were completed in accordance with AASHTO LRFD Section 10.6.3.1.2 for each culvert based on the culvert dimensions, the subgrade conditions summarized above (i.e., underdrain backfill material placed and compacted after the over-excavation of unsuitable material or Glacial Lacustrine soils), and the subsurface conditions present at depth. Recommended bearing resistances for the culverts are as follows:

- Culverts should be evaluated at the Service Limit State not to exceed a presumptive bearing resistance equal to 3 kips per square foot (ksf) in accordance with AASHTO LRFD Table C10.6.2.6.1-1.

- Strength Limit State bearing resistance should not exceed the following values, which are based on a resistance factor (ϕ_f) equal to 0.45 (AASHTO LRFD Table 10.5.5.2.2-1).

  - Sta. 13+43 (48-in. dia.): 7 ksf factored bearing resistance, 16 ksf nominal bearing resistance
  - Sta. 24+93 (10-ft span): 10 ksf factored bearing resistance, 22 ksf nominal bearing resistance

- Sta. 123+85 (60-in. dia.): 8 ksf factored bearing resistance, 18 ksf nominal bearing resistance

Bearing resistance calculations are provided in Appendix C.

SETTLEMENT

Based on our review of preliminary plan and profile drawings provided by you, it is our understanding that proposed finish grades will be approximately equal to existing grades at each of the three culvert locations. It is also our understanding that the proposed culverts will be larger in cross section than the existing culverts. As a result, we anticipate that constructing the proposed improvements will not result in a stress increase in the foundation soils present below the culverts, which are primarily granular in nature. Any settlement that does occur as a result of elastic compression of the foundation soils is expected to be negligible (i.e., < ¼ in.) and will likely occur rapidly during and immediately after culvert placement and backfilling operations, prior to final paving.

Construction Considerations

The primary purpose of this section is to comment on geotechnical aspects of proposed construction. This section is written primarily for the individuals having responsibility for preparation of geotechnical related plans and specifications as well as personnel appointed to monitor construction activities. Prospective Contractors should evaluate the potential for construction problems on the basis of their own knowledge and experience in the Woodstock, Maine area, and on the basis of similar projects in other localities, taking into account their proposed construction methods, procedures, equipment and personnel. Please note that the construction considerations provided below relate to the subject project only.

EXCAVATION

Excavation will be required to remove existing culverts and construct the proposed culverts. Based on proposed roadway grades, the proposed culvert invert elevations and the anticipated subgrade conditions excavation depths ranging between approximately 10 and 15 ft BGS will be required to construct the culverts. We anticipate that excavation and over-excavation (where required) of the in-situ soils (primarily fill, alluvial, wetland and topsoil/root mat) can be accomplished using normal earth-excavating equipment. We do not anticipate that bedrock excavation will be required to construct the culverts. Please note that the Glacial Lacustrine soils that will be present at the bottom of the excavations (after over-excavation of Wetland Deposit and Topsoil/Root Mat soils) are considered susceptible to disturbance from construction activities especially when the soils are wet or saturated. We anticipate that excavations may be made using sloped-open cut techniques. We recommended that the Contractor be responsible for the design, stability and safety of all excavations in accordance with local, state and federal regulations.

DEWATERING

We anticipate that excavation dewatering will be needed and can likely be accomplished by using ditches and open pumping from sumps. We recommend that the Contractor be made responsible for controlling all infiltration from groundwater and surface runoff to permit subgrade preparation, fill placement and construction in-the-dry.

Excavation and control of water should be done by methods that prevent disturbance to subgrade soils (i.e., Glacial Lacustrine soils). Sumps and pumps should be designed with proper filters to control the loss of fine grained soil.

Dewatering and discharge of dewatering effluent should be performed in accordance with all applicable local, state and federal regulations. Dewatering discharge should be recharged on site if possible. If on-site recharge is not feasible, dewatering discharge will likely need to be directed to the local storm drain system. Sedimentation tanks and other treatment methods may be required for legal disposal of the effluent into the storm drain system.

SUBGRADE PREPARATION

As discussed in previous sections of this report, we anticipate that soils present at the bottom of the excavations will likely consist of Glacial Lacustrine Deposit. These soils can easily be disturbed by construction activities if care is not taken in excavating within a few feet of design subgrade levels and in protecting the subgrade surfaces after preparation and prior to backfilling. The following guidelines are recommended to protect subgrade soils beneath the culverts:

- Make final excavations into natural bearing soils using smooth-bladed equipment to limit disturbance. We recommend the use of lightweight tracked grading equipment, such as low ground-pressure bulldozers, within 2 ft of subgrade elevation to the extent possible.
- Prevent water from accumulating on soil surfaces to reduce the possibility of soil disturbance. All filling should be performed in-the-dry. Subgrades that become disturbed due to water infiltration should be re-excavated and stabilized. Subgrade stabilization methods could include placement of a concrete mudmat or additional Crushed Stone 3/4 -inch that is fully encapsulated in Separation Geotextile with approval of the Resident and/or Geotechnical Engineer.
- Exposed subgrades should be examined in the field by the Resident and/or Geotechnical Engineer to verify strength and bearing capacity. Excavation may be necessary to remove weak, disturbed or otherwise unacceptable soils.
- All topsoil, organic matter, debris fill, and other unsuitable material be over-excavated (removed) prior to subgrade preparation and placement of fill/backfill.
- Granular subgrade surfaces could be proofrolled with self-propelled, static/vibratory compaction equipment until firm and prior to placement of Granular Borrow Material for Underwater Backfill or Crushed Stone ¾-inch if the soil appears dry and no “free” water is observed as determined by the Resident and/or Geotechnical Engineer. To minimize

disturbance, we recommend that wet/saturated granular or cohesive soils exposed at subgrade level not be proofrolled.

- Disturbance due to water and adverse weather could be reduced by maintaining excavations at least 12 in. above the final bearing level until immediately before placing fill material. Alternatively, it may be desirable to protect the exposed soil subgrade areas, as soon as possible after acceptance by the Resident and/or Geotechnical Engineer, by placing the culvert and backfill materials.
- Limit equipment traffic across the exposed soil bearing surfaces.
- If disturbance and rutting occur, the disturbed materials should be removed and replaced to the satisfaction of the Resident and/or Geotechnical Engineer.
- We recommend that the Contractor be made responsible for protecting subgrade surfaces. Any damage to the subgrade surface resulting from Contractor means and methods should be repaired to the satisfaction of the Resident and/or Geotechnical Engineer at no additional expense to MaineDOT.

FILLING, BACKFILLING AND COMPACTION REQUIREMENTS

Placement of compaction of fills should not be conducted when air temperatures are low enough (approximately 30 degrees F., or below) to cause freezing of the moisture in the fill during or before placement. Fill materials should not be placed on snow, ice or uncompacted frozen soil. Compacted fill should not be placed on frozen soil. No fill should be allowed to freeze prior to compaction. At the end of each day's operations, the last lift of fill, after compaction, should be rolled by a smooth-wheeled roller to eliminate ridges of uncompacted soil.

We recommend that fill and backfill be placed below, adjacent to and above the culverts in lift thicknesses not exceeding 9 in. loose measure (prior to compaction) and compacted using self-propelled static/vibratory equipment. Each lift of fill and backfill should be compacted to a minimum of 95 percent of the materials maximum dry density determined in accordance with ASTM D 1557.

Limitations and Closure

This report is prepared for the exclusive use of MaineDOT relative to the subject project. There are no intended beneficiaries other than MaineDOT. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than MaineDOT for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from MaineDOT and Haley & Aldrich. Use of this report by such other person or entity without the written authorization of MaineDOT and Haley & Aldrich shall be at such other person’s or entities sole risk and shall be without legal exposure or liability to Haley & Aldrich.

Use of this report by any person or entity, including by MaineDOT, for a purpose other than relative to the subject project is expressly prohibited unless such person or entity obtains written authorization from Haley & Aldrich indicating that the report is adequate for such other use. Use of this report by any other person or entity for such other purpose without written authorization by Haley & Aldrich shall be at such person's or entities sole risk and shall be without legal exposure or liability to Haley & Aldrich.

The information provided herein is based, in part, upon the data obtained from the referenced subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations then appear, it may be necessary to reevaluate the recommendations of this report.

It is our understanding that this report may be included as a reference document in the documents that will be provided to the prospective Contractors for bidding. Please note that the recommendations included herein are superseded by the information contained in the documents and that the information contained in the documents takes precedence over the information provided in this report.

We appreciate the opportunity to provide geotechnical consulting services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely yours,
HALEY & ALDRICH, INC.

Bryan C. Steinert, P.E.
Project Manager

Wayne A. Chadbourne, P.E.
Senior Associate

Enclosures:
- Table I – Culvert Subsurface Exploration Location Data
- Table II – Culvert Subsurface Exploration Subsurface Data
- Figure 1 – Project Locus
- Figure 2 - Boring Location Plan and Interpretive Subsurface Cross Section – Sta. 13+42
- Figure 3 - Boring Location Plan and Interpretive Subsurface Cross Section – Sta. 24+93
- Figure 4 - Boring Location Plan and Interpretive Subsurface Cross Section – Sta. 123+85
- Appendix A – Test Boring Logs
- Appendix B – Laboratory Test Results
- Appendix C – Geotechnical Calculations

TABLES

TABLE I
Culvert Subsurface Exploration Location Data
Route 26 Highway Rehabilitation
MaineDOT WIN 018767.00
Woodstock, Maine

Haley & Aldrich, Inc. File No.: 130458-002

Test Boring No.[1]	Ground Surface Elevation[3,4]	Station[5]	Offset Distance & Direction[5]	Coordinates[2]	
				Northing	Easting
HB-WOOD-201	723.8	13+15.7	9.9 RT	565,341.13	914,304.51
HB-WOOD-202	723.1	13+81.2	12.4 LT	565,274.66	914,285.91
HB-WOOD-203	705.9	24+62.9	18.7 RT	564,235.54	914,131.31
HB-WOOD-204	706.4	25+20.9	13.9 LT	564,169.45	914,137.06
HB-WOOD-215	756.7	123+85.2	15.4 RT	569,776.53	907,840.41
HB-WOOD-216	756.3	123+88.6	14.6 LT	569,751.69	907,823.38

Notes:
[1] Test boring locations are shown on Figures 2, 3 and 4, Boring Location Plan and Interpretive Subsurface Cross Sections.
[2] As-drilled coordinates of test borings were determined by MaineDOT using GPS survey equipment, are measured in feet and reference NAD83, Maine 2000 West Zone coordinate system.
[3] Ground surface elevations at test boring locations were determined in the field by MaineDOT using GPS survey equipment.
[4] Elevations are measured in feet and reference the North American Vertical Datum of 1988 (NAVD 88).
[5] Station and offset information determined by MaineDOT and provided to Haley & Aldrich.

	Individual	Date
Prepared By:	KAR	9/12/2017
Checked By:	BCS	5/15/2018
Reviewed By:	WAC	6/14/2018
Revised By:	KAR	10/30/2019

TABLE II
Culvert Subsurface Exploration Subsurface Data
Route 26 Highway Rehabilitation
MaineDOT WIN 018767.00
Woodstock, Maine

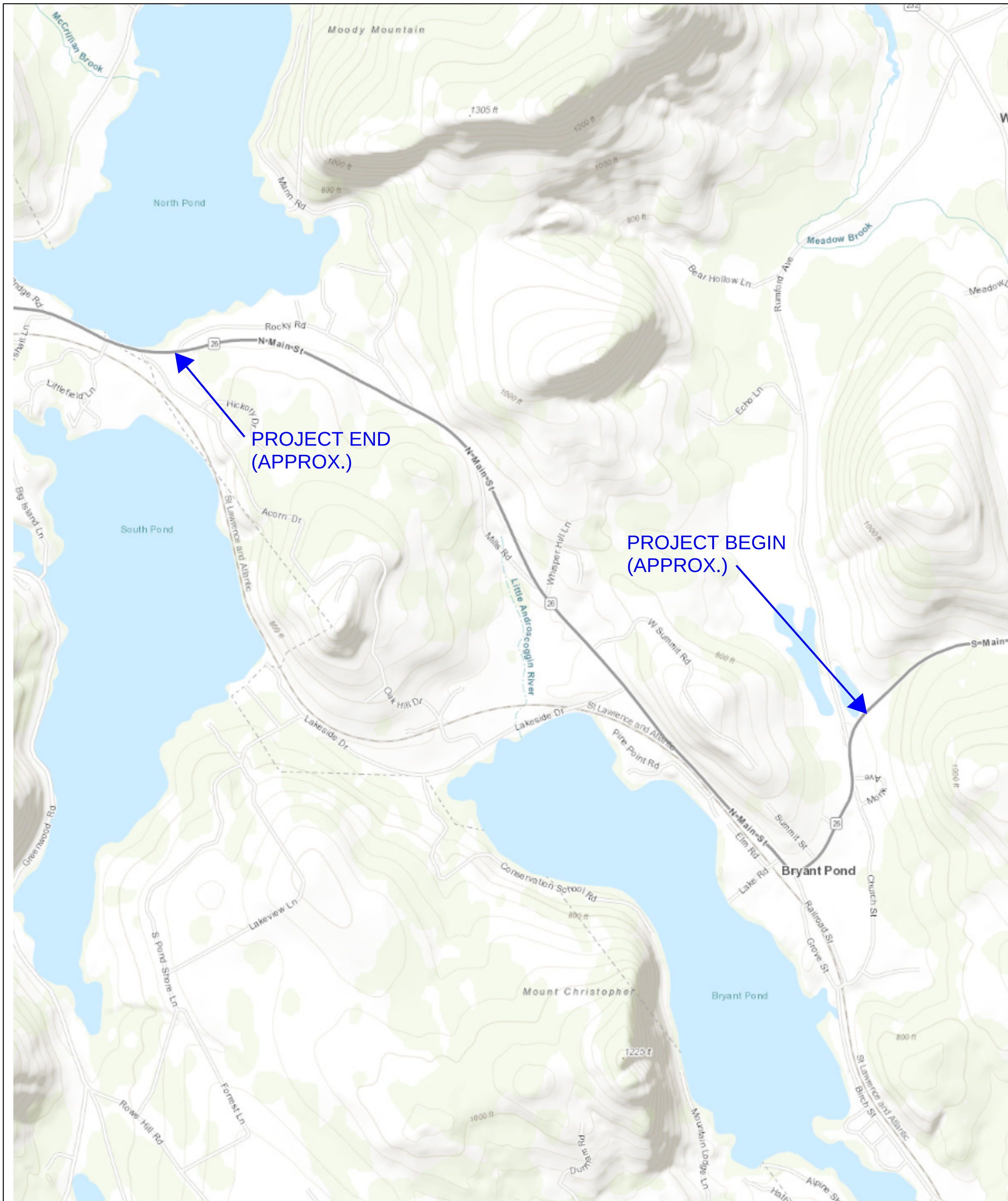
Haley & Aldrich, Inc. File No.: 130458-002

Test Boring No.[1]	Ground Surface Elevation[2,3]	Approximate Strata Thickness[4] (ft)							Approximate Elevation of Top of Bedrock[2,3]	Approximate Elevation of Bottom of Exploration[2,3]
		Bituminous Concrete	Fill	Topsoil / Root Mat	Wetland	Alluvial	Glacial Lacustrine	Glacial Till		
HB-WOOD-201	723.8	1.4	6.9	NE	5.7	NE	> 8	--	--	701.8
HB-WOOD-202	723.1	NE	3.7	NE	5.0	2.8	> 15.5	--	--	696.1
HB-WOOD-203	705.9	NE	6.5	NE	3.0	NE	11.5	> 1	--	683.9
HB-WOOD-204	706.4	0.7	6.6	NE	2.2	NE	14.9	> 2.6	--	679.4
HB-WOOD-215	756.7	NE	4.6	2.9	NE	NE	4.8	3.3	741.1	736.0
HB-WOOD-216	756.3	NE	3.2	3.3	NE	NE	8.1	3.0	738.7	733.7

Notes:
[1] Test boring locations are shown on Figures 2, 3 and 4, Boring Location Plan and Interpretive Subsurface Cross Sections.
[2] Ground surface elevations at test boring locations were determined in the field by MaineDOT using GPS survey equipment.
[3] Elevations are measured in feet and reference the North American Vertical Datum of 1988 (NAVD 88).
[4] "NE" indicates stratum was not encountered in test boring.

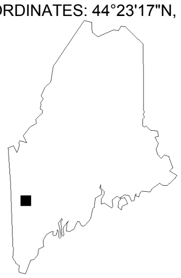
	Individual	Date
Prepared By:	KAR	9/12/2017
Checked By:	BCS	5/15/2018
Reviewed By:	WAC	6/14/2018
Revised By:	KAR	10/30/2019

FIGURES



MAP SOURCE: ESRI

SITE COORDINATES: 44°23'17"N, 70°39'37"W



HALEY ALDRICH

ROUTE 26 HIGHWAY REHABILITATION
MAINEDOT WIN 018767.00
WOODSTOCK, MAINE

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
DECEMBER 2019

FIGURE 1

130458-002_1_LOCUS.PDF

HALEY ALDRICH

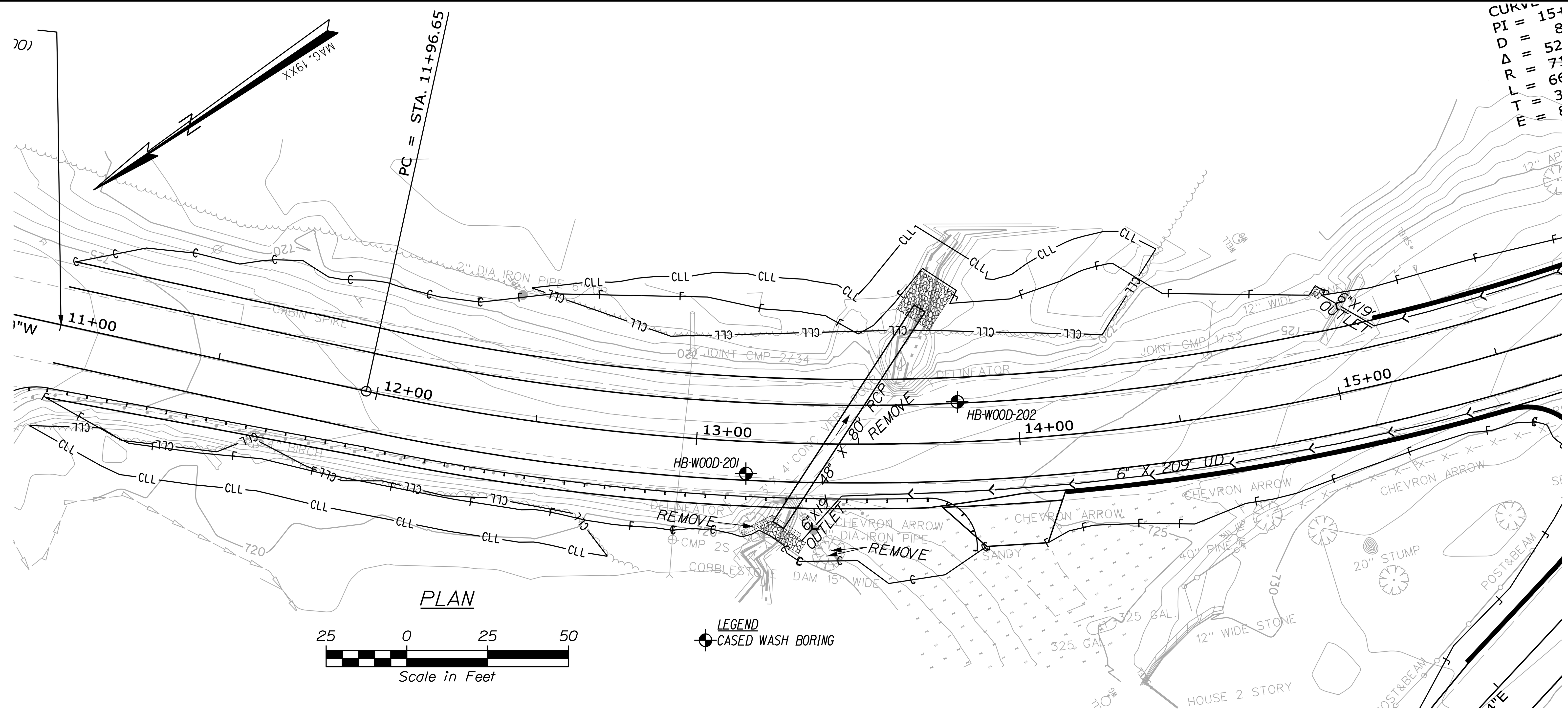
ROUTE 26 HIGHWAY REHABILITATION
MAINEDOT WIN 018767.00
WOODSTOCK, MAINE

BORING LOCATION PLAN AND INTERPRETIVE SUBSURFACE CROSS SECTION - STA 13+42

SCALE: AS SHOWN
DECEMBER 2019

FIGURE 2

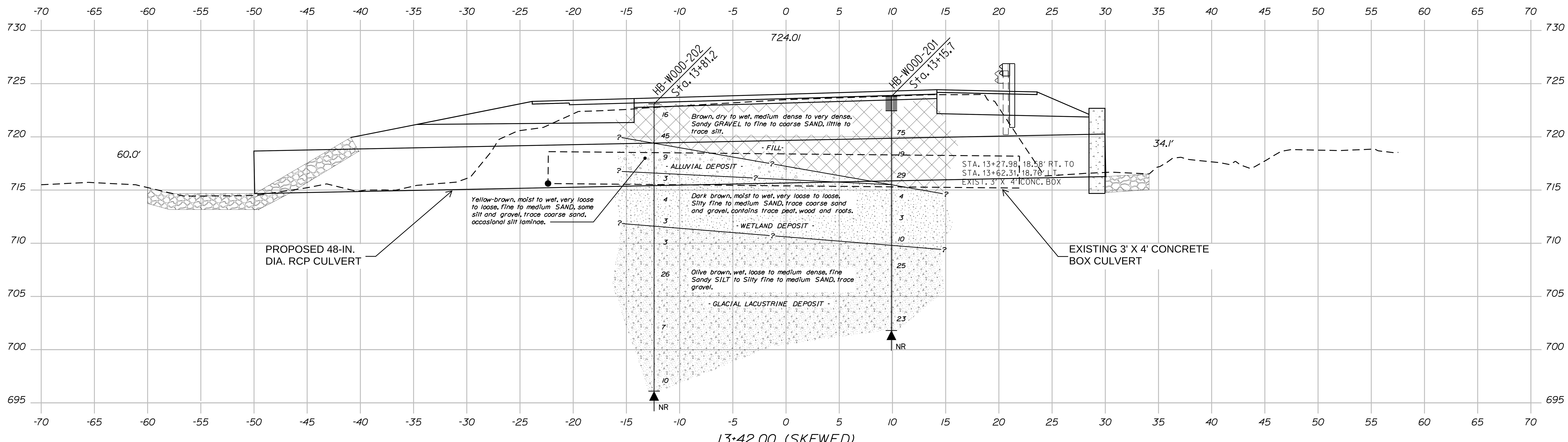
G:\PROJECTS\130458 - Woodstock\Deliverables\Culvert Report\Figures\Figures 2 through 4.p
kruss



PLAN

25 0 25 50
Scale in Feet

LEGEND
CASED WASH BORING



LEGEND

Boring No. Offset

- Pavement Thickness, if applicable
- 10 Energy Corrected Standard Penetration Test (SPT) N60-Value (Blows Per Foot)
- V1=855 psf Denotes in-situ Vane Shear Test Performed at depth shown with Peak Undrained Shear Strength Provided
- Weathered Bedrock, if applicable
- Approximate Top of Bedrock
- ROD= Rock Quality Designation of Bedrock Core Sample
- BOE= Bottom of Exploration
- NR No Refusal
- R Refusal
- WOH = Weight of Hammer
- WOR= Weight of Rods

CROSS SECTION

HORIZ 25 0 25 50
VERT 5 0 5 10
SCALE

Note: This generalized interpretive soil cross section 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.

Filename: ...\msta\001_BLP&ISCS 13+42 1.dgn Division: GEOTECH Username: Terry.White Date:4/13/2018

DEPARTMENT

PROJ. MANAGER	BY	DATE
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	B.STEINERT	
DESIGN3-DETAILED3	T.WHITE	OCT 2017
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE
P.E. NUMBER
DATE

WOODSTOCK
ROUTE 26

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE CROSS SECTION

SHEET NUMBER
1
OF _

HALEY ALDRICH

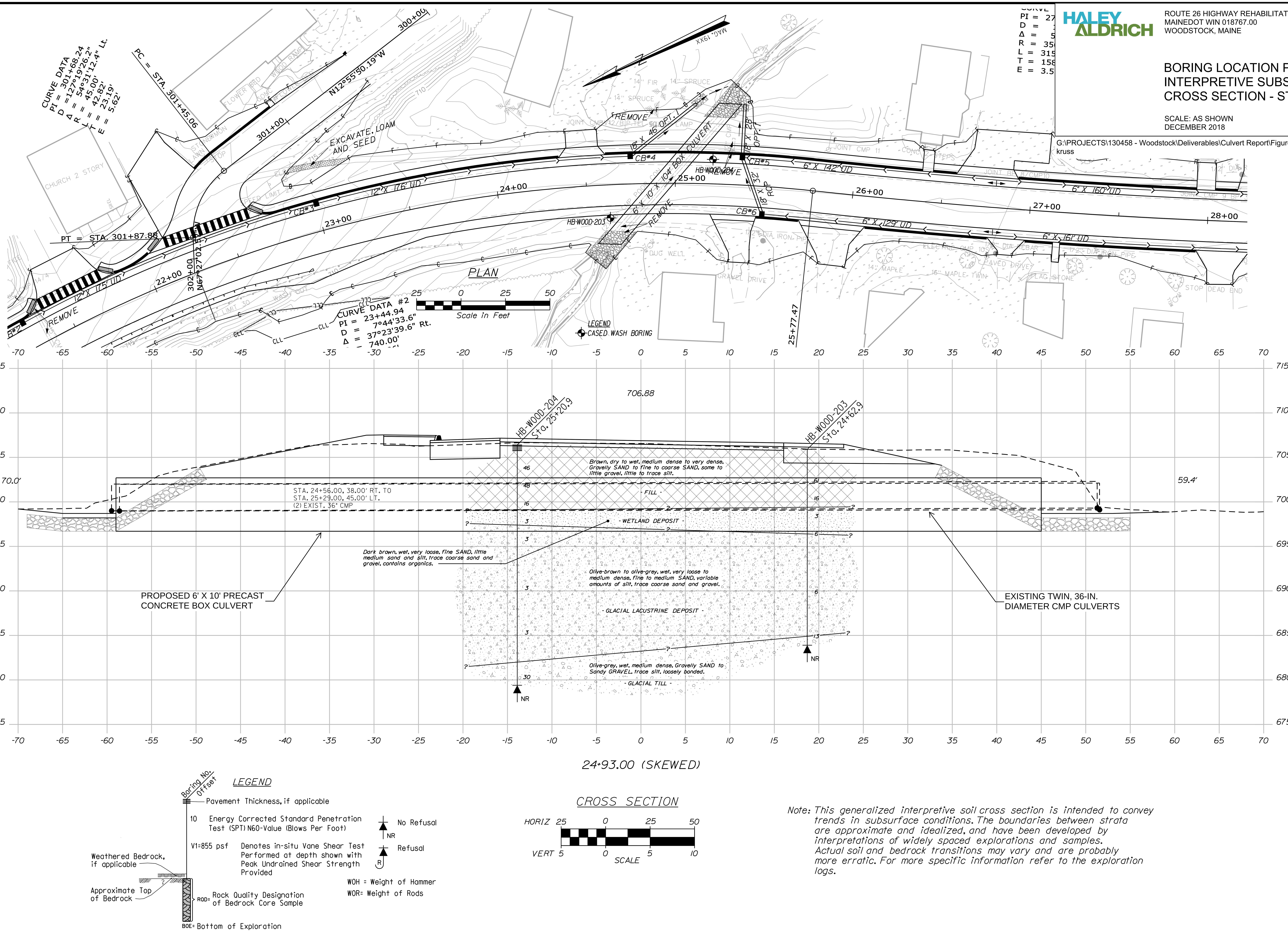
ROUTE 26 HIGHWAY REHABILITATION
MAINEDOT WIN 018767.00
WOODSTOCK, MAINE

BORING LOCATION PLAN AND INTERPRETIVE SUBSURFACE CROSS SECTION - STA 24+93

SCALE: AS SHOWN
DECEMBER 2018

FIGURE 3

G:\PROJECTS\130458 - Woodstock\Deliverables\Culvert Report\Figures\Figures 2 through 4.p
kruss



Note: This generalized interpretive soil cross section 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.

WOODSTOCK
ROUTE 26

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE CROSS SECTION

SHEET NUMBER 2 OF _

Filename: ...\msta\001_BLP&ISCS 24+93 2.dgn Division: GEOTECH Username: Terry.White Date:4/13/2018

HALEY ALDRICH

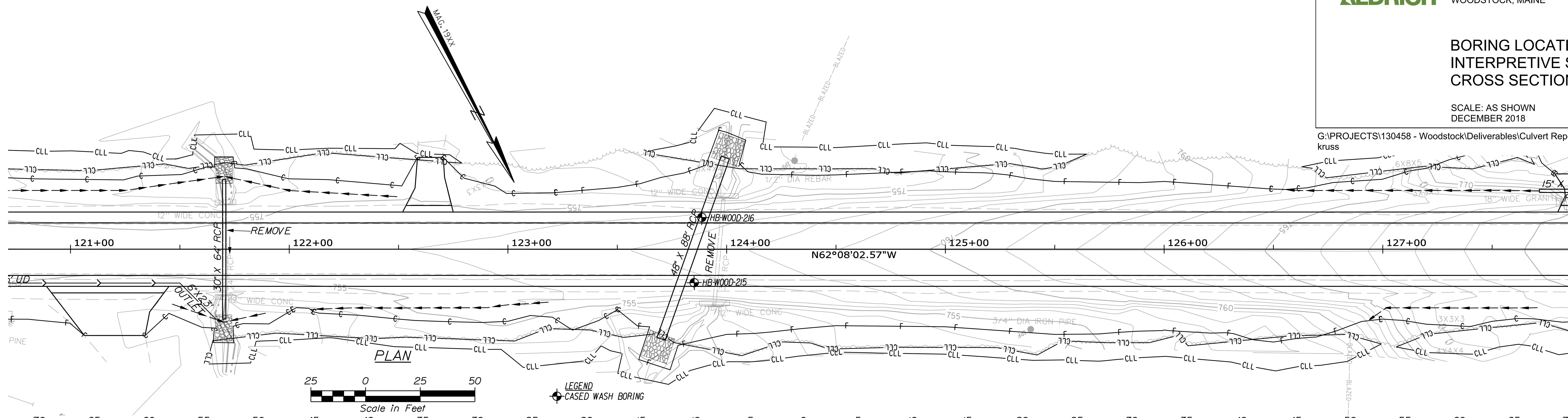
ROUTE 26 HIGHWAY REHABILITATION
MAINEDOT WIN 018767.00
WOODSTOCK, MAINE

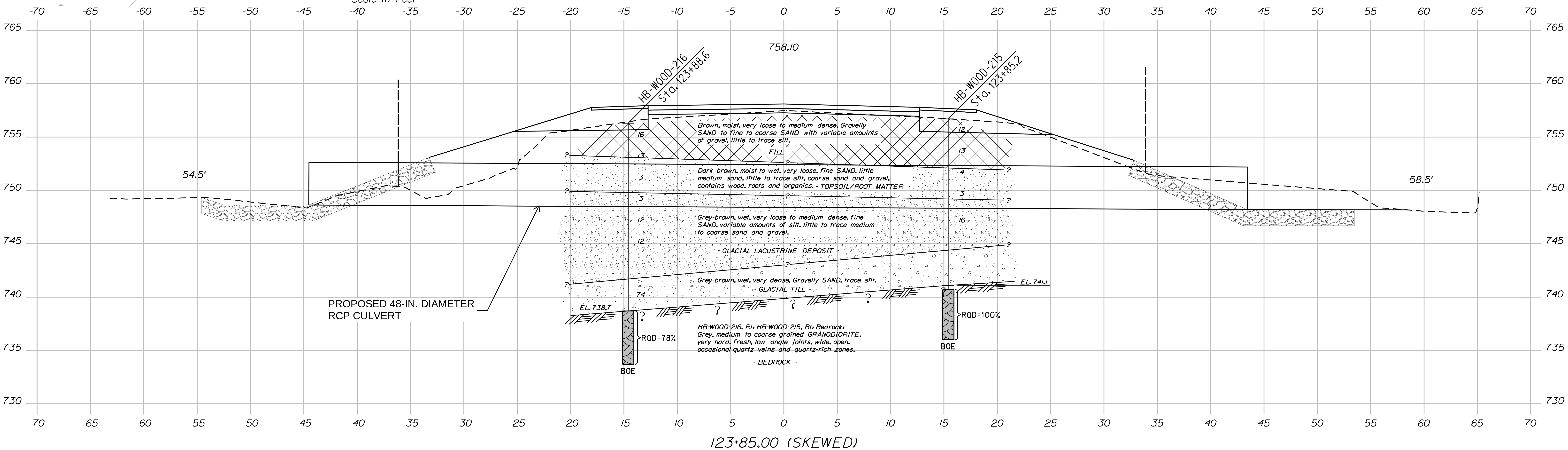
BORING LOCATION PLAN AND INTERPRETIVE SUBSURFACE CROSS SECTION - STA 123+85

SCALE: AS SHOWN
DECEMBER 2018

FIGURE 4

G:\PROJECTS\130458 - Woodstock\Deliverables\Culvert Report\Figures\Figures 2 through 4.p
kruss





LEGEND

Boring No. / Offset

Pavement Thickness, if applicable

10 — Energy Corrected Standard Penetration Test (SPT) N60-Value (Blows Per Foot)

V1=855 psf — Denotes in-situ Vane Shear Test Performed at depth shown with Peak Undrained Shear Strength Provided

Weathered Bedrock, if applicable

Approximate Top of Bedrock

RQD= Rock Quality Designation of Bedrock Core Sample

BOE= Bottom of Exploration

NR — No Refusal

R — Refusal

WOH = Weight of Hammer

WOR= Weight of Rods

CROSS SECTION

HORIZ 25 0 25 50

VERT 5 0 5 10

SCALE

Note: This generalized interpretive soil cross section 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.

Date:4/13/2018 Username: Terry.White Division: GEOTECH Filename: ...\MSTA\001_BLP&ISCS 123+85 3.dgn

PROJ. MANAGER			
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN2-DETAILED2	B.STEINERT	T.WHITE	OCT 2017
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

BY / DATE / SIGNATURE / P.E. NUMBER / DATE

DEPARTMENT

WOODSTOCK
ROUTE 26

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE CROSS SECTION

SHEET NUMBER

3

OF _

APPENDIX A

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

Desired Soil Observations (in this order, 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):

$$\text{RQD (\%)} = \frac{\text{sum of the lengths of intact pieces of core* > 4 inches}}{\text{length of core advance}}$$

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

Correlation of RQD to Rock Mass Quality

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

Desired Rock Observations (in this order, 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	Blow Counts
Bridge Name / Town	Sample Recovery
Boring Number	Date
Sample Number	Personnel Initials
Sample Depth	

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Route 26 Highway Rehabilitation	**Boring No.:**	HB-WOOD-201		
Location:	Woodstock, Maine	**WIN:**	18767.00		
Driller:	New England Boring Contractors	**Elevation (ft.)**	723.8	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-22-17/8-22-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	--
Boring Location:	STA 13+15.7, 9.9 ft RT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	6.6 ft
Hammer Efficiency Factor:	0.869	**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

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows
0							SSA
	1D	8/8	1.5 - 2.2	10/50(3.0)			
	2D	24/13	2.5 - 4.5	8/19/33/12	52	75	
	3D	24/11	4.5 - 6.5	14/5/8/13	13	19	
5							
	4D	24/7	6.5 - 8.5	4/6/14/5	20	29	25
							31
	5D	24/10	8.5 - 10.5	7/2/1/2	3	4	8
							1
10	6D	24/10	10.5 - 12.5	1/1/1/1	2	3	2
							6
	7D	24/16	12.5 - 14.5	2/2/5/8	7	10	9
							24
							35
15	8D	24/11	15.0 - 17.0	6/7/10/8	17	25	15
							32
							50
							47
							45
20	9D	24/17	20.0 - 22.0	6/7/9/10	16	23	
25							

Elevation (ft.)	Depth (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	0	-BITUMINOUS CONCRETE-	
722.5	1.4	Brown, dry, very dense, Gravelly SAND, trace silt, well graded -FILL-(SW) PID=0.0 ppm	
721.6	2.2	Cobbles and coarse gravel -FILL-	G#300176 A-1-a, SP-SM WC=4.4%
721.3	2.5	Brown, dry, very dense, Gravelly fine to coarse SAND, little silt, poorly-graded -FILL-(SP-SM) PID=0.0 ppm	G#300177 A-1-b, SM WC=13.5%
		Brown, wet, medium dense, fine to coarse SAND, some gravel, little silt, contains asphalt pieces, slight asphalt-like odor -FILL-(SM) PID=0.0 ppm	
		Note: Water encountered at 5.5 ft.	
		Brown, wet, medium dense, fine to coarse SAND, little silt, trace fine and coarse gravel, well graded -FILL-(SW-SM) PID=0.0 ppm	
715.5	8.3	Dark brown, wet, loose, fine to coarse SAND, some silt, trace gravel, strong organic odor, contains wood pieces -WETLAND DEPOSIT-(SM) PID=0.0 ppm	G#300178 A-2-4, SM WC=66.8% Ignition Loss 8.8%
		Dark brown, wet, very loose, Silty fine SAND, little coarse gravel, trace medium to coarse sand and fine gravel, strong organic odor, contains wood and roots -WETLAND DEPOSIT-(SM) PID=0.0 ppm	G#300179 A-4, SM WC=36.2% Ignition Loss 3.0%
		Dark brown, wet, loose, fine SAND, some silt, little medium sand, trace coarse sand and fine gravel, organic odor, contains wood -WETLAND DEPOSIT-(SM) PID=0.0 ppm	G#300180 A-2-4, SM WC=30.6% Ignition Loss 1.8%
709.8	14.0	Olive-brown, wet, medium dense, fine SAND, little silt, little medium sand, trace coarse sand and fine gravel, contains wood pieces -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	
		Olive-brown, wet, medium dense, fine SAND, little medium sand and silt, trace coarse sand and fine gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	G#300181 A-2-4, SM WC=21.3% Ignition Loss 0.4%
		Olive-grey, wet, medium dense, fine SAND, some silt, trace medium to coarse sand, trace gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	G#300182 A-2-4, SM WC=19.3%
701.8	22.0	**Bottom of Exploration at 22.0 feet below ground surface.**	

Remarks:

PID = photoionization detector

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: Route 26 Highway Rehabilitation
Location: Woodstock, Maine

Boring No.: HB-WOOD-202
WIN: 18767.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	723.1	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; HW-300#/18
Date Start/Finish:	8-21-17/8-21-17	**Drilling Method:**	SSA/HW Drive	**Core Barrel:**	NQ-2.0 in.
Boring Location:	STA 13+81.2, 12.4 ft LT	**Casing ID/OD:**	HW-4.0 in. ID	**Water Level*:**	13.0 ft
Hammer Efficiency Factor:	0.869	**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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)
0	1D	24/13	0.0 - 2.0	5/5/6/9	11	16	SSA	
	2D	24/11	2.0 - 4.0	8/18/13/6	31	45		
								719.4
	3D	24/4	4.0 - 6.0	5/3/3/4	6	9		
5								
	4D/A	24/13	6.0 - 8.0	6/1/1/2	2	3	25 22	716.6
							15	
	MD	24/0	8.0 - 10.0	2/1/2/2	3	4	10	
							13	
10	5D	24/17	10.0 - 12.0	13/1/1/3	2	3	17	
							29	711.6
	6D	24/4	12.0 - 14.0	2/1/1/2	2	3	25	
							32	
							61	708.9
15	7D	24/14	15.0 - 17.0	16/9/9/12	18	26	71	
							63	
							62	
							64	
							55	
20	8D	24/14	20.0 - 22.0	5/3/2/3	5	7	47	
							35	
							51	
							58	
25							50	

Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
Brown, dry, medium dense, Gravelly fine to medium SAND, trace coarse sand and silt, well graded -FILL-(SW-SM) PID=0.0 ppm	G#300183 A-1-b, SW-SM WC=4.3%
Brown, dry, dense, Sandy GRAVEL, trace silt, well graded -FILL-(GW-GM) PID=0.0 ppm Note: Occasional cobbles in fill based on drill action.	G#300184 A-1-a, GW-GM WC=2.8%
3.7	
Yellow-brown, wet, loose, fine to medium SAND, some silt and gravel, trace coarse sand, occasional silt laminae 1/8-in. thick, oxidation staining observed -ALLUVIAL DEPOSIT-(SM) PID=0.0 ppm Samples 3D and 4D combined.	
4D (6.0-6.5 ft bgs) Yellow-brown to olive-brown, moist, very loose, fine to medium SAND, some silt and gravel, trace coarse sand, oxidized staining observed -ALLUVIAL DEPOSIT-(SM) PID=0.0 ppm Samples 3D and 4D combined.	G#300186 A-2-4, SM WC=37.9% Ignition Loss 9.4%
6.5	
4D/A (6.5-8.0 ft bgs) Dark brown, moist, very loose, fine to medium SAND, some silt, little gravel, trace coarse sand, contains roots, wood, peat, strong organic odor -WETLAND DEPOSIT-(SM) Note: Drill wash water contains black and dark brown silt, wood and coarse sand, strong organic odor from 8 to 10 ft.	G#300187 A-4, SM WC=33.9% Ignition Loss 3.8%
Brown to olive-brown, wet, very loose, Silty fine SAND, trace medium to coarse sand and gravel, trace peat, contains roots -WETLAND DEPOSIT-(SM) PID=0.0 ppm	
11.5	
Brown to olive-brown, very loose, Silty fine SAND, trace medium and coarse sand and gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm Note: Drill action indicates strata change at 14.2 ft.	G#300188 A-2-4, SM WC=20.3%
14.2	
Olive-grey, wet, medium dense, Silty fine to medium SAND, some silt, trace coarse sand and gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	
Olive-grey, wet, loose, fine Sandy SILT trace medium and coarse sand and fine gravel -GLACIAL LACUSTRINE DEPOSIT-(CL)	G#300189 A-4, CL WC=19.6%

Remarks:

PID = photoionization detector

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 26 Highway Rehabilitation
Location: Woodstock, Maine

Boring No.: HB-WOOD-202
WIN: 18767.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	723.1	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; HW-300#/18
Date Start/Finish:	8-21-17/8-21-17	**Drilling Method:**	SSA/HW Drive	**Core Barrel:**	NQ-2.0 in.
Boring Location:	STA 13+81.2, 12.4 ft LT	**Casing ID/OD:**	HW-4.0 in. ID	**Water Level*:**	13.0 ft
Hammer Efficiency Factor:	0.869	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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 140 lb. 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 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	MD	24/0	25.0 - 27.0	4/4/3/5	7	10				No recovery, drill wash water contents contains fine sand	
								696.1		27.0	
										Bottom of Exploration at 27.0 feet below ground surface.	
30											
35											
40											
45											
50											

Remarks:

PID = photoionization detector

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: Route 26 Highway Rehabilitation		**Boring No.:**	HB-WOOD-203
Location: Woodstock, Maine		**WIN:**	18767.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	705.9	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-22-17/8-22-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	--
Boring Location:	STA 24+62.9, 18.7 ft RT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.8 ft
Hammer Efficiency Factor:	0.869	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)
0	1D	18/9	0.0 - 1.5	2/7/50			SSA	
								704.4
	2D	24/9	2.5 - 4.5	9/28/14/8	42	61		703.6
	3D	24/10	4.5 - 6.5	5/1/10/23	11	16		
5								
	4D	24/9	6.5 - 8.5	2/1/1/1	2	3	3	699.4
							4	
	5D/A	24/16	8.5 - 10.5	1/1/3/8	4	6	5	
							5	696.4
10							15	
							25	
							27	
							25	
							22	
15	6D	24/12	15.0 - 17.0	2/2/2/3	4	6	20	
							25	
							23	
							24	
							20	
20	7D	24/11	20.0 - 22.0	WOH/2/7/15	9	13		684.9
								683.9
25								

Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
Brown, dry, very dense, fine to coarse SAND, some gravel, well graded -FILL-(SW) PID=0.0 ppm	
1.5	
Cobbles and coarse gravel -FILL-	
2.3	
Brown, dry, very dense, Gravelly fine to medium SAND, trace silt and coarse sand, well graded -FILL-(SW-SM) PID=0.0 ppm	G#300190 A-1-b, SW-SM WC=4.3%
Brown, wet, medium dense, fine to medium SAND, some gravel, trace silt and coarse sand, well graded -FILL-(SW-SM) PID=0.0 ppm Note: Water encountered at 5.5 ft.	G#300191 A-1-b, SW-SM WC=13.1%
6.5	
Dark brown, wet, very loose, fine SAND, little medium sand, trace silt, coarse sand and gravel, contains trace peat, roots, strong organic odor, poorly-graded -WETLAND DEPOSIT-(SP-SM)	G#300192 A-3, SP-SM WC=59.3% Ignition Loss 8.1%
5D (8.5-9.5 ft bgs) Dark brown, wet, loose, fine SAND, little silt, trace medium and coarse sand and gravel, contains organics, strong organic odor -WETLAND DEPOSIT-(SM) PID=0.0 ppm	G#300193 A-2-4, SM WC=56.2% Ignition Loss 6.4%
9.5	
5D/A (9.5-10.5 ft bgs) Olive-brown to olive-grey, wet, loose, fine to medium SAND, trace silt, coarse sand and gravel, trace organics, slight organic odor, poorly-graded -GLACIAL LACUSTRINE DEPOSIT-(SP-SM)	G#300194 A-3, SP-SM WC=25.5% Ignition Loss 1.5%
Olive-grey, wet, loose, fine to medium SAND, little silt, trace coarse sand and gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	G#300195 A-2-4, SM WC=21.6%
Olive-grey, wet, very loose, fine SAND, trace silt and medium sand, single 1/8-in. thick silt laminae -GLACIAL LACUSTRINE DEPOSIT-(SP) PID=0.0 ppm	
21.0	
Olive-grey, wet, medium dense, Sandy GRAVEL, trace silt, well graded, loosely bonded -GLACIAL TILL-(GW) PID=0.0 ppm	
22.0	
Bottom of Exploration at 22.0 feet below ground surface.	

Remarks:

PID = photoionization detector

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Route 26 Highway Rehabilitation			**Boring No.:**	HB-WOOD-204
Location:	Woodstock, Maine			**WIN:**	18767.00
Driller:	New England Boring Contractors	**Elevation (ft.)**	706.4	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-22-17/8-22-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	--
Boring Location:	STA 25+20.9, 13.9 ft LT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	5.3 ft
Hammer Efficiency Factor:	0.869	**Hammer Type:**	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

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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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	705.8		-BITUMINOUS CONCRETE- 0.7	
	1D	24/14	1.5 - 3.5	13/15/17/21	32	46				Brown, dry, dense, fine to medium SAND, some gravel, little silt and coarse sand -FILL-(SM) PID=0.0 ppm	G#300196 A-1-b, SM WC=4.5%
	2D	24/18	3.5 - 5.5	18/13/20/10	33	48				Brown to red-brown, dry, dense, fine to coarse SAND, some gravel, trace silt -FILL-(SM) PID=0.0 ppm	G#300197 A-1-b, SM WC=6.6%
5											
	3D	24/7	5.5 - 7.5	7/6/5/5	11	16				Brown, dry, medium dense, fine to coarse SAND, little gravel, well graded -FILL-(SW) PID=0.0 ppm	
										7.3	
	4D/A	24/24	7.5 - 9.5	1/1/1/2	2	3	3	699.1		4D (7.5-9.0 ft bgs) Dark brown, moist, very loose, fine to medium SAND, trace silt, trace coarse sand and gravel, strong organic odor, contains rootmat, poorly-graded -WETLAND DEPOSIT-(SP-SM) PID=0.0 ppm	G#300198 A-2-4, SP-SM WC=166.4% Ignition Loss 54.5%
							7	697.4			
	5D	24/12	9.5 - 11.5	2/1/1/1	2	3	5			9.0	
10							8			4D/A (9.0-9.5 ft bgs) Grey-brown, wet, very loose, fine SAND, little silt and medium sand, trace coarse sand and gravel -INTERBEDDED WETLAND/GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm Samples 4D/A and 5D combined.	G#300199A-2-4, SMWC= 42.0%Ignition Loss 6.3%
							19	694.7		Grey-brown, wet, very loose, fine SAND, little silt and medium sand, trace coarse sand and gravel -INTERBEDDED WETLAND/GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm Samples 4D/A and 5D combined.	
							29				
							30				
							24	691.9		Note: Drill action indicates increase in resistance at 11.7 ft. 11.7	
15	6D	24/7	15.0 - 17.0	1/1/1/2	2	3	5			Note: Drill action indicates decrease in resistance at 14.5 ft. Wash water contains fine sand, trace silt. 14.5	G#300200 A-3, SP-SM WC=25.1%
							7				
							13			Olive-grey, wet, very loose, fine SAND, little medium sand, trace silt, coarse sand and gravel, poorly-graded -GLACIAL LACUSTRINE DEPOSIT-(SP-SM) PID=0.0 ppm	
							13				
							15				
20	7D	24/11	20.0 - 22.0	1/1/1/1	2	3	22			Olive-grey, wet, very loose, fine SAND, some silt, trace medium sand -GLACIAL LACUSTRINE DEPOSIT-(SM)	G#300101 A-2-4, SM WC=23.7%
							19				
							23				
							16				
25							38	682.0		24.4	

Remarks:

PID = photoionization detector

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 26 Highway Rehabilitation
Location: Woodstock, Maine

Boring No.: HB-WOOD-204
WIN: 18767.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	706.4	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-22-17/8-22-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	--
Boring Location:	STA 25+20.9, 13.9 ft LT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	5.3 ft
Hammer Efficiency Factor: 0.869		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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 140 lb. 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 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	8D	24/6	25.0 - 27.0	7/10/11/9	21	30				Olive-grey, wet, medium dense, Gravelly SAND, well graded, loosely bonded -GLACIAL TILL-(SW)	
								679.4		27.0 **Bottom of Exploration at 27.0 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

PID = photoionization detector

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Route 26 Highway Rehabilitation	**Boring No.:**	HB-WOOD-215		
Location:	Woodstock, Maine	**WIN:**	18767.00		
Driller:	New England Boring Contractors	**Elevation (ft.)**	756.7	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-23-17/8-23-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	NQ 2.0 in.
Boring Location:	STA 123+85.2, 15.4 ft RT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	6.1 ft
Hammer Efficiency Factor:	0.869	**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
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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/12	0.0 - 2.0	2/4/4/5	8	12	SSA			Brown, moist, medium dense, fine to coarse SAND, some gravel, little silt -FILL-(SM) PID=0.0 ppm	G#300121 A-1-b, SM WC=7.8%
	2D	24/3	2.0 - 4.0	4/4/5/5	9	13				Brown, moist, medium dense, gravelly SAND, well graded -FILL-(SW) PID=0.0 ppm	
	3D/A	24/21	4.0 - 6.0	4/2/1/3	3	4		752.1		3D (4.0-4.6 ft bgs) Brown to light brown, moist, very loose, fine SAND, little medium sand, trace silt and gravel, poorly-graded -FILL-(SP) PID=0.0 ppm	G#300122 A-2-4, SM WC=45.1%
5										4.6	Ignition Loss 23.3%
	MD	24/0	6.0 - 8.0	1/1/1/5	2	3	1			3D/A (4.6-6.0 ft bgs) Dark brown, moist, very loose, fine SAND, little medium sand and silt, trace coarse sand and gravel, slight organic odor, contains roots and wood -TOPSOIL/ROOTMAT-(SM) PID=0.0 ppm	
							8	749.2		7.5	
	4D	24/14	8.5 - 10.5	4/5/6/7	11	16	13			Grey-brown, wet, medium dense, fine SAND, some silt, trace medium sand and gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	G#300123 A-2-4, SM WC=24.2%
							15				
10							31				
							45			Note: Drill wash water contains fine to coarse sand at 12.3 ft.	
							120	744.4		12.3	
							120				
							133				
15	5D	7/7	15.0 - 15.6	23/50(1.0)			81	741.1		Brown-grey, wet, very dense, Gravelly SAND, trace silt, well graded -GLACIAL TILL-(SW) PID=0.0 ppm 15.6	
	R1	56/56	16.0 - 20.7	RQD = 100%			NQ Core			Top of Bedrock at El.741.1 R1: Grey, medium to coarse grained, metamorphosed GRANODIORITE. Very hard, fresh. Single joint at 19.2 ft dipping at low angle, parallel to foliation, wide, open, slightly discolored joint surface, planar, rough, occasional quartz veins and quartz-rich zones, migmatitic texture Rock Quality=Excellent Recovery=100% -SONGO GRANODIORITE FORMATION- R1 Core Times (min:sec): 16.0-17.0' (2:07); 17.0-18.0' (1:45); 18.0-19.0' (1:18); 19.0-20.0' (1:23); 20.0-20.7' (1:25)	
20								736.0		20.7 **Bottom of Exploration at 20.7 feet below ground surface.**	
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Route 26 Highway Rehabilitation

Location: Woodstock, Maine

Boring No.: HB-WOOD-216

WIN: 18767.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	756.3	**Auger ID/OD:**	--
Operator:	M. Porter	**Datum:**	NAVD 88	**Sampler:**	Split Spoon 1.375 in. ID
Logged By:	K. Russ	**Rig Type:**	Mobile B-59 Truck	**Hammer Wt./Fall:**	SS-140#/30; NW-300#/18
Date Start/Finish:	8-23-17/8-23-17	**Drilling Method:**	SSA/NW Drive	**Core Barrel:**	NQ 2.0 in.
Boring Location:	STA 123+88.6, 14.6 ft LT	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	5.4 ft
Hammer Efficiency Factor: 0.869		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/14	0.0 - 2.0	2/4/7/10	11	16	SSA			Brown, moist, medium dense, fine to coarse SAND, little silt and gravel -FILL-(SM) PID=0.0 ppm	G#300124 A-1-b, SM WC=7.5%
	2D	24/4	2.0 - 4.0	8/6/3/2	9	13				Brown, moist, medium dense, Gravelly SAND, well graded -FILL-(SW) PID=0.0 ppm	
								753.1		3.2	
	3D	24/24	4.0 - 6.0	1/1/1/1	2	3				Dark brown, wet, very loose, fine SAND, little medium sand, trace silt, coarse sand and gravel, poorly-graded, contains wood and organics -TOPSOIL/ROOTMAT-(SP-SM) PID=0.0 ppm 4D (6.0-6.5 ft bgs)	G#300125 A-2-4, SP-SM WC=34.7%
5											
	4D/A	24/12	6.0 - 8.0	WOH/1/1/1	2	3	WOH	749.8		6.5 4D/A (6.5-8.0 ft bgs) Grey-brown, wet, very loose, fine SAND, little medium sand, trace silt and gravel, poorly-graded -GLACIAL LACUSTRINE DEPOSIT-(SP-SM) PID=0.0 ppm	G#302626 A-3, SP-SM WC=28.1%
							2				G#302627 A-2-4, SM WC=21.9%
	5D	24/19	8.0 - 10.0	1/3/5/6	8	12	4			Grey-brown, wet, medium dense, fine SAND, little silt, trace medium to coarse sand and gravel -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	
							6				
10	6D	24/11	10.0 - 12.0	2/2/6/7	8	12	10			Grey-brown, wet, medium dense, fine SAND, some silt, trace medium to coarse sand -GLACIAL LACUSTRINE DEPOSIT-(SM) PID=0.0 ppm	G#302628 A-2-4, SM WC=23.7%
							24				
							25				
							29				
							75	741.7		Note: Drill wash water contains fine to coarse sand at 14.6 ft. 14.6	
15	7D	24/15	15.0 - 17.0	25/31/20/17	51	74	32			Grey-brown, wet, very dense, Gravelly SAND, trace silt, well graded -GLACIAL TILL-(SW) PID=0.0 ppm	
							30				
	R1	60/47	17.6 - 22.6	RQD = 78%			35(7.0) NQ Core	738.7		17.6 Top of Bedrock at El.738.7 R1: Grey, medium to coarse grained, GRANODIORITE. Very hard, fresh. Single joint at 20.2 ft dipping at low angle, wide, open, slightly weathered band of biotite, planar, rough, occasional quartz/pegmatitic intrusions Rock Quality=Good Recovery=78% -SONGO GRANODIORITE FORMATION- R1 Core Times (min:sec): 17.6-18.6' (1:29); 18.6-19.6' (1:34); 19.6-20.6' (1:17); 20.6-21.6' (1:13); 21.6-22.6' (1:26)	
20											
								733.7		22.6 **Bottom of Exploration at 22.6 feet below ground surface.**	
25											

Remarks:

PID = photoionization detector

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.

Top Row: *HB-WOOD-215, Run No. R1, 16.0 ft (left) to 20.7 ft (right)****; Top Middle Row:*** *HB-WOOD-216, Run No. R1, 17.6 ft. (left) to 22.6 ft (right)*

APPENDIX B

Laboratory Test Results

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Woodstock Work Number: 18767.00

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	Classification AASHTO	Classification Frost
HB-WOOD-201, 2D	13+15.7	9.9 Rt.	2.5-4.5	300176	1	4.4			SP-SM	A-1-a	0
HB-WOOD-201, 3D	13+15.7	9.9 Rt.	4.5-6.5	300177	1	13.5			SM	A-1-b	II
HB-WOOD-201, 5D	13+15.7	9.9 Rt.	8.5-10.5	300178	1	66.8			SM	A-2-4	II
HB-WOOD-201, 6D	13+15.7	9.9 Rt.	10.5-12.5	300179	1	36.2			SM	A-4	III
HB-WOOD-201, 7D	13+15.7	9.9 Rt.	12.5-14.5	300180	2	30.6			SM	A-2-4	II
HB-WOOD-201, 8D	13+15.7	9.9 Rt.	15.0-17.0	300181	2	21.3			SM	A-2-4	II
HB-WOOD-201, 9D	13+15.7	9.9 Rt.	20.0-22.0	300182	2	19.3			SM	A-2-4	II
HB-WOOD-202, 1D	13+81.2	12.4 Lt.	0.0-2.0	300183	3	4.3			SW-SM	A-1-b	0
HB-WOOD-202, 2D	13+81.2	12.4 Lt.	2.0-4.0	300184	3	2.8			GW-GM	A-1-a	0
HB-WOOD-202, 3D/4D	13+81.2	12.4 Lt.	4.0-6.5	300185	3	12.3			SM	A-2-4	II
HB-WOOD-202, 4D/A	13+81.2	12.4 Lt.	6.5-8.0	300186	3	37.9			SM	A-2-4	II
HB-WOOD-202, 5D	13+81.2	12.4 Lt.	10.0-12.0	300187	4	33.9			SM	A-4	III
HB-WOOD-202, 7D	13+81.2	12.4 Lt.	15.0-17.0	300188	4	20.3			SM	A-2-4	II
HB-WOOD-202, 8D	13+81.2	12.4 Lt.	20.0-22.0	300189	4	19.6			CL	A-4	IV
HB-WOOD-203, 2D	24+62.9	18.7 Rt.	2.5-4.5	300190	5	4.3			SW-SM	A-1-b	0
HB-WOOD-203, 3D	24+62.9	18.7 Rt.	4.5-6.5	300191	5	13.1			SW-SM	A-1-b	0
HB-WOOD-203, 4D	24+62.9	18.7 Rt.	6.5-8.5	300192	5	59.3			SP-SM	A-3	0
HB-WOOD-203, 5D	24+62.9	18.7 Rt.	8.5-9.5	300193	5	56.2			SM	A-2-4	II
HB-WOOD-203, 5D/A	24+62.9	18.7 Rt.	9.5-10.5	300194	5	25.5			SP-SM	A-3	0
HB-WOOD-203, 6D	24+62.9	18.7 Rt.	15.0-17.0	300195	5	21.6			SM	A-2-4	II
HB-WOOD-204, 1D	25+20.9	13.9 Lt.	1.5-3.5	300196	6	4.5			SM	A-1-b	II
HB-WOOD-204, 2D	25+20.9	13.9 Lt.	3.5-5.5	300197	6	6.6			SM	A-1-b	II
HB-WOOD-204, 4D	25+20.9	13.9 Lt.	7.5-9.0	300198	6	166			SP-SM	A-2-4	0
HB-WOOD-204, 4D/A-5D	25+20.9	13.9 Lt.	9.0-11.5	300199	6	42.0			SM	A-2-4	II
HB-WOOD-204, 6D	25+20.9	13.9 Lt.	15.0-17.0	300200	6	25.1			SP-SM	A-3	0
HB-WOOD-204, 7D	25+20.9	13.9 Lt.	20.0-22.0	300101	6	23.7			SM	A-2-4	II
HB-WOOD-205, 1D	53+07.2	2.5 Rt.	1.0-3.0	300102	7	4.8			SM	A-1-b	II
HB-WOOD-205, 2D	53+07.2	2.5 Rt.	3.0-5.0	300103	7	9.6			SM	A-4	III
HB-WOOD-205, 3D	53+07.2	2.5 Rt.	5.0-7.0	300104	7	8.0			SM	A-2-4	II
HB-WOOD-205, 4D	53+07.2	2.5 Rt.	7.0-9.0	300105	7	6.9			SM	A-2-4	II
HB-WOOD-207, 1D	54+93.5	16.2 Lt.	1.0-3.0	300106	8	3.3			SM	A-1-b	II
HB-WOOD-207, 2D	54+93.5	16.2 Lt.	3.0-4.0	300107	8	3.8			SM	A-1-b	II
HB-WOOD-207, 2D/A-3D	54+93.5	16.2 Lt.	4.0-7.0	300109	8	11.4			SM	A-2-4	II
HB-WOOD-207, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			SM	A-2-4	II
HB-WOOD-209, 1D	56+87.6	1.9 Lt.	[illegible]	[illegible]	9	1.6			SM	A-1-b	II
HB-WOOD-209, 2D	56+87.6	1.9 Lt.	3.0-5.0	300112	9	12.0			SM	A-2-4	II
HB-WOOD-209, 3D	56+87.6	1.9 Lt.	5.5-7.5	300113	9	3.9			SM	A-1-b	II
HB-WOOD-209, 4D	56+87.6	1.9 Lt.	7.5-9.5	300114	9	10.1			SM	A-2-4	II
HB-WOOD-211, 1D	58+81	15.8 Lt.	1.2-3.2	300115	10	6.6			SM	A-1-b	II
HB-WOOD-211, 2D	58+81	15.8 Lt.	3.5-4.8	300116	10	2.7			SM	A-1-b	II
HB-WOOD-211, 3D	58+81	15.8 Lt.	7.5-9.5	300117	10	7.5			SM	A-2-4	II

SEE CULVERT REPORT FOR REMAINING LABORATORY ANALYSIS RESULTS

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

Laboratory Testing Summary Sheet

Town(s): Woodstock   Work Number: 18767.00

SEE CULVERT REPORT FOR REMAINING LABORATORY ANALYSIS RESULTS

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
HB-WOOD-213, 1D	60+77.4	3.0 Lt.	1.0-3.0	300118	10	2.3			SW-SM	A-1-a	0
HB-WOOD-213, 2D	60+77.4	3.0 Lt.	3.0-5.0	300119	10	3.1			SM	A-1-b	II
HB-WOOD-213, 3D	60+77.4	3.0 Lt.	5.0-7.0	300120	10	5.2			SM	A-1-b	II
HB-WOOD-215, 1D	123+85.2	15.4 Rt.	0.0-2.0	300121	11	7.8			SM	A-1-b	II
HB-WOOD-215, 3D/A	123+85.2	15.4 Rt.	4.6-6.0	300122	11	45.1			SM	A-2-4	II
HB-WOOD-215, 4D	123+85.2	15.4 Rt.	8.5-10.5	300123	11	24.2			SM	A-2-4	II
HB-WOOD-216, 1D	123+88.6	14.6 Lt.	0.0-2.0	300124	12	7.5			SM	A-1-b	II
HB-WOOD-216, 3D	123+88.6	14.6 Lt.	4.0-6.0	300125	12	34.7			SP-SM	A-2-4	0
HB-WOOD-216, 4D/A	123+88.6	14.6 Lt.	6.5-8.0	302626	12	28.1			SP-SM	A-3	0
HB-WOOD-216, 5D	123+88.6	14.6 Lt.	8.0-10.0	302627	12	21.9			SM	A-2-4	II
HB-WOOD-216, 6D	123+88.6	14.6 Lt.	10.0-12.0	302628	12	23.7			SM	A-2-4	II
						Loss of Ignition, % (T 267)					
HB-WOOD-201, 5D	13+15.7	9.9 Rt.	8.5-10.5	300178	1				8.8		
HB-WOOD-201, 6D	13+15.7	9.9 Rt.	10.5-12.5	300179	1				3.0		
HB-WOOD-201, 7D	13+15.7	9.9 Rt.	12.5-14.5	300180	2				1.8		
HB-WOOD-201, 8D	13+15.7	9.9 Rt.	15.0-17.0	300181	2				0.4		
HB-WOOD-202, 4D/A	13+81.2	12.4 Lt.	6.5-8.0	300186	3				9.4		
HB-WOOD-202, 5D	13+81.2	12.4 Lt.	10.0-12.0	300187	4				3.8		
HB-WOOD-203, 4D	24+62.9	18.7 Rt.	6.5-8.5	300192	5				8.1		
HB-WOOD-203, 5D	24+62.9	18.7 Rt.	8.5-9.5	300193	5				6.4		
HB-WOOD-203, 5D/A	24+62.9	18.7 Rt.	9.5-10.5	300194	5				1.5		
HB-WOOD-204, 4D	25+20.9	13.9 Lt.	7.5-9.0	300198	6				54.5		
HB-WOOD-204, 4D/A-5D	25+20.9	13.9 Lt.	9.0-11.5	300199	6				6.3		
HB-WOOD-215, 3D/A	123+85.2	15.4 Rt.	4.6-6.0	300122	11				23.3		
HB-WOOD-216, 3D	123+88.6	14.6 Lt.	4.0-6.0	300125	12	Ignition Test not run.					

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

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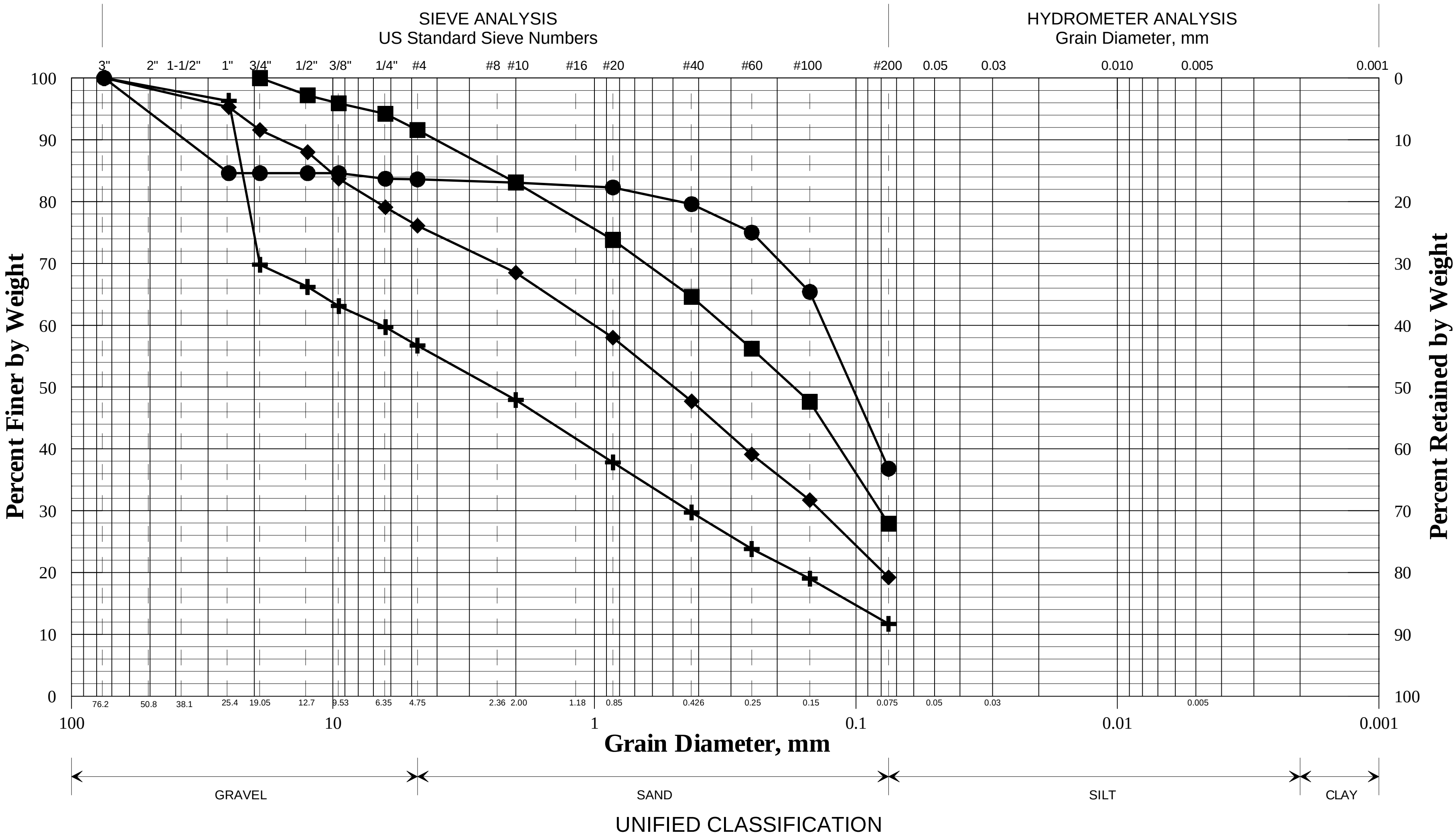
PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-201/2D	13+15.7	9.9 RT	2.5-4.5	Gravelly SAND, little silt.	4.4			
◆	HB-WOOD-201/3D	13+15.7	9.9 RT	4.5-6.5	SAND, some gravel, little silt.	13.5			
■	HB-WOOD-201/5D	13+15.7	9.9 RT	8.5-10.5	SAND, some silt, trace gravel.	66.8			
●	HB-WOOD-201/6D	13+15.7	9.9 RT	10.5-12.5	Silty SAND, little gravel.	36.2			
▲									
✖									

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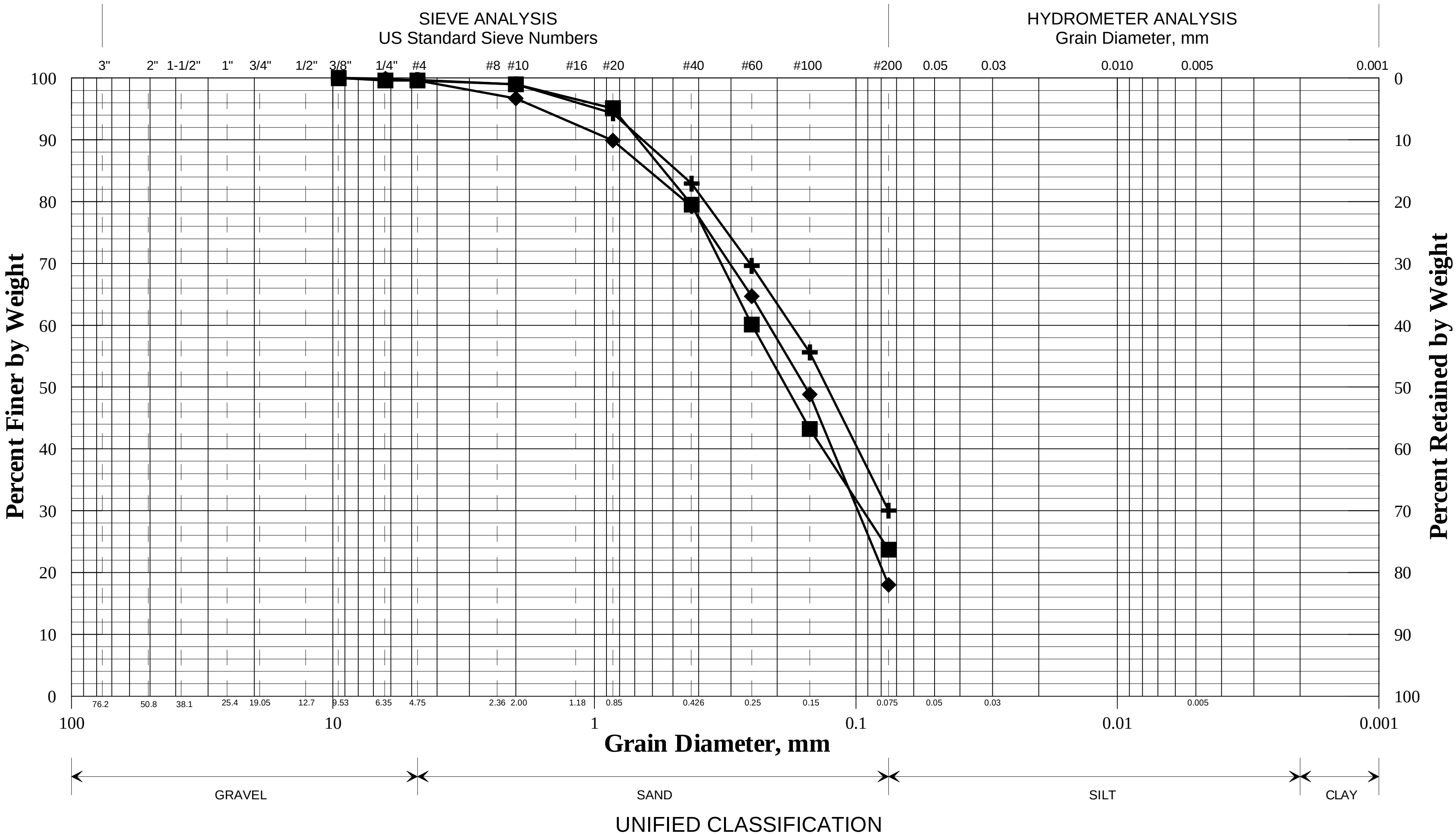
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-201/7D	13+15.7	9.9 RT	12.5-14.5	SAND, some silt, trace gravel.	30.6			
◆	HB-WOOD-201/8D	13+15.7	9.9 RT	15.0-17.0	SAND, little silt, trace gravel.	21.3			
■	HB-WOOD-201/9D	13+15.7	9.9 RT	20.0-22.0	SAND, some silt, trace gravel.	19.3			
●									
▲									
✖									

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SHEET 2

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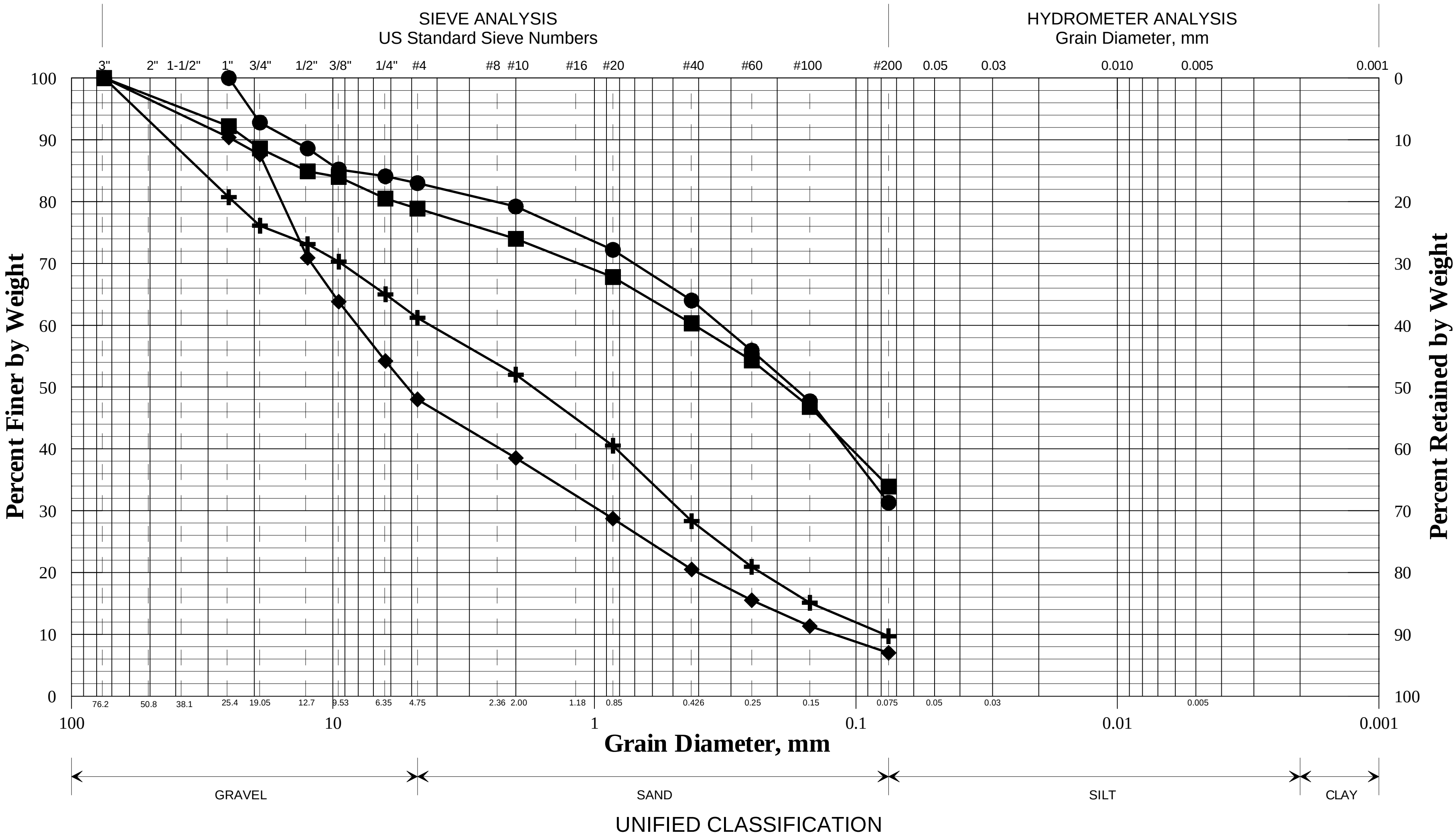
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-202/1D	13+81.2	12.4 LT	0.0-2.0	Gravelly SAND, trace silt.	4.3			
◆	HB-WOOD-202/2D	13+81.2	12.4 LT	2.0-4.0	Sandy GRAVEL, trace silt.	2.8			
■	HB-WOOD-202/3D+4D	13+81.2	12.4 LT	4.0-6.5	SAND, some silt, some gravel.	12.3			
●	HB-WOOD-202/4DA	13+81.2	12.4 LT	6.5-8.0	SAND, some silt, little gravel.	37.9			
▲									
✖									

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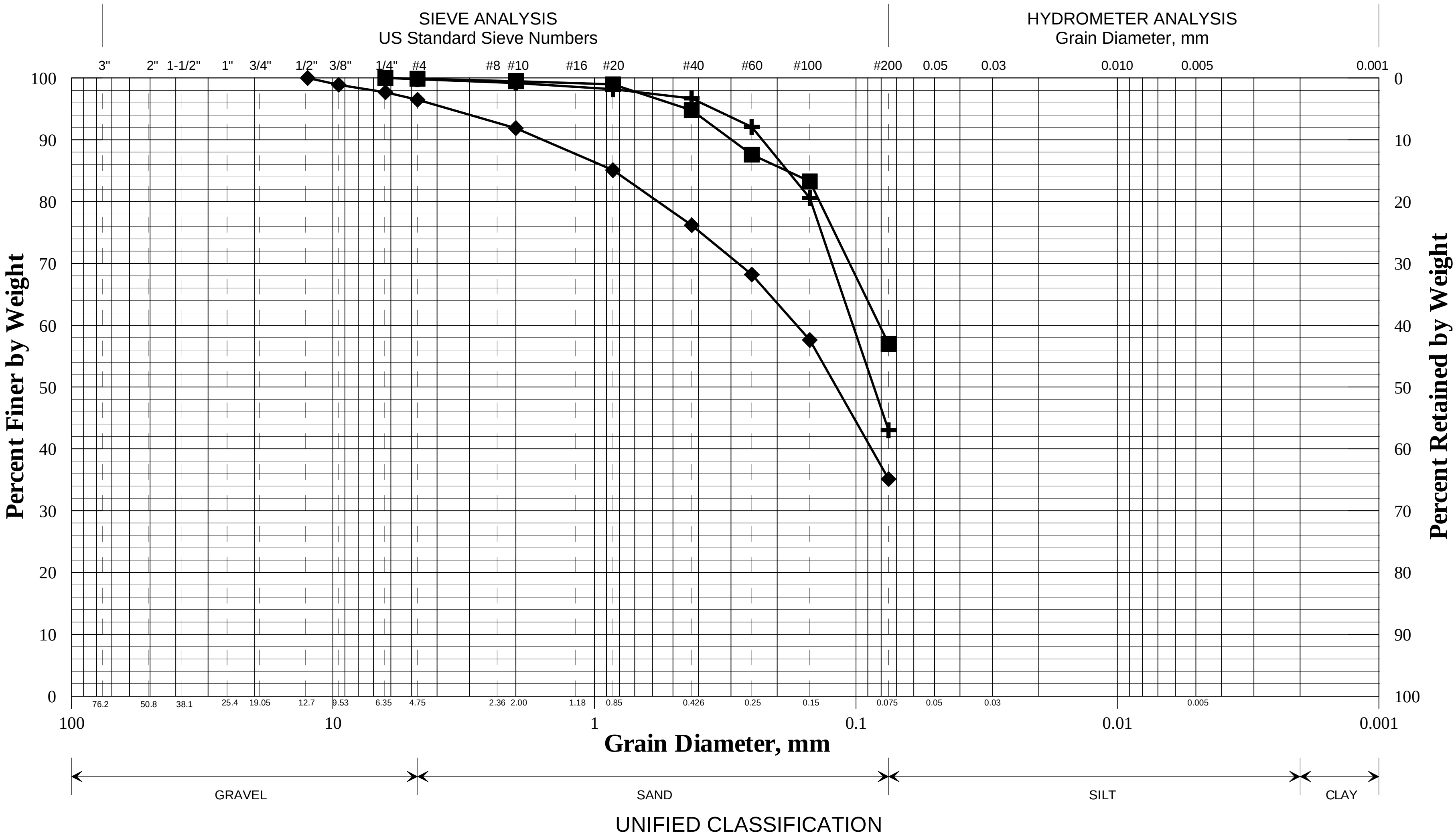
SHEET 3

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-202/5D	13+81.2	12.4 LT	10.0-12.0	Silty SAND, trace gravel.	33.9			
◆	HB-WOOD-202/7D	13+81.2	12.4 LT	15.0-17.0	SAND, some silt, trace gravel.	20.3			
■	HB-WOOD-202/8D	13+81.2	12.4 LT	20.0-22.0	Sandy SILT, trace gravel.	19.6			
●									
▲									
✖									

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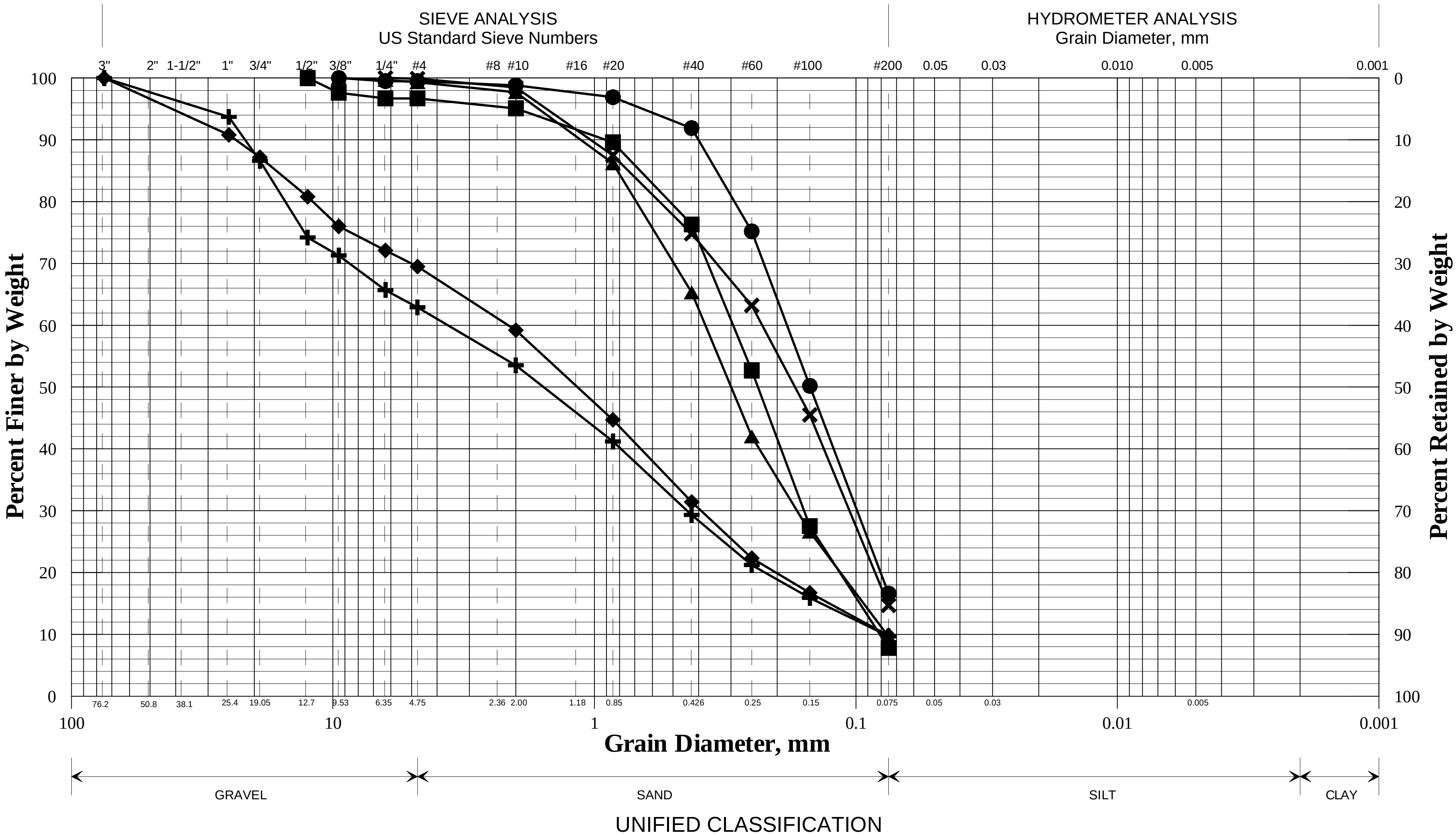
SHEET 4

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-203/2D	24+62.9	18.7 RT	2.5-4.5	Gravelly SAND, trace silt.	4.3			
◆	HB-WOOD-203/3D	24+62.9	18.7 RT	4.5-6.5	SAND, some gravel, trace silt.	13.1			
■	HB-WOOD-203/4D	24+62.9	18.7 RT	6.5-8.5	SAND, trace silt, trace gravel.	59.3			
●	HB-WOOD-203/5D	24+62.9	18.7 RT	8.5-9.5	SAND, little silt, trace gravel.	56.2			
▲	HB-WOOD-203/5DA	24+62.9	18.7 RT	9.5-10.5	SAND, trace silt, trace gravel.	25.5			
✖	HB-WOOD-203/6D	24+62.9	18.7 RT	15.0-17.0	SAND, little silt, trace gravel.	21.6			

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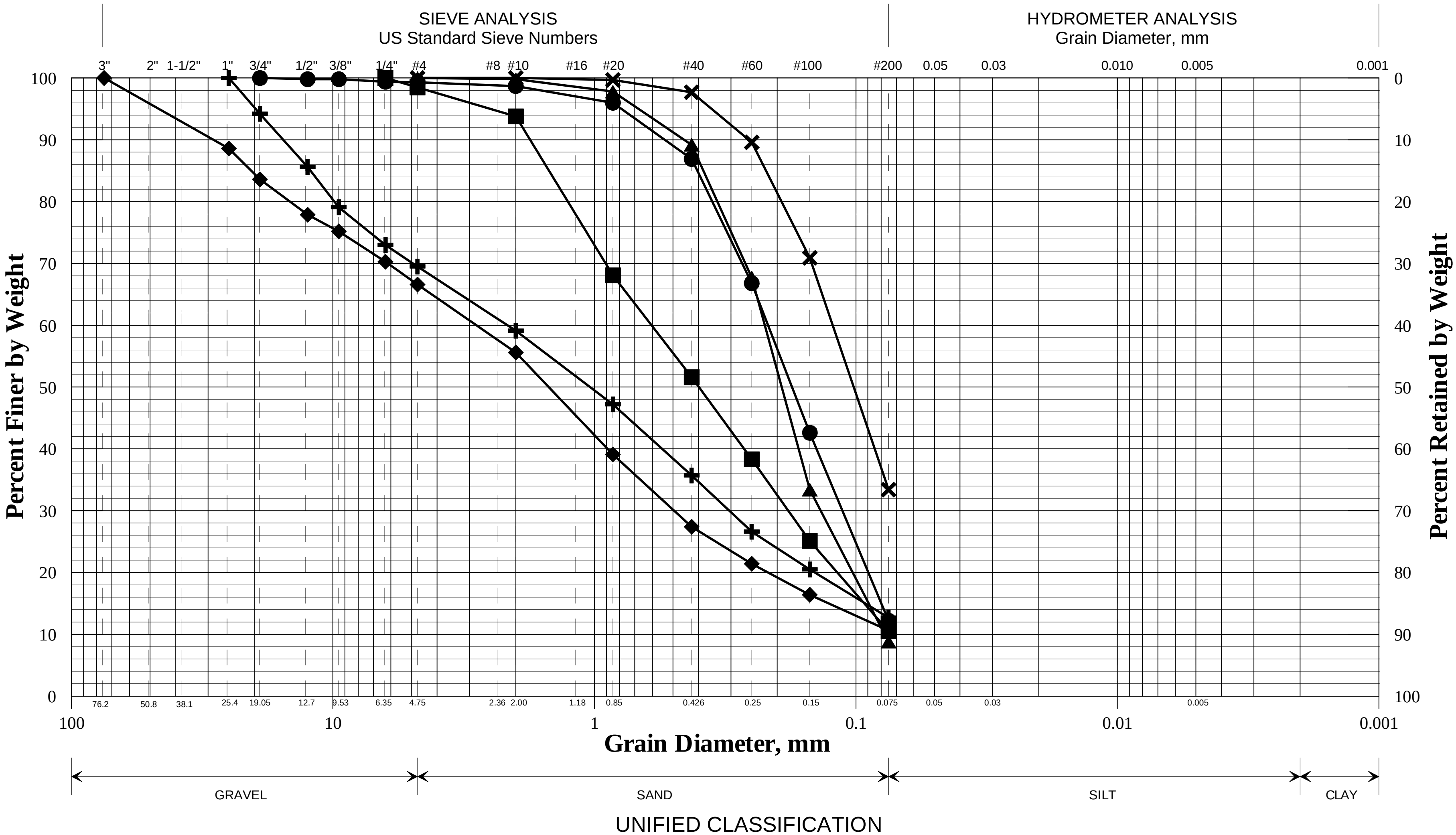
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-204/1D	25+20.9	13.9 LT	1.5-3.5	SAND, some gravel, little silt.	4.5			
◆	HB-WOOD-204/2D	25+20.9	13.9 LT	3.5-5.5	SAND, some gravel, trace silt.	6.6			
■	HB-WOOD-204/4D	25+20.9	13.9 LT	7.5-9.0	SAND, trace silt, trace gravel.	166.4			
●	HB-WOOD-204/4DA+5D	25+20.9	13.9 LT	9.0-11.5	SAND, little silt, trace gravel.	42.0			
▲	HB-WOOD-204/6D	25+20.9	13.9 LT	15.0-17.0	SAND, trace silt.	25.1			
✖	HB-WOOD-204/7D	25+20.9	13.9 LT	20.0-22.0	SAND, some silt.	23.7			

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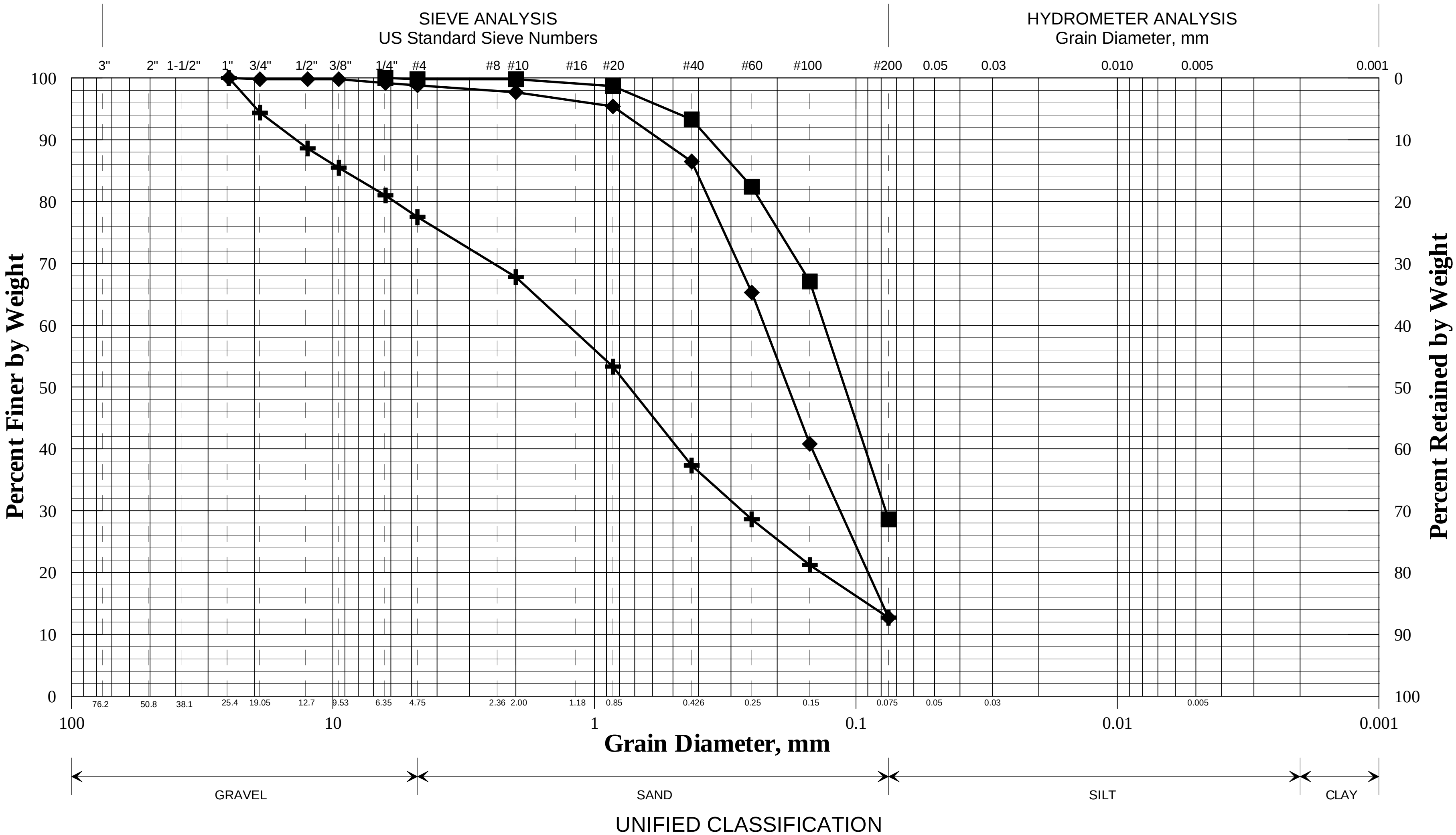
SHEET 6

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-215/1D	123+85.2	15.4 RT	0.0-2.0	SAND, some gravel, little silt.	7.8			
◆	HB-WOOD-215/3DA	123+85.2	15.4 RT	4.6-6.0	SAND, little silt, trace gravel.	45.1			
■	HB-WOOD-215/4D	123+85.2	15.4 RT	8.5-10.5	SANDm some silt, trace gravel.	24.2			
●									
▲									
✖									

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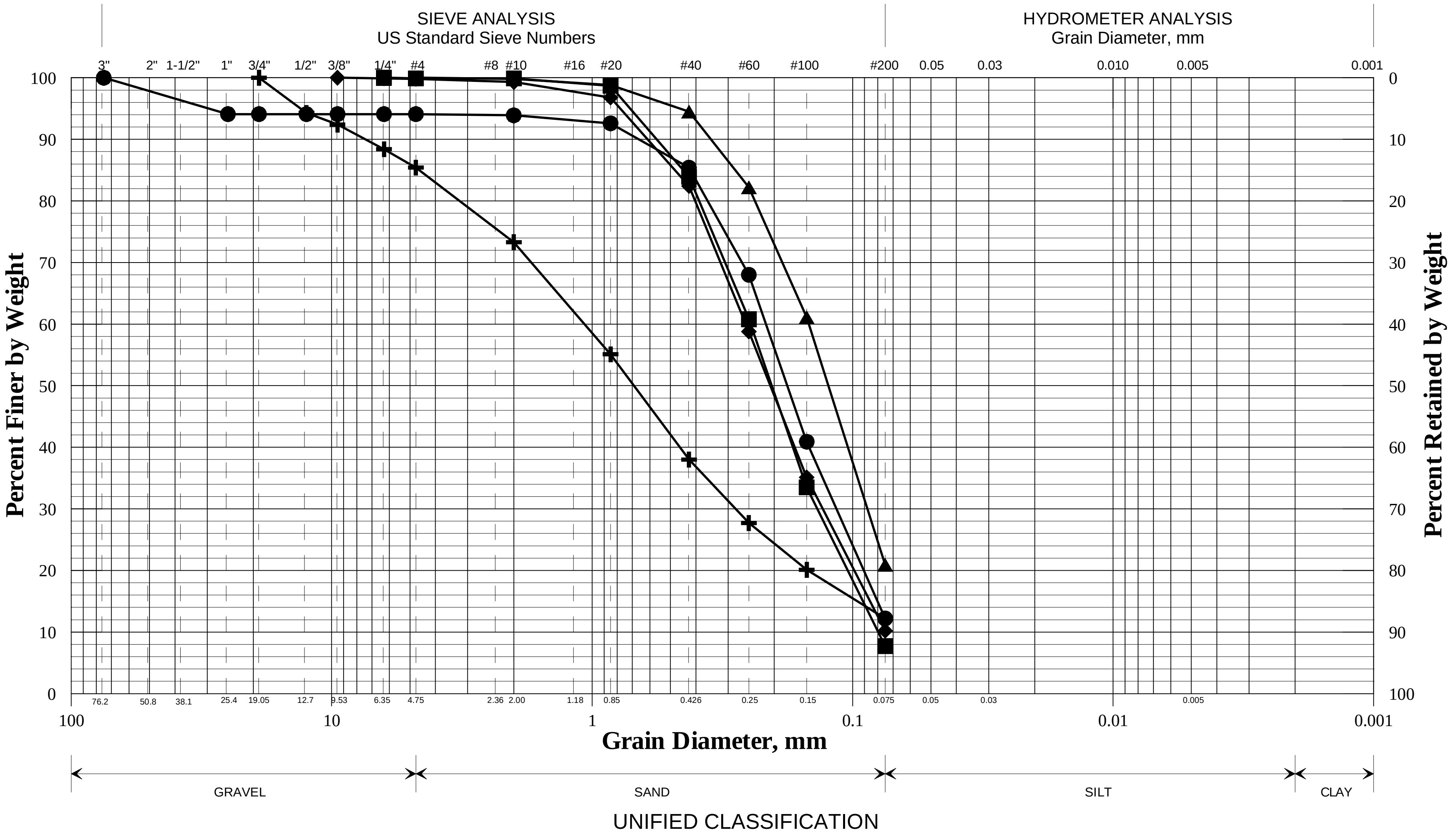
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-WOOD-216/1D	123+88.6	14.6 LT	0.0-2.0	SAND, little gravel, little silt.	7.5			
◆	HB-WOOD-216/3D	123+88.6	14.6 LT	4.0-6.0	SAND, trace silt, trace gravel.	34.7			
■	HB-WOOD-216/4DA	123+88.6	14.6 LT	6.5-8.0	SAND, trace silt, trace garvel.	28.1			
●	HB-WOOD-216/5D	123+88.6	14.6 LT	8.0-10.0	SAND, little silt, trace gravel.	21.9			
▲	HB-WOOD-216/6D	123+88.6	14.6 LT	10.0-12.0	SAND, some silt.	23.7			
✖									

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APPENDIX C

Geotechnical Calculations

Client	Maine Department of Transportation	Date	30-Oct-19
Project	Route 26 Improvements, Woodstock, Maine	Computed by	KAR
Subject	Bearing Resistance of Proposed Culverts, STA 13+42	Checked by	EAF

PROBLEM STATEMENT & OBJECTIVE

Calculate the Strength and Service Limit State bearing resistance of the replacement culverts for the Route 26 Improvements in Woodstock, Maine.

EXECUTIVE SUMMARY

1. The factored bearing resistance at the Strength Limit State is	7.0	ksf.
2. The presumptive bearing resistance for Spread Footing Foundation at the Service Limit State Modified after U.S. Department of Navy (1982) for the existing naturally deposited soils from Table C10.6.2.6.1-1 (See page 3)	3.0	ksf.

REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 8th Edition, 2017.

AVAILABLE INFORMATION

1. Plan set titled, "Woodstock, Oxford County, Route 26" dated September 13, 2017.

ASSUMPTIONS

1. The vertical load eccentricity will be assumed as zero since the culvert is fully embedded into the soil.
2. Fully saturated soils beneath footing (culvert) and fully saturated soils above the footing (culvert) to evaluate the highest groundwater table expected within the service life of the structure.
3. Bottom of culvert at El. 715.
4. Subsurface conditions based on borings HB-WOOD-201 and HB-WOOD-202 (test boring logs in Appendix A).
5. Bottom of culvert is 9 ft below ground surface.
6. Culvert size considered: 4 ft diameter x 84 ft long.
7. Culvert will bear on loose granular fill material.
8. Soil properties for granular fill will be 125 pcf (unit weight) and 32 degrees (phi angle).
9. Full area will be considered for service limit state.
10. Assume overexcavation of wetland deposit, to be replaced with granular fill with blow counts averaging 10.

PROCEDURE FOR STRENGTH LIMIT STATE

AASHTO LRFD Equation 10.6.3.1.2a-1 Basic Formulation for Nominal Bearing Resistance

$$q_R = \varphi_b q_n$$ Equation 10.6.3.1.1-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$ Equation 10.6.3.1.2a-1

$$N_{cm} = N_c s_c i_c$$ Equation 10.6.3.1.2a-2

$$N_{qm} = N_q s_q d_q i_q$$ Equation 10.6.3.1.2a-3

$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$ Equation 10.6.3.1.2a-4

q_R = factored strength limit state bearing resistance (ksf) = RF x q_n

φ_b = resistance factor from Table 10.5.5.2.2-1

q_n = nominal strength limit state bearing resistance (ksf)

c = cohesion, taken as undrained shear strength (ksf)

N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f =	footing embedment depth (ft)
D_w =	depth of water (ft)
B =	footing width (ft)
e_B =	footing width eccentricity (ft) as specified in Section 10.6.3.3
B' =	effective footing width (B-2e) (ft)
L =	footing length (ft)
e_L =	footing length eccentricity (ft) as specified in Section 10.6.3.3
L' =	effective footing length (L-2e) (ft)
C_{wq},$C_{w\gamma}$ =	correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c,s_q,s_γ =	footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q =	correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim).
i_c,i_q,i_γ =	load inclination factors

CALCULATION FOR STRENGTH LIMIT STATE

B =	4.0	ft	Assume no eccentricity about the culvert
e_B =	0.0	ft	
B' =	4.0	ft	
L =	84.0	ft	
e_L =	0.0	ft	
L'=	84.0	ft	
c =	0	ksf	
γ =	125	pcf	
ϕ =	32	degrees	
D_w	0	ft	
D_f	9	ft	
C_{wq}	0.5		
$C_{w\gamma}$	0.5		
N_c	35.5		
S_c	1.03		
i_c	1		
N_{cm}	36.6		
N_q	23.2		
S_q	1.03		
d_q	1		
i_q	1		
N_{qm}	23.9		
N_γ	30.2		
S_γ	0.98		
i_γ	1		
$N_{\gamma m}$	29.6		

q_n	17.1	ksf	say 16 ksf
RF	0.45		
q_R	7.7	ksf	say 7 ksf

BEARING RESISTANCE AT THE SERVICE LIMIT STATE

AASHTO Section 10.6.2.6 - Bearing Resistance at the Service Limit State

The use of presumptive values shall be based on the knowledge of geological conditions at or near the structure site... These bearing resistances are settlement limited, e.g., 1.0-in., and apply only at the service limit state.'

Two test borings were performed within close proximity to the proposed culvert at STA. 13+42

Assuming overexcavation of the 'Wetland Deposit' has occurred at the location of the proposed culvert at STA 13+42, bearing resistance values can be correlated from the subsurface conditions encountered within the 'Glacial Lacustrine Deposit'.

Table C10.6.2.6.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf) Ordinary Range	Bearing Resistance (ksf) Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense Medium dense to dense Loose	12–20 8–14 4–12	14 10 6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense Medium dense to dense Loose	8–12 4–8 2–6	8 6 3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense Medium dense to dense Loose	6–12 2–6 1–2	8 4 1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard Medium stiff to stiff Soft	4–8 2–6 1–2	6 3 1

CONCLUSIONS AND RECOMMENDATIONS

Strength Limit State

The factored bearing resistance for the strength limit state is	7.7	ksf	say 7 ksf
The presumptive bearing resistance at the service limit state	3.0 - 5.0	ksf	say 3 ksf

PROBLEM STATEMENT & OBJECTIVE

Calculate the Strength and Service Limit State bearing resistance of the replacement culverts for the Route 26 Improvements in Woodstock, Maine.

EXECUTIVE SUMMARY

1. The factored bearing resistance at the Strength Limit State is	10.0	ksf.
2. The presumptive bearing resistance for Spread Footing Foundation at the Service Limit State Modified after U.S. Department of Navy (1982) for the existing naturally deposited soils from Table C10.6.2.6.1-1 (See page 3)	3.0	ksf.

REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 8th Edition, 2017.

AVAILABLE INFORMATION

1. Plan set titled, "Woodstock, Oxford County, Route 26" dated September 13, 2017.

ASSUMPTIONS

1. The vertical load eccentricity will be assumed as zero since the culvert is fully embedded into the soil.
2. Fully saturated soils beneath footing (culvert) and fully saturated soils above the footing (culvert) to evaluate the highest groundwater table expected within the service life of the structure.
3. Bottom of culvert at El. 697.
4. Subsurface conditions based on borings HB-WOOD-203 and HB-WOOD-204 (test boring logs in Appendix A).
5. Bottom of culvert is 10 ft below ground surface.
6. Culvert size considered: 6 ft rise x 10 ft span x 126 ft long.
7. Culvert will bear on loose granular fill material.
8. Soil properties for granular fill will be 125 pcf (unit weight) and 32 degrees (phi angle).
9. Full area will be considered for service limit state.
10. Assume overexcavation of wetland deposit and into the glacial lacustrine deposit, to be replaced with granular fill with blow counts averaging 10.

PROCEDURE FOR STRENGTH LIMIT STATE

AASHTO LRFD Equation 10.6.3.1.2a-1 Basic Formulation for Nominal Bearing Resistance

$$q_R = \varphi_b q_n$$ Equation 10.6.3.1.1-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$ Equation 10.6.3.1.2a-1

$$N_{cm} = N_c s_c i_c$$ Equation 10.6.3.1.2a-2

$$N_{qm} = N_q s_q d_q i_q$$ Equation 10.6.3.1.2a-3

$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$ Equation 10.6.3.1.2a-4

q_R = factored strength limit state bearing resistance (ksf) = RF x q_n
φ_b = resistance factor from Table 10.5.5.2.2-1
q_n = nominal strength limit state bearing resistance (ksf)
c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f = footing embedment depth (ft)
D_w = depth of water (ft)
B = footing width (ft)
e_B = footing width eccentricity (ft) as specified in Section 10.6.3.3
B' = effective footing width (B-2e) (ft)
L = footing length (ft)
e_L = footing length eccentricity (ft) as specified in Section 10.6.3.3
L' = effective footing length (L-2e) (ft)
$C_{wq}, C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_q, s_γ = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim).
i_c, i_q, i_γ = load inclination factors

CALCULATION FOR STRENGTH LIMIT STATE

B =	10.0	ft	Assume no eccentricity about the culvert
e_B =	0.0	ft	
B' =	10.0	ft	
L =	126.0	ft	
e_L =	0.0	ft	
L'=	126.0	ft	
c =	0	ksf	
γ =	125	pcf	
ϕ =	32	degrees	
D_w	0	ft	
D_f	10	ft	
C_{wq}	0.5		
$C_{w\gamma}$	0.5		
N_c	35.5		
S_c	1.05		
i_c	1		
N_{cm}	37.3		
N_q	23.2		
S_q	1.05		
d_q	1		
i_q	1		
N_{qm}	24.4		
N_γ	30.2		
S_γ	0.97		
i_γ	1		
$N_{\gamma m}$	29.2		
q_n	24.4	ksf	say 22 ksf
RF	0.45		
q_R	11.0	ksf	say 10 ksf

BEARING RESISTANCE AT THE SERVICE LIMIT STATE

AASHTO Section 10.6.2.6 - Bearing Resistance at the Service Limit State

The use of presumptive values shall be based on the knowledge of geological conditions at or near the structure site... These bearing resistances are settlement limited, e.g., 1.0-in., and apply only at the service limit state.'

Two test borings were performed within close proximity to the proposed culvert at STA. 24+93

Assuming overexcavation of the 'Wetland Deposit' has occurred at the location of the proposed culvert at STA 24+93, bearing resistance values can be correlated from the subsurface conditions encountered within the 'Glacial Lacustrine Deposit'.

Table C10.6.2.6.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf) Ordinary Range	Bearing Resistance (ksf) Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense Medium dense to dense Loose	12–20 8–14 4–12	14 10 6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense Medium dense to dense Loose	8–12 4–8 2–6	8 6 3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense Medium dense to dense Loose	6–12 2–6 1–2	8 4 1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard Medium stiff to stiff Soft	4–8 2–6 1–2	6 3 1

CONCLUSIONS AND RECOMMENDATIONS

Strength Limit State

The factored bearing resistance for the strength limit state is	11.0	ksf	say 10 ksf
The presumptive bearing resistance at the service limit state	3.0 - 5.0	ksf	say 3 ksf

Client	Maine Department of Transportation	Date	31-Oct-19
Project	Route 26 Improvements, Woodstock, Maine	Computed by	KAR
Subject	Bearing Resistance of Proposed Culverts, STA 123+85	Checked by	EAF

PROBLEM STATEMENT & OBJECTIVE

Calculate the Strength and Service Limit State bearing resistance of the replacement culverts for the Route 26 Improvements in Woodstock, Maine.

EXECUTIVE SUMMARY

1. The factored bearing resistance at the Strength Limit State is	8.0	ksf.
2. The presumptive bearing resistance for Spread Footing Foundation at the Service Limit State Modified after U.S. Department of Navy (1982) for the existing naturally deposited soils from Table C10.6.2.6.1-1 (See page 3)	3.0	ksf.

REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 8th Edition, 2017.

AVAILABLE INFORMATION

1. Plan set titled, "Woodstock, Oxford County, Route 26" dated September 13, 2017.

ASSUMPTIONS

1. The vertical load eccentricity will be assumed as zero since the culvert is fully embedded into the soil.
2. Fully saturated soils beneath footing (culvert) and fully saturated soils above the footing (culvert) to evaluate the highest groundwater table expected within the service life of the structure.
3. Bottom of culvert at El. 748.5.
4. Subsurface conditions based on borings HB-WOOD-215 and HB-WOOD-216 (test boring logs in Appendix A).
5. Bottom of culvert is 10 ft below ground surface.
6. Culvert size considered: 5 ft diameter x 88 ft long.
7. Culvert will bear on glacial lacustrine deposit.
8. Soil properties for granular fill will be 125 pcf (unit weight) and 32 degrees (phi angle).
9. Full area will be considered for service limit state.
10. Assume overexcavation of topsoil/root matter deposit, to be replaced with granular fill with blow counts averaging 10.

PROCEDURE FOR STRENGTH LIMIT STATE

AASHTO LRFD Equation 10.6.3.1.2a-1 Basic Formulation for Nominal Bearing Resistance

$$q_R = \varphi_b q_n$$ Equation 10.6.3.1.1-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$ Equation 10.6.3.1.2a-1

$$N_{cm} = N_c s_c i_c$$ Equation 10.6.3.1.2a-2

$$N_{qm} = N_q s_q d_q i_q$$ Equation 10.6.3.1.2a-3

$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$ Equation 10.6.3.1.2a-4

- q_R = factored strength limit state bearing resistance (ksf) = RF x q_n
- φ_b = resistance factor from Table 10.5.5.2.2-1
- q_n = nominal strength limit state bearing resistance (ksf)
- c = cohesion, taken as undrained shear strength (ksf)
- N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
- N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
- N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
- γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f = footing embedment depth (ft)
D_w = depth of water (ft)
B = footing width (ft)
e_B = footing width eccentricity (ft) as specified in Section 10.6.3.3
B' = effective footing width (B-2e) (ft)
L = footing length (ft)
e_L = footing length eccentricity (ft) as specified in Section 10.6.3.3
L' = effective footing length (L-2e) (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c,s_q,s_γ = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim).
i_c,i_q,i_γ = load inclination factors

CALCULATION FOR STRENGTH LIMIT STATE

B =	5.0	ft	Assume no eccentricity about the culvert
e_B =	0.0	ft	
B' =	5.0	ft	
L =	88.0	ft	
e_L =	0.0	ft	
L'=	88.0	ft	
c =	0	ksf	
γ =	125	pcf	
ϕ =	32	degrees	
D_w	0	ft	
D_f	10	ft	
C_{wq}	0.5		
$C_{w\gamma}$	0.5		
N_c	35.5		
S_c	1.04		
i_c	1		
N_{cm}	36.8		
N_q	23.2		
S_q	1.04		
d_q	1		
i_q	1		
N_{qm}	24.0		
N_γ	30.2		
S_γ	0.98		
i_γ	1		
$N_{\gamma m}$	29.5		

q_n	19.6	ksf	say 18 ksf
RF	0.45		
q_R	8.8	ksf	say 8 ksf

BEARING RESISTANCE AT THE SERVICE LIMIT STATE

AASHTO Section 10.6.2.6 - Bearing Resistance at the Service Limit State

The use of presumptive values shall be based on the knowledge of geological conditions at or near the structure site... These bearing resistances are settlement limited, e.g., 1.0-in., and apply only at the service limit state.'

Two test borings were performed within close proximity to the proposed culvert at STA. 123+85

Assuming overexcavation of the 'topsoil/root mat' has occurred at the location of the proposed culvert at STA 123+85, bearing resistance values can be correlated from the subsurface conditions encountered within the 'Glacial Lacustrine Deposit'.

Table C10.6.2.6.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf) Ordinary Range	Bearing Resistance (ksf) Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense Medium dense to dense Loose	12–20 8–14 4–12	14 10 6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense Medium dense to dense Loose	8–12 4–8 2–6	8 6 3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense Medium dense to dense Loose	6–12 2–6 1–2	8 4 1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard Medium stiff to stiff Soft	4–8 2–6 1–2	6 3 1

CONCLUSIONS AND RECOMMENDATIONS

Strength Limit State

The factored bearing resistance for the strength limit state is	8.8	ksf	say 8 ksf
The presumptive bearing resistance at the service limit state	3.0 - 5.0	ksf	say 3 ksf