MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

VILLAGE BRIDGE
OVER KENDUSKEAG STREAM
KENDUSKEAG, MAINE

(LRFD Update of Soil Report No. 2005-19)

STATE OF MAINE
MICHAEL J. MOREAU
No. 6085
LICENSED
PROFESSIONAL ENGINEER

Prepared by:

Michael J. Moreau, P.E.
Geotechnical Design Engineer

Reviewed by:

Laura Krusinski, P.E.
Senior Geotechnical Engineer

Penobscot County
PIN 17576.00

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GEOTECHNICAL DESIGN AND CONSTRUCTION SUMMARY

This report provides geotechnical recommendations for replacement of the Village Bridge over Kenduskeag Stream in Kenduskeag, Maine. The replacement structure will be a simply supported, single-span bridge with cantilever-type abutments on spread footings cast on bedrock or seals constructed on bedrock. The design and construction recommendations below are discussed in greater detail in Section 7.0 Evaluation and Recommendations.

This report is an update of Soil Report No. 2005-15 to address bridge design changes and AASHTO Load Resistance Factor Design requirements as referenced in AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010, (herein referred to as LRFD). This report contains all of the subsurface information gathered for the original bridge design as well as additional subsurface information collected for the new bridge design.

Cantilever Abutments and Wingwalls – The abutments and wingwalls will be designed to resist all lateral earth loads, vehicular loads, superstructure loads, and any loads transferred through the superstructure. Abutments and wingwalls will be designed for all relevant strength, service and extreme limit states in accordance with LRFD.

The design of project abutments founded on spread footings at the strength limit state shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure. A sliding resistance factor, φ_τ, of 0.90 shall be applied to the nominal sliding resistance of abutments and wingwalls founded on spread footings on bedrock. A maximum frictional coefficient of 0.70 at the bedrock-concrete interface should be assumed. For footings on bedrock, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed three-eighths (3/8ths) of the footing dimensions, in either direction.

The bedrock at the site is highly fractured. Excavation of several feet of friable, weathered bedrock may be required and should be planned and accounted for on the estimated quantities sheet. The full extent of the rock excavation needed will not be known until the foundation excavation is made.

Earth loads shall be calculated using an active earth pressure coefficient, K_a, of 0.31 calculated using Rankine Theory for cantilever wingwalls. The designer may assume Soil Type 4 [Bridge Design Guide (BDG) Section 3.6.1] for backfill soil properties. The backfill properties are as follows: ϕ = 32 degrees, γ = 125 pounds per cubic foot (pcf). Additional lateral earth pressure due to construction or live load surcharge is required for the abutments and wingwalls if an approach slab is not specified. If a structural approach slab is specified, some reduction of surcharge loads is permitted.

Factored Bedrock Bearing Resistance – The factored bearing resistance at the strength limit state for spread footings on bedrock should not exceed 15 kips per square foot (ksf). Based on presumptive bearing resistance values, a factored bearing resistance of 16 ksf may be used when analyzing the service limit state and for preliminary footing sizing, as allowed in LRFD C10.6.2.6.1. In no instance shall the service limit state bearing stress exceed the nominal resistance of the footing concrete, which may be taken as $0.3f'c$. The minimum footing size is 2 feet wide regardless of the applied bearing pressure or bearing material.

Settlement – Settlement of the bridge abutments due to elastic compression of the bedrock and any silt seams in the bedrock will be negligible and will occur during construction. Settlement of wall footings constructed on bedrock will be negligible. New approach fills and a grade rise of about 2½ feet are planned. Settlement beneath the new approaches will be negligible. Wall footings constructed on compacted fill soil may experience settlement on the order of ¼-inch or less. Differential settlements will also be on the order of ¼-inch or less. Most of the settlement will occur as the fill is placed and post-construction settlement will be negligible.

Frost Protection – Foundations placed on bedrock are not subject to heave by frost. Thus, there are no frost embedment requirements for project footings cast directly on sound bedrock. Retaining wall foundations placed on granular soils should be founded a minimum of 6.5 feet below finish exterior grade for frost protection. Riprap is not considered as contributing to the overall thickness of soils required for frost protection.

Scour and Riprap – Bridge approach slopes and slopes at wingwalls should be armored with 3 feet of riprap in accordance with the MaineDOT Bridge Design Guide (BDG) Section 2.3.11. The riprap section shall be underlain by Class A erosion control geotextile and a 1 foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill, as shown in Standard Detail 610 (03) except where riprap is placed directly over exposed bedrock. Riprap shall meet the requirements of Section 703.26, Plain and Hand Laid Riprap. Riprap shall extend 1.5 feet horizontally in front of walls before sloping down at a maximum 1.75H:1V slope to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation.

Seismic Design Considerations – In accordance with LRFD 4.7.4.2, seismic analysis is not required for single-span bridges regardless of seismic zone. However, superstructure connections and bridge seat dimensions must satisfy LRFD Article 3.10.9 and 4.7.4.4, respectively.

Construction Considerations –

<u>Excavation</u>

- Construction of new abutment and retaining wall structures will require soil and loose/weathered bedrock excavation. Earth support systems may be required.
- Remove the old abutments in their entirety.
- Prepare bedrock subgrade for abutment footings by creating level benches or a completely level surface. Bedrock excavation may use conventional equipment, but may also require drilling and blasting methods. All loose bedrock fragments and soil debris should be removed from bearing surfaces and the surfaces washed with high pressure water and air before concrete or seal concrete is placed for the abutment foundations.

<u>Blasting</u>

- Where blasting is required, conduct pre and post-blast condition surveys, as well as, blast vibration monitoring at nearby residences and bridge structures in accordance with

MaineDOT Standard Specification 105.2.6, Use of Explosives and industry standards at the time of blast.

Dewatering

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

Reuse of Excavated Soil and Bedrock

- Do not use excavated existing subbase aggregate for pavement structure construction or to re-base shoulders or for abutment and wall backfill soil. Excavated subbase sand and gravel may be used as fill below subgrade elevation in fill embankment areas.
- Do not use excavated existing fill or glacial till soils for fill anywhere beneath the pavement structure, dressing slopes, abutments or walls. Use these soils to dress slopes only below the bottom elevation of the shoulder subbase gravel.
- Glacial till or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. It may be necessary to spread out and dry portions of these soils that are excessively moist.

Embankment Fill Areas

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

Erosion Control

- Use MaineDOT Best Management Practices February 2008 to minimize erosion of fine-grained soils found on the project site.

1.0 INTRODUCTION

The Maine Department of Transportation (MaineDOT) plans to replace Village Bridge carrying Stetson Road over Kenduskeag Stream in the Town of Kenduskeag, Penobscot County, Maine. We show the project location on Sheet 1, Site Location Map, appended to this report. We conducted subsurface investigations at the bridge site to develop geotechnical recommendations for the structure replacement. This report summarizes our findings, discusses our evaluation of the subsurface conditions and presents our geotechnical recommendations for design and construction of the bridge foundations.

The existing bridge built in 1932 consists of a 110-foot long, single-span, steel truss with a 21-foot curb to curb width supported on concrete abutments. The east abutment is founded on a spread footing on gravel soil while the west abutment is founded on bedrock. Maintenance records indicate that the abutments were jacketed with concrete in 1991. At that time the remaining life of the abutments was expected to be approximately 15 years. Current plans call for the complete removal and replacement of the existing superstructure and substructure.

The bridge substructures have experienced severe deterioration and a substantial substructure concrete rehabilitation was constructed in 1991. At present, there has been some section loss in the substructure abutments and the deck has undergone significant cracking. The superstructure is narrow and has suffered collision damage from both truck traffic and high ice flows. As of the year 2010, the bridge sufficiency rating was 37.1.

Preliminary design studies by MaineDOT Bridge Program have identified cantilever-type abutments on spread footings to be the most practicable foundation type for this site. The spread footings will be founded directly on bedrock or seal concrete founded on bedrock. The proposed bridge will consist of a 114-foot, single span steel girder superstructure with a total width of 37 feet. The bridge will have 11-foot travel lanes, 5-foot shoulders, and a 5-foot wide sidewalk. The current bridge replacement plans include profile changes of up to approximately 3 feet higher than original grades at the center of the bridge and grading back down to original grade east and west of the bridge.

2.0 GEOLOGIC SETTING

The Village Bridge on Stetson Road in Kenduskeag crosses the Kenduskeag Stream approximately 2.5 miles east of the town line as shown on Sheet 1, Site Location Map, presented at the end of this report. Kenduskeag Stream flows in a southeasterly direction through Kenduskeag to Bangor and into the Penobscot River.

According to the "Surficial Geologic Map of Maine" published by the Maine Geological Survey (MGS) (1985), the surficial soils in the vicinity of the site consist of glaciomarine deposits. Glaciomarine deposits are generally comprised of silt, clay, sand and minor amounts of gravel. Sand is dominant in some areas, but may be underlain by finer-grained sediments. The unit contains small areas of till that are not completely covered by marine sediments. The unit is generally deposited in areas where the topography is gently sloping except where dissected by modern streams and commonly has a branching network of steep-walled stream gullies. These soils were generally deposited as glacial sediments that accumulated on the ocean floor during the late-glacial marine submergence of lowland areas in southern Maine.

According to the Bedrock Geologic Map of Maine , MGS, (1985), the bedrock at the Village Bridge site consists of Silurian-Ordovician age calcareous sandstone, interbedded sandstone and impure limestone of the Vassalboro Formation.

3.0 SUBSURFACE INVESTIGATION

MaineDOT investigated subsurface conditions at the site by drilling five test borings BB-KS-101, BB-KS-103, BB-KS-104, BB-KS-105, BB-KS-107, and two probes BP-KS-102 and BP-KS-106 in March 2005 and four test borings BB-KS-201 through BB-KS-204 in August 2010 to address the revised bridge design. The approximate boring locations are shown on Sheet 2, Boring Location Plan and Interpretive Subsurface Profile, found at the end of this report. All of the soil borings were terminated with bedrock cores and the probes were terminated on apparent bedrock. The only exception is boring BB-KS-107 which was drilled through existing Abutment No. 2 (east) in order to evaluate the condition of the abutment concrete. We present the details and sampling methods used, field data obtained, and soil and groundwater conditions encountered in the boring logs in Appendix A and on Sheet 3, Boring Logs, provided at the end of this report.

The MaineDOT geotechnical team member selected the boring locations and drilling methods, designated the type and depth of sampling techniques, and identified field and laboratory testing requirements. A MaineDOT Inspector certified under the Northeast Transportation Technician Certification Program logged the subsurface conditions encountered on the field logs in the March 2005 borings and a consultant inspector logged the August 2010 borings. The field crew tied down the boring locations by taping distances to adjacent site features. The boring locations were later picked up by MaineDOT survey.

The drill crew used solid stem auger and cased wash boring techniques to conduct the borings. Soil samples were obtained, where possible, at 5-foot intervals using Standard Penetration Test (SPT) methods. In the 200 series borings, the standard penetration resistances, or N-values, discussed in this report are corrected for average hammer energy transfer. We compute the corrected or, N_{60}-values, by applying an average hammer energy transfer factor of 0.84 to the raw field N-values obtained with the MaineDOT drill rig. Bedrock was cored using an NQ-2 core barrel producing a 2.0-inch diameter rock core.

4.0 LABORATORY TESTING

We conducted a laboratory soil testing program on selected samples recovered from the 100 series test borings to evaluate soil classification, material reuse, and subgrade soil properties. Laboratory testing consisted of 15 standard grain size analyses with natural water contents tests. We present results of laboratory testing in Appendix B, Laboratory Test Data. The AASHTO and Unified Soil Classification System (USCS) soil classifications and water content data are also presented on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

The surficial geology map shows that the bridge site is located in an area of glaciomarine sediments which may include small units of glacial till. However, the bridge site is situated at the end of short fill extensions built across the Kenduskeag Stream flood plain. Consequently, the soil behind the abutments is predominantly granular fill and cobbles overlying a thin veneer of glacial till. Only at BB-KS-101 and BB-KS-203 did we observe a glacial till layer of significance which was approximately 4 and 3 feet thick, respectively. We found that the glacial till overlies bedrock. All of the boring locations are underlain by phyllite bedrock. We provide an interpretive subsurface profile depicting the site stratigraphy on Sheet 2, Boring Location Plan and Interpretive Subsurface Profile, found at the end of this report. A summary description of the subsurface conditions follows:

5.1 Granular Fill

We encountered granular fill to a depth ranging between approximately 10.8 and 16.7 feet below ground surface (bgs). The granular fill generally consists of fine to coarse sand, with some gravel to gravelly and trace to some silt. We observed one instance of fill consisting of organic silt with wood just above bedrock in BB-KS-204. Drill attitude also indicated the presence of cobbles and granite blocks at various levels in the fill. The SPT N_{60}-values in the granular fill ranged from 4 to 80 blows per foot (bpf) indicating that the unit is very loose to very dense in consistency.

The granular fill samples subjected to laboratory testing had water contents ranging between approximately 5 and 9 percent. Grain size analyses conducted on selected samples of the fill soils indicate that the soils are classified as A-1-a, A-1-b, or A-2-4 by the AASHTO Classification System and SM or SW-SM under the Unified Soil Classification System.

5.2 Glacial Till

We generally encountered a layer of glacial till beneath the granular fill. The glacial till found in the borings generally comprised of gravelly fine to coarse sand with little to some silt, or fine to coarse sandy gravel with little silt. The thickness of this soil unit ranged between approximately 1.2 and 4.0 feet. SPT N_{60}-values ranged from 22 to 67 bpf, indicating the till deposit is medium dense to very dense in consistency.

The glacial till samples selected for testing had water contents ranging between approximately 14 and 50 percent. Grain size analyses of the glacial till samples indicate that the soils are classified as A-1-a, A-1-b, or A-4 by the AASHTO Classification System and SM, ML, or GW-GM under the Unified Soil Classification System.

5.3 Bedrock

We encountered bedrock at approximate depths ranging from 1.8 to 18.0 feet bgs. Locally, the bedrock is mapped as Silurian-Ordovician age calcareous sandstone, interbedded sandstone and impure limestone of the Vassalboro Formation. Visual identification of rock cores indicates that the bedrock at all the cored boring locations is a green or greyish green, fine-grained, meta-sedimentary phyllite that is hard, severely weathered to fresh with very close to moderately close joints. The bedrock contains quartzite and calcite seams, fractures that are oriented horizontal to vertical along steeply dipping bedding planes and is iron-stained along the fractures. We determined that the rock quality designation (RQD) of the bedrock ranged from 0 to 50 percent which correlates to a very poor to poor rock mass quality. The table below summarizes the top of bedrock elevations at the boring locations:

Substructure	Boring	Station	Depth to Bedrock (feet bgs)	Elevation of Bedrock Surface (feet)
Abutment No. 1	BB-KS-101	14+84.9, 6.1 RT	16.5	108.8
	BP-KS-102	14+84.6, 3.9 LT	18.0	107.3
	BB-KS-201	14+46.9, 11.2 LT	13.2	111.7
	BB-KS-203	14+71.4, 8.0 RT	16.7	108.3
Mid-Stream Borings	BB-KS-103	15+35.7, 13.2 LT	2.7	106.6
	BB-KS-104	15+51.8, 8.3 RT	1.8	107.8
Abutment No. 2	BB-KS-105	16+12.7, 5.6 LT	14.9	110.4
	BP-KS-106	16+12.7, 7.5 RT	14.3	111.0
	BB-KS-202	16+54.3, 9.7 LT	12.0	113.0
	BB-KS-204	16+28.5, 6.4 RT	16.7	108.2

Bedrock Depth and Elevation at the Boring Locations

5.4 Groundwater

We observed the groundwater level at approximately the ground surface (streambed boring) to 12.5 feet bgs in the borings. However, the groundwater level will fluctuate with seasonal changes, runoff, and adjacent construction activities.

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

6.0 FOUNDATION ALTERNATIVES

Soil Report 2005-19 summarized the maintenance activities performed and assessments of the existing abutments when the project team considered reuse of the abutments in 2005. In the end, a significant body of data (including coring the entire height of abutment No. 2 concrete) demonstrated the need to replace the existing substructures in their entirety. The presence of shallow bedrock also indicates that full height cantilever abutments on spread footings is the most practical and durable substructure alternative. Consequently, Section 7.0, Evaluation and Recommendations, of this report provides geotechnical design recommendations for full height cantilever abutments on spread footings founded on bedrock, or seal concrete founded on bedrock.

7.0 EVALUATION AND RECOMMENDATIONS

The design team has selected single-span, full height cast-in-place cantilever abutments on spread footings cast directly on bedrock or seal concrete on bedrock to replace the bridge at the Kenduskeag site. The design methodology used in the following evaluation is referenced from the AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010.

7.1 Spread Footings on Bedrock

The borings encountered bedrock approximately 12 to 18 feet below the existing bridge approaches at the boring locations. It is therefore considered feasible that cofferdams, seals (if required) and spread footings could be practically and economically constructed to bear on bedrock. The boring logs indicate that the bedrock at the site is highly fractured. Thus, it will be necessary to excavate all dislodged, loose fractured or weathered bedrock before placing seal or spread footing concrete. The full extent of the weathered bedrock excavation needed will not be known until the foundation excavation is made.

7.2 Abutment and Wingwall Design

Abutments and wingwalls shall be proportioned for all applicable load combinations in LRFD Articles 3.4.1 and 11.5.5 and shall be designed for all relevant strength, service and extreme limit states. The design of project abutments and wingwalls founded on spread footings at the strength limit state shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure.

A sliding resistance factor, φ_τ, of 0.90 shall be applied to the nominal sliding resistance of cast-in-place, abutments and wingwalls founded on spread footings on bedrock. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.70 at the bedrock-concrete interface.

For footings on bedrock, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed three-eighths (3/8^{ths}) of the footing dimensions, in either direction.

A resistance factor of 1.0 shall be used to assess spread footing design at the service limit state, including: settlement, excessive horizontal movement and overall stability. The overall stability of the foundation should be investigated at the Service I Load Combination and a resistance factor, φ, of 0.65.

Cantilever-type abutments and wingwalls shall be designed as unrestrained meaning that they are free to rotate at the top in an active state of earth pressure. Earth loads shall be calculated using an active earth pressure coefficient, K_a = 0.31, calculated using Rankine Theory for cantilever-type abutments and wingwalls. See Appendix C – Calculations, for supporting documentation. The designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows: ϕ = 32 degrees, γ = 125 pcf.

Additional lateral earth pressure due to construction surcharge or live load surcharge is required per Section 3.6.8 of the BDG for the abutments and wingwalls if an approach slab is not specified. In the case where a structural approach slab is specified, reduction of the surcharge loads is permitted per LRFD Article 3.11.6.5. The live load surcharge on walls may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) of 2.0 feet, per LRFD Table 3.11.6.4-1. The live load surcharge on abutments may be estimated as a uniform earth pressure due to an equivalent height of soil (h_{eq}) taken from the table below:

Abutment Height (feet)	h_{eq} (feet)
5.0	4.0
10.0	3.0
$\geq$ 20.0	2.0

All abutment and wingwall designs shall include a drainage system behind them to intercept any groundwater. Drainage behind the structure shall be in accordance with Section 5.4.1.4, Drainage, of the BDG.

Backfill within 10 feet of the abutments and wingwalls and side slope fill shall conform to MaineDOT Specification 709.19, Granular Borrow for Underwater Backfill. This gradation specifies 10 percent or less of material passing the No. 200 sieve. This material is specified in order to reduce the amount of fines and to minimize frost action behind the structure and below the approach slab.

Slopes in front of and sloping down to the wingwalls should be constructed with riprap and not exceed 1.75H:1V.

7.3 Factored Bedrock Bearing Resistance

Substructure spread footings shall be proportioned to provide stability against bearing capacity failure. Application of permanent and transient loads are specified in LRFD Article 11.5.5. The stress distribution may be assumed to be a triangular or trapezoidal distribution over the effective base as shown in LRFD Figure 11.6.3.2-2. The factored bearing resistance for any structure founded on bedrock shall be investigated at the strength limit state using factored loads and a factored bearing resistance of 15 ksf. This assumes a bearing resistance factor, φ_b, for spread footings on bedrock of 0.45, based on bearing resistance evaluation using semi-empirical methods. A factored bearing resistance of 16 ksf may be used for preliminary footing sizing and to control settlements when analyzing the service limit state load combination. See Appendix C, Calculations, for supporting documentation.

In no instance shall the factored service limit state bearing stress exceed the nominal compressive resistance of the footing concrete, which may be taken as $0.3f'c$. No footing shall be less than 2 feet wide regardless of the applied bearing pressure or bearing material.

7.4 Settlement

The current bridge replacement plans include profile changes of up to approximately 3 feet higher than original grades centered on the bridge. No compressible soils or peat occur beneath the existing approach embankments. Consequently, settlement beneath approach embankments resulting from new profile grades will be negligible.

We anticipate that all return walls behind the abutments will be founded on bedrock. If retaining walls or parts of retaining walls are founded on native or compacted fill soils, we estimate that settlements beneath the wall footings constructed on native soil or compacted granular fill will be on the order of ¼ inch or less. Differential settlement will also be on the order of ¼-inch or less. We anticipate that all of these settlements will occur during construction and will have minimal effect on the completed structure.

We expect that any settlement of the bridge abutments will be due to the elastic compression of the bedrock and minor settlement due to silt seams in the bedrock. We estimate that this settlement will be on the order of 0.1 inch or less and will occur during construction.

7.5 Frost Protection

Abutment and return wing spread footings at the site will be founded on bedrock. Therefore, heave due to frost is not a design issue, and no requirements for minimum embedment depth are necessary.

We have evaluated the potential frost depth at the site. Based on State of Maine frost depth maps, BDG Figure 5-1, the site has a design-freezing index of approximately 1850 F-degree days. Considering an assumed water content of 10 percent, this correlates to a frost depth of 7.6 feet at this site. We also considered frost depth projections computed by Modberg software developed by the US Army Cold Regions Research and Engineering Laboratory. The results of the Modberg frost depth model indicate a potential frost depth of 6.0 feet. Consequently, we recommend that any foundations or leveling pads constructed at the site be founded a minimum of 6.5 feet below finished exterior grade. This minimum embedment applies only to foundations constructed on soil and not those founded on bedrock.

7.6 Scour and Riprap

We expect that abutment and return wing spread footings will be founded on bedrock. The bedrock at the site is not considered to be erodible. Therefore, no specific scour protection recommendations are needed. However, if any abutment or wingwall footing is constructed on soil, they should be embedded for scour protection and armored with riprap.

The riprap layer shall be at least 3 feet thick. Stone riprap shall conform to MaineDOT Standard Specification 703.26, Plain and Hand Laid Riprap. For wingwalls and retaining walls, the riprap shall extend 1.5 feet horizontally in front of the walls before sloping at maximum 1.75H:1V slope to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation. The riprap section shall be underlain by Class A erosion control geotextile and a 1 foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill, as shown in Standard Detail 610 (03).

7.7 Seismic Design Considerations

In conformance with LRFD Article 4.7.4.2, seismic analysis is not required for single-span bridges, regardless of seismic zone, however, superstructure connections and bridge seat dimensions shall be satisfied per LRFD 3.10.9 and 4.7.4.4, respectively. Furthermore, the bridge is not classified as a major structure since construction costs will be less than $10 million dollars, nor is it classified as functionally important. Consequently, seismic earth loads do not need to be considered in bridge substructure design.

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD Manual and LRFD Articles 3.10.3.1 and 3.10.6:

- Peak Ground Acceleration coefficient (PGA) = 0.070
- Design spectral acceleration coefficient at 0.2-second period, S_{DS} = 0.151
- Design spectral acceleration coefficient at 1.0-second period, S_{D1} = 0.045
- Site Class B (rock with an average shear wave velocity = 2,500ft/sec < v_s < 5,000ft/sec)
- Seismic Zone 1, based on an S_{D1} < 0.15g

7.8 Construction Considerations

7.8.1 Excavation

Construction of the new abutment structures and any retaining walls will require soil and loose weathered rock excavation. Earth support systems may be required.

We anticipate that the existing abutments will be removed in their entirety. Cofferdams will be needed.

The abutment foundation subgrade should consist of sound bedrock. The bearing surface should be cleaned of all overburden soils, and loose, dislodged bedrock fragments should be removed by mechanical means. Mechanical means include expansive agents, use of hydraulic hoe ram, hydraulic splitters, or wedging and prying. We recommend final bedrock surface preparation by washing with a high pressure water jet.

The nature, slope, and degree of fracturing in the bedrock will not be evident until the foundation excavation is made. The bedrock surface shall be cleared of all loose fractured bedrock and loose decomposed bedrock and soil. Excavation of highly sloped and loose bedrock material may be done using conventional excavation methods, but may require drilling and blasting techniques. We recommend anchoring, doweling, benching or other means of improving sliding resistance if the prepared bedrock surface is steeper than 4:1 (H:V) in any direction. The final bearing surface shall then be washed with high pressure water and air prior to concrete being placed for the footing. The final bedrock surface shall be approved by the Resident prior to placing seal or footing concrete.

Surface water should be diverted from the foundation excavation throughout the period of construction. We recommend removing any groundwater encountered at the base of the foundation excavation by using a sump pump located in a corner of the excavation outside of the foundation footprint.

The native glacial till soil is susceptible to disturbance and rutting as a result of exposure to water or construction traffic. We recommend that the contractor protect the subgrade from exposure to water and any unnecessary construction traffic. If disturbance and rutting occur, we recommend that the contractor remove and replace the disturbed materials and replace with compacted gravel borrow.

7.8.2 Blasting

Bedrock excavation may be needed to achieve abutment and wingwall subgrade elevation. The contractor should conduct all blasting work for the project in accordance with MaineDOT Standard Specification 105.2.6, Use of Explosives. We also recommend that the contractor conduct pre and post-blast surveys, as well as, blast vibration monitoring at nearby residences and bridge structures in accordance with industry standards at the time of blast.

7.8.3 Dewatering

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

7.8.4 Reuse of Excavated Soil and Bedrock

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

We do not recommend using excavated glacial till soils as fill directly beneath the pavement structure. The glacial till is typically susceptible to strength loss when wet or disturbed. The excavated till soils may be allowed as fill in accordance with the Standard Specification 203 as shown on Standard Detail 203 (01). This soil may also be used for dressing slopes, but only below the bottom elevation of the shoulder subbase gravel.

The native glacial till or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. Contractors should expect that prior to placement and compaction it may be necessary to spread out and dry portions of these soils that are excessively moist.

7.8.5 Embankment Areas Outside of Abutment/Wingwall Backfill Envelope

Embankment approach slopes that are created or extended as part of the bridge construction effort should be designed as earth fill slopes no steeper than 2:1 (H:V). Slopes steeper than 2:1 (H:V) typically require reinforcement or rock fill surfacing.

We recommend that all new embankment fill be thoroughly and systematically compacted to the full limit of the slope. Where new fill slope extensions are constructed over existing slopes, we recommend benching the existing slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, to prevent creation of a preferential slip plane under the new embankment fill.

The new embankment fill loads and densification of the fill materials during construction will result in ground surface settlement and consolidation of the underlying soils. We anticipate that most of this settlement will occur during and immediately after construction of the embankments. Post-construction settlement is expected to be minimal.

7.8.6 Erosion Control Recommendations

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

8.0 CLOSURE

This report has been prepared for use by the MaineDOT Bridge Program for specific application to the replacement of the Village Bridge over the Kenduskeag Stream in Kenduskeag, Maine. We have prepared the report in accordance with generally accepted soil and foundation engineering practices. No other intended use or warranty is expressed or implied.

In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. Further, the analyses and recommendations are based in part upon limited soil explorations completed at discrete locations on the project site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

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

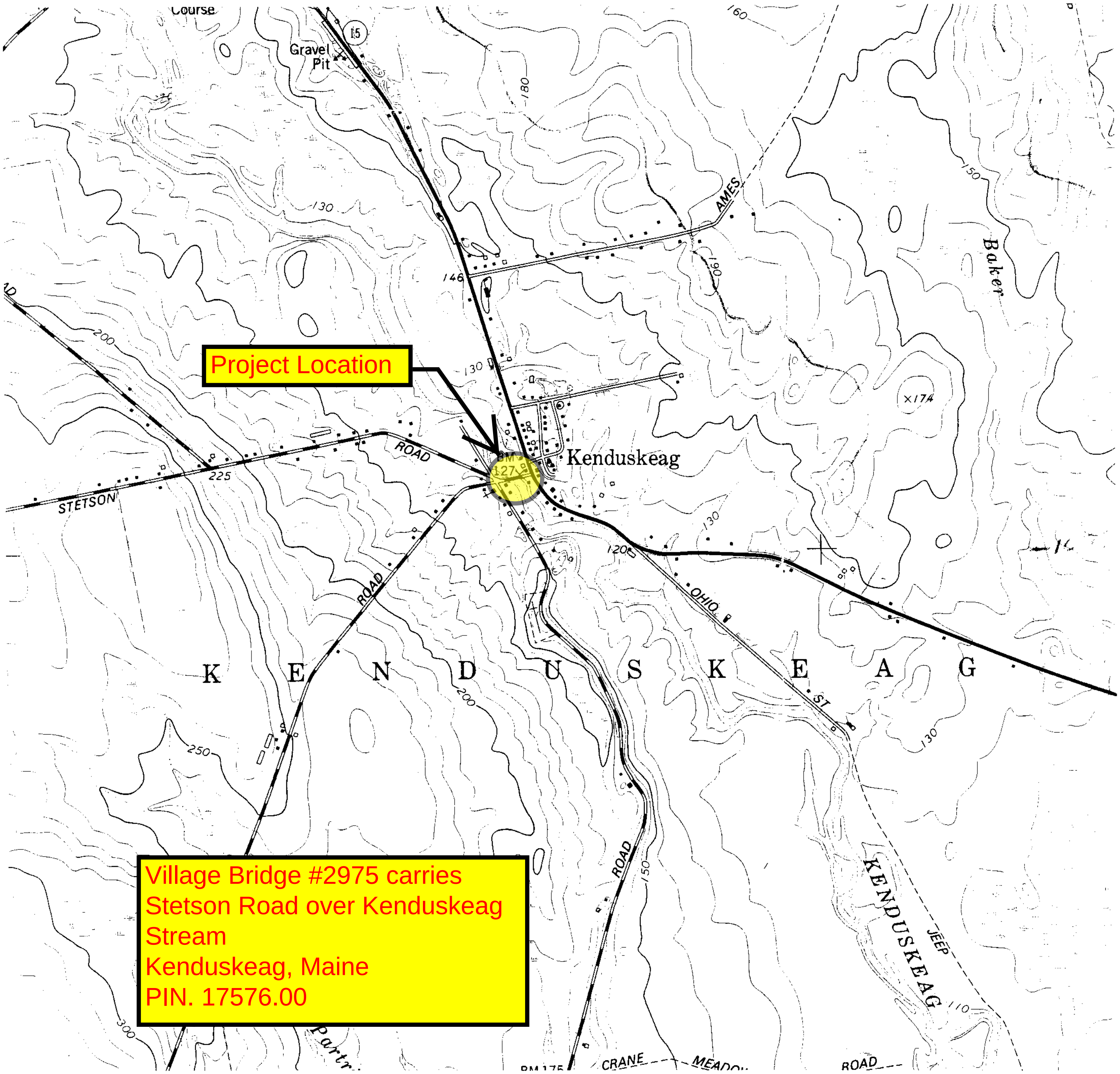
REFERENCES

AASHTO, (2010), AASHTO LRFD Bridge Design Specifications, Fifth Edition, 2010, AASHTO, Washington, D.C.

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

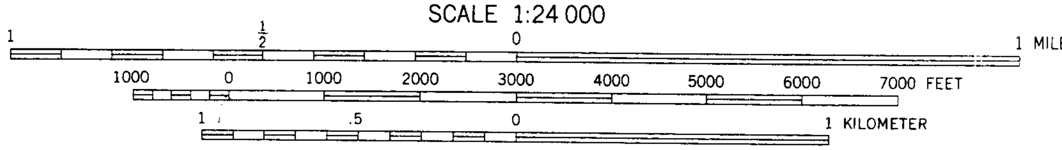
MaineDOT, (2003), Bridge Design Guide, MaineDOT Bridge Program, Augusta, ME.

<u>Sheets</u>

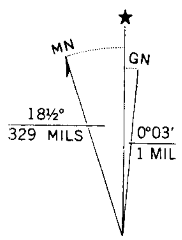


KENDUSKEAG QUADRANGLE
MAINE—PENOBSCOT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 BANGOR 15' QUADRANGLE

SCALE 1:24 000

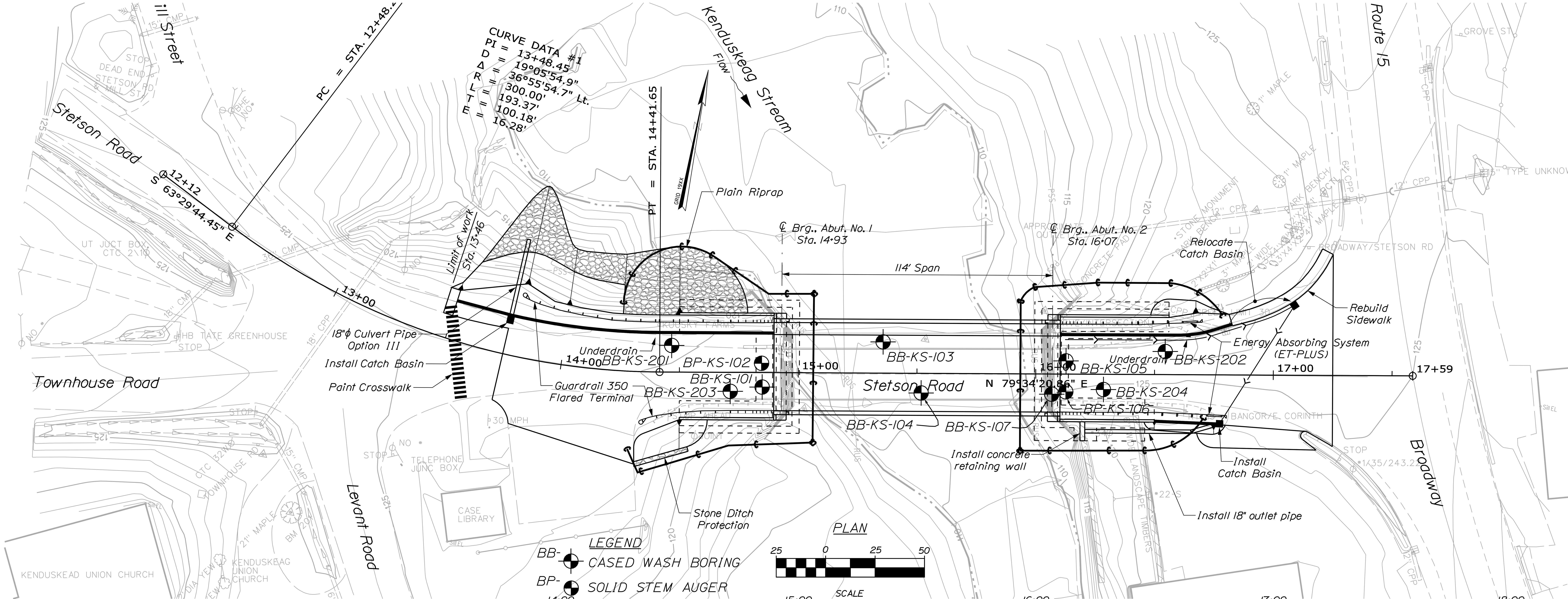


CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

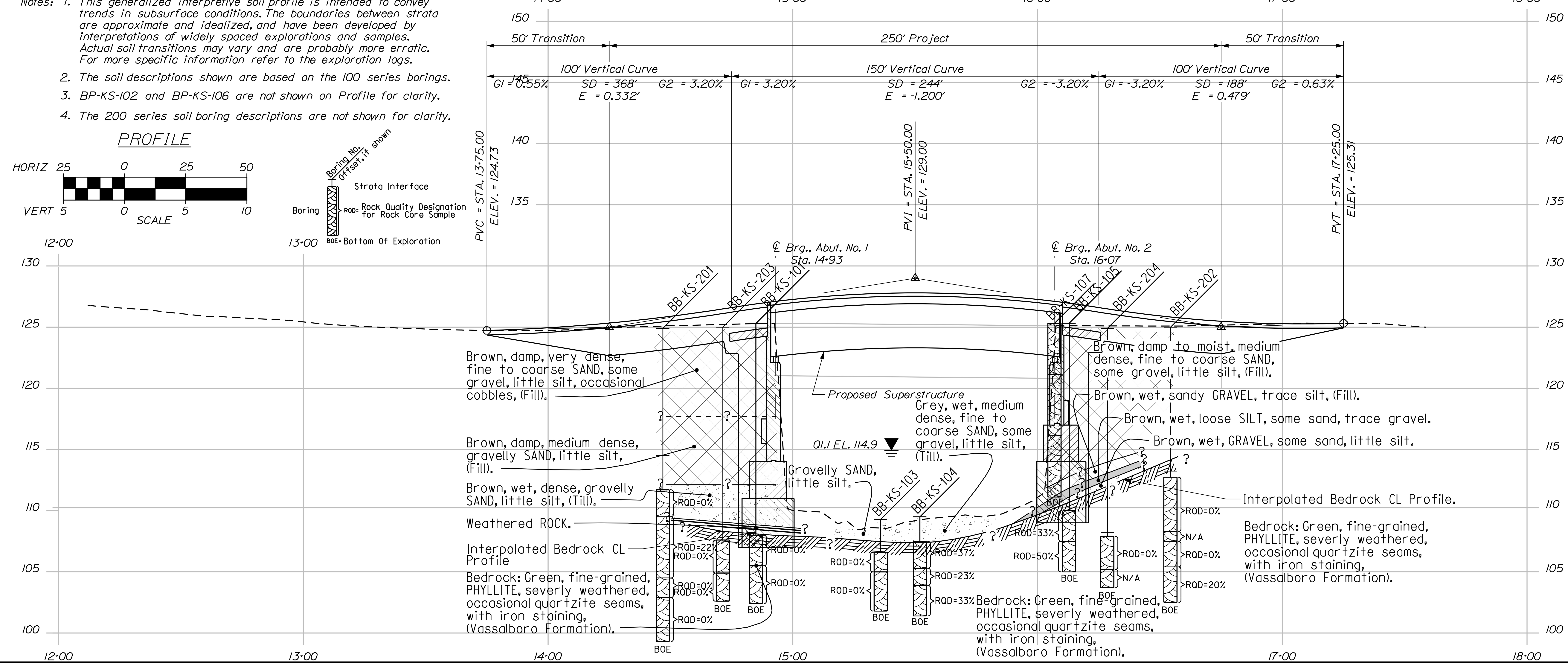


UTM GRID AND 1975 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Filename: ...\GEOTECH\MSTA\006_BLP&ISP1.dgn Division: GEOTECH Username: terry.white Date:11/4/2010



Notes:
1. This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.
2. The soil descriptions shown are based on the 100 series borings.
3. BP-KS-102 and BP-KS-106 are not shown on Profile for clarity.
4. The 200 series soil boring descriptions are not shown for clarity.



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BR-1757(600)X

BRIDGE NO. 2975

PIN 17576.00

BRIDGE PLANS

		BY	DATE
PROJ. MANAGER	S. BODGE		
DESIGN-DETAILED	M.MOREAU	T.WHITE	JUNE 2010
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE

VILLAGE BRIDGE
KENDUSKEAG STREAM
KENDUSKEAG PENOBSCOT COUNTY

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 4

Filename: ...\msta\007_BORING LOGS1.dgn

Division: GEOTECH

Username: terry.white

Date:11/4/2010

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Boring No.: BP-KS-102

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	4.5"
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	3/21/05-3/21/05	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	14+84.6, 3.9 Lt.	Casing ID/OD:	N/A	Water Level*:	None Observed

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

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0						SSA		No descriptions taken.	
18.00							107.30	Weathered ROCK.	
19.10							106.20	Bottom of Exploration at 19.1 feet below ground surface. REFUSAL	

Remarks:

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

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

Page 1 of 1 — Boring No.: BP-KS-102

Boring No.: BB-KS-101

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	4.5" SSA
Operator:	B.Wilder/G. Lidstone	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	M. Moreau	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	3/21/05-3/21/05	Drilling Method:	Cased Wash Boring	Core Barrel:	NW
Boring Location:	14+84.9, 6.1 Rt.	Casing ID/OD:	HW	Water Level*:	12.5' bgs

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger
Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods
Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value
1D	24/24	1.00 - 3.00	23/43/37/38	80
2D	24/15	3.00 - 5.00	25/32/25/28	57
3D	12/12	5.00 - 6.00	16/55(6")	---
4D	24/8	7.50 - 9.50	7/5/6/5	11
5D	24/12	10.00 - 12.00	3/5/7/8	12
6D	24/9	12.50 - 14.50	22/17/25/10	42
7D	24/16	15.00 - 17.00	7/4/18/30	22
R1	30/30	17.30 - 19.80	RQD = 0%	
R2	37.2/37.2	19.80 - 22.90	RQD = 0%	

Casing Blows: SSA, 43, 39, 25/3, 50, 50, 45, 150, a50 NW

Depth (ft.)	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0	124.80	Pavement	
0.50		Brown, damp, very dense, well graded, fine to course SAND, some gravel, little silt, occasional cobbles, (Fill).	G#181080 A-1-b, SM WC=6.2%
		Similar to above, some silt.	G#181081 A-1-b, SM WC=7.0%
		Similar to above, some gravel. Refusal on spoon at 6.0' bgs. Cobble from 6.0-6.2' bgs.	G#181082 A-2-4, SM WC=6.7%
7.50	117.80	Brown, damp, medium dense, gravelly SAND, little silt, (Fill).	G#181083 A-1-a, SM WC=6.0%
		Brown, damp, medium dense, fine to course SAND, some gravel, some silt.	G#181084 A-1-b, SM WC=7.0%
12.50	112.80	Brown, wet, dense, gravelly SAND, little silt, (Till).	G#181085 A-1-b, SM WC=24.8%
		Brown, wet, dense, fine to coarse SAND, some gravel, little silt and organics, wood (Till).	G#181086 A-1-b, SM WC=28.6%
16.50	108.80	Weathered ROCK. a50 blows for 0.3'. Refusal at 17.1' bgs. Roller coned ahead from 17.1-17.3' bgs.	
17.30	108.00	Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, (Vassalboro Formation). R1: Core Times (min:sec) 17.3-18.3' (6:30) 18.3-19.8' (7:00) 100% Recovery R2: Core Times (min:sec) 19.8-20.8' (8:00) 20.8-21.8' (7:00) 21.8-22.8' (8:00) 22.8-22.9' (4:00) 100% Recovery	
22.90	102.40	Bottom of Exploration at 22.9 feet below ground surface.	

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1 — Boring No.: BB-KS-101

Boring No.: BB-KS-103

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	109.3	Auger ID/OD:	4.5" SSA
Operator:	B.Wilder/G. Lidstone	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	M. Moreau	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	3/22/05-3/22/05	Drilling Method:	Cased Wash Boring	Core Barrel:	NW
Boring Location:	15+35.7, 13.2 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value
R1	19.2/19.2	2.70 - 4.30	RQD = 0%	
R2	38.4/38.4	4.30 - 7.50	RQD = 0%	

Casing Blows: 30, 43, a300 NW

Depth (ft.)	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0		Gravelly SAND, little silt in wash water. a300 blows for 0.7'.	
2.70	106.60	Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, (Vassalboro Formation). R1: Core Times (min:sec) 2.7-3.7' (8:00) 3.7-4.3' (5:00) 100% Recovery R2: Core Times (min:sec) 4.3-5.3' (6:00) 5.3-6.3' (7:00) 6.3-7.3' (7:00) 7.3-7.5' (5:00) 100% Recovery	
7.50	101.80	Bottom of Exploration at 7.5 feet below ground surface.	

Remarks:
16.8' from middle of sidewalk to Ground.
Sidewalk elevation taken from spot elevation from topo plans.

Page 1 of 1 — Boring No.: BB-KS-103

Boring No.: BB-KS-104

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	109.5	Auger ID/OD:	4.5" SSA
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	3/23/05-3/23/05	Drilling Method:	Cased Wash Boring	Core Barrel:	NW
Boring Location:	15+51.8, 8.3 Rt.	Casing ID/OD:	HW	Water Level*:	At Ground Surface

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value
1D	21/13	0.00 - 1.75	7/11/14/50(3")	25
R1	26.4/26.4	2.00 - 4.20	RQD = 37%	
R2	16.8/16.8	4.20 - 5.60	RQD = 23%	
R3	30/30	5.60 - 8.10	RQD = 33%	

Casing Blows: 30, 125, NW

Depth (ft.)	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0		Grey, wet, medium dense, fine to coarse SAND, some gravel, little silt, (Till).	G#181087 A-1-b, SM WC=11.1%
1.75	107.75	Rock fragments, weathered rock at 1.75' bgs.	
2.00	107.50	Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, (Vassalboro Formation) . R1: Core Times (min:sec) 2.0-3.0' (7:30) 3.0-4.0 (11:00) 4.0-4.2' (8:00) 100% Recovery R2: Core Times (min:sec) 4.2-5.2' (6:30) 5.2-5.6' (6:00) 100% Recovery R3: Core Times (min:sec) 5.6-6.6' (8:00) 6.6-7.6' (7:00) 7.6-8.1 (6:00) 100% Recovery	
8.10	101.40	Bottom of Exploration at 8.1 feet below ground surface.	

Remarks:
16.0' from Bridge Deck to Ground. Bridge Deck 1.1' thick.

Page 1 of 1 — Boring No.: BB-KS-104

Boring No.: BB-KS-107

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	N/A
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	N/A
Logged By:	G. Lidstone	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	3/25/05-3/25/05	Drilling Method:	Core thru Bridge Abut#2	Core Barrel:	NQ-2"
Boring Location:	16+06.8, 8.5 Rt.	Casing ID/OD:	N/A	Water Level*:	N/A

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value
R1	50.4/50.4	0.00 - 4.20		
R2	60/60	4.20 - 9.20		
R3	60/60	9.20 - 14.20		

Casing Blows: NQ

Depth (ft.)	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0		CONCRETE R1: Core Times (min:sec) 0.0-1.0' (4:08) 1.0-2.0' (9:13) 2.0-3.0' (4:57) 3.0-4.0' (10:02) 4.0-4.2' (3:00) No loss of drilling water.	
		R2: Core Times (min:sec) 4.2-5.2' (2:50) 5.2-6.2' (3:02) 6.2-7.2' (2:58) 7.2-8.2' (2:17) 8.2-9.2' (2:15) No loss of drilling water.	
		R3: Core Times (min:sec) 9.2-10.2' (1:45) 10.2-11.2' (1:52) 11.2-12.2' (2:05) 12.2-13.2' (2:12) 13.2-14.2' (2:15) No loss of drilling water	
14.20	111.10	Bottom of Exploration at 14.2 feet below ground surface.	

Remarks:

Page 1 of 1 — Boring No.: BB-KS-107

Boring No.: BB-KS-105

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	4.5" SSA
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	G. Lidstone	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	3/28/05-3/29/05	Drilling Method:	Cased Wash Boring	Core Barrel:	NW
Boring Location:	16+12.7, 5.6 Lt.	Casing ID/OD:	NQ-2"	Water Level*:	12.0' bgs

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value
1D	24/13	1.00 - 3.00	9/13/10/15	23
2D	24/14	3.00 - 5.00	19/16/17/18	33
3D	24/13	5.00 - 7.00	10/14/12/9	26
4D	24/12	7.50 - 9.50	6/7/7/8	14
5D	24/9	10.00 - 12.00	5/7/8/13	15
6D/AB	24/8	13.00 - 15.00	35/3/9/47	12
R1	30/27	15.30 - 17.80	RQD = 33%	
R2	30/30	17.80 - 20.30	RQD = 50%	

Casing Blows: SSA, 22, 28, 117, 47, 68, NQ

Depth (ft.)	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0	125.05	Pavement	
0.25	124.30	Brown, damp, fine to course SAND, some gravel, little silt, (Fill).	G#181088 A-1-a, SW-SM WC=9.1%
1.00		Brown, moist, medium dense, fine to coarse SAND, some gravel, little silt, (Fill).	G#181089 A-1-b, SM WC=6.4%
		Similar to above.	G#181090 A-1-b, SW-SM WC=6.2%
		Similar to above.	G#181091 A-1-b, SM WC=5.3%
		Similar to above.	G#181092 A-1-b, SW-SM WC=6.8%
12.00	113.30	Brown, wet, sandy GRAVEL, trace silt, (Fill).	
13.40	111.90	(6D/A) 13.4-14.2' bgs. Brown, wet, loose, SILT, some sand, trace gravel.	G#181093 A-4, ML WC=49.6%
14.20	111.10	(6D/B) 14.2-14.9' bgs. Brown, wet, GRAVEL, some sand, little silt.	G#181094 A-1-a, GP-GM WC=14.0%
14.90	110.40	Weathered ROCK. Washed ahead from 15.0-15.3' bgs.	
15.30	110.00	Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, (Vassalboro Formation). R1: Core Times (min:sec) 15.3-16.3' (4:02) 16.3-17.3' (4:15) 17.3-17.8 (3:00) R2: Core Times (min:sec) 17.8-18.8' 18.8-19.8' 19.8-20.3'	
20.30	105.00	Bottom of Exploration at 20.3 feet below ground surface.	

Remarks:

Page 1 of 1 — Boring No.: BB-KS-105

Boring No.: BP-KS-106

Project:	Village Bridge #2975 over Kenduskeag Stream	Location:	Stetson Road, Kenduskeag, Maine	PIN:	17576.00
Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	4.5"
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	3/21/05-3/21/05	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	16+12.7, 7.5 Rt.	Casing ID/OD:	N/A	Water Level*:	12.5' bgs

Depth (ft.)	Casing Blows	Elevation (ft.)	Visual Description and Remarks
0	SSA		No descriptions taken.
14.30		111.00	Weathered ROCK.
14.50		110.80	Bottom of Exploration at 14.5 feet below ground surface. REFUSAL

Remarks:

Page 1 of 1 — Boring No.: BP-KS-106

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BR-1757(600)X

BRIDGE NO. 2975 — PIN 17576.00 — BRIDGE PLANS

		BY	DATE
PROJ. MANAGER	S. BODGE		
DESIGN-DETAILED	M.MOREAU	T.WHITE	JUNE 2010
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

VILLAGE BRIDGE
KENDUSKEAG STREAM
KENDUSKEAG PENOBSCOT COUNTY

BORING LOGS

SHEET NUMBER 3 OF 4

Filename: ...\msta\008_BORING LOGS2.dgn Division: GEOTECH Username: terry.white Date:11/4/2010

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-201
PIN: 17576.00

Driller:	MaineDOT	Elevation (ft.)	124.9	Auger ID/OD:	5" SSA
Operator:	Giguere/Giles/Daggett	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	Be Schonewald	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	8/24 /10; 07:30-10:40	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	14+46.9, 11.2 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
						SSA	
1D	24/8	1.00 - 3.00	5/5/3/6	8	11		
						NQ-2	
MD	24/0	6.10 - 8.10	2/2/1/1	3	4	---	
						18	
						81	
						[a]40	
R1	60/36	10.40 - 15.40	RQD = [b]0%			NQ-2	114.50
							111.70
R2	60/54	15.40 - 20.40	RQD = 22%				109.50
R3	19.2/18	20.40 - 22.00	RQD = 0%				104.50
							102.90
R4	43.2/30	22.00 - 25.60	RQD = 0%				
							99.30

Visual Description and Remarks

Brown, damp, medium dense, gravelly, fine to medium SAND, trace to little silt, trace coarse sand, (Fill).

Cored through Boulder from 5.2-6.1 ft bgs.

Failed sample attempt, likely missed sample and low blow counts due to disturbance from coring boulder. No resample for same reason.

[a]40 blows for 8".

10.40
Top 2.8 ft R1: Granite Boulders or Blocks, (Fill).
[b]RQD applies to bedrock, not overlying boulders/blocks.

13.20
Top of Bedrock at Elev. 111.7 ft.
R1:Bedrock: Greyish green, fine grained, hard, slightly weathered, calcareous muscovite PHYLLITE. Evidence of quartz seam. Lower portion of sample consists primarily of subrounded to sunangular gravel. [Vassalboro Formation]
R1:Core Times (min:sec)
10.4-11.4 ft (2:45)
11.4-12.4 ft (3:20)
12.4-13.4 ft (1:45)
13.4-14.4 ft (2:20)
14.4-15.4 ft (2:10) 60% Recovery

15.40
R2:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered, calcareous muscovite PHYLLITE with evidence of thin, steeply dipping bedding. Numerous calcite, quartz and quartz-feldspar veins and seams. Highly weathered seam from 18.6- 19.1 ft. Close to moderately close, low and high angle, stepped and undulating, rough, fresh to discolored, tight to open breaks along bedding and across calcite and quartz veins and seams. Evidence of mud seams in bottom 12". [Vassalboro Formation]
R2:Core Times (min:sec)
15.4-16.4 ft (2:55)
16.4-17.4 ft (4:10)
17.4-18.4 ft (5:30)
18.4-19.4 ft (4:15)
19.4-20.4 ft (4:05) 90% Recovery

20.40
R3:Bedrock: Same as R2 with more frequent, typically vertical breaks. Bottom of sample consists of angular gravel.[Vassalboro Formation]

R3:Core Times (min:sec)
20.4-21.4 ft (3:20)
21.4-22.0 ft (-:--) 94% Recovery

22.00
R4:Bedrock: Same as R2. Core sample consists of angular gravel.[Vassalboro Formation]

R4:Core Times (min:sec)
22.0-23.0 ft (-:--)
23.0-24.0 ft (3:20)
24.0-25.0 ft (2:55)
25.0-25.6 ft (-:--) 75% Recovery

25.60
Bottom of Exploration at 25.60 feet below ground surface.

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

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

Page 1 of 1

Boring No.: BB-KS-201

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-203
PIN: 17576.00

Driller:	MaineDOT	Elevation (ft.)	125.0	Auger ID/OD:	5" SSA
Operator:	Giguere/Giles/Daggett	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	Be Schonewald	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	8/24/10; 10:50-14:05	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	14+71.4, 8.0 Rt.	Casing ID/OD:	HW & NW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
						SSA	124.40
1D	24/16	1.00 - 3.00	10/10/9/7	19	27		
2D	24/10	5.00 - 7.00	3/4/5/5	9	13		
3D	24/11	10.00 - 12.00	8/10/5/6	15	21	78	
						69	
						235	
						WASH	111.20
4D	24/11	15.00 - 17.00	4/10/38/33	48	67		
							108.30
R1	32.4/23	17.40 - 20.10	RQD = 0%			NQ-2	107.60
R2	27.6/26	20.10 - 22.40	RQD = 0%				104.90
							102.60

Visual Description and Remarks

PAVEMENT.
0.60
Brown, damp, medium dense, fine to coarse sandy GRAVEL, trace to little silt, (Fill).

Brown, damp, medium dense, gravelly fine to coarse SAND, trace to little silt, (Fill).

Brown, damp, medium dense, gravelly fine to coarse SAND, trace to little silt, (Fill).

Roller Bit through 0.8 ft thick timber at approximately 13.0 ft bgs.
13.80
Greenish grey, very dense, fine to coarse sandy GRAVEL, little silt, (Till). Bottom 4" of sample consists primarily of crushed rock.
16.70
Top of Bedrock at Elev. 108.3 ft.
17.40
R1:Bedrock: Greyish green, fine grained, hard, slightly weathered calcareous muscovite PHYLLITE. Upper 1.5 ft contains more biotite and is coarser grained; possible schist. Core sample consists primarily of subrounded to subangular gravel. [Vassalboro Formation]
R1:Core Times (min:sec)
17.4-18.4 ft (4:25)
18.4-19.4 ft (5:00)
19.4-20.1 ft (-:--) 71% Recovery
20.10
R2:Bedrock: Same as lower portion of R1. Core sample consists of angular gravel and slabs. Evidence of vertical breaks along bedding. Evidence of mud seams.
R2:Core Times (min:sec)
20.1-21.1 ft (-:--)
21.1-22.1 ft (4:10)
22.1-22.4 ft (3:35) 94% Recovery
22.40
Bottom of Exploration at 22.40 feet below ground surface.

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

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

Page 1 of 1

Boring No.: BB-KS-203

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-204
PIN: 17576.00

Driller:	MaineDOT	Elevation (ft.)	124.9	Auger ID/OD:	5" SSA
Operator:	Giguere/Giles/Daggett	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	Be Schonewald	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	8/24/10-8/25/10	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	16+28.5, 6.4 Rt.	Casing ID/OD:	HW & NW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
						SSA	124.70
1D	24/15	1.00 - 3.00	12/10/7/8	17	24		
2D	24/15	5.00 - 7.00	5/4/7/5	11	15		
3D	4.8/3	10.00 - 10.40	50(4.8")	---		---	

						8	
						26	
4D/AB	24/9	15.00 - 17.00	1/2/2/13	4	6		
							108.20
							107.90
R1	32.4/26	17.00 - 19.70	RQD = 0%			NQ-2	
R2	18/18	19.70 - 21.20	RQD = 0%				105.20
							103.70

Visual Description and Remarks

PAVEMENT.
0.20
Brown, damp, medium dense, fine to coarse SAND, some gravel, trace to little silt, (Fill).

Brown, dry, medium dense, gravelly, fine to coarse SAND, trace to little silt, (Fill).

Brown, moist, fine to coarse SAND, some gravel, little silt, rock in tip of spoon, (Fill).
Probable Boulder at 10.4 ft bgs.

HW Casing break at 12.5 ft . Moved ahead approximately 3 ft and continued boring with NW Casing.

4D/A (15.0-16.7 ft). Brown, loose, very fine sandy ORGANIC SILT with wood layers bottom and top, (Fill).
16.70
4D/B (16.7-17.0 ft). Greyish green crushed ROCK.
Top of Bedrock at Elev. 108.2 ft.
17.00
R1:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered calcareous muscovite PHYLLITE, with evidence of thin, vertical bedding. One highly weathered quartz and feldspar seam. Edivence (mud) of decomposition of calcite-rich beds. Most of core sample is angular gravel; broken along vertical bedding. [(Vassalboro Formation)
R1:Core Times (min:sec)
17.0-18.0 ft (3:45)
18.0-19.0 ft (3:00)
19.0-19.7 ft (-:--) 80% Recovery
19.70
R2:Bedrock: Same as R1.
R2:Core Times (min:sec)
19.7-20.0 ft (-:--)
20.0-21.0 ft (3:55)
21.0-21.2 ft (-:--) 100% Recovery
21.20
Bottom of Exploration at 21.20 feet below ground surface.

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

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

Page 1 of 1

Boring No.: BB-KS-204

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-202
PIN: 17576.00

Driller:	MaineDOT	Elevation (ft.)	125.0	Auger ID/OD:	5" SSA
Operator:	Giguere/Giles/Daggett	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	Be Schonewald	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	8/25/10; 9:35-12:35	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	16+54.3, 9.7 Lt.	Casing ID/OD:	NW	Water Level*:	8.9 ft bgs.
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
						SSA	124.45
1D	24/18	1.00 - 3.00	12/25/12/14	37	52		
2D	24/7	5.00 - 7.00	3/4/3/2	7	10		
3D/AB	24/17	10.00 - 12.00	13/17/18/24	35	49	WASH	114.20
						AHEAD	113.00
R1	50.4/48	12.50 - 16.70	RQD = 0%			NQ-2	112.50
R2	9.6/9.6	16.70 - 17.50	RQD = 0%				108.30
R3	25.2/ 25.2	17.50 - 19.60	RQD = 0%				107.50
R4	34.8/32	19.60 - 22.50	RQD = 20%				105.40
							102.50

Visual Description and Remarks

PAVEMENT.
0.55
Brown, damp, very dense, gravelly fine to coarse SAND, trace to little silt, (Fill).

Brown, damp, loose, fine to medium SAND, some gravel, little silt, trace coarse sand, (Fill). Tip of spoon moist to wet.

3D/A (10.0-10.8 ft). Brown, wet, dense fine to medium SAND, trace to little silt, (Fill).
10.80
3D/B (10.8-12.0 ft). Brown, dense, gravelly fine to coarse SAND, little to some silt. Bottom 12" decomposed rock, (Till) .
12.00
Top of Bedrock at Elev. 113.0 ft.
12.50
R1:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered, calcereous muscovite PHYLLITE, with thin, steeply dipping to vertical bedding. Very close, high angle, stepped and undulating, rough to smooth, fresh to decomposed, open breaks along bedding. Much of core sample is angular gravel; broked along bedding. [Vassalboro Formation]
R1:Core Times (min:sec)
12.5-13.5 ft (4:40)
13.5-14.5 ft (4:30)
14.5-15.5 ft (5:25)
15.5-16.5 ft (6:00)
16.5-16.7 ft (-:--) 95% Recovery
16.70
R2:Bedrock: Same as R1. Core sample consists primarily of angular gravel; broken along vertical bedding. Evidence of decomposition of calcite-rich layers (mud). No complete 1 ft runs for core times.
100% Recovery
17.50
R3:Bedrock: Same as R1.
R3:Core Times (min:sec)
17.5-18.5 ft (10:25)
18.5-19.5 ft (7:30)
19.5-19.6 ft (-:--) 100% Recovery
19.60
R4:Bedrock: same as R1, except fresh, more intact.
R4:Core Times (min:sec)
19.6-20.6 ft (-:--)
20.6-21.6 ft (7:00)
21.6-22.5 ft (6:20) 92% Recovery
22.50
Bottom of Exploration at 22.50 feet below ground surface.

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

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

Page 1 of 1

Boring No.: BB-KS-202

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BR-1757(600)X

PIN 17576.00

BRIDGE NO. 2975

BRIDGE PLANS

PROJ. MANAGER	S. BODGE	BY	DATE
DESIGN-DETAILED	M.MOREAU	T.WHITE	JUNE 2010
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

VILLAGE BRIDGE
KENDUSKEAG STREAM
KENDUSKEAG PENOBSCOT COUNTY

BORING LOGS

SHEET NUMBER

4

OF 4

Appendix A

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)
Color (Munsell color chart)
Moisture (dry, damp, moist, wet, saturated)
Density/Consistency (from above right hand side)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc., if applicable)
Cementation (weak, moderate, or strong, if applicable, ASTM D 2488)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation
Groundwater level

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

TERMS DESCRIBING DENSITY/CONSISTENCY

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

Modified Burmister System

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

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

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

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

Rock Quality Designation (RQD):

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

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

Correlation of RQD to Rock Mass Quality

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

Desired Rock Observations: (in this order)
Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -tightness (tight, open or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A
Recovery

Sample Container Labeling Requirements:

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

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Village Bridge #2975 over Kenduskeag Stream **Location:** Stetson Road, Kenduskeag, Maine	**Boring No.:** BB-KS-101 **PIN:** 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.3	**Auger ID/OD:**	4½" SSA
Operator:	B.Wilder/G. Lidstone	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	M. Moreau	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	3/21/05-3/21/05	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NW
Boring Location:	14+84.9, 6.1 Rt.	**Casing ID/OD:**	HW	**Water Level*:**	12.5' bgs
Hammer Efficiency Factor:	0.6	**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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
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HSA = Hollow Stem Auger
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WOR/C = weight of rods or casing
WO1P = Weight of one person
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T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	124.80		Pavement ——0.50	
	1D	24/24	1.00 - 3.00	23/43/37/38	80	80				Brown, damp, very dense, well graded, fine to coarse SAND, some gravel, little silt, occasional cobbles, (Fill).	G#181080 A-1-b, SM WC=6.2%
	2D	24/15	3.00 - 5.00	25/32/25/28	57	57				Similar to above, some silt.	G#181081 A-1-b, SM WC=7.0%
5	3D	12/12	5.00 - 6.00	16/55(6")	---					Similar to above, some gravel. Refusal on spoon at 6.0' bgs. Cobble from 6.0-6.2' bgs.	G#181082 A-2-4, SM WC=6.7%
	4D	24/8	7.50 - 9.50	7/5/6/5	11	11		117.80		- - - 7.50 Brown, damp, medium dense, gravelly SAND, little silt, (Fill).	G#181083 A-1-a, SM WC=6.0%
10	5D	24/12	10.00 - 12.00	3/5/7/8	12	12	43			Brown, damp, medium dense, fine to coarse SAND, some gravel, some silt.	G#181084 A-1-b, SM WC=7.0%
							39				
	6D	24/9	12.50 - 14.50	22/17/25/10	42	42	25/3	112.80		——12.50 Brown, wet, dense, gravelly SAND, little silt, (Till).	G#181085 A-1-b, SM WC=24.8%
							50				
							50				
15	7D	24/16	15.00 - 17.00	7/4/18/30	22	22	45			- - - Brown, wet, medium dense, fine to coarse SAND, some gravel, little silt and organics, wood (Till).	G#181086 A-1-b, SM WC=28.6%
							150	108.80		——16.50 Weathered ROCK.	
	R1	30/30	17.30 - 19.80	RQD = 0%			a50 NW	108.00		a50 blows for 0.3'. Refusal at 17.1' bgs. Roller coned ahead from 17.1-17.3' bgs. ——17.30 Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation]. R1: Core Times (min:sec) 17.3-18.3' (6:30) 18.3-19.8' (7:00) 100% Recovery	
	R2	37.2/37.2	19.80 - 22.90	RQD = 0%						R2: Core Times (min:sec) 19.8-20.8' (8:00) 20.8-21.8' (7:00) 21.8-22.8' (8:00) 22.8-22.9' (4:00) 100% Recovery	
20											
								102.40		——22.90 **Bottom of Exploration at 22.90 feet below ground surface.**	
25											

Remarks:

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BP-KS-102
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.3	**Auger ID/OD:**	4½"
Operator:	G. Lidstone/B. Hyland	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	3/21/05-3/21/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	14+84.6, 3.9 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	1.0	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			No descriptions taken.	
5											
10											
15											
								107.30		Weathered ROCK. 18.00	
								106.20		19.10	
										Bottom of Exploration at 19.10 feet below ground surface. REFUSAL	
20											
25											

Remarks:

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-103
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	109.3	**Auger ID/OD:**	4½" SSA
Operator:	B.Wilder/G. Lidstone	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	M. Moreau	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	3/22/05-3/22/05	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NW
Boring Location:	15+35.7, 13.2 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	1.0	**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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							30			Gravelly SAND, little silt in wash water.	
							43				
	R1	19.2/19.2	2.70 - 4.30	RQD = 0%			a300 NW	106.60		a300 blows for 0.7'. 2.70	
										Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation]. R1: Core Times (min:sec) 2.7-3.7' (8:00) 3.7-4.3' (5:00) 100% Recovery	
	R2	38.4/38.4	4.30 - 7.50	RQD = 0%						R2: Core Times (min:sec) 4.3-5.3' (6:00) 5.3-6.3' (7:00) 6.3-7.3' (7:00) 7.3-7.5' (5:00) 100% Recovery	
5								101.80		7.50	
										Bottom of Exploration at 7.50 feet below ground surface.	
10											
15											
20											
25											

Remarks:

16.8' from middle of sidewalk to Ground.
Sidewalk elevation taken from spot elevation from topo plans.

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

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Boring No.: BB-KS-103

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-104
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	109.5	**Auger ID/OD:**	4½" SSA
Operator:	G. Lidstone/B. Hyland	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	3/23/05-3/23/05	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NW
Boring Location:	15+51.8, 8.3 Rt.	**Casing ID/OD:**	HW	**Water Level*:**	At Ground Surface
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	21/13	0.00 - 1.75	7/11/14/50(3")	25	25	30			Grey, wet, medium dense, fine to coarse SAND, some gravel, little silt, (Till).	G#181087 A-1-b, SM WC=11.1%
							125	107.75		1.75	
								107.50		Rock fragments, weathered rock at 1.75' bgs.	
	R1	26.4/26.4	2.00 - 4.20	RQD = 37%			NW			2.00	
										Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation] . R1: Core Times (min:sec) 2.0-3.0' (7:30) 3.0-4.0 (11:00) 4.0-4.2' (8:00) 100% Recovery	
	R2	16.8/16.8	4.20 - 5.60	RQD = 23%						R2: Core Times (min:sec) 4.2-5.2' (6:30) 5.2-5.6' (6:00) 100% Recovery	
5	R3	30/30	5.60 - 8.10	RQD = 33%						R3: Core Times (min:sec) 5.6-6.6' (8:00) 6.6-7.6' (7:00) 7.6-8.1 (6:00) 100% Recovery	
								101.40		8.10	
										Bottom of Exploration at 8.10 feet below ground surface.	
10											
15											
20											
25											

Remarks:

16.0' from Bridge Deck to Ground. Bridge Deck 1.1' thick.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Village Bridge #2975 over Kenduskeag Stream Location: Stetson Road, Kenduskeag, Maine	Boring No.: BB-KS-105 PIN: 17576.00

Driller:	MaineDOT	Elevation (ft.)	125.3	Auger ID/OD:	4½" SSA
Operator:	G. Lidstone/B. Hyland	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	G. Lidstone	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	3/28/05-3/29/05	Drilling Method:	Cased Wash Boring	Core Barrel:	NW
Boring Location:	16+12.7, 5.6 Lt.	Casing ID/OD:	NQ-2"	Water Level*:	12.0' bgs
Hammer Efficiency Factor:	0.6	Hammer Type:	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
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MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	125.05		Pavement — 0.25	
	1D	24/13	1.00 - 3.00	9/13/10/15	23	23		124.30		Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill). — 1.00	G#181088 A-1-a, SW-SM WC=9.1%
	2D	24/14	3.00 - 5.00	19/16/17/18	33	33				Brown, moist, dense, fine to coarse SAND, some gravel, little silt, (Fill).	G#181089 A-1-b, SM WC=6.4%
5	3D	24/13	5.00 - 7.00	10/14/12/9	26	26				Similar to above except medium dense.	G#181090 A-1-b, SW-SM WC=6.2%
	4D	24/12	7.50 - 9.50	6/7/7/8	14	14				Similar to above.	G#181091 A-1-b, SM WC=5.3%
10	5D	24/9	10.00 - 12.00	5/7/8/13	15	15	22			Similar to above.	G#181092 A-1-b, SW-SM WC=6.8%
							28				
							117	113.30		— 12.00 Brown, wet, sandy GRAVEL, trace silt, (Fill).	
	6D/AB	24/8	13.00 - 15.00	35/3/9/47	12	12	47	111.90		— 13.40 (6D/A) 13.4-14.2' bgs. Brown, wet, stiff, SILT, some sand, trace gravel.	G#181093 A-4, ML WC=49.6%
							68	111.10		— 14.20 (6D/B) 14.2-14.9' bgs. Brown, wet, GRAVEL, some sand, little silt.	G#181094 A-1-a, GP-GM WC=14.0%
15	R1	30/27	15.30 - 17.80	RQD = 33%			NQ	110.40 110.00		— 14.90 Weathered ROCK. Washed ahead from 15.0-15.3' bgs. — 15.30	
	R2	30/30	17.80 - 20.30	RQD = 50%						Bedrock: Green, fine-grained, PHYLLITE, severly weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation]. R1: Core Times (min:sec) 15.3-16.3' (4:02) 16.3-17.3' (4:15) 17.3-17.8 (3:00)	
20								105.00		R2: Core Times (min:sec) 17.8-18.8' 18.8-19.8' 19.8-20.3' — 20.30	
										Bottom of Exploration at 20.30 feet below ground surface.	
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BP-KS-106
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.3	**Auger ID/OD:**	4½"
Operator:	G. Lidstone/B. Hyland	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	3/21/05-3/21/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	16+12.7, 7.5 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	12.5' bgs
Hammer Efficiency Factor:	1.0	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			No descriptions taken.	
								111.00		14.30	
								110.80		Weathered ROCK. 14.50	
15										**Bottom of Exploration at 14.50 feet below ground surface.** REFUSAL	
5											
10											
20											
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-107
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.3	**Auger ID/OD:**	N/A
Operator:	G. Lidstone/B. Hyland	**Datum:**	NAVD 88	**Sampler:**	N/A
Logged By:	G. Lidstone	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	3/25/05-3/25/05	**Drilling Method:**	Core thru Bridge Abut#2	**Core Barrel:**	NQ-2"
Boring Location:	16+06.8, 8.5 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	N/A
Hammer Efficiency Factor:	1.0	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
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MD = Unsuccessful Split Spoon Sample attempt
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MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	50.4/50.4	0.00 - 4.20				NQ			CONCRETE R1: Core Times (min:sec) 0.0-1.0' (4:08) 1.0-2.0' (9:13) 2.0-3.0' (4:57) 3.0-4.0' (10:02) 4.0-4.2' (3:00) No loss of drilling water.	
5	R2	60/60	4.20 - 9.20							R2: Core Times (min:sec) 4.2-5.2' (2:50) 5.2-6.2' (3:02) 6.2-7.2' (2:58) 7.2-8.2' (2:17) 8.2-9.2' (2:15) No loss of drilling water.	
10	R3	60/60	9.20 - 14.20							R3: Core Times (min:sec) 9.2-10.2' (1:45) 10.2-11.2' (1:52) 11.2-12.2' (2:05) 12.2-13.2' (2:12) 13.2-14.2' (2:15) No loss of drilling water	
								111.30		14.00	
								111.10		Gravel 14.20	
15										**Bottom of Exploration at 14.20 feet below ground surface.**	
20											
25											

Remarks:

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

Boring No.: BB-KS-107

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-201
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24 /10; 07:30-10:40	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	14+46.9, 11.2 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA				
	1D	24/8	1.00 - 3.00	5/5/3/6	8	11				Brown, damp, medium dense, gravelly, fine to medium SAND, trace to little silt, trace coarse sand, (Fill).	
5							NQ-2			Cored through Boulder from 5.2-6.1 ft bgs.	
	MD	24/0	6.10 - 8.10	2/2/1/1	3	4	---			Failed sample attempt, likely missed sample and low blow counts due to disturbance from coring boulder. No resample for same reason.	
							18				
							81				
							a40			a40 blows for 8".	
10	R1	60/36	10.40 - 15.40	RQD = b0%			NQ-2	114.50		10.40 Top 2.8 ft R1: Granite Boulders or Blocks, (Fill). bRQD applies to bedrock, not overlying boulders/blocks.	
								111.70		13.20 Top of Bedrock at Elev. 111.7 ft. R1:Bedrock: Greyish green, fine grained, hard, slightly weathered, calcareous muscovite PHYLLITE. Evidence of quartz seam. Lower portion of sample consists primarily of subrounded to sunangular gravel. [Vassalboro Formation] _R1:Core Times (min:sec) 10.4-11.4 ft (2:45) 11.4-12.4 ft (3:20) 12.4-13.4 ft (1:45) 13.4-14.4 ft (2:20) 14.4-15.4 ft (2:10) 60% Recovery	
15	R2	60/54	15.40 - 20.40	RQD = 22%				109.50		15.40 R2:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered, calcareous muscovite PHYLLITE with evidence of thin, steeply dipping bedding. Numerous calcite, quartz and quartz-feldspar veins and seams. Highly weathered seam from 18.6- 19.1 ft. Close to moderately close, low and high angle, stepped and undulating, rough, fresh to discolored, tight to open breaks along bedding and across calcite and quartz veins and seams. Evidence of mud seams in bottom 12". [Vassalboro Formation] R2:Core Times (min:sec) 15.4-16.4 ft (2:55) 16.4-17.4 ft (4:10) 17.4-18.4 ft (5:30)	
20	R3	19.2/18	20.40 - 22.00	RQD = 0%				104.50			
	R4	43.2/30	22.00 - 25.60	RQD = 0%				102.90			
25											

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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:** Village Bridge #2975 over Kenduskeag Stream **Location:** Stetson Road, Kenduskeag, Maine	**Boring No.:** BB-KS-201 **PIN:** 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24 /10; 07:30-10:40	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	14+46.9, 11.2 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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MD = Unsuccessful Split Spoon Sample attempt
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MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										18.4-19.4 ft (4:15)	
								99.30		19.4-20.4 ft (4:05) 90% Recovery	
										20.40	
										R3:Bedrock: Same as R2 with more frequent, typically vertical breaks. Bottom of sample consists of angular gravel.[Vassalboro Formation]	
										R3:Core Times (min:sec) 20.4-21.4 ft (3:20) 21.4-22.0 ft (-:--) 94% Recovery	
										22.00	
30										R4:Bedrock: Same as R2. Core sample consists of angular gravel.[Vassalboro Formation]	
										R4:Core Times (min:sec) 22.0-23.0 ft (-:--) 23.0-24.0 ft (3:20) 24.0-25.0 ft (2:55) 25.0-25.6 ft (-:--) 75% Recovery	
										25.60	
										Bottom of Exploration at 25.60 feet below ground surface.	
35											
40											
45											
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-202
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.0	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/25/10; 9:35-12:35	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	16+54.3, 9.7 Lt.	**Casing ID/OD:**	NW	**Water Level*:**	8.9 ft bgs.
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	124.45		PAVEMENT. 0.55	
	1D	24/18	1.00 - 3.00	12/25/12/14	37	52				Brown, damp, very dense, gravelly fine to coarse SAND, trace to little silt, (Fill).	
5	2D	24/7	5.00 - 7.00	3/4/3/2	7	10				Brown, damp, loose, fine to medium SAND, some gravel, little silt, trace coarse sand, (Fill). Tip of spoon moist to wet.	
10	3D/AB	24/17	10.00 - 12.00	13/17/18/24	35	49	WASH	114.20		3D/A (10.0-10.8 ft). Brown, wet, dense fine to medium SAND, trace to little silt, (Fill). 10.80	
							AHEAD	113.00		3D/B (10.8-12.0 ft). Brown, dense, gravelly fine to coarse SAND, little to some silt. Bottom 12" decomposed rock, (Till) . 12.00	
	R1	50.4/48	12.50 - 16.70	RQD = 0%			NQ-2	112.50		Top of bedrock at Elev. 113.0 ft. 12.50 R1:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered, calcereous muscovite PHYLLITE, with thin, steeply dipping to vertical bedding. Very close, high angle, stepped and undulating, rough to smooth, fresh to decomposed, open breaks along bedding. Much of core sample is angular gravel; broked along bedding. [Vassalboro Formation] R1:Core Times (min:sec) 12.5-13.5 ft (4:40) 13.5-14.5 ft (4:30) 14.5-15.5 ft (5:25) 15.5-16.5 ft (6:00) 16.5-16.7 ft (-:--) 95% Recovery 16.70	
15	R2	9.6/9.6	16.70 - 17.50	RQD = 0%				108.30		R2:Bedrock: Same as R1. Core sample consists primarily of angular gravel; broken along vertical bedding. Evidence of decomposition of calcite-rich layers (mud). No complete 1 ft runs for core times. 100% Recovery 17.50	
	R3	25.2/25.2	17.50 - 19.60	RQD = 0%				107.50		R3:Bedrock: Same as R1. R3:Core Times (min:sec) 17.5-18.5 ft (10:25) 18.5-19.5 ft (7:30) 19.5-19.6 ft (-:--) 100% Recovery 19.60	
20	R4	34.8/32	19.60 - 22.50	RQD = 20%				105.40			
								102.50			
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Village Bridge #2975 over Kenduskeag Stream	**Location:**	Stetson Road, Kenduskeag, Maine	**Boring No.:**	BB-KS-202
				PIN:	17576.00
Driller:	MaineDOT	**Elevation (ft.)**	125.0	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/25/10; 9:35-12:35	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	16+54.3, 9.7 Lt.	**Casing ID/OD:**	NW	**Water Level*:**	8.9 ft bgs.
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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S_u = Insitu Field Vane Shear Strength (psf)
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N-uncorrected = Raw field SPT N-value
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N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
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G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample 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										R4:Bedrock: same as R1, except fresh, more intact. R4:Core Times (min:sec) 19.6-20.6 ft (-:--) 20.6-21.6 ft (7:00) 21.6-22.5 ft (6:20) 92% Recovery	
										22.50	
										Bottom of Exploration at 22.50 feet below ground surface.	
30											
35											
40											
45											
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-203
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.0	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24/10; 10:50-14:05	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	14+71.4, 8.0 Rt.	**Casing ID/OD:**	HW & NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

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HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	124.40		PAVEMENT. 0.60	
	1D	24/16	1.00 - 3.00	10/10/9/7	19	27				Brown, damp, medium dense, fine to coarse sandy GRAVEL, trace to little silt, (Fill).	
5	2D	24/10	5.00 - 7.00	3/4/5/5	9	13				Brown, damp, medium dense, gravelly fine to coarse SAND, trace to little silt, (Fill).	
10	3D	24/11	10.00 - 12.00	8/10/5/6	15	21	78			Brown, damp, medium dense, gravelly fine to coarse SAND, trace to little silt, (Fill).	
							69				
							235			Roller Bit through 0.8 ft thick timber at approximately 13.0 ft bgs.	
							WASH	111.20		13.80	
15	4D	24/11	15.00 - 17.00	4/10/38/33	48	67				Greenish grey, very dense, fine to coarse sandy GRAVEL, little silt, (Till). Bottom 4" of sample consists primarily of crushed rock.	
								108.30		16.70 Top of Bedrock at Elev. 108.3 ft.	
	R1	32.4/23	17.40 - 20.10	RQD = 0%			NQ-2	107.60		17.40 R1:Bedrock: Greyish green, fine grained, hard, slightly weathered calcareous muscovite PHYLLITE. Upper 1.5 ft contains more biotite and is coarser grained; possible schist. Core sample consists primarily of subrounded to subangular gravel. [Vassalboro Formation] R1:Core Times (min:sec) 17.4-18.4 ft (4:25) 18.4-19.4 ft (5:00) 19.4-20.1 ft (-:--) 71% Recovery	
20	R2	27.6/26	20.10 - 22.40	RQD = 0%				104.90		20.10 R2:Bedrock: Same as lower portion of R1. Core sample consists of angular gravel and slabs. Evidence of vertical breaks along bedding. Evidence of mud seams. R2:Core Times (min:sec) 20.1-21.1 ft (-:--) 21.1-22.1 ft (4:10)	
								102.60			
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-203
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	125.0	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24/10; 10:50-14:05	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	14+71.4, 8.0 Rt.	**Casing ID/OD:**	HW & NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
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N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										22.1-22.4 ft (3:35) 94% Recovery	
										22.40 **Bottom of Exploration at 22.40 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BB-KS-204
PIN: 17576.00

Driller:	MaineDOT	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24/10-8/25/10	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	16+28.5, 6.4 Rt.	**Casing ID/OD:**	HW & NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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	124.70		PAVEMENT. 0.20	
	1D	24/15	1.00 - 3.00	12/10/7/8	17	24				Brown, damp, medium dense, fine to coarse SAND, some gravel, trace to little silt, (Fill).	
5	2D	24/15	5.00 - 7.00	5/4/7/5	11	15				Brown, dry, medium dense, gravelly, fine to coarse SAND, trace to little silt, (Fill).	
10	3D	4.8/3	10.00 - 10.40	50(4.8")	---		---			Brown, moist, fine to coarse SAND, some gravel, little silt, rock in tip of spoon, (Fill). Probable Boulder at 10.4 ft bgs.	

							---			HW Casing break at 12.5 ft . Moved ahead approximately 3 ft and continued boring with NW Casing.	
							8				
							26				
15	4D/AB	24/9	15.00 - 17.00	1/2/2/13	4	6				4D/A (15.0-16.7 ft). Brown, loose, very fine sandy ORGANIC SILT with wood layers bottom and top, (Fill).	
								108.20		16.70	
	R1	32.4/26	17.00 - 19.70	RQD = 0%			NQ-2	107.90		4D/B (16.7-17.0 ft). Greyish green crushed ROCK. Top of Bedrock at Elev. 108.2 ft. 17.00	
										R1:Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered calcareous muscovite PHYLLITE, with evidence of thin, vertical bedding. One highly weathered quartz and feldspar seam. Edivence (mud) of decomposition of calcite-rich beds. Most of core sample is angular gravel; broken along vertical bedding. [(Vassalboro Formation)	
	R2	18/18	19.70 - 21.20	RQD = 0%				105.20			
20								103.70		R1:Core Times (min:sec) 17.0-18.0 ft (3:45) 18.0-19.0 ft (3:00) 19.0-19.7 ft (-:--) 80% Recovery 19.70	
										R2:Bedrock: Same as R1. R2:Core Times (min:sec) 19.7-20.0 ft (-:--)	
25											

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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:	Village Bridge #2975 over Kenduskeag Stream	**Boring No.:**	BB-KS-204		
Location:	Stetson Road, Kenduskeag, Maine	**PIN:**	17576.00		
Driller:	MaineDOT	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" SSA
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/24/10-8/25/10	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	16+28.5, 6.4 Rt.	**Casing ID/OD:**	HW & NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										20.0-21.0 ft (3:55) 21.0-21.2 ft (-:--) 100% Recovery	
										21.20 **Bottom of Exploration at 21.20 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

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

Appendix B

Laboratory Test Data

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Kenduskeag Project Number: 17576.00

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C.	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
BB-KS-101, 1D	14+84.9	6.1 Rt.	1.0-3.0	181080	1	6.2			SM	A-1-b	II
BB-KS-101, 2D	14+84.9	6.1 Rt.	3.0-5.0	181081	1	7.0			SM	A-1-b	II
BB-KS-101, 3D	14+84.9	6.1 Rt.	5.0-6.0	181082	1	6.7			SM	A-2-4	II
BB-KS-101, 4D	14+84.9	6.1 Rt.	7.5-9.5	181083	1	6.0			SM	A-1-a	II
BB-KS-101, 5D	14+84.9	6.1 Rt.	10.0-12.0	181084	1	7.0			SM	A-1-b	II
BB-KS-101, 6D	14+84.9	6.1 Rt.	12.5-14.5	181085	2	24.8			SM	A-1-b	II
BB-KS-101, 7D	14+84.9	6.1 Rt.	15.0-17.0	181086	2	28.6			SM	A-1-b	II
BB-KS-104, 1D	15+51.8	8.3 Rt.	0.0-1.75	181087	2	11.1			SM	A-1-b	II
BB-KS-105, 1D	16+12.7	5.6 Lt.	1.0-3.0	181088	2	9.1			SW-SM	A-1-a	0
BB-KS-105, 2D	16+12.7	5.6 Lt.	3.0-5.0	181089	2	6.4			SM	A-1-b	II
BB-KS-105, 3D	16+12.7	5.6 Lt.	5.0-7.0	181090	3	6.2			SW-SM	A-1-b	0
BB-KS-105, 4D	16+12.7	5.6 Lt.	7.5-9.5	181091	3	5.3			SM	A-1-b	II
BB-KS-105, 5D	16+12.7	5.6 Lt.	10.0-12.0	181092	3	6.8			SW-SM	A-1-b	0
BB-KS-105, 6D/A	16+12.7	5.6 Lt.	13.4-14.2	181093	3	49.6			ML	A-4	IV
BB-KS-105, 6D/B	16+12.7	5.6 Lt.	14.2-14.9	181094	3	14.0			GP-GM	A-1-a	0

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

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

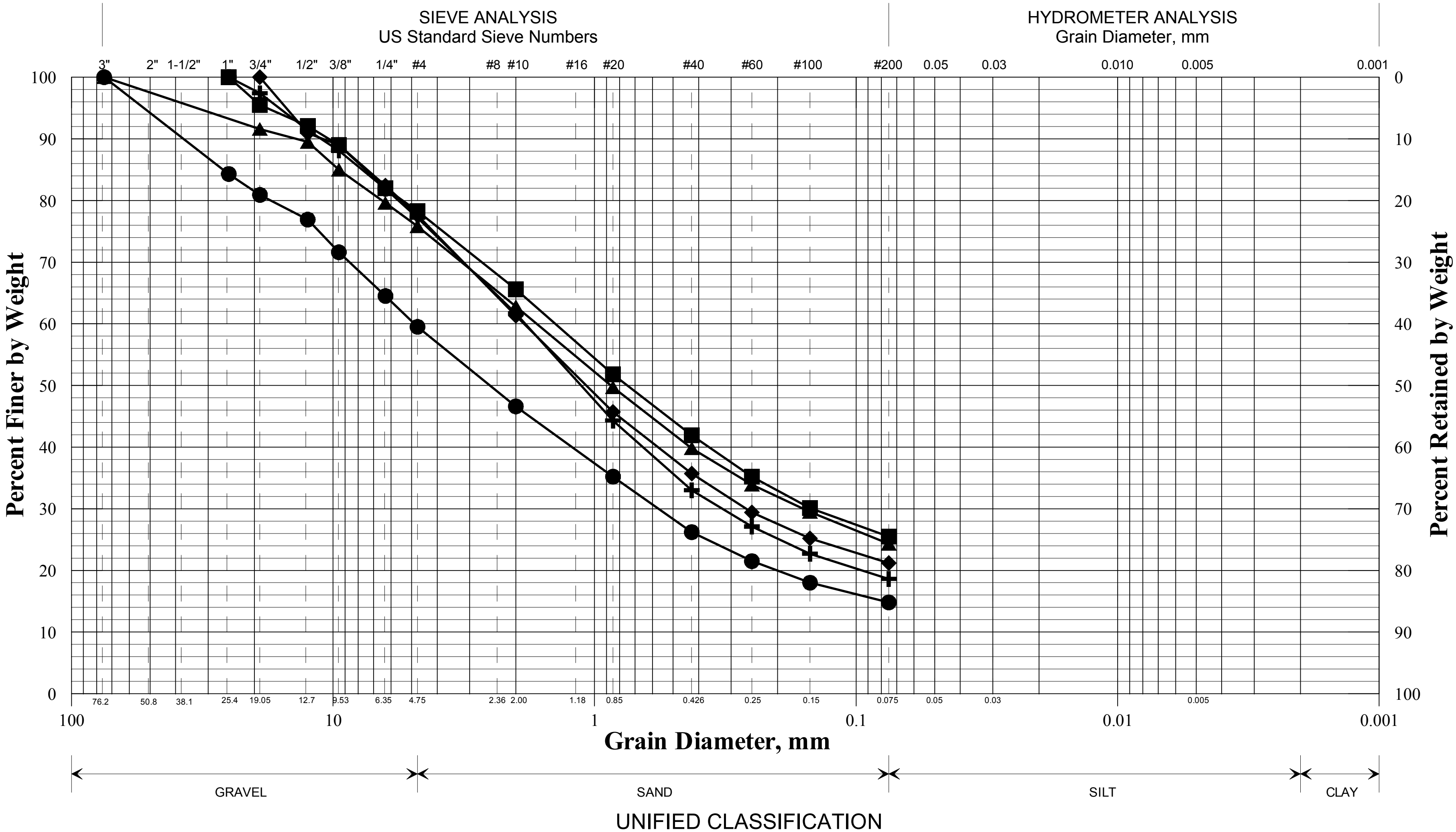
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

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

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

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

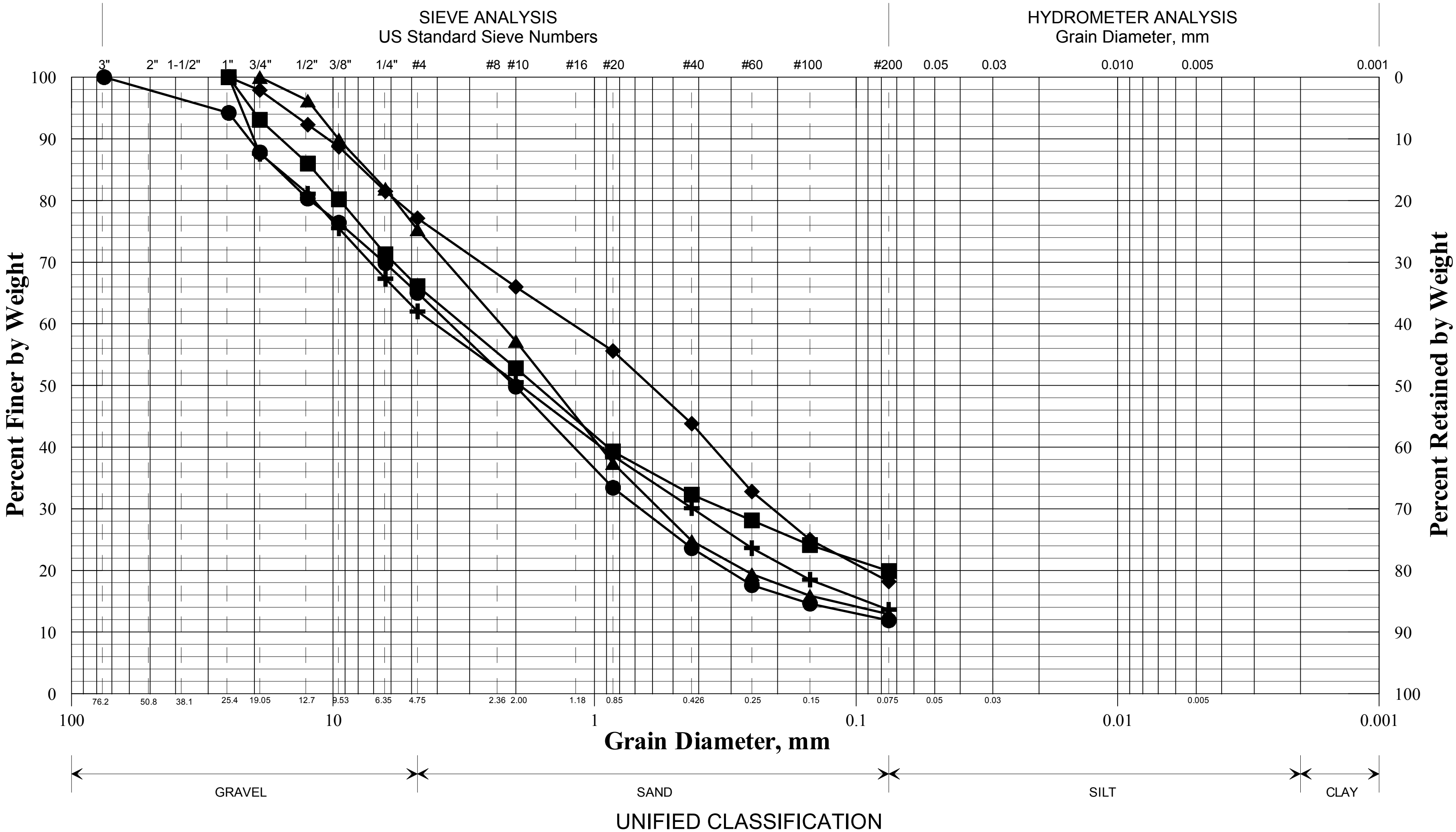


	Boring/Sample No.	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-KS-101/1D	1.0-3.0	SAND, some gravel, little silt.	6.2			
◆	BB-KS-101/2D	3.0-5.0	SAND, some gravel, some silt.	7.0			
■	BB-KS-101/3D	5.0-6.0	SAND, some silt, some gravel.	6.7			
●	BB-KS-101/4D	7.5-9.5	Gravelly SAND, little silt.	6.0			
▲	BB-KS-101/5D	10.0-12.0	SAND, some gravel, some silt.	7.0			
✖							

PIN:	017576.00
Town:	Kenduskeag
Reported by:	WHITE, TERRY A
Date:	5/19/2005

SHEET NO. 1

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE

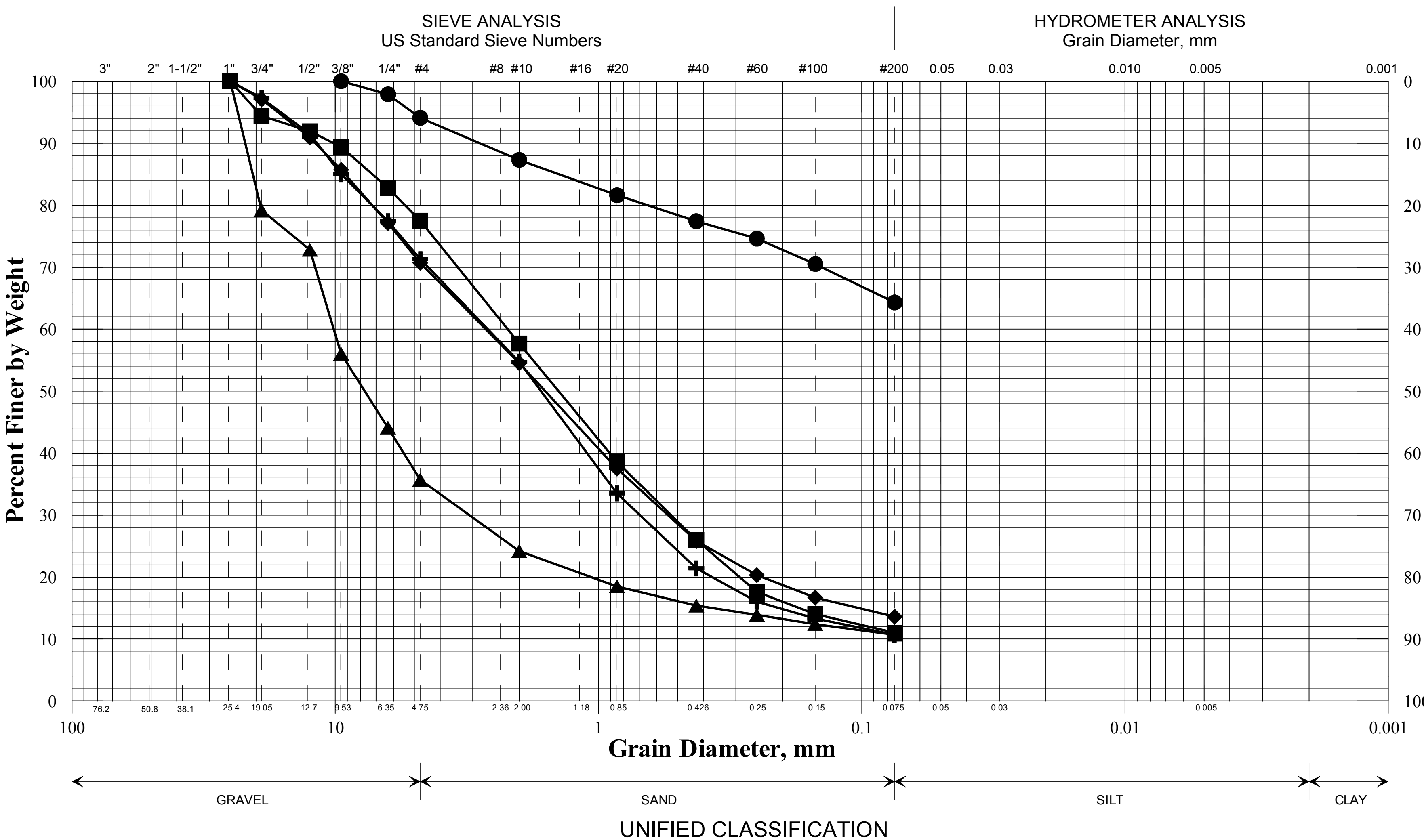


	Boring/Sample No.	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-KS-101/6D	12.5-14.5	Gravelly SAND, little silt.	24.8			
◆	BB-KS-101/7D	15.0-17.0	SAND, some gravel, little silt.	28.6			
■	BB-KS-104/1D	0.0-1.75	SAND, some gravel, little silt.	11.1			
●	BB-KS-105/1D	1.0-3.0	SAND, some gravel, little silt.	9.1			
▲	BB-KS-105/2D	3.0-5.0	SAND, some gravel, little silt.	6.4			
✖							

PIN:	017576.00
Town:	Kenduskeag
Reported by:	WHITE, TERRY A
Date:	5/19/2005

SHEET NO. 2

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-KS-105/3D	5.0-7.0	SAND, some gravel, little silt.	6.2			
◆	BB-KS-105/4D	7.5-9.5	SAND, some gravel, little silt.	5.3			
■	BB-KS-105/5D	10.0-12.0	SAND, some gravel, little silt.	6.8			
●	BB-KS-105/6D(A)	13.4-14.2	SILT, some sand, trace gravel.	49.6			
▲	BB-KS-105/6D(B)	14.2-14.9	GRAVEL, some sand, little silt.	14.0			
✖							

PIN:	017576.00
Town:	Kenduskeag
Reported by:	WHITE, TERRY A
Date:	5/19/2005

SHEET NO. 3

Appendix C

Calculations

ABUTMENT AND WINGWALL PASSIVE AND ACTIVE EARTH PRESSURES:

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

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

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

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

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

$K_a = 0.31$

Rankine Theory - Passive Earth Pressure from Bowles 5th Edition Section 11-5, pg 602

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

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

$$K_{p\_rank} := \frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$K_{p\_rank} = 3.25$

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

For gravity walls , semi-gravity walls, prefabricated modular walls, and cantilever walls and abutments with short heels where wall and backfill interface friction is considered, use Coulomb Theory

Angle of back face of wall: $\alpha := 90deg$

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

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

$\delta = \beta$ $\quad \delta := \beta$

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

$K_a = 0.31$

Coulomb Theory - Passive Earth Pressure from MaineDOT Bridge Design Guide
Section 3.6.6, pg. 3-8

Angle of back face of wall: $\alpha := 90deg$

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

Friction angle between fill and wall:
From LRFD Table 3.11.5.3-1, pg. 3-74, δ ranges from 17 to 22 $\quad \delta := 20deg$

Angle of backfill from horizontal: $\beta := 0deg$

$$K_p := \frac{\sin(\alpha-\phi)^2}{\sin(\alpha)^2\cdot\sin(\alpha+\delta)\cdot\left(1-\sqrt{\dfrac{\sin(\phi+\delta)\cdot\sin(\phi-\beta)}{\sin(\alpha-\delta)\cdot\sin(\beta+\alpha)}}\right)^2}$$

$K_p = 6.89$

Frost Protection:
Method 1

From the Maine Design Freezing Index Map:

DFI = 1850 degree-days

Site has Granular Soils With Wn = 10% or less

From the 2003 Bridge Design Guide Table 5-1:

$Frost\_depth := [0.5 \cdot (92.6in - 90.1in) + 90.1in]$

$Frost\_depth = 91.35 \cdot in$

$Frost\_depth = 7.61 \cdot ft$

Method 2

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

Project Location: Orono, Maine

Air Design Freezing Index          =  1588 F-days
N-Factor                           =  0.70
Surface Design Freezing Index      =  1112 F-days
Mean Annual Temperature            =  43.5 deg F
Design Length of Freezing Season = 132 days

---------------------------------------------------------
Layer
#:Type          t    w%    d    Cf   Cu    Kf   Ku     L
---------------------------------------------------------
1-Asphalt      6.0   .1  140.0  28   28    .9   .9     0
2-Coarse      65.9  2.0  140.0  25   27   1.0  1.3   403
---------------------------------------------------------

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

*********************************************************
  Total Depth of Frost Penetration = 5.99 ft = 71.9 in.
*********************************************************
```

Ok Use 6.5 feet

BEARING RESISTANCE - FOOTINGS ON COMPACTED FILL SOILS:

Consider this for use with PCMG and Wingwalls; however it's likely that all footings will bear on bedrock.

SERVICE LIMIT STATE:

Based on LRFD Table C10.6.2.6.1-1 - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State."

Bearing Material Recommended	Consistency in Place	Allowable Bearing Pressure (tons per sq. foot)	Value
Coarse to Medium sand, little gravel	Very compact	4 to 6	4 tsf (8 ksf)
	Medium to compact	2 to 4	3 tsf (6 ksf)
	Loose	1 to 3	1.5 tsf (3 ksf)

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

STRENGTH LIMIT STATE:

Nominal and Factored Bearing Resistance for spread footings on fill soils At the Strength Limit State:
This may considered for PCMG or Cast-In-Place Wall Bases.

Assumptions:

1. Footings will be embedded 6.5 feet for frost protection.

   $D_f := 6.5ft$

2. Assumed parameters for soils:
   Assume granular fill

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

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

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

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

3. Use Terzaghi strip equations as L > B

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

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

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

$q_{eff\_str} = 0.44 \cdot ksf$

Look at several wall base widths:

$$B := \begin{pmatrix} 4 \\ 6 \\ 8 \end{pmatrix} ft$$

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

$s_c := 1.0$

$s_\gamma := 1.0$

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

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

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

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

$$q_{nom} = \begin{pmatrix} 13.2 \\ 14.7 \\ 16.1 \end{pmatrix} \cdot ksf$$

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

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

$$q_{fac} = \begin{pmatrix} 5.9 \\ 6.6 \\ 7.3 \end{pmatrix} \cdot ksf$$

Recommend **6.0 ksf** for **Strength Limit State** Factored Bearing Resistance for wall bases 8 feet or less wide.

BEARING RESISTANCE - FOOTINGS ON BEDROCK:

SERVICE LIMIT STATE:

Method 1

Method: Based on LRFD Table C10.6.2.6.1-1 (Based on NAVFAC DM 7.2, May 1982) - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State."

Description of Bedrock Materials:

Highly fractured PHYLLITE, RQD 0%

Bearing Material:	Weathered bedrock, RQD less than 25%
Consistency in Place:	Medium hard rock
Bearing Resistance:	Range 16 - 24 ksf
Recommeded Value	16 ksf

Method 2

Method: AASHTO Standard Specifications - 17th Edition, 2002

Section 4.4.8.1.1 - Competent Rock
Figure 4.4.8.1.1A - for footings supported on competent rock
Average RQD of site bedrock is 0%

Allowable contact stress: 10 tsf (20 ksf)

Use a Factored Bearing Resistance of **16 ksf** for **Service Limit State** analysis and preliminary sizing of the footings.

STRENGTH LIMIT STATE:

Method 3

Method: AASHTO Standard Specifications - 17th Edition, 2002

Section 4.4.8.1.2 - Footings on Broken or Jointed Rock, Pg. 62
Table 4.4.8.1.2A - for footings supported on Broken or Jointed Rock, Pg. 63

a. estimated Rock Mass Rating — Very Poor (RQD ~0)

b. Rock Category per 4.4.8.1.2B — B, Phylite

c. Unconfined compressive strength, Co — 3500 psi

d. Nms, per Table 4.4.8.1.2A — Use q_{ult} of equivalent soil mass

e. $Q_{ult} = Q_{nom}$ — q_{ult} of equivalent soil mass

Nominal Bearing Resistance for Spread Footings on Fractured Bedrock Using Equivalent Soil Mass:

Use Terzaghi Strip Footing Equation to Calculate Q_{nom}.

Assumptions:

1. Footings only embedded by riprap layer 3.0 feet.

   $D_f := 3.0ft$

2. Assumed parameters for soils:
   Assume granular fill

   Moist unit weight: $\gamma_m := 145pcf$

   Saturated unit weight: $\gamma_{sat} := 150pcf$

   Soil angle of internal friction: $\phi_{ns} := 36$ Assume similar to dense till

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

3. Use Terzaghi strip equations as L > B

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

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

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

$q_{eff\_str} = 0.26 \cdot ksf$

Look at several typical footing widths:

$$B := \begin{pmatrix} 12 \\ 14 \\ 16 \end{pmatrix} ft$$

Terzaghi Shape Factors from Bowles 5th Ed.,Table 4-1, p. 220, for strip footing:

$$s_c := 1.0$$

$$s_\gamma := 1.0$$

Meyerhof Bearing Capacity Factors For $\phi = 36$ deg — Bowles 5th Ed. Table 4-4 pg. 223

$N_c := 50.55$ $N_q := 37.7$ $N_\gamma := 44.4$

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

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

$$Q_{nom} = \begin{pmatrix} 33.2 \\ 37.1 \\ 41 \end{pmatrix} \cdot ksf$$

Resistance Factor from LRFD Table 10.5.5.2.2-1 pg. 10-39: $\phi_b := 0.45$

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

Factored Bearing Resistance

$$q_{fac} = \begin{pmatrix} 15 \\ 16.7 \\ 18.5 \end{pmatrix} \cdot ksf$$

Use a **Strength Limit State** Factored Bearing Resistance of **15 ksf.**

SETTLEMENT ANALYSIS:

Estimate Settlement for PCMG or Cast-In-Place Wall Footing on Soil Using Hough Method:
Ref. LRFD Section 10.6.2.4.2, pg. 10-56

Assumptions:
B = 8 ft
Maximum grade rise is 2.5 feet
Soil thickness below footing is 4 feet (Assumed)
Use N1 of 40 (assumed corrected N_{60} value for very dense till or compacted fill)
I Influence factors from LRFD Figure 10.6.2.4.1-1, pg. 10-56
Bearing Capacity Indices (C') from LRFD Figure 10.6.2.4.2-1, pg. 10-59

$N1 := 40 \qquad I := 0.9 \qquad C' := 135$

$\sigma_o := (120pcf - 62.4pcf)\cdot 6.5ft$

$\Delta\sigma_v := 2.5ft\cdot 125pcf\cdot I \qquad \Delta\sigma_v = 0.28\cdot ksf$

$$\Delta H := 4ft\cdot\left(\frac{1}{C'}\right)\cdot\log\left(\frac{\sigma_o + \Delta\sigma_v}{\sigma_o}\right)$$

$\Delta H = 0.09\cdot in$

OK, Say 1/4 inch or less settlement below PCMG or Cast-In-Place wall footing on soil.

Settlement of Footings on Rock, LRFD Section 10.6.2.4.4

Assumptions:

Borings show evidence of silt seams, Assume 3 in thick

$e_o := 1.0$

$C_r := 0.05$

Depth of seam approximately 7 feet below top of rock

Footing Width B = 15 feet, So depth of Influence is 0.5B

LRFD Figure 10.6.2.4.1-1 Boussinesq Stress Contours: Stress is approximately $0.8q_o$

$q_o := 16ksf$

$\Delta\sigma_v := 0.8\cdot q_o + 2ft\cdot(125pcf) \qquad \Delta\sigma_v = 13.05\cdot ksf$

$\gamma_{fill} := 120pcf$

$\gamma_{rock} := 150pcf$

$\gamma_{till} := 135pcf$

$\sigma_v := \gamma_{fill} \cdot 12ft + (\gamma_{till} - 62.4pcf) \cdot 3ft + (\gamma_{rock} - 62.4pcf) \cdot 7ft$

$\sigma_v = 2.27 \cdot ksf$

Calculate Settlement:

$$\Delta H := 3in \cdot \left(\frac{C_r}{1 + e_o}\right) \cdot \log\left[\frac{(\sigma_v + \Delta\sigma_v)}{\sigma_v}\right] \qquad \Delta H = 0.06 \cdot in$$

OK Say up to 0.1 inch of settlement possible due to consolidation of silt seam in bedrock.

SEISMIC DESIGN PARAMETERS:

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
State - Maine
Zip Code - 04456
Zip Code Latitude = 44.888300
Zip Code Longitude = -068.988300
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.070	PGA - Site Class B
0.2	0.151	Ss - Site Class B
1.0	0.045	S1 - Site Class B

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Spectral Response Accelerations SDs and SD1
State - Maine
Zip Code - 04456
Zip Code Latitude = 44.888300
Zip Code Longitude = -068.988300
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.070	As - Site Class B
0.2	0.151	SDs - Site Class B
1.0	0.045	SD1 - Site Class B