SCHONEWALD
ENGINEERING
ASSOCIATES, INC.

GEOTECHNICAL DESIGN REPORT
REPLACEMENT OF WING BRIDGE (BRIDGE #2955) OVER SANDY RIVER
PHILLIPS, MAINE
MaineDOT WIN 22616.00

PREPARED FOR:

Stantec Consulting Services, Inc.
Scarborough, Maine

PREPARED BY:

Isabel V. (Be) Schonewald, P.E.
Schonewald Engineering Associates, Inc. (SchonewaldEA)
129 Middle Road
Cumberland, Maine 04021
Be@SchonewaldEngineering.com

STATE OF MAINE
ISABEL V. SCHONEWALD
No. 7528
LICENSED
PROFESSIONAL ENGINEER
12/31/18

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SchonewaldEA Project No. 16-010

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EXECUTIVE SUMMARY

This Geotechnical Design Report presents subsurface information and provides final geotechnical design and construction recommendations for the replacement of Wing Bridge over the Sandy River located on Route 4 in Phillips, Maine (MaineDOT WIN 22616.00). The replacement bridge will be an 88-foot long, single span structure that will be supported on full-height abutments founded on prepared bedrock; the abutments will be at a 35-degree skew with the roadway.

Subsurface conditions encountered in the test borings completed at the Wing Bridge site consisted of about 3 to 3.5 feet of Granular Fill over an approximately 5- to 20-foot thickness of reworked glacial till (Till Fill). On the west end of the existing bridge, the Till Fill was underlain by approximately 6 feet of glacial till. Bedrock underlying the site consists of porphyroblastic Phyllite with high-angle foliation (remnant bedding) of poor to fair quality.

A pile-supported integral abutment bridge is not feasible at this location due to inadequate depth of overburden overlying bedrock (MaineDOT's Bridge Design Guide dated August 2003 together with March 2014 updates (MaineDOT BDG)). Concerns that piles would be overstressed during driving through the glacial till (fill) and weathered rock and/or would not achieve the required depth due to obstructions resulting in the need to pre-excavate the pile locations also do not favor a pile-supported structure.

Therefore, the footings for the full height abutments should bear directly on prepared bedrock or a mud leveling pad (seal) poured on the prepared bedrock surface. No part of the footings should bear on soil. The contractor should remove any overburden soil and weathered rock that can be removed using ordinary excavation equipment to expose competent bedrock. It is anticipated that the bedrock surface underlying the abutments will be highly irregular based on the rock core obtained in the test borings and visual inspection of the river upstream and downstream of the existing structure. The prepared bearing surface should not slope steeper than 4H:1V; stepping the bearing surface to flatten the overall slope is acceptable. The final bedrock surface should be cleaned prior to pouring a seal or the footings. Dowels should be used to pin the footing or seal to the prepared bedrock surface given the steeply dipping foliated rock encountered in the test borings.

The strength limit state bearing resistance was evaluated based on the Rock Mass Rating (RMR) of the bedrock underlying the site and using methods outlined by Wyllie and Hoek-Brown. A factored bearing resistance (q_r) of 15 ksf is recommended for the strength limit state design of footings bearing on rock. Regardless of the calculated bearing pressure, the minimum footing dimension should not be less than two feet. For evaluation of sliding on the base of the footings if dowels are not used to pin the footing or seal, the bearing material should conservatively be treated as a soil with the friction angle (δ) between the cast-in-place concrete footing and the soil taken as 30 degrees. A resistance factor ($\varphi\tau$) for sliding, based upon the footing bearing on sandy soil, is 0.80, in accordance with Table 10.5.5.2.2-1 of the 2017 LRFD Manual. Sliding resistance will be increased significantly if dowels are used to pin the footing or seal to the prepared bedrock surface. The footing stems (walls) should be designed based upon use of MaineDOT Granular Borrow backfill. To provide adequate drainage, MaineDOT Granular Borrow for Underwater Backfill, which allows significantly less fines, should be used within 10 feet behind the stem wall, measured from 18 inches off the back of the footing. Granular Borrow for Underwater Backfill should extend up to or slightly above the predicted Q_{100} flood elevation.

Because the footings and/or seals will bear directly on prepared bedrock, settlement, frost action, and scour protection are not concerns. However, doweling the footing or seal to bedrock should provide protection against extreme scour events. The Wing Bridge site is classified as a Seismic Zone 1. Seismic analysis is not required for bridges in Seismic Zone 1, however, the design of superstructure connections should consider seismic forces.

INTRODUCTION

Schonewald Engineering Associates, Inc. (SchonewaldEA) has prepared this Geotechnical Design Report for Stantec Consulting Services, Inc. (Stantec) to present subsurface information and provide final geotechnical design and construction recommendations for the replacement of Wing Bridge over the Sandy River located on Route 4 in Phillips, Maine (MaineDOT WIN 22616.00).

SchonewaldEA's work on this project has been completed under two separate contracts. Preliminary work that included the subsurface investigation and laboratory testing program, as well as development of preliminary design recommendations was completed in accordance with a project assignment under SchonewaldEA's GCA with MaineDOT. The work for MaineDOT culminated with the preparation of a Preliminary Design Memorandum for the project that was dated September 2, 2015. Final design work commenced in Fall 2016. SchonewaldEA's final design phase of work has been completed in accordance with a Subconsultant Agreement with Stantec that is dated October 25, 2016.

A quality assurance review of the technical aspects of SchonewaldEA's work was completed by Stephen J. Rabasca, P.E. of SoilMetrics, LLC located in Cape Elizabeth, Maine. This report is subject to the limitations contained in the Closure section of the report.

BACKGROUND AND PROJECT DESCRIPTION

In July 2014, SchonewaldEA was retained by MaineDOT to provide geotechnical field and design services to support the preliminary engineering for the reconstruction of an approximately 4.6-mile long segment of Route 4 in Madrid Township-Phillips. The segment of Route 4 includes two bridges over the Sandy River; Weymouth Bridge (Bridge #2934) in the Madrid Township portion of the segment and Wing Bridge (Bridge #2955) in the Phillips portion of the segment. The Wing Bridge replacement in Phillips (MaineDOT WIN 22616.00) is the subject of this geotechnical design report.

Sheet 1 – Location Map depicts the location of the Wing Bridge and is included with the Figures. Where Route 4 crosses the Sandy River, the river flows north to south and is at a skew of approximately 35 degrees to the roadway. Based on field observations and a review of the design drawings for the existing Wing Bridge that was constructed in the 1930s, the existing bridge is a single-span structure founded on shallow spread footings that bear on rock with mass concrete abutment walls. Rock was observed in the river channel at all four corners of the existing Wing Bridge. The former bridge had abutments consisting of field stone laid in mortar. It appears that the existing east abutment is coincident with the former field stone east abutment. The former field stone west abutment, however, is visible about 60 feet to the southeast of the existing west abutment. Reportedly the downstream wing walls of the existing structure were removed and replaced in the mid-1980s.

SchonewaldEA understands the following about the replacement structure:

- Single, 88-foot long span with a 35-degree skew;
- Profile raise of approximately 3 feet;
- Horizontal alignment shifted approximately 4 feet northerly (project left);
- Proposed width of 30 feet curb to curb;
- Proposed abutments located approximately 12 feet behind the existing abutments;
- Proposed full height abutments on rock both ends, similar to what is there today;
- Temporary earth support will be required;
- Construction-phase detour bridge will be located upstream (northerly) of the Route 4 alignment and will result in a significant cut slope in the northeast quadrant; and
- Remnants of the pre-existing easterly abutment will be removed, while remnants of the pre-existing west abutment will remain.

GEOLOGICAL SETTING

Surficial geology along the Sandy River through Phillips, including the project site, is mapped as glacial till and shallow bedrock (thin drift) (Surficial Geologic Map of Maine). The project site is mapped near a contact between the massive pelite member of the Carrabassett Formation (a meta pelite (mudstone) of Silurian age) and the Madrid Formation (a meta interbedded sandstone and limestone of Devonian-Silurian age) (Bedrock Geologic Map of Maine).

SUBSURFACE INVESTIGATION

SchonewaldEA retained Maine Test Borings of Hermon, Maine to drill four test borings at the Wing Bridge site to evaluate subsurface conditions. The test borings were designated BB-PSR-101 through -104. The test borings were drilled on August 26 and 28, 2014 and were observed and logged by SchonewaldEA. The approximate locations of the test borings are depicted on Sheet 2 –Boring Location Plan & Interpretive Subsurface Profile that is included with the Figures.

The test borings were drilled through the approach fill behind each corner of the existing bridge abutments to ascertain the depth to and the engineering characteristics of the bedrock underlying the proposed abutments. The test borings were advanced using standard cased wash boring techniques. Each boring was extended through overburden to refusal and 10 feet of NQ2 (N-size, double-barrel core barrel) rock core was obtained. Standard Penetration Tests (SPTs) were completed and split-spoon soil samples obtained near the ground surface and at five-foot intervals to the bottom of the overburden. SPTs were conducted using a rope and cathead.

Logs of the subsurface explorations are included as Appendix A. Note that the logs contained in Appendix A are formatted for an 8-1/2-inch by 14-inch page size so that each log will fit on a single page. Photographs of the rock core collected from the Wing Bridge test borings are included as Appendix B.

LABORATORY TESTING

Representative specimens of the rock core obtained in the test borings were submitted to the Thielsch Engineering geotechnical laboratory in Cranston, Rhode Island for unconfined (uniaxial) compressive strength testing. The laboratory testing program is summarized in the following table.

Boring No.	Sample No.	Specimen Depth	Sample Representative of: Tests Performed:
BB-PSR-101	R2	22.8 to 23.3 ft. BGS	bedrock; uniaxial compressive strength test
BB-PSR-103	R2	25.0 to 25.4 ft. BGS	bedrock; uniaxial compressive strength test

Subsurface conditions, including the results of the rock testing, are discussed in the following section. Laboratory test results are summarized on the test boring logs included in Appendix A and the laboratory test report is included as Appendix C.

GEOPHYSICAL SURVEYS

MaineDOT retained Hager-Richter Geoscience, Inc. (HRG) to complete a geophysical survey of the approaches to the Wing Bridge to obtain additional information regarding bedrock depths. HRG conducted seismic refraction profiling along two lines, one in each lane of Route 4 that were centered on the existing bridge and extended approximately 115 feet behind each abutment. HRG also conducted a ground penetrating radar (GPR) survey of an approximately 330-foot by 25-foot area centered on the bridge. HRG completed their field work on September 8, 2014. A copy of HRG's 2014 report is included as Appendix D.

HRG's interpretation of the topography of the top of the bedrock surface in the study area is depicted on Figure 4 in their 2014 report. SchonewaldEA notes that the test boring logs that are included in the HRG report were preliminary in nature and provided to HRG to aid them in the field; the test borings logs provided in the HRG report have been superseded by the test boring logs included in Appendix A of this geotechnical design report.

In late 2016, SchonewaldEA again retained HRG to complete a limited geophysical survey of the existing steep slope located in the northeast quadrant of the Wing Bridge replacement project area. The objective of HRG's 2016 work was to better define subsurface conditions underlying the proposed cut slope in the northeast quadrant of the Wing Bridge detour/ Route 4 alignment shift. Specifically, information regarding the depth to and configuration of the bedrock surface in the vicinity of the proposed significant cut was necessary to establish plan limits, slope design criteria, and construction cost estimates. A copy of HRG's 2016 report is attached as Appendix E.

The 2016 geophysical survey was completed on November 15 and 16, 2016 and consisted of seismic refraction surveys along four transect lines that totaled approximately 970 linear feet. The positions of the seismic refraction lines were selected by the project team to provide adequate survey coverage of the proposed "detour cut slope" in the rough terrain. The locations of the transects are depicted on Figure 2 in HRG's 2016 report that is included as Appendix E. Figure 7 is a color contour plot of the bedrock surface topography model generated from the seismic survey and the logs for nearby borings provided to HRG by SchonewaldEA. The contours shown on Figure 7 represent interpolations based on the seismic refraction survey data and available boring information relative to NAVD88.

Based on the results of comparing seismically determined elevations at intersecting seismic lines and with nearby borings, and on the results from other similar seismic refraction surveys, HRG estimates the accuracy (standard deviation) of the depths of competent bedrock determined by the seismic refraction survey to be about ± 10 percent of the depth of bedrock or ± 2 feet, whichever is greater.

SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test borings completed at the Wing Bridge site consisted of about 3 to 3.5 feet of Granular Fill over an approximately 5- to 20-foot thickness of reworked glacial till (Till Fill). On the west end of the existing bridge, the Till Fill was underlain by approximately 6 feet of glacial till. Bedrock underlying the site consists of porphyroblastic Phyllite of poor to fair quality. An Interpretive Subsurface Profile is included on Sheet 2 in the Figures.

<u>Granular Fill</u>: All of the test borings encountered Granular Fill below pavement. The Granular Fill was typically medium dense, gravelly fine to coarse sand, with varying amounts of silt. The bottom of the Granular Fill was observed to range from 3.0 to 3.5 feet Below the Ground Surface (BGS).

<u>Till Fill</u>: All of the test borings encountered reworked glacial till below the Granular Fill. The Till Fill was typically loose, fine to medium sand, with varying amounts of gravel and silt. The bottom of the Till Fill was observed to range from between 9 and 13 feet BGS behind the west abutment to about 17 to 24 feet BGS behind the east abutment. It is likely that glacial till excavated for the construction of the highway was reused as fill behind the existing bridge abutments, the loose in-situ relative density being the result of standard construction practices and available compaction equipment at the time the existing bridge was constructed around 1933. The excavation for the construction of the existing east abutment likely extended to bedrock in order to remove the field stone abutment of the prior bridge that it replaced.

Glacial Till: Glacial Till was encountered in the test borings located behind the existing west abutment below the fill materials. The Glacial Till was typically dense to very dense, gravel, with varying amounts of sand and silt. Drilling behavior suggested that large gravel and cobbles were present throughout the glacial till stratum. The Glacial Till varied from about 4 to 6 feet thick behind the west abutment.

Detailed descriptions of the soils encountered in the test borings are provided on the logs included in Appendix A.

Bedrock: Bedrock was encountered at depths ranging from 22.5 and 23.9 feet BGS (elevations 768.8 and 767.3 feet, respectively) behind the east abutment. Bedrock was encountered at depths ranging from 16.4 and 18.8 feet BGS (elevations 773.5 and 771.3 feet, respectively) behind the west abutment. The bedrock core obtained in the test borings consisted of medium to hard, slightly weathered to fresh, aphanitic, light grey PORPHYROBLASTIC PHYLLITE, with muscovite bands, plagioclase phenocrysts, and high-angle relic bedding. PHYLLITE is a foliated metamorphic rock (Rock Type B). The protolith rock is a pelite or mudstone.

The Rock Quality Designations (RQDs) of the rock cores obtained in the test borings located behind the east abutment ranged from 53 to 85 percent. The RQDs of the rock cores obtained in the test borings located behind the west abutment ranged from 24 to 80 percent. Two specimens of the rock core were submitted for uniaxial compressive strength tests. The test results indicate the uniaxial compressive strength of the PORPHYROBLASTIC PHYLLITE ranged from 239 to 1,122 ksf. Based on these test results and the rock core obtained from the test borings, the Rock Mass Rating (RMR), corrected for joint orientation, was determined to be 40, which is Poor to Fair.

Detailed descriptions of the rock encountered in the test borings are provided on the logs included in Appendix A; photos of the rock core are provided in Appendix B. We note that a significant thickness of weathered rock was encountered in test borings BB-PSR-103 and -104 that were located on the upstream side of the existing bridge in the northeast and northwest corners, respectively. We also note that while coring rock in test boring BB-PSR-102 (southeast corner), drill water was observed discharging from behind the southerly end of the east abutment wing wall, likely along the bedrock interface.

The bedrock surface depicted on the Interpretive Subsurface Profile included on Sheet 2 in the Figures was developed utilizing both the test boring data and HRG's 2014 geophysical data. The interpreted bedrock surface elevation contours presented by HRG based on their 2014 geophysical survey show rock to be about 7 feet higher than the test boring data at the east end of the bridge and about 3 to 4 feet higher than the test boring data at the west end of the bridge. This apparent discrepancy is likely a result of the weathered rock zone observed in some of the test borings, as noted above.

IMPLICATIONS OF SUBSURFACE CONDITIONS

As indicated in the previous sections, the test borings encountered dense glacial till over (relatively) shallow bedrock.

Dense Glacial Till Deposit: The glacial till fill and the glacial till were observed to contain large gravel, cobbles, and boulders that was difficult to penetrate with the casing and the action of a roller cone.

Shallow Bedrock Depth: Bedrock was encountered at depths ranging from 22.5 and 23.9 feet BGS (elevations 768.8 and 767.3 feet, respectively) behind the east abutment. Bedrock was encountered at depths ranging from 16.4 and 18.8 feet BGS (elevations 773.5 and 771.3 feet, respectively) behind the west abutment. The geophysical survey indicates that the bedrock surface varies between elevations 774 to 776.5 under the proposed abutments. The difference may be the result of a significant, but variable depth of weathered rock over bedrock that is sound enough to core.

A pile-supported integral abutment bridge is not feasible at this location due to inadequate depth of overburden overlying bedrock (MaineDOT's Bridge Design Guide dated August 2003 together with March 2014 updates (MaineDOT BDG)). Concerns that piles would be overstressed during driving through the glacial till (fill) and weathered rock and/or would not achieve the required depth due to obstructions resulting in the need to pre-excavate the pile locations also do not favor a pile-supported structure.

GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

SchonewaldEA provides the following geotechnical recommendations for the design and construction of the Wing Bridge replacement. These recommendations are based on the MaineDOT BDG, as well as the geotechnical provisions set forth in the AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010 (2010 LRFD manual) and the 8th Edition, 2017 (2017 LRFD manual). The replacement bridge will be an 88-foot long, single span structure that will be supported on full-height abutments founded on prepared bedrock; the abutments will be at a 35-degree skew with the roadway.

FULL HEIGHT ABUTMENT FOOTING DESIGN

The footings for the full height abutments should bear directly on prepared bedrock or a mud leveling pad (seal) poured on the prepared bedrock surface. No part of the footings should bear on soil. The contractor should remove any overburden soil and weathered rock that can be removed using ordinary excavation equipment to expose competent bedrock. It is anticipated that the bedrock surface underlying the abutments will be highly irregular based on the rock core obtained in the test borings and visual inspection of the river upstream and downstream of the existing structure. The prepared bearing surface should not slope steeper than 4H:1V; stepping the bearing surface to flatten the overall slope is acceptable. In accordance with Section 5.3.1.2 of MaineDOT's BDG, the final bedrock surface should be cleaned and washed prior to pouring a seal or the footings. The prepared bedrock surface should be inspected and accepted by the Resident prior to any concrete placement. Dowels should be used to pin the footing or seal to the prepared bedrock surface given the steeply dipping foliated rock encountered in the test borings.

For service limit state only, a presumptive bearing resistance equal to 20 ksf may be used for the design of footings bearing on prepared bedrock. This is anticipated to result in total (immediate) settlements less than one inch. For the service limit state structural design, use the lesser of this recommended bearing resistance or the nominal resistance of concrete ($0.3f'c$).

For the evaluation of strength limit state bearing resistance, SchonewaldEA evaluated the Rock Mass Rating (RMR) of the bedrock underlying the site using methodology developed by Hoek and Brown and outlined in the 2010 LRFD Manual and based on rock core descriptions and laboratory unconfined compressive strength test data. Methods outlined by Wyllie and Hoek-Brown were then used to develop recommendations for the strength limit state bearing resistance. A nominal bearing resistance (q_n) on rock equal to 33 ksf is reasonable. Using a bearing resistance factor (φ_b) of 0.45 for spread footings on rock in accordance with Table 10.5.5.2.2-1 in the 2017 LRFD Manual, a factored bearing resistance (q_r) of 15 ksf is recommended for the strength limit state design of footings bearing on rock. Regardless of the calculated bearing pressure, the minimum footing dimension should not be less than two feet. Rock Mass Rating and Rock Mass Bearing Capacity calculations are provided as Appendix F.

For evaluation of sliding on the base of the footings if dowels are not used to pin the footing or seal, the bearing material should conservatively be treated as a soil with the friction angle (δ) between the cast-in-place concrete footing and the soil taken as 30 degrees. This is in accordance with Table

C3.11.5.3-1 in the 2017 LRFD Manual. A resistance factor ($\varphi\tau$) for sliding, based upon the footing bearing on sandy soil is 0.80, in accordance with Table 10.5.5.2.2-1 of the 2017 LRFD Manual. Sliding resistance will be increased significantly if dowels are used to pin the footing or seal to the prepared bedrock surface.

SETTLEMENT

For footings bearing on prepared bedrock, settlement in not a concern.

FROST ACTION

Likewise, frost action is not a concern for footings bearing on prepared bedrock.

SCOUR PROTECTION

Scour protection also is not a concern, though doweling the footing or seal to bedrock should provide protection against extreme scour events.

ABUTMENT STEM WALL DESIGN

The footing stems (walls) should be designed based upon a MaineDOT Granular Borrow backfill, having the following design parameters:

- Internal friction angle (φ) equal to 32 degrees;
- Total unit weight (γ_t) equal to 0.125 kips per cubic foot (kcf);
- Coulomb active earth pressure coefficient (K_a) equal to 0.274; and
- At-rest earth pressure coefficient (K_0) equal to 0.470.

To provide adequate drainage, MaineDOT Granular Borrow for Underwater Backfill, which allows significantly less fines, should be used within 10 feet behind the stem wall, measured from 18 inches off the back of the footing. Granular Borrow for Underwater Backfill should extend up to or slightly above the predicted Q_{100} flood elevation. Additionally, footing drains, drainage/strip drains, and weep holes should be provided to limit hydrostatic pressures. Groundwater should be set at a level three feet up the stem in accordance with the MaineDOT BDG regardless of the groundwater controls provided.

SEISMIC DESIGN CONSIDERATIONS

The following seismic parameters for the Wing Bridge site were developed using the general procedure for determining seismic hazard that is set forth in Articles 3.10.1.2 and 3.10.4 of the 2017 LRFD, and conservatively assigning a Site Class of “B” based on related Table 3.10.3.1-1.

Peak Ground Acceleration Coefficient	PGA	0.08g	Fig 3.10.2.1-1
Short-Period Spectral Acceleration Coefficient	S_s	0.16g	Fig 3.10.2.1-2
Long-Period Spectral Acceleration Coefficient	S_1	0.045g	Fig 3.10.2.1-3
Site Factor with Site Class B	F_v	1.0	Table 3.10.3.2-3
Site Factor with Site Class B	F_{pga}	1.0	Table 3.10.3.2-1
Seismic Zone Determination ($S_{D1} = F_v*S_1$)	S_{D1}	0.045	Eq. 3.10.4.2-6
Acceleration Coefficient ($A_s = F_{pga}*PGA$)	A_s	0.08	Eq. 3.10.4.2-2

With S_{D1} less than 0.15, the Wing Bridge site is classified as Seismic Zone 1 in accordance with Table 3.10.6-1 of the 2017 LRFD Manual. Per Article 4.7.4 of the 2017 LRFD Manual, seismic analysis is not required for bridges in Seismic Zone 1. However, the design of superstructure connections should consider seismic forces.

CONSTRUCTION CONSIDERATIONS

Construction will require soil excavation. Earth support systems shall be implemented if laying back slopes is not feasible. Regardless of the method of excavation, all excavations and earth support systems/cofferdams shall meet all applicable OSHA regulations. The Contractor's design of earth support systems shall account for shallow bedrock conditions and the possibility of encountering obstructions in the fill materials and underlying glacial till. The design of temporary earth support systems should consider internal bracing and/or rock sockets.

It is anticipated that there will be seepage of water from fractures and joints exposed in the bedrock surface. The Contractor shall control such water, as well as groundwater infiltration from the overburden and surface water run-on using temporary ditches, sumps, granular drainage blankets, stone ditch protection or hand-laid riprap with geotextile underlayment to divert groundwater and surface water to allow construction in the dry.

If soil-filled pockets are encountered at the bearing elevations, the soil shall be removed. The contractor shall also remove any weathered bedrock that can be removed using ordinary excavation equipment to expose competent bedrock at the required elevations. The bedrock bearing surface shall be clean and free of debris, soil or loose rock.

If blasting is necessary and allowed per environmental permits, it shall be preapproved by the resident and shall be conducted in accordance with section 105.2.7 of the MaineDOT standard specifications. The contractor shall conduct pre-and post-blast surveys, as well as blast vibration monitoring, at any nearby structures in accordance with industry standards at the time of the blast.

The design of the foundations for the temporary detour bridge should also account for shallow bedrock and the possibility of encountering obstructions in the fill materials and underlying glacial till.

DETOUR CUT

As discussed above, HRG completed a geophysical survey in 2016 that focused on assessing the top of the competent bedrock surface underlying and in the vicinity of the proposed backslope cut for the temporary Wing Bridge detour. The 2016 geophysical data was needed by the design team to establish the pitch of the cut slope (i.e., 2H:1V for soil cut or steeper for rock cut) and for estimating the excavation type (i.e., common or rock) and quantity for the Wing Bridge detour. Based on the existing topography, Stantec's proposed grades for the temporary detour, and HRG's interpretation of the top of competent bedrock under the bridge detour cut slope, we do not anticipate encountering competent rock while excavating for the temporary detour. For that reason, the project team assumed the excavation for the detour will be soil (common) and the cut slope should be no steeper than 2H:1V.

CLOSURE

This report has been prepared for the use of Stantec Consulting Services, Inc. for specific application to the replacement of Wing Bridge over the Sandy River that is located on Route 4 in Phillips, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

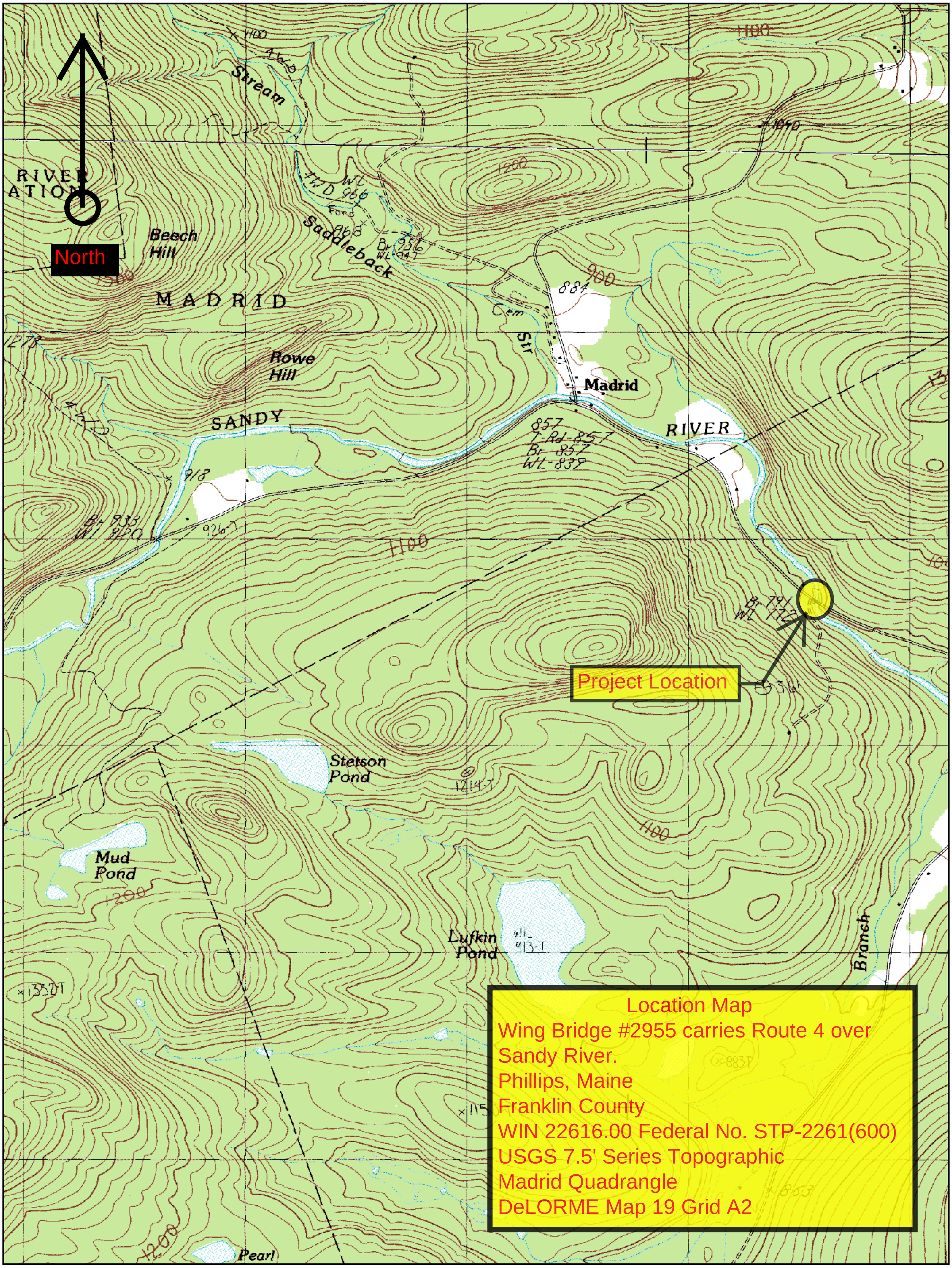
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes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

It is recommended that a geotechnical engineer be provided the opportunity for a review of the design and specifications in order that the earthwork and foundation recommendations and construction considerations presented in this report are properly interpreted and implemented in the design and specifications.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

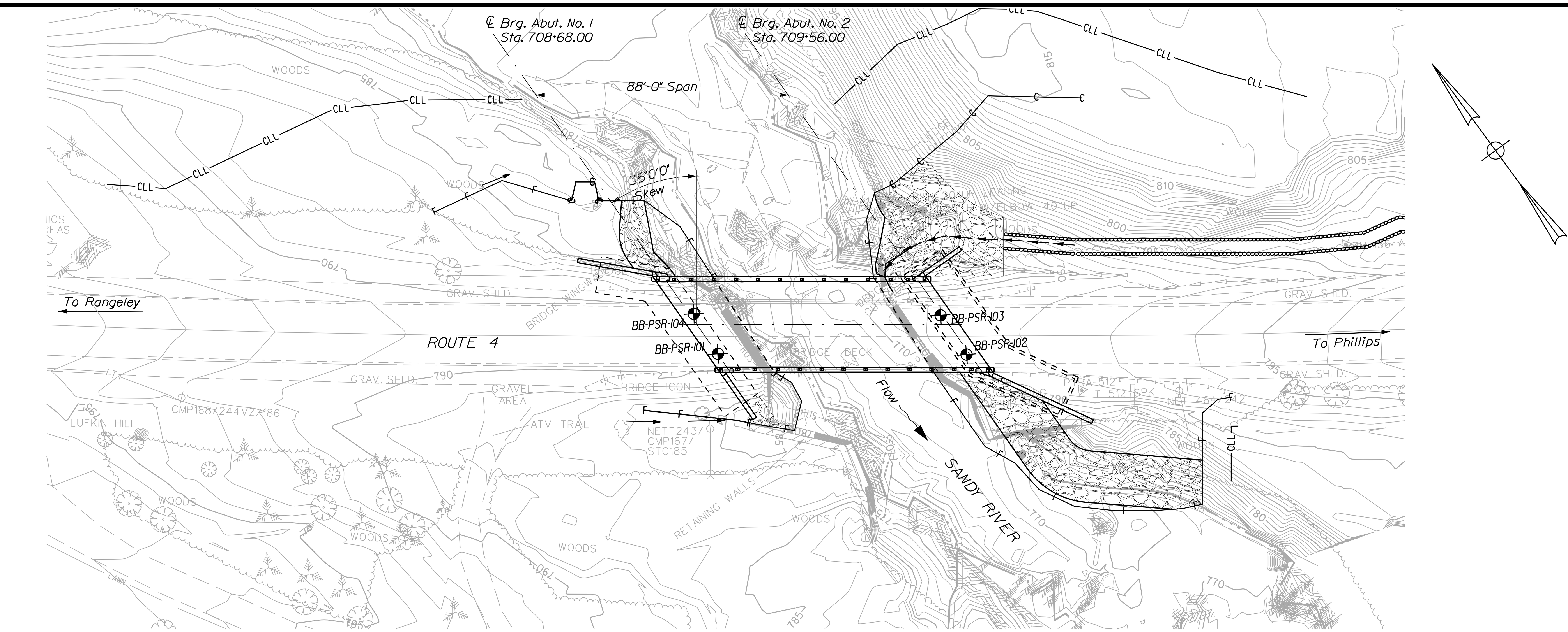
FIGURES

SHEETS 1 AND 2



Map Scale 1:24000

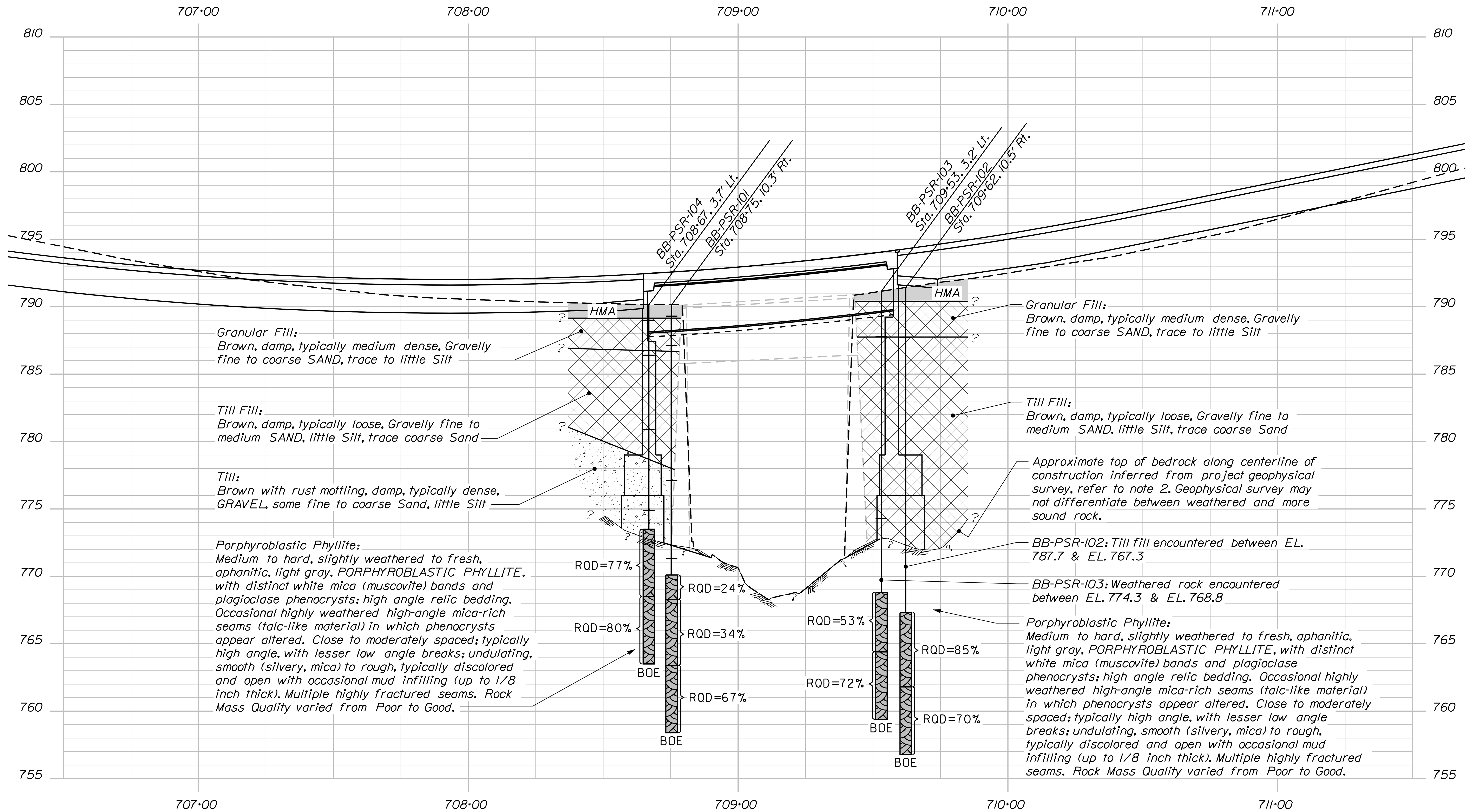
The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch. Road names used on this map may not match official road names.



LEGEND
CASED WASH BORING

BORING LOCATION PLAN

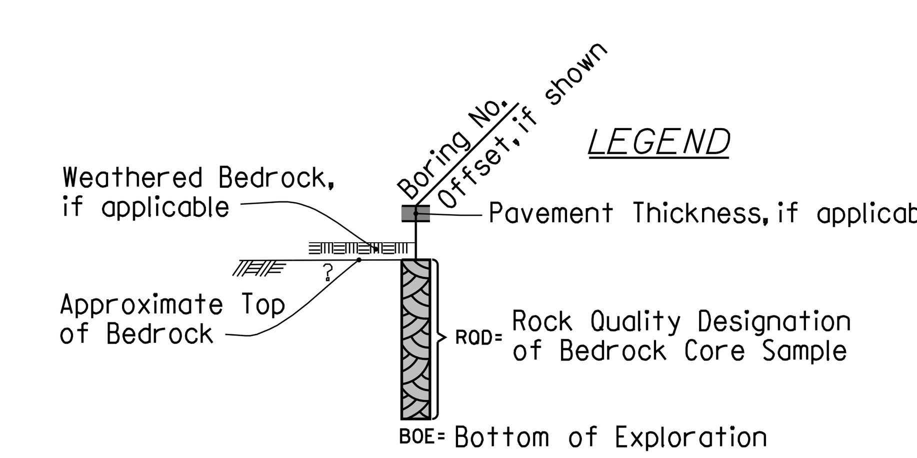
25 0 25 50
Scale of Feet



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 and bedrock transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

2. The approximate top of bedrock depicted on this Interpretive Subsurface Profile was inferred from subsurface information in widely spaced explorations, as well as the result of a geophysical survey. A copy of the geophysical survey report is included as an appendix to the project geotechnical report.



LEGEND

INTERPRETIVE SUBSURFACE PROFILE

Horiz. 25 0 25 50
Vert. 5 0 5 10
Scale of Feet

Filename: ...\MSTA\458_BLP-ISP_PHI_01.dgn Division: BRIDGE Username: dataylor Date:12/20/2018

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
STP-2261(600)
WIN 22616.00
BRIDGE NO. 2955
BRIDGE PLANS

PROJ. MANAGER	M. WIGHT	BY	DATE
DESIGN-DETAILED	IVS	DB	DEC 2018
CHECKED-REVIEWED	IVS	IVS	DEC 2018
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE

WING BRIDGE
SANDY RIVER
PHILLIPS FRANKLIN COUNTY

BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 2

Schonewald Engineering Associates, Inc.

APPENDIX A

SUBSURFACE EXPLORATION LOGS

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-101

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	790.1	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/26/14; 1500 / 8/27/14; 1025	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+75, 10.3 RT	**Casing ID/OD:**	HW to 16.9'; NW to 20.0'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA	789.3		9 inches HMA (0.8)	
	1D	24/13	1.0 - 3.0	12-17-12-8	29				1D: Brown, dry, m. dense, Gravelly fine to coarse SAND, trace Silt. GRANULAR FILL	
							787.1		3.0 — Numerous cobbles below 3 feet.	
5	2D	24/7	4.0 - 6.0	5-6-3-4	9				2D: Dark brown, damp, loose, Gravelly fine to coarse SAND, trace to little Silt. TILL FILL	
10	3D	24/9	9.0 - 11.0	3-5-3-4	8	--			3D: Brown, damp, loose, fine to medium SAND, some Gravel, little Silt, trace coarse Sand. TILL FILL	
						30				
						36				
						16				
						42	777.1		13.0	
						--				
15	4D	22/12	15.0 - 16.8	4-20-69-50/4"	89				4D: Brownish-rgay, v. dense, GRAVEL, some fine to coarse Sand, little Silt. TILL	
							771.3		18.8 — Top of rock at 18.8 ft; roller cone and set casing to 20.0	
20	R1	21/19	20.0 - 21.8	RQD = 24%					R1: Medium to hard, slightly weathered to fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Very close to close, predominately horizontal breaks; undulating, rough, typically discolored and open with mud infilling.	
	R2	59/55	21.8 - 26.7	RQD = 34%					R2: same as R1, except close, predominately high angle with lesser horizontal breaks. Highly broken and weathered from 24.5 to 25.4 feet.	
			22.9 - 23.3							UCT qp = 7,795 psi
25										
	R3	60/54	26.7 - 31.7	RQD = 67%					R3: same as R1, except moderate to widely spaced, high-angle breaks. Highly broken and weathered from 26.7 to 27.3 feet.	
30										
							758.4		31.7 — **Bottom of Exploration at 31.7 feet below ground surface.**	
35										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-102

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.2	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1030 / 8/27/14; 1420	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+62, 10.5 RT	**Casing ID/OD:**	NW to 23.8'(pull); HW spun to 24.2'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			10 inches HMA	
							790.4		0.8	
	1D	24/13	1.0 - 3.0	14-14-19-11	33				1D: Brown, damp, dense, fine to medium Sandy GRAVEL, trace to little Silt, trace coarse Sand. GRANULAR FILL	
							787.7		3.5	
5	2D	24/14	4.0 - 6.0	5-4-3-3	7				2D: Brown, damp, loose, Gravelly fine to medium SAND, little Silt, trace coarse Sand. TILL FILL	
10	3D	24/10	9.0 - 11.0	2-3-4-3	7	--			3D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
						14				
						9				
						17				
						13				
15	MD	24/0	14.0 - 16.0	4-3-4-9	7	3			No recovery.	
						19				
						26				
						43				
						34				
20	4D	24/5	19.0 - 21.0	8-4-4-5	8	13			4D: Brown-gray, loose, GRAVEL, little fine to coarse Sand, trace Silt. TILL FILL	
						17				
						40				
						60				
							767.3		23.9	
25	R1	60/60	24.4 - 29.4	RQD = 85%					Top of rock at 23.9 ft; spin HW casing to 24.2 ft; roller cone to 24.4 ft R1: Hard, slightly weathered, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; near vertical relic bedding. Close to wide, horizontal and high angle breaks; undulating, rough, typically discolored and open with occasional mud infilling.	
30	R2	60/60	29.4 - 34.4	RQD = 70%					R2: same as R1	
							756.8		34.4	
35									**Bottom of Exploration at 34.4 feet below ground surface.** Noted drill water seeping out from behind southerly end of wing wall, apparently at ledge interface	

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-103

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.3	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1445 / 8/28/14; 0850	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+53, 3.2 LT	**Casing ID/OD:**	HW to 17.3'; NW to 22.5'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			10.5 inches HMA	
							790.4		0.9	
	1D	24/14	1.0 - 3.0	15-16-14-14	30				1D: Brown, dry, m. dense, fine to coarse Sandy GRAVEL, trace Silt. GRANULAR FILL	
							787.8		3.5	
5	2D	24/11	4.0 - 6.0	3-3-2-3	5				2D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
10	3D	24/8	9.0 - 11.0	3-4-3-4	7	RC			3D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
15	4D	24/6	14.0 - 16.0	4-5-5-3	10				4D: Brown, loose, fine to medium Sandy GRAVEL, little Silt, trace coarse Sand. TILL FILL	
							774.3		17.0	
	R1	35/15	17.3 - 20.2						Apparent top of weathered rock. R1: Appear to be in near vertical seam of highly weathered rock (PHYLLITE). Short piece of core with high angle breaks top and bottom. Bottom open fracture includes significant thickness of very fine Sandy SILT with roots infilling.	
20	5D	6/6	20.2 - 20.7	50/6"					5D: Gray, Silty very fine SAND, trace Gravel. Broken rock in tip of spoon. Roller cone ahead - no pressure, rapid penetration. Fetch up at 22.5 ft. Drive NW to 22.5 ft.	
							768.8		22.5	
	R2	53/47	22.5 - 26.9	RQD = 53%					R2: Medium to hard, slightly weathered from 22.5 to 24.8 feet, otherwise fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Highly weathered high-angle mica-rich seam from 22.5 to 23.5 feet; phenocrysts appear altered; talc-like material Close to moderately spaced, moderate to high angle breaks; undulating, smooth (mica) to rough, typically discolored and open with mud infilling (1/8 inch thick). Significant fracture zone from 24.2 to 24.8 feet.	
25			25.0 - 25.4							UCT qp = 1,657 psi
	R3	60/57	26.9 - 31.9	RQD = 72%					R3: same as R2, except slightly weathered where mica-rich seams intersect core surface; horizontal and moderately dipping breaks. Highly fractured (v. close spacing) below 31.1 feet.	
30										
							759.4		31.9	
									Bottom of Exploration at 31.9 feet below ground surface.	
35										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-104 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	789.9	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/28/14; 0855 / 8/28/14; 1135	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+67, 3.7 LT	**Casing ID/OD:**	HW and NW (telescoped) to 16.4'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			11 inches HMA	
							789.0		0.9	
	1D	24/14	1.0 - 3.0	12-13-8-29	21				1D: Brown, dry, m. dense, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. (GRANULAR) FILL	
							786.4		3.5	
5	2D	24/4	4.0 - 6.0	4-4-3-2	7				2D: Brown, damp, loose, Gravelly fine to medium SAND, little Silt, trace coarse Sand. (TILL) FILL	
							780.9		9.0	
10	3D	24/10	9.5 - 11.5	10-7-4-4	11	RC			3D: Top 2": Brown, damp, fine to medium SAND, some Gravel, little Silt, trace coarse Sand. Btm 8": Gray, damp, fine Sandy GRAVEL, little Silt; appears to be decomposed cobble. TILL	
15	4D	24/10	14.0 - 16.0	6-11-33-10	44		774.9		4D: Top 2": Brown, damp, Gravelly fine to medium SAND, little Silt, trace coarse Sand. Btm 8": Gray, damp, fine Sandy GRAVEL, little to some Silt; appears to be crushed/weathered rock. TILL changing to WEATHERED ROCK	
									15.0	
							773.5		16.4	
	R1	60/60	16.4 - 21.4	RQD = 77%					R1: Hard, fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Fewer and less well defined phenocrysts than in BB-PSR-101 through -103. Top 0.3 feet weathered and broken, otherwise moderately spaced (2), high angle breaks; undulating, smooth (silvery, mica), slightly discolored and open; no infilling observed.	
20										
	R2	60/60	21.4 - 26.4	RQD = 80%					R2: same as R1, except only 1 horizontal discolored fracture and 1 high angle fracture along a mica-rich zone.	
25										
							763.5		26.4	
									Bottom of Exploration at 26.4 feet below ground surface.	
30										
35										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

APPENDIX B

ROCK CORE PHOTOGRAPHS

Photo 1: Core box containing rock core from test borings BB-PSR-101 and BB-PSR-102 - left side of core box (top portion of cores).
From top to bottom 1) BB-PSR-101, R-1 and R-2; 2) BB-PSR-101, R-3; 3) BB-PSR-102, R-1; 4) BB-PSR-102, R-2.

Photo 2: Core box containing rock core from test borings BB-PSR-101 and BB-PSR-102 – right side of core box (bottom portion of cores).
From top to bottom 1) BB-PSR-101, R-1 and R-2; 2) BB-PSR-101, R-3; 3) BB-PSR-102, R-1; 4) BB-PSR-102, R-2.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

ROCK CORE PHOTOGRAPHS
TEST BORINGS BB-PSR-101 AND BB-PSR-102
WING BRIDGE REPLACEMENT
PHILLIPS, MAINE

Sheet No.:

1 of 3

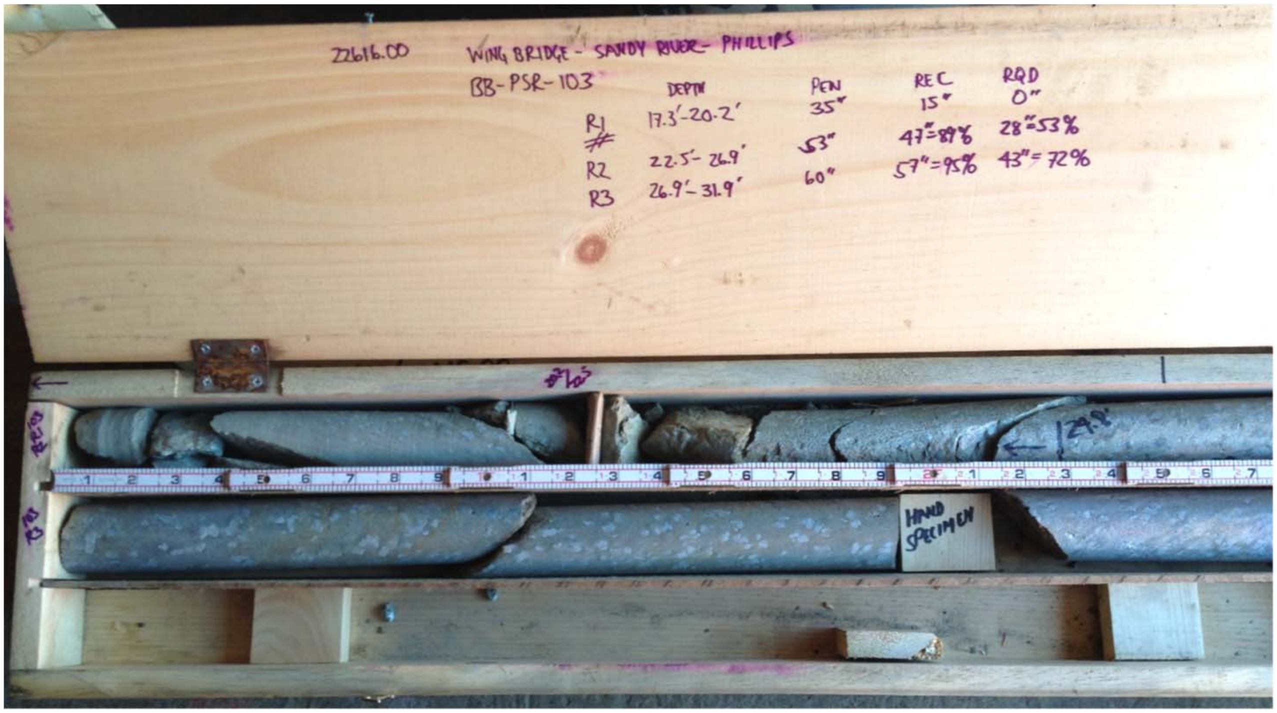


Photo 3: Core box containing rock core from test boring BB-PSR-103 - left side of core box (top portion of cores). From top to bottom 1) BB-PSR-103, R-1 and R-2; 2) BB-PSR-103, R-3.

Photo 4: Core box containing rock core from test boring BB-PSR-103 – right side of core box (bottom portion of cores).
From top to bottom 1) BB-PSR-103, R-1 and R-2; 2) BB-PSR-103, R-3.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

ROCK CORE PHOTOGRAPHS
TEST BORING BB-PSR-103
WING BRIDGE REPLACEMENT
PHILLIPS, MAINE

Sheet No.:

2 of 3

Photo 5: Core box containing rock core from test boring BB-PSR-104 - left side of core box (top portion of cores). From top to bottom 1) BB-PSR-104, R-1; 2) BB-PSR-104, R-2.

Photo 6: Core box containing rock core from test boring BB-PSR-104 – right side of core box (bottom portion of cores).
From top to bottom 1) BB-PSR-104, R-1; 2) BB-PSR-104, R-2.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

ROCK CORE PHOTOGRAPHS
TEST BORING BB-PSR-104
WING BRIDGE REPLACEMENT
PHILLIPS, MAINE

Sheet No.:

3 of 3

APPENDIX C

LABORATORY TEST REPORT

LABORATORY TESTING DATA SHEET

Project Name MaineDOT Weymouth & Wing Bridges
Location Madrid and Phillips, ME
Reviewed By Matthew Pelyga (signature)

Schonewald Engineering Assoc. No. 14-113 74-14-0003.18
Assigned By B. Schonewald

Project Engineer B. Schonewald
Report Date 10/21/2014
Date Reviewed 10/22/2012

Boring	Sample No.	Depth Ft.	Lab No.	Do in.	L in.	(1) Unit Wt. PCF	(2) Wet Density PCF	Bulk Gs.	Compression Tests (ASTM D7012 D) (3) Other Tests	(4) Strength PSI	(5) Strain %	(6) Conf. Stress	(7) E sec PSI EE+06	(8) Poisson's Ratio	στ KSI	Rock Formation or Description or Remarks
BB-PSR-101	R2	22.9-23.3	3	1.970	4.539	173.6			U	7,795	0.27		2.42	1.08		
BB-PSR-103	R2	25.0-25.4	4	1.968	4.627	159.8			U	1,657	0.26		0.67	0.06		

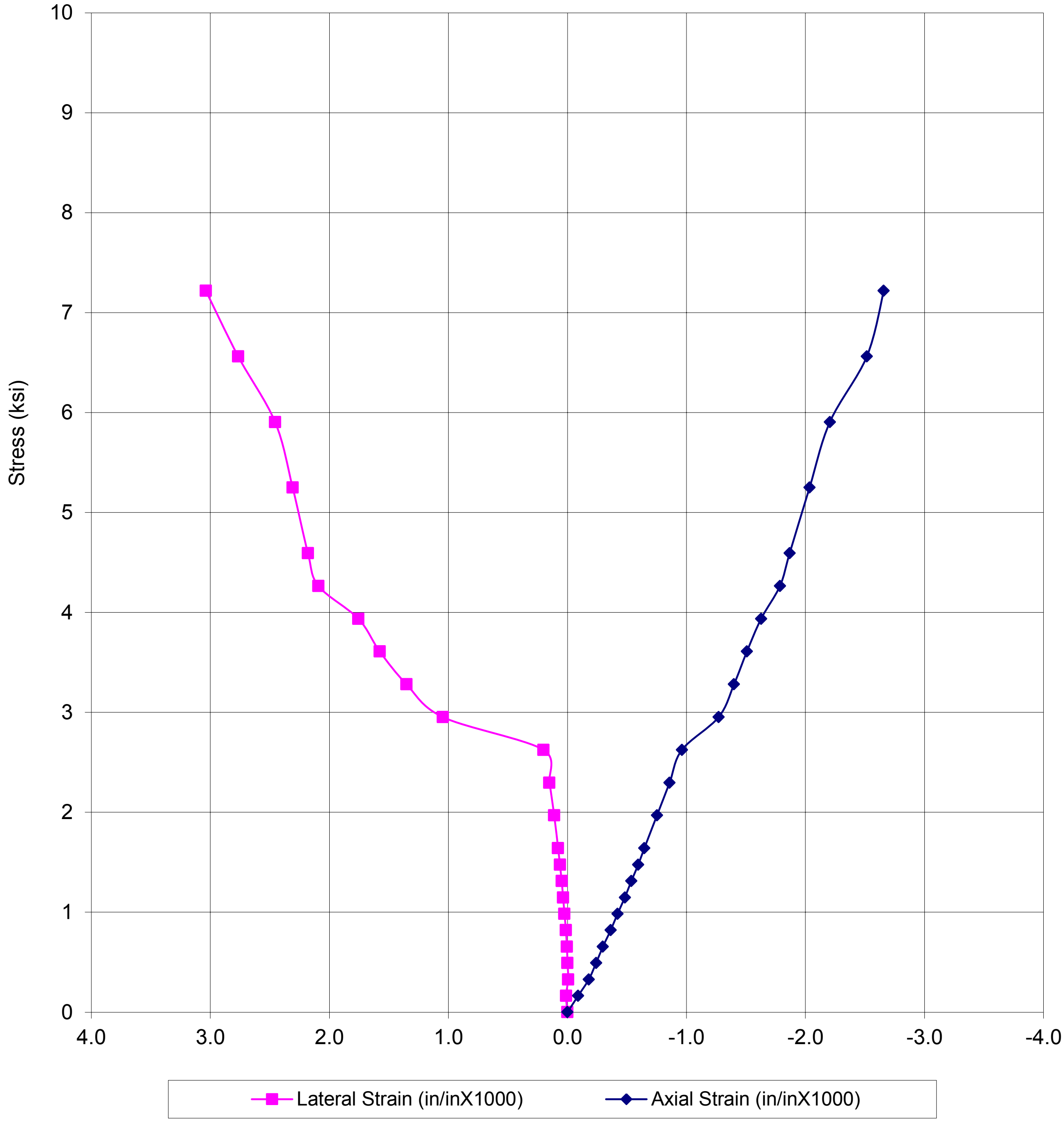
(1) Volume Determined By Measuring Dimensions
(2) Determined by Measuring Dimensions and Weight of Saturated Sample

(3) P=Petrographic PLD=Point Load (diametrical), PLA= Point Load (Axial) RST= Splitting Tensile U= Unconfined Compressive Strength
(4) Taken at Peak Deviator Stress

(5) Strain at Peak Deviator Stress
(6) Represents Confining Stress on Triaxial Tests
(7) Represents Secant Modulus at 50% of Total Failure Stress
(8) Represents Secant Poisson's Ratio at 50% of Total Failure Stress

THIELSCH ENGINEERING
195 Frances Avenue
Cranston, RI 02910 401-467-6454

MaineDOT Weymouth & Wing Bridges
Madrid and Phillips, ME

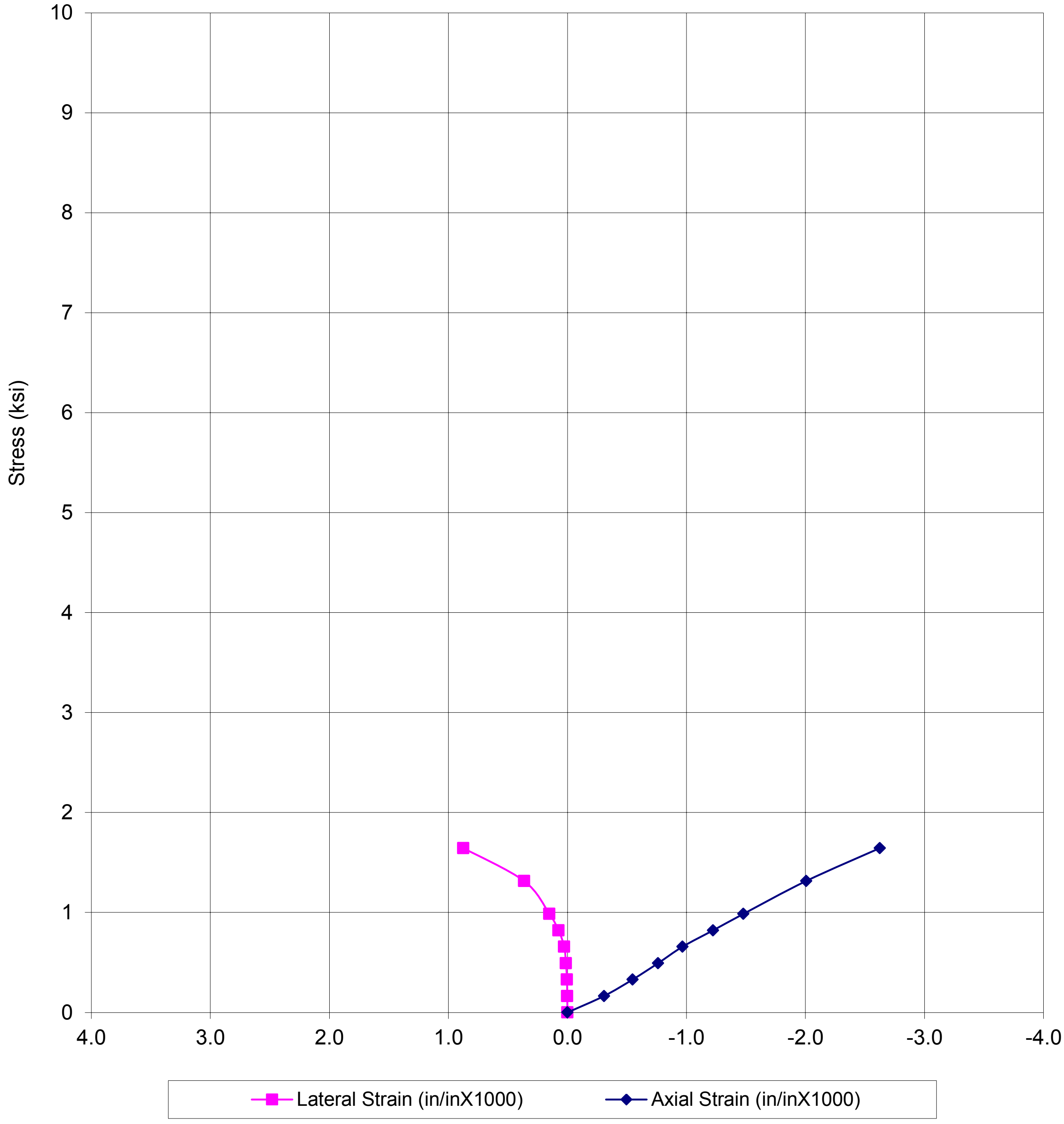


Rock Testing

Schonewald EA	14-113	Test Method	ASTM D7012
Boring No.	BB-PSR-101	File No.	CTS-74-14-0003.18
Sample No.	R2	Date:	10/17/14
Depth:	22.9-23.3'	Test No.	U 3

THIELSCH ENGINEERING

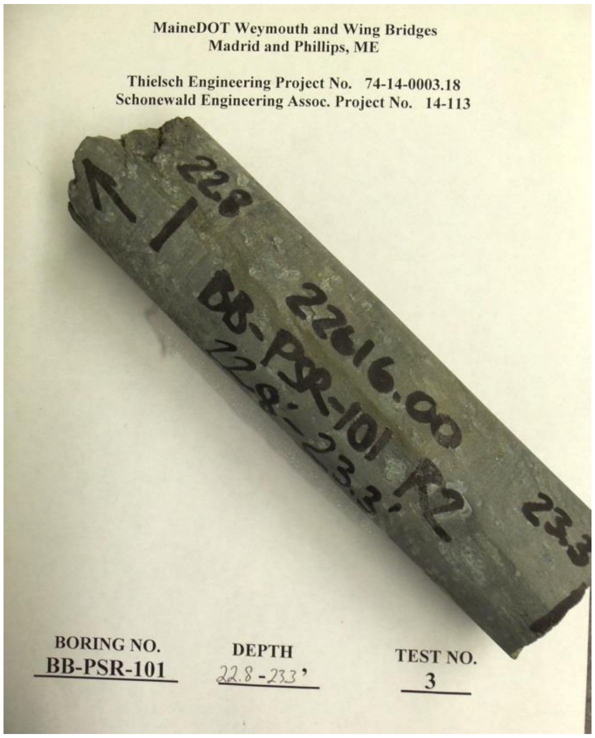
MaineDOT Weymouth & Wing Bridges
Madrid and Phillips, ME



Rock Testing

Schonewald EA	14-113	Test Method	ASTM D7012
Boring No.	BB-PSR-103	File No.	CTS-74-14-0003.18
Sample No.	R2	Date:	10/20/14
Depth:	25.0-25.4'	Test No.	U 4

THIELSCH ENGINEERING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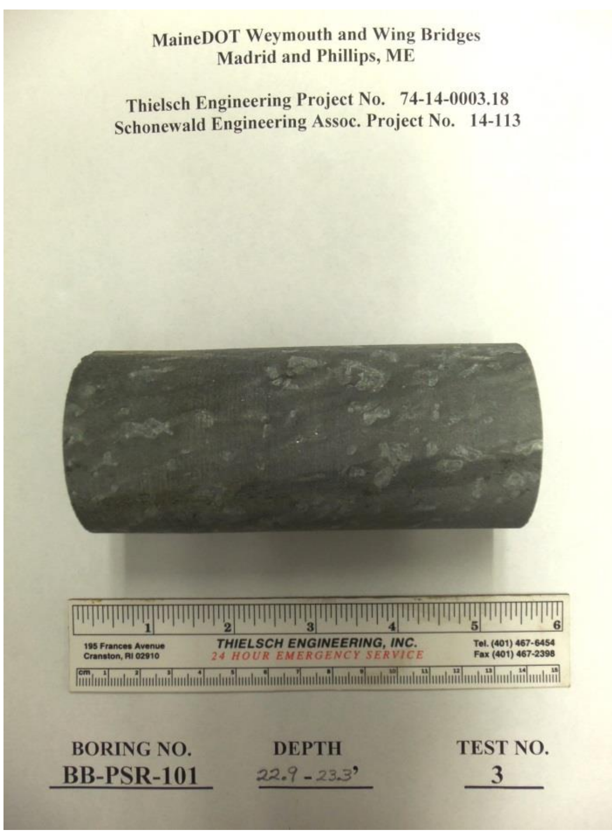
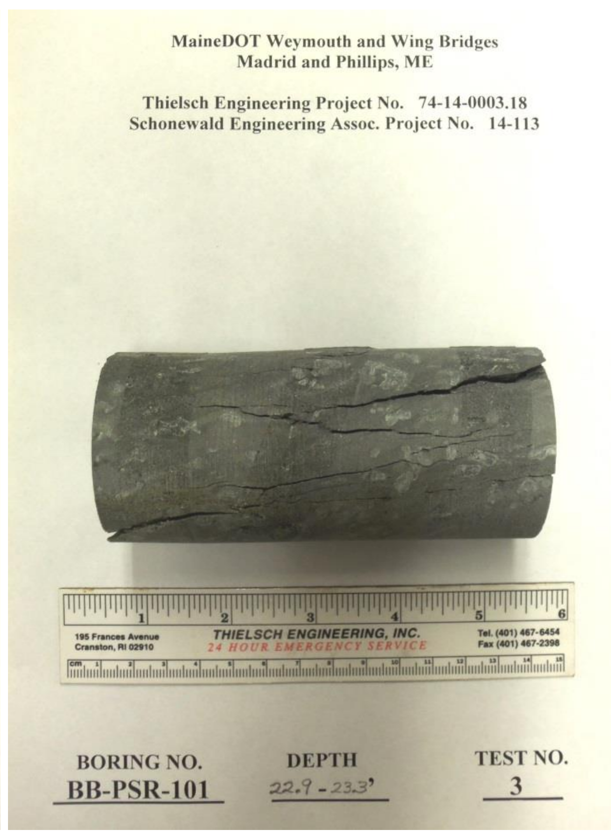
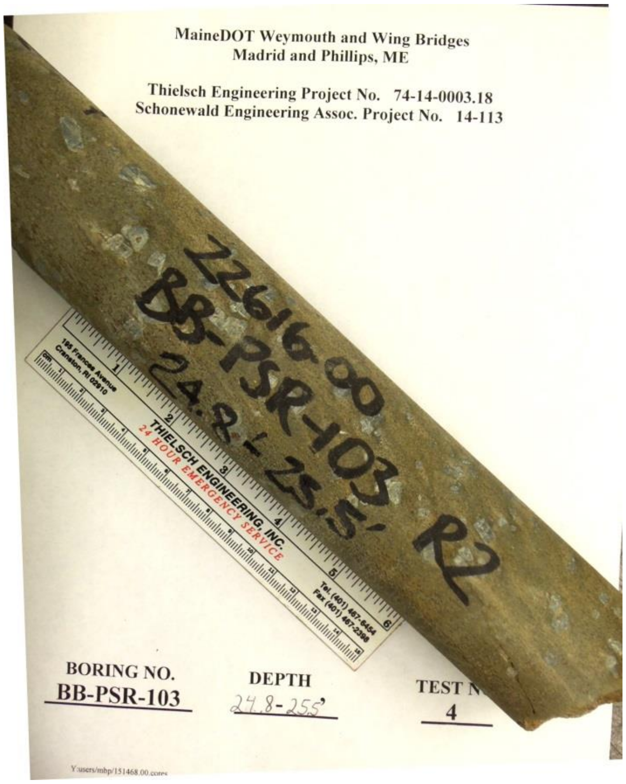
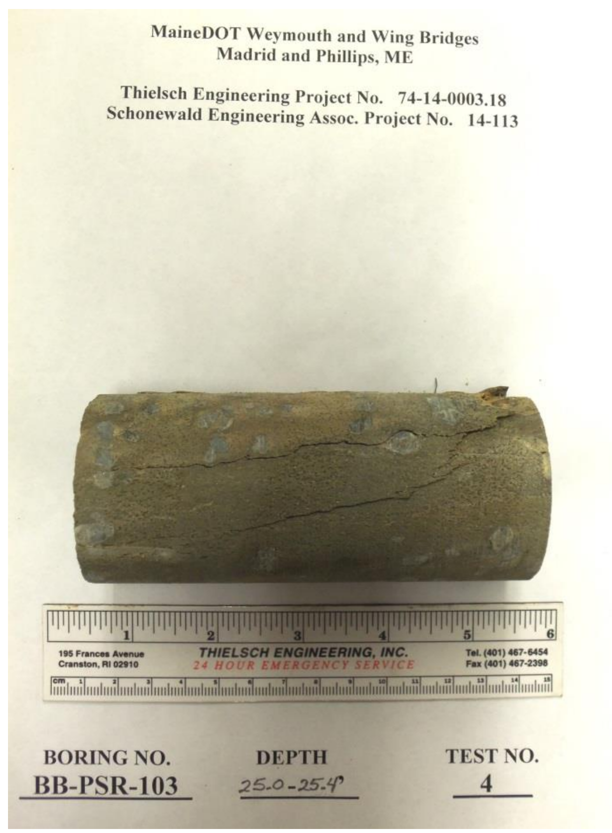
Madrid and Phillips, ME
Thielsch Engineering Project No. 74-14-0003.18
Schonewald Engineering Assoc. Project No. 14-113
22.8
22616.00
BB-PSR-101
22.8'-23.3'
R2
23.3
BORING NO.
BB-PSR-101
DEPTH
22.8-23.3'
TEST NO.
3


MaineDOT Weymouth and Wing Bridges
Madrid and Phillips, ME
Thielsch Engineering Project No. 74-14-0003.18
Schonewald Engineering Assoc. Project No. 14-113
195 Frances Avenue
Cranston, RI 02910
THIELSCH ENGINEERING, INC.
24 HOUR EMERGENCY SERVICE
Tel. (401) 467-6454
Fax (401) 467-2398
BORING NO.
BB-PSR-101
DEPTH
22.9-23.3'
TEST NO.
3


MaineDOT Weymouth and Wing Bridges
Madrid and Phillips, ME
Thielsch Engineering Project No. 74-14-0003.18
Schonewald Engineering Assoc. Project No. 14-113
195 Frances Avenue
Cranston, RI 02910
THIELSCH ENGINEERING, INC.
24 HOUR EMERGENCY SERVICE
Tel. (401) 467-6454
Fax (401) 467-2398
BORING NO.
BB-PSR-101
DEPTH
22.9-23.3'
TEST NO.
3


MaineDOT Weymouth and Wing Bridges
Madrid and Phillips, ME
Thielsch Engineering Project No. 74-14-0003.18
Schonewald Engineering Assoc. Project No. 14-113
22616.00
BB-PSR-103
24.8'-25.5' R2
195 Frances Avenue
Cranston, RI 02910
THIELSCH ENGINEERING, INC.
24 HOUR EMERGENCY SERVICE
Tel. (401) 467-6454
Fax (401) 467-2398
BORING NO.
BB-PSR-103
DEPTH
24.8-25.5'
TEST N
4


MaineDOT Weymouth and Wing Bridges
Madrid and Phillips, ME
Thielsch Engineering Project No. 74-14-0003.18
Schonewald Engineering Assoc. Project No. 14-113
195 Frances Avenue
Cranston, RI 02910
THIELSCH ENGINEERING, INC.
24 HOUR EMERGENCY SERVICE
Tel. (401) 467-6454
Fax (401) 467-2398
BORING NO.
BB-PSR-103
DEPTH
25.0-25.4'
TEST NO.
4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Schonewald Engineering Associates, Inc.

APPENDIX D

HRG'S 2014 GEOPHYSICAL REPORT

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
WING BRIDGE
PHILLIPS TOWNSHIP, MAINE
PIN 22616.00

MAINE DOT CONTRACT
NO. 20110613000000006486

Prepared for:

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

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - D10
Salem, New Hampshire 03079

File 14J61
December, 2014

0. EXECUTIVE SUMMARY

Hager-Richter Geoscience, Inc. conducted a geophysical survey of approaches to the Wing Bridge, which carries State Route 4 over the Sandy River, in Phillips Township, Maine for the Maine Department of Transportation (MaineDOT) in September, 2014. The geophysical survey was performed in support of a geotechnical investigation of the Site by the Maine Department of Transportation (MaineDOT) for a project to replace portions of Route 4 between Madrid and Phillips, Maine.

The geophysical survey was conducted using the seismic refraction and ground penetrating radar (GPR) methods. Seismic refraction profiling was conducted along two 315-foot long seismic lines located along each shoulder of the roadway. The GPR survey was conducted on the roadway approximately between highway stationing 707+35 and 710+65 in an approximately 330-foot by 25-foot area centered on the bridge.

Based on the results of the geophysical survey conducted by Hager-Richter Geoscience, Inc. along State Route 4 in the vicinity of the approaches to the Wing Bridge over the Sandy River in Phillips, Maine for the Maine Department of Transportation (MaineDOT) in September, 2014, we conclude the following:

- Based on the available boring and seismic data, a prominent bedrock low is present at the location of the Sandy River, and is wider and deeper on the south side of the bridge.
- The depth of bedrock along the seismic lines varies from about 9 and 24 feet below ground surface.
- The elevation of competent bedrock in the locations surveyed varies between 768 and 785 feet for a total relief of 17 feet.

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1. INTRODUCTION

Hager-Richter Geoscience, Inc. conducted a geophysical survey of approaches to the Wing Bridge, which carries State Route 4 over the Sandy River, in Phillips Township, Maine for the Maine Department of Transportation (MaineDOT) in September, 2014. Two geophysical methods were used: seismic refraction and ground penetrating radar. The geophysical survey was performed in support of a geotechnical investigation of the Site by the Maine Department of Transportation (MaineDOT) for a project to replace portions of Route 4 between Madrid and Phillips, Maine. A similar geophysical survey of the approaches to the Weymouth Bridge in Madrid Township, Maine was also conducted as part of the project.[1]

The general location of the Site is shown in Figure 1. Four borings (BB-PSR-101 to BB-PSR-104) were drilled in the Route 4 roadway, two borings on either side of the Wing Bridge within approximately 10 to 15 feet of the bridge. The borings encountered bedrock at approximately 16-20 feet depth on the west side of the bridge and 17-24 feet on east side of the bridge. Bedrock was encountered deeper in the borings located on the south side of Route 4. MaineDOT required information on the depth of bedrock in the vicinity of the bridge.

Hager-Richter conducted seismic refraction profiling along two 315-foot long seismic lines - one line on each side of the road and each line centered and extending over the bridge and approaches. In addition, Hager-Richter conducted a GPR survey on the roadway approximately between highway stationing 707+50 and 710+65 in an approximately 330-foot by 25-foot area centered on the bridge. Figure 2 is a modified site plan showing the locations of the seismic lines and the area covered by the GPR survey.

Route 4 is a two-lane road with paved and gravel shoulders. The natural ground surface in the area of interest dips toward the river. The Route 4 road surface gently dips toward the river as it crosses the raised approaches and bridge deck. According to plans provided by MaineDOT, the river bed is approximately 16 to 22 feet below the top of the bridge deck. Bedrock outcrops occur in the river bed in the vicinity of the bridge.

Hager-Richter personnel were on-site on September 8, 2014. Jeffrey Reid, P.G., and Steven Grant, P.G., conducted the survey. The project was coordinated with Ms. Kitty Breskin, P.E., of MaineDOT. MaineDOT personnel were onsite during the field work to provide lane closures and traffic control. MaineDOT provided plans showing site features, surface

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[1] **MaineDOT Contract No. 20110613000000006486,** Geophysical Survey, Weymouth Bridge, Madrid Township, Maine, PIN 22615.00, HR File 14J061, December, 2014

topography, and the locations of borings. Data analysis and interpretation were completed at the Hager-Richter offices. Original data and field notes will be retained in the Hager-Richter files for a minimum of three years.

2. EQUIPMENT AND PROCEDURES

2.1 SEISMIC REFRACTION

2.1.1 Equipment. We used two Geometrics Geode units connected to, and controlled by, a notebook PC computer. The software provides for the acquisition, display, plotting, filtering and storage of seismic data. The seismogram image presented in real time on the notebook screen allows the operator to verify the quality of the data. The stored digital data are transferred to our server at the end of the field day for storage, backup, and future data processing.

The Geodes were coupled to two 24-element seismic spread cables for a total of up to 48 geophones. Each deployment of (up to) 48 co-linear geophones is called a spread, and multiple end-to-end spreads can be conducted to survey long transects. The geophones measure only the vertical component, and their resonant frequency is 12 Hz.

Seismic energy is provided by a 12-lb sledge hammer striking an aluminum base plate, an EWG, or a Betsy seisgun. The Betsy seisgun uses a shotgun blank as the seismic source and is not classified as a weapon or explosive under Federal regulations. The EWG is an accelerated weight drop, using industrial elastics to accelerate the weight. The number of stacks per shot point is variable, and the quality of the stacked seismic signal for each shot point was verified in the field. Six to nine shot points were used for each 48-geophone spread -- one off each end of the cable, one at each end of the cable, and two to five internal to the spread. This configuration provides reversed profiles.

2.1.2 Data Analysis and Interpretation. The seismic data are analyzed using the Generalized Reciprocal Method (GRM) of seismic refraction interpretation. The method is described in detail in Palmer (1980).[2] GRM allows for some variation in the surface topography as well as lateral variation in the seismic velocity of the upper layers. The method uses the principle of migration whereby the refractor need only be planar over a short distance, thus allowing the calculation of depth to an undulating interface. In addition, GRM is relatively insensitive to dip angles as high as 20°, unlike most other methods that can be sensitive to dips as low as 5°. GRM also allows for the calculation of depth below each geophone instead of below only the shot points as in the Time-Intercept and Crossover Distance methods. The GRM software that we use for data analysis (IXRefraX by Interpex) contains several internal tests for data consistency.

[2] Palmer, Derecke (1980) The Generalized Reciprocal Method of Seismic Refraction Interpretation, Society of Exploration Geophysicists, 104 p.

The results are used to construct an interpreted velocity profile of the subsurface for each seismic line. The velocities of seismic waves are functions of the types of geologic material through which they pass. One can thus infer the general subsurface stratigraphy from the velocities determined. Seismic velocities are expressed in feet per second (ft/s).

A widespread misconception about the seismic refraction method is that one cannot detect velocity inversions (layers of lower velocity material underlying higher velocity material) or hidden layers (layers of intermediate velocity too thin to produce first arrival signals), common conditions in stratified sediments. If present and undetected, such layers can cause large errors in the depths calculated for the various layers. However, using GRM, the presence of such layers can be inferred readily, and more importantly, the method uses average velocities for the detected and undetected layers to determine accurate depths to the refractors that are detected.

2.1.3 Limitations of the Method. The accuracy (standard deviation) of the apparent *depths* of relatively competent bedrock determined by the seismic refraction survey is about ± 10% of the apparent depth of bedrock, or ± 2 feet, whichever is greater. **The bedrock model shown as a profile, bedrock elevation contour plot, or listed as tabular data should not be used for contract bedrock removal quantities.** Like all geophysical methods, the seismic refraction method is based on the assumption that the local geology is uncomplicated. In particular, the seismic refraction method assumes that interfaces between geologic materials correlate with sharp increases in seismic velocity and that the interfaces are relatively flat-lying. The method is not very sensitive to lateral variations within layers, and relatively subtle features such as fracture zones within bedrock are generally difficult to detect unless there is a topographic expression of the feature. The accuracy of the method is degraded in areas with strong topographic relief at the surface and/or where the interfaces have apparent dips greater than about 20°.

Where two materials do not exhibit contrasting velocities, or where velocities gradually increase with depth, a clear refracted signal is not generated, and the seismic refraction method cannot be used to distinguish the two materials. In some cases, the "geophysical contact" between materials with contrasting velocities does not correlate exactly with the "geologic contact." For example, where a highly weathered bedrock is overlain by a dense material such as till, the velocity range of the weathered bedrock might overlap or approach the velocity range of the till, and the two materials cannot be distinguished seismically. In such cases, the depth determined by seismic refraction is the depth of *competent* bedrock, which might be located at some depth below the geologic contact.

The depth relations of the water table and bedrock may constitute a significant problem for the seismic refraction technique. This problem is that of a "blind layer." A blind layer occurs where the thickness of the saturated overburden is less than about half the depth of bedrock. In such cases, the water-saturated material immediately above bedrock is "blind" in the sense that no refracted seismic energy from it will be received as a first arrival of seismic energy, and all methods used to reduce the seismic data to determine the depth of bedrock, the objective of this survey, use *only* first arrivals. Thus, the saturated layer will not be detected where it is close to bedrock, and most methods of seismic data reduction will indicate that bedrock is considerably deeper than it actually is. Although GRM, the method used by Hager-Richter to reduce the seismic refraction data, does not use first arrivals through the water saturated zone (because there is none to use) in such cases, GRM determines the depth of bedrock correctly by using the *average* velocity of the saturated and unsaturated zones.

A "hidden layer" occurs where a lower velocity material underlies a higher velocity material, a common situation in stratified sediments. An example is where sands are present under layers of clay or till. As in the case of a "blind layer," most methods of seismic refraction data reduction will indicate that bedrock is shallower than it actually is, if a hidden layer is present but not detected. Internal tests in the seismic refraction data reduction software that we use (IXRefraX by Interpex) indicate that such layers might be present, and an average velocity of the two layers is used to determine the depth of bedrock.

2.1.4 Site Specific. The seismic refraction survey consisted of two parallel 315-foot lines, one located on each shoulder of Route 4. Each line consisted of two 115-foot long sections along the approaches containing active geophones, separated by a 85-foot gap across the bridge. MaineDOT provided site plans showing site features, surface topography, and boring locations. Hager-Richter located the seismic lines in the field using site features such as the bridge, boreholes, and roadway. The locations of the seismic lines are shown on Figure 2. Elevations along the seismic line were determined from site plans provided by MaineDOT.

A geophone spacing of 5 feet was used for the seismic lines. The seismic source was a 12-pound sledge hammer striking an aluminum plate. Seven shot points were used for each line -- four internal shot points, one shot point at each end of the line, and one external shot located in-line but offset from each end of the line. The photograph below shows the setup of Seismic Line 2.

2.2 GPR

2.2.1 General. The GPR survey was conducted using our GSSI UtilityScan DF subsurface imaging radar system. Data were recorded digitally, and the GPR data were reviewed in the field. The system includes a survey wheel that triggers the recording of the data at fixed intervals, thereby increasing the accuracy of the locations of features detected along the survey lines. The UtilityScan DF acquires data simultaneously from an 800 MHZ and a 300 MHZ antenna. The GPR data were processed using RADAN 7™ software licensed by Geophysical Survey Systems, Inc.

Photograph of Line 1 across the Wing Bridge, looking west. Geophones are planted in the gravel shoulders on either side of the bridge. The seismograph is located in the center of the bridge.

2.2.2 Limitations of the Method. There are limitations of the GPR technique as used to detect and/or locate targets such as those of the objectives of this survey: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical properties of the target and the surrounding soil, and (4) spacing of the traverses. Of these restrictions, only the last is controllable by us.

The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with snow piles, high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna with the ground. In many cases, the GPR signal will not penetrate below concrete pavement, especially inside buildings, and a target may not be detectable. The GPR method also commonly does not provide useful data under canopies found at some facilities.

The electrical conductivity of the ground determines the attenuation of the GPR signals, and thereby limits the maximum depth of exploration. For example, the GPR signal does not penetrate clay-rich soils, and targets buried in clay might not be detected.

A definite contrast in the electrical conductivities of the surrounding ground and the target material is required to obtain a reflection of the GPR signal. If the contrast is too small then the reflection may be too weak to recognize, possibly due to deeply corroded metal in the target, the target can be missed.

2.2.3 Site Specific. GPR traverses were conducted in one direction approximately between highway stationing 707+50 and 710+65 in the 330-foot by 25-foot area of interest. GPR traverses oriented approximately parallel to the roadway were spaced 4 or 6 feet apart. MaineDOT provided site plans showing site features, surface topography, and boring and probe locations. Hager-Richter located the GPR traverses in the field using site features such as the road, lines on the roadway, and the bridge structure. The location of the GPR survey area is shown on Figure 2.

3. RESULTS AND DISCUSSIONS

3.1 GENERAL

The geophysical survey of the roadway in the vicinity of the Wing Bridge consisted of seismic refraction profiling along two 315-foot long lines located approximately along the road shoulders of Route 4 and a GPR survey in a 315-foot by 25-foot survey area located on the roadway and centered on the bridge. The locations of the seismic refraction traverses and the GPR survey area are shown in Figure 2.

3.2 SEISMIC REFRACTION

3.2.1 General. The seismic refraction survey consisted of two transects designated as Seismic Lines 1 and 2. The results of the seismic refraction survey are shown in profile form in Figure 3 and as a bedrock elevation contour plot in Figure 4, and are listed in Table 1.

3.2.2 Data Quality. The quality of the seismic refraction data was excellent. A measure of the accuracy of the data can be obtained by comparing the depths determined seismically with depths reported from nearby borings that intersect bedrock, and the internal consistency of the data can be assessed by comparison of the depths determined at intersecting seismic lines or with results from other geophysical methods. For the present survey, four borings (BB-PSR-101 to 104) were drilled in the roadway in the vicinity of the east and west ends of the bridge and Table 2 compares the depths of bedrock determined from (A) the boring data and (B) seismically. The borings on the south side of the highway (BB-PSR-101 and 102) encountered bedrock at -elevations of 767-770 feet and borings on the north side of the highway (BB-PSR-103 and 104) encountered bedrock at an elevation of 774 feet. Seismically determined elevations for the top of bedrock for Seismic Line 1, located within 5 feet of BB-PSR-101 and 102 and Seismic Line 2, located within 5 feet of BB-PSR-103 and 104, differ by 1 foot or less from bedrock elevations reported in the boring logs.

For the present survey, the seismic lines are parallel and do not intersect, and GPR signal penetration was insufficient to detect bedrock. However, based on the results of comparing seismically determined elevations with the refusal depth reported for nearby borings, and on the results from other similar seismic refraction surveys, we estimate the accuracy (standard deviation) of the *depths* of competent bedrock determined by the seismic refraction survey to be about ± 10% of the depth of bedrock, or ± 2 feet), whichever is greater.

3.2.3 Interpretation of Velocities. Materials with two distinct velocity ranges were detected at the Site. The upper material exhibits a velocity range of 1,350 ft/s to 1,600 ft/s and is interpreted to consist of mostly unsaturated soils and fill materials.

The lower material exhibits a velocity range of 12,600 to 14,900 ft/s and is interpreted to be competent bedrock. Where the top of bedrock is highly fractured and/or deeply weathered, it might exhibit lower velocities that cannot be detected as a distinct layer on the basis of the seismic refraction data. Thus, the top of rock determined on the basis of seismic refraction data generally is the top of *competent* bedrock, which might be located somewhat below the geologic contact between the overburden and bedrock.

3.2.4 Bedrock Depths and Configuration. The results of the seismic refraction survey are listed in Table 1, presented as seismic profiles in Figure 3, and presented as a bedrock elevation contour plot in Figure 4. Seismic Lines 1 and 2 each have an 85-foot gap in the bridge section where seismic data could not be acquired. The depth of competent bedrock along the seismic lines varies between about 9 and 24 feet below ground surface. The elevation of competent bedrock in the locations surveyed varies between 768 and 785 feet for a total relief of 17 feet.

Figure 4 shows a color contour plot of the bedrock elevation model generated from the seismic refraction data and the bedrock boring data. The contours represent interpolations based on the seismic data and available boring information. The contours shown represent non-unique models for bedrock elevation and depth, respectively, (i.e., different valid conceptual models can be developed to fit the data set), and the elevation and depth of competent bedrock at any particular location may differ from that shown. Bedrock elevations and depths based on additional data, such as additional borings or seismic data, may differ significantly from those shown on the plates. **The bedrock model shown as profiles or listed as tabular data should not be used for contract bedrock removal quantities.**

Examination of the seismic profiles and the bedrock topographic model shows that a prominent bedrock low is present at the location of the Sandy River. The bedrock low is wider and deeper on the south side of the bridge (downstream side).

3.3 GPR

3.3.1 General. The GPR survey of the 330-foot by 25-foot area of interest consisted of GPR traverses oriented approximately parallel to the roadway and spaced 4 or 6 feet apart. The location of the GPR survey area is shown in Figure 2.

Apparent GPR signal penetration was greatest along the gravel shoulders of Route 4. In such areas two-way traveltime reflections were received from no more than about 60 ns. Based on site-specific time-to-depth conversions for the GPR signal, the GPR signal penetration is estimated to have been no more than about 7 feet for the Highway shoulders. GPR signal penetration was generally less in the central portion of the Route 4 travel lanes, with GPR signal penetration limited to no more than 30 ns, or about 3.5 feet.

3.3.2 Data Quality and Interpretation. Strong GPR reflections consistent with those expected for the top of bedrock were not detected in the GPR records for the subject site. GPR signal penetration for the survey area was not sufficient to produce reflections from bedrock, which is consistent with the results of the seismic refraction survey that determined bedrock depth in the area varies between 9 and 24 feet.

4. CONCLUSIONS

Based on the results of the geophysical survey conducted by Hager-Richter Geoscience, Inc. along State Route 4 in the vicinity of the approaches to the Wing Bridge over the Sandy River in Phillips, Maine for the Maine Department of Transportation (MaineDOT) in September, 2014, we conclude the following:

- Based on the available boring and seismic data, a prominent bedrock low is present at the location of the Sandy River, and is wider and deeper on the south side of the bridge.

- The depth of bedrock along the seismic lines varies from about 9 and 24 feet below ground surface.

- The elevation of competent bedrock in the locations surveyed varies between 768 and 785 feet for a total relief of 17 feet.

5. LIMITATIONS

This report was prepared for the exclusive use of the Maine Department of Transportation (Client). No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by Client or any third party shall be at Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the preparation of this Report consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and are not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

HAGER-RICHTER
GEOSCIENCE, INC.

MaineDOT Contract No. 20110613000000006486
Geophysical Survey
Wing Bridge
Phillips Township, Maine
PIN 22615.00 HR File 14J061 December, 2014

TABLE 1
SEISMIC REFRACTION RESULTS
WING BRIDGE
PHILLIPS, MAINE

Line	Location (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
1	0+15	965301.94	737241.19	791	11	780
1	0+20	965305.97	737238.22	791	12	778
1	0+25	965309.99	737235.25	791	12	779
1	0+30	965314.02	737232.29	790	12	778
1	0+35	965318.04	737229.32	790	13	778
1	0+40	965322.06	737226.35	790	13	778
1	0+45	965326.09	737223.39	790	13	778
1	0+50	965330.11	737220.42	790	13	778
1	0+55	965334.14	737217.45	790	13	777
1	0+60	965338.16	737214.48	790	13	778
1	0+65	965342.19	737211.52	790	13	778
1	0+70	965346.21	737208.55	790	13	778
1	0+75	965350.24	737205.58	790	13	777
1	0+80	965354.26	737202.62	790	13	777
1	0+85	965358.29	737199.65	790	13	777
1	0+90	965362.31	737196.68	790	14	777
1	0+95	965366.33	737193.72	790	14	776
1	1+00	965370.36	737190.75	790	15	775
1	1+05	965374.38	737187.78	790	15	775
1	1+10	965378.41	737184.81	790	17	773
1	1+15	965382.43	737181.85	790	18	772
1	1+20	965386.46	737178.88	790	19	771
1	1+25	965390.48	737175.91	790	19	771
1	1+30	965394.51	737172.95	790	20	770
85-foot gap for bridge						
1	2+15	965462.92	737122.51	791	24	767
1	2+20	965466.95	737119.54	791	23	768
1	2+25	965470.97	737116.57	791	23	768
1	2+30	965475.00	737113.60	792	23	769
1	2+35	965479.02	737110.64	792	23	769
1	2+40	965483.04	737107.67	792	22	770
1	2+45	965487.07	737104.70	792	21	771

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. Easting and northing coordinates and elevations for the seismic lines were determined from topographic plans provided by MaineDOT

MaineDOT Contract No. 20110613000000006486
Geophysical Survey
Wing Bridge
Phillips Township, Maine
PIN 22615.00 HR File 14J061 December, 2014

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Location (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
1	2+50	965491.09	737101.74	792	20	772
1	2+55	965495.12	737098.77	792	19	774
1	2+60	965499.14	737095.80	793	18	775
1	2+65	965503.17	737092.84	793	17	776
1	2+70	965507.19	737089.87	793	15	778
1	2+75	965511.22	737086.90	793	14	779
1	2+80	965515.24	737083.93	793	13	780
1	2+85	965519.26	737080.97	794	13	781
1	2+90	965523.29	737078.00	794	12	782
1	2+95	965527.31	737075.03	794	12	782
1	3+00	965531.34	737072.07	794	11	783
1	3+05	965535.36	737069.10	794	11	783
1	3+10	965539.39	737066.13	794	12	783
1	3+15	965543.41	737063.16	795	11	783
1	3+20	965547.44	737060.20	795	11	784
1	3+25	965551.46	737057.23	795	11	784
1	3+30	965555.49	737054.26	795	10	785
2	0+00	965304.49	737267.18	791	13	778
2	0+05	965308.52	737264.23	791	12	779

Line	Location	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	0+10	965312.55	737261.27	791	12	779
2	0+15	965316.59	737258.32	791	12	779
2	0+20	965320.62	737255.36	791	13	778
2	0+25	965324.65	737252.41	791	13	778
2	0+30	965328.69	737249.45	791	13	778
2	0+35	965332.72	737246.50	791	13	778
2	0+40	965336.75	737243.54	791	13	778
2	0+45	965340.79	737240.59	791	13	777
2	0+50	965344.82	737237.64	791	13	777
2	0+55	965348.86	737234.68	790	13	777
2	0+60	965352.89	737231.73	790	13	777
2	0+65	965356.92	737228.77	790	13	777
2	0+70	965360.96	737225.82	790	13	777
2	0+75	965364.99	737222.86	790	13	777
2	0+80	965369.02	737219.91	790	13	777
2	0+85	965373.06	737216.95	790	14	776
2	0+90	965377.09	737214.00	790	14	776
2	0+95	965381.12	737211.04	790	15	775
2	1+00	965385.16	737208.09	790	16	774

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. Easting and northing coordinates and elevations for the seismic lines were determined from topographic plans provided by MaineDOT

MaineDOT Contract No. 20110613000000006486
Geophysical Survey
Wing Bridge
Phillips Township, Maine
PIN 22615.00 HR File 14J061 December, 2014

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Location (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	1+05	965389.19	737205.13	790	17	773
2	1+10	965393.23	737202.18	790	17	773
2	1+15	965397.26	737199.22	790	17	773
85-foot gap for bridge						
2	2+00	965465.83	737148.99	791	19	772
2	2+05	965469.86	737146.04	791	18	773
2	2+10	965473.90	737143.08	791	18	774
2	2+15	965477.93	737140.13	791	17	775
2	2+20	965481.96	737137.17	792	15	776
2	2+25	965486.00	737134.22	792	14	777
2	2+30	965490.03	737131.26	792	13	779
2	2+35	965494.06	737128.31	792	12	780
2	2+40	965498.10	737125.35	792	11	781
2	2+45	965502.13	737122.40	792	10	782
2	2+50	965506.16	737119.45	792	10	782
2	2+55	965510.20	737116.49	792	10	782
2	2+60	965514.23	737113.54	792	10	783
2	2+65	965518.26	737110.58	793	10	783
2	2+70	965522.30	737107.63	793	9	783

Line	Location	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	2+75	965526.33	737104.67	793	10	783
2	2+80	965530.36	737101.72	793	10	783
2	2+85	965534.40	737098.76	793	10	784
2	2+90	965538.43	737095.81	793	9	784
2	2+95	965542.47	737092.85	794	10	783
2	3+00	965546.50	737089.90	794	10	784
2	3+05	965550.53	737086.94	794	10	784
2	3+10	965554.57	737083.99	794	11	784
2	3+15	965558.60	737081.03	794	11	784

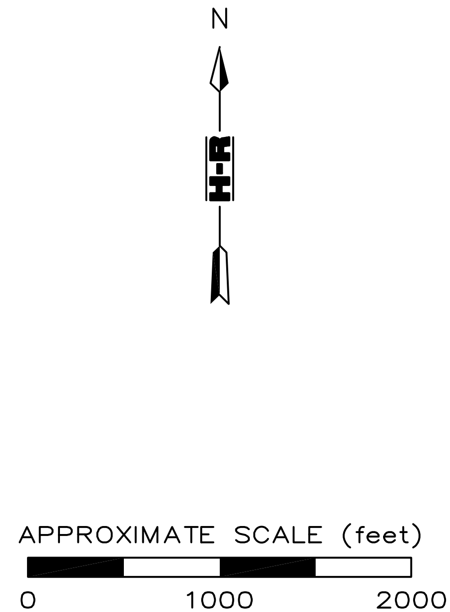
Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. Easting and northing coordinates and elevations for the seismic lines were determined from topographic plans provided by MaineDOT

TABLE 2
COMPARISON OF BEDROCK ELEVATIONS
WING BRIDGE
PHILLIPS TOWNSHIP, MAINE

Comparison of Seismically Determined Bedrock Elevations with Bedrock Elevations Reported in Boring Logs

Seismic Line and Location / Boring	Distance from Seismic Line to Boring	Bedrock Elevations (feet)		Bedrock Depth from Boring (feet)	Difference	
		Seismic Line	Boring		Feet	Percent
SL1 1+31 / BB-PSR-101	4.5' N	770	770	20	0	0
SL1 2+18 / BB-PSR-102	4.6' N	768	767	24	1	4
SL2 1+20 / BB-PSR-104	4.2' S	773	774	16	1	6
SL2 2+07 / BB-PSR-103	4.7' S	773	774	17	1	6
				Average	1	4
				Standard Deviation	1	3

Boring information provided by MaineDOT. The absolute differences in feet reflect the absolute difference between bedrock elevation determined for a location on a seismic line and bedrock elevation reported for a nearby boring. The percentage differences were calculated by dividing the absolute differences in feet by the bedrock depth reported in the boring log.



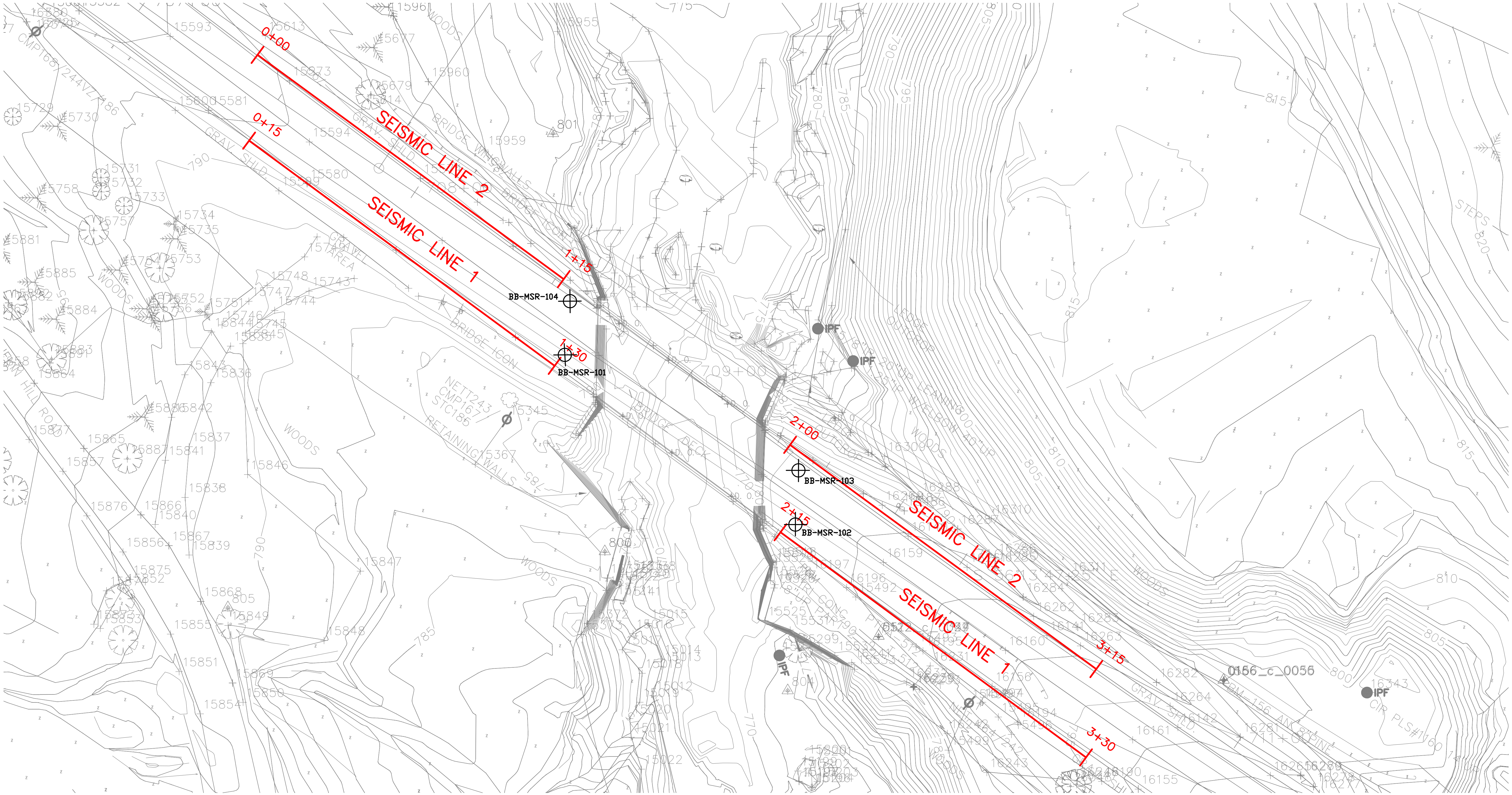
NOTE:

Modified from Google Earth Pro aerial photograph.

Figure 1
General Site Location
Wing Bridge
Phillips Township, Maine
PIN 22616.00

File 14J61	December, 2014

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

SEISMIC LINE

SCALE (feet)

0 30 60

N

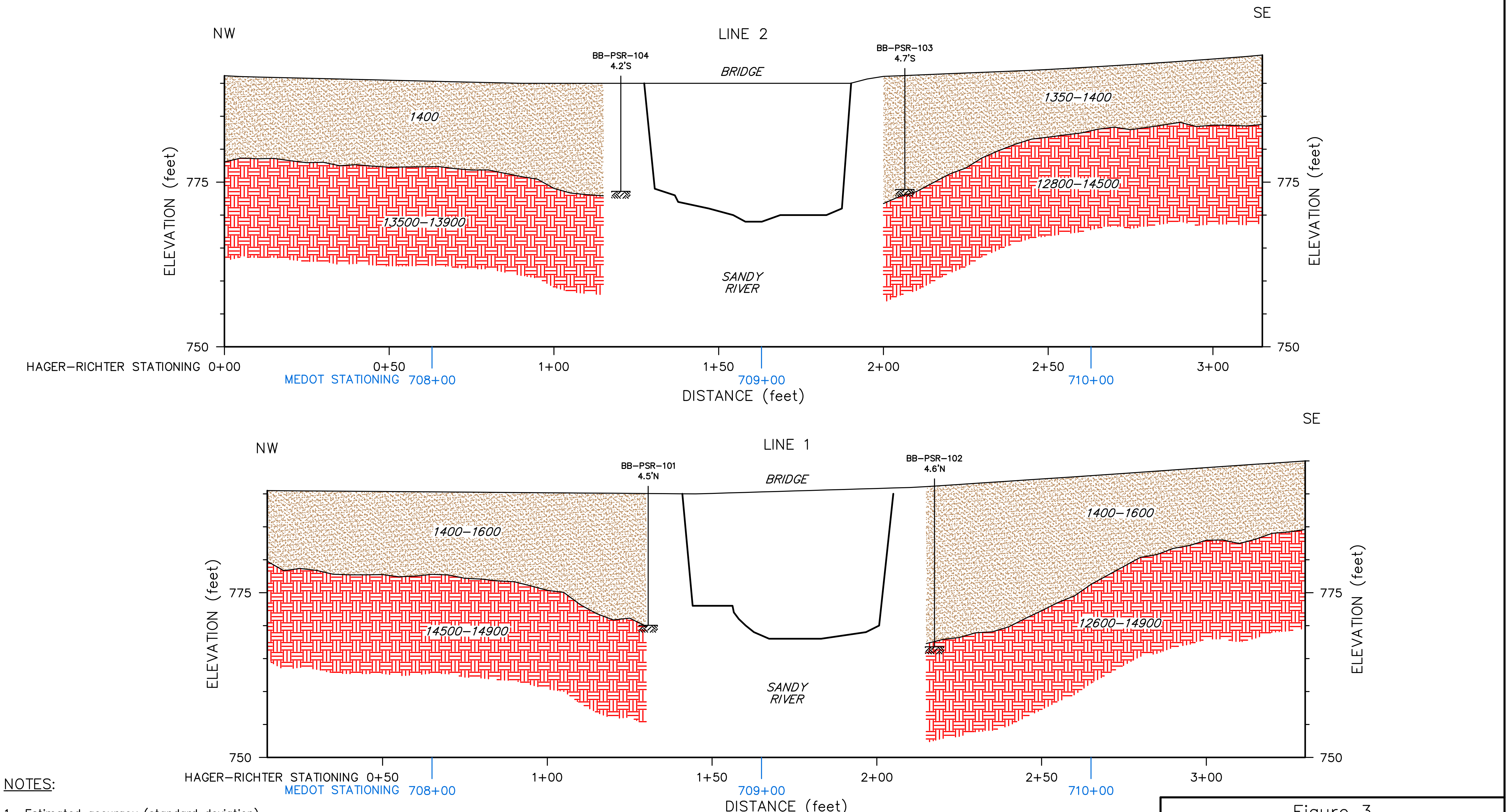
NOTE:

Modified from site plan provided by Maine Department of Transportation, identified as ALIGNMENTS.dgn.

Figure 2
Site Plan
Wing Bridge
Phillips Township, Maine
PIN 22616.00

File 14J61	December, 2014

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



NOTES:

1. Estimated accuracy (standard deviation) of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by Maine Department of Transportation.
4. Data were analyzed using the Generalized Reciprocal Method.

LEGEND

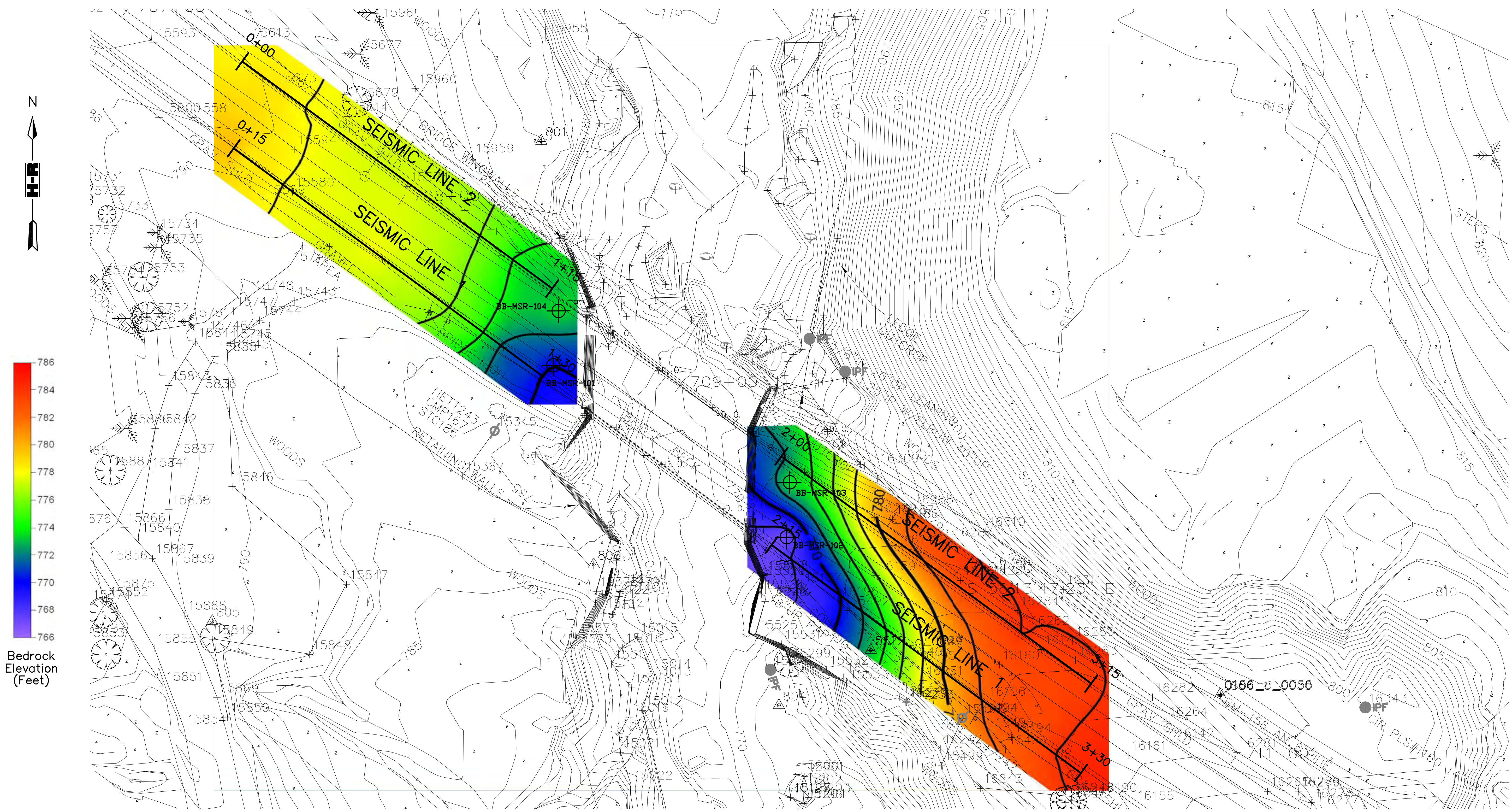
- Unsaturated soils
- Competent bedrock
- 13500–13900 Velocity (fps)
- Interface determined from seismic refraction data
- BB–PSR–104 4.2'S Boring with identification, distance from traverse, and depth of bedrock based on logs provided by Maine Department of Transportation

HORIZONTAL SCALE (feet)
0 30 60
Vertical Exaggeration = 2X

Figure 3
Seismic Lines 1 & 2
Wing Bridge
Phillips Township, Maine
PIN 22616.00

File 14J61	December, 2014

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



NOTES:

1. Modified from site plan provided by Maine Department of Transportation, identified as ALIGNMENTS.dgn.

2. Contour Interval = 2 Feet.

3. Bedrock elevation shown on this plot is a non-unique model. The contours represent interpolations based on seismic refraction data. The elevations of the bedrock surface at any particular location may differ from that shown. Bedrock elevation based on additional data may differ significantly.

LEGEND

SEISMIC LINE

SCALE (feet)

0 30 60

Figure 4
Bedrock Elevation
Wing Bridge
Phillips Township, Maine
PIN 22616.00

File 14J61	December, 2014

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

APPENDIX
BORING LOGS

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-101

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/26/14; 1500 / 8/27/14; 1025	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 708+66, 15 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0									9 inches HMA	
	1D	24/13	1.0 - 3.0	12-17-12-8	29					
									Numerous cobbles below 3 feet.	
	2D	24/7	4.0 - 6.0	5-6-3-4	9					
5										
	3D	24/9	9.0 - 11.0	3-5-3-4	8					
10										
15										
	4D	22/12	15.0 - 16.8	4-20-69-50/4"	89					
20									R1: Medium to hard, slightly weathered to fresh, aphanitic, medium gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Very close to close, predominately horizontal breaks; undulating, rough, typically discolored and open with mud infilling.	
	R1	21/19	20.0 - 21.8	RQD = 24%%					R2: same as R1, except close, predominately high angle with lesser horizontal breaks. Highly broken and weathered from 24.5 to 25.4 feet.	
	R2	59/55	21.8 - 26.7	RQD = 34%%						
25										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 11.2 feet NB of bridge deck, 6.2 feet RT of exist. centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-101

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/26/14; 1500 / 8/27/14; 1025	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 708+66, 15 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25										
	R3	60/54	26.7 - 31.7	RQD = 67%%					R3: same as R1, except moderate to widely spaced, high-angle breaks. Highly broken and weathered from 26.7 to 27.3 feet.	
30										
							-31.7		31.7 **Bottom of Exploration at 31.7 feet below ground surface.**	
35										
40										
45										
50										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 11.2 feet NB of bridge deck, 6.2 feet RT of exist. centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-102 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/27/14; 1030 / 8/27/14; 1420	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 709+51, 20 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0									10 inches HMA	
	1D	24/13	1.0 - 3.0	14-14-19-11	33					
	2D	24/14	4.0 - 6.0	5-4-3-3	7					
5										
	3D	24/10	9.0 - 11.0	2-3-4-3	7					
10										
	MD	24/0	14.0 - 16.0	4-3-4-9	7					
15										
	4D	24/5	19.0 - 21.0	8-4-4-5	8					
20										
	R1	60/60	24.4 - 29.4	RQD = 85%%					R1: Hard, slightly weathered, aphanitic, medium gray,	
25										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 12.1 feet SB of bridge deck, 6.3 feet RT of exist. centerline

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-102 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/27/14; 1030 / 8/27/14; 1420	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 709+51, 20 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25									PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; near vertical relic bedding. Close to wide, horizontal and high angle breaks; undulating, rough, typically discolored and open with occasional mud infilling.	
	R2	60/60	29.4 - 34.4	RQD = 70%%					R2: same as R1	
30										
							-34.4		34.4	
35									**Bottom of Exploration at 34.4 feet below ground surface.** Noted drill water seeping out from behind end of wing, apparently at ledge interface	
40										
45										
50										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 12.1 feet SB of bridge deck, 6.3 feet RT of exist. centerline

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-103 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/27/14; 1445 / 8/28/14; 0850	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 709+42, 5 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample Information								Visual Description and Remarks	Lab. Testing Results
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log		
0									10.5 inches HMA	
	1D	24/14	1.0 - 3.0	15-16-14-14	30					
	2D	24/11	4.0 - 6.0	3-3-2-3	5					
5										
	3D	24/8	9.0 - 11.0	3-4-3-4	7					
10										
	4D	24/6	14.0 - 16.0	4-5-5-3	10					
15										
	R1	35/15	17.3 - 20.2	RQD = 0%%					R1: Appear to be in near vertical seam of highly weathered rock (PHYLLITE). Short piece of core with near vertical breaks top and bottom. Bottom open fracture includes significant thickness of very fine Sandy SILT with roots infilling.	
20										
	5D	6/6	20.2 - 20.7	50/6"					5D: Gray, Silty very fine SAND, trace Gravel. Broken rock in tip of spoon.	
	R2	53/47	22.5 - 26.9	RQD = 53%%					R2: Medium to hard, slightly weathered from 22.5 to 24.8 feet, otherwise fresh, aphanitic, medium gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Highly weathered high-angle mica-rich seam from 22.5 to 23.5 feet; phenocrysts appear altered; talc-like material Close to	
25										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 13.4 feet SB of bridge deck, 7.6 feet LT of exist. centerline

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	PROJECT: Wing Bridge, Route 4 over Sandy River; LOCATION: Phillips, Maine	Boring No.: BB-PSR-103; WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/27/14; 1445 / 8/28/14; 0850	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 709+42, 5 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25									moderately spaced, moderate to high angle breaks; undulating, smooth (mica) to rough, typically discolored and open with mud infilling (1/8 inch thick). Significant fracture zone from 24.2 to 24.8 feet.	
	R3	60/57	26.9 - 31.9	RQD = 72%%					R3: same as R2, except slightly weathered where mica-rich seams intersect core surface; horizontal and moderately dipping breaks.	
30										
							-31.9		31.9	
									Bottom of Exploration at 31.9 feet below ground surface.	
35										
40										
45										
50										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 13.4 feet SB of bridge deck, 7.6 feet LT of exist. centerline

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-104

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/28/14; 0855 / 8/28/14; 1135	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 708+58, 1 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0									11 inches HMA	
	1D	24/14	1.0 - 3.0	12-13-8-29	21					
	2D	24/4	4.0 - 6.0	4-4-3-2	7					
5										
	3D	24/10	9.5 - 11.5	10-7-4-4	11					
10										
	4D	24/10	14.0 - 16.0	6-11-33-10	44					
15										
	R1	60/60	16.4 - 21.4	RQD = 77%%					R1: Hard, fresh, aphanitic, medium gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Top 0.3 feet weathered and broken, otherwise moderately spaced (2), high angle breaks; undulating, smooth (silvery, mica), slightly discolored and open; no infilling observed.	
20										
	R2	60/60	21.4 - 26.4	RQD = 80%%					R2: same as R1, except only 1 horizontal discolored fracture and 1 high angle fracture along a mica-rich zone.	
25										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 10.3 feet NB of bridge deck, 7.3 feet LT of exist. centerline

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

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

Boring No.: BB-PSR-104

Schonewald Engineering Associates, Inc.	PROJECT: Wing Bridge Route 4 over Sandy River LOCATION: Phillips, Maine	Boring No.: BB-PSR-104 WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**		**Auger ID/OD:**	
Operator:	Enos/Dube	**Datum:**		**Sampler:**	
Logged By:	Schonewald	**Rig Type:**		**Hammer Wt./Fall:**	
Date Start/Finish:	8/28/14; 0855 / 8/28/14; 1135	**Drilling Method:**		**Core Barrel:**	NQ2
Boring Location:	Sta 708+58, 1 RT	**Casing ID/OD:**		**Water Level*:**	

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
MV = Unsuccessful Insitu Vane Shear Test attempt

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOC = weight of casing
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
-- = not recorded
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
WC = water content, percent
G = grain size analysis

Depth (ft.)	Sample Information						Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows				
25										
							-26.4		26.4 Bottom of Exploration at 26.4 feet below ground surface.	
30										
35										
40										
45										
50										

Remarks:

Station and Offset provided above are based upon centerline depicted on Stantec's 8/20/14 design sketches.
Based upon existing: 10.3 feet NB of bridge deck, 7.3 feet LT of exist. centerline

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.

SCHONEWALD
ENGINEERING
ASSOCIATES, INC.

APPENDIX E

HRG'S 2016 GEOPHYSICAL REPORT

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
WING BRIDGE - U.S. ROUTE 4 OVER SANDY RIVER
PHILLIPS, MAINE
MAINEDOT WIN 22616.00

Prepared for:

Schonewald Engineering Associates, Inc.
129 Middle Road
Cumberland, Maine 04021

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - D10
Salem, New Hampshire 03079

File 16J74
December, 2016

HAGER-RICHTER
GEOSCIENCE, INC.

CONSULTANTS IN GEOLOGY AND GEOPHYSICS
8 INDUSTRIAL WAY - D10
SALEM, NEW HAMPSHIRE 03079-5820
TELEPHONE (603) 893-9944
FAX (603) 893-8313

December 6, 2016
File 16J74

Isabel V. Schonewald, P.E.
Schonewald Engineering Associates, Inc.
129 Middle Road
Cumberland, Maine 04021

Email: Be@SchonewaldEngineering.com

RE: Geophysical Survey
Wing Bridge - U.S. Route 4 Over Sandy River
Phillips, Maine
MaineDOT WIN 22616.00

Dear Ms. Schonewald:

In this letter, we report the results of a surface geophysical survey conducted by Hager-Richter Geoscience, Inc. (H-R) in support of a geotechnical investigation for the above referenced project located on US Route 4 in Phillips, Maine for Schonewald Engineering Associates, Inc. (SchonewaldEA) in November, 2016. The scope of the project and area of interest were specified by SchonewaldEA. As you know, Hager-Richter conducted a similar survey for the bridge replacement project in 2014 for MaineDOT.[1]

INTRODUCTION

The site is the Wing Bridge, which carries U.S. Route 4 over Sandy River in Phillips, Franklin County, Maine. The general location of the Wing Bridge is shown in Figure 1. SchonewaldEA is conducting a geotechnical investigation for the replacement of the Wing Bridge for Stantec on behalf of MaineDOT. As part of the design for a temporary bridge to be located to the north of the existing bridge, SchonewaldEA required the depth of bedrock under a steep slope on the northeast side of the bridge. The geophysical survey consisted of seismic refraction profiling.

The area of interest for the survey was located north of U.S. Route 4 on the east side of the Sandy River, and included ditch and shoulder areas, a steep wooded slope, and a relatively flat wooded area above the steep slope. A borrow pit located north of the highway cuts into the flat wooded area. Figure 2 is a site plan showing the locations of the seismic refraction lines and nearby borings.

[1] Hager-Richter report entitled "Geophysical Survey, Wing Bridge, Phillips Township, Maine, PIN 22616.00, Maine Dot Contract No. 20110613000000006486," dated December, 2104.

Four borings were located on the east side of the Sandy River, and the boring logs are reproduced in Appendix 1. Borings BB-PSR-102 and BB-PSR-103, located behind the east abutment to the existing bridge structure, encountered competent phyllite bedrock at depths of 22 to 24 feet (elevation of 767 to 769 feet) below the road surface. Material above the bedrock was largely fill added for the roadway approach at the locations of Borings BB-PSR-102 and BB-PSR-103.

Borings HB-PM-156 and HB-PM-157, located on the north shoulder of the highway approximately 100 ft and 400 ft, respectively, from the east bridge abutment, met refusal at depths of approximately 14 and 15 (elevations of 780 and 793 feet), respectively, after drilling through dense till. The boring log for HB-PM-156 indicates refusal is due to either to weathered rock or brown cemented till. Rock coring was not completed in either of these highway test borings to ascertain the character of the refusal.

OBJECTIVE

The objective of the geophysical survey was to determine the depth and configuration of the bedrock surface in the vicinity of a steep slope on the northeast side of the Wing Bridge in Phillips, Maine.

THE SURVEY

The geophysical survey consisted of the seismic refraction method. Steven Grant, P.G., and Bryan Carnahan conducted the seismic refraction survey on November 15 and 16, 2016. The fieldwork was coordinated with Ms. Isabel V. Schonewald, P.E., of SchonewaldEA who was on site for the beginning of the field work. The planned locations of the seismic refraction transects were staked and cleared by MaineDOT. The actual locations of the seismic lines conformed to the planned locations of the lines with the exception that the bend point of Line 2 was shifted 2 feet south to avoid tree stumps, and Line 4 was extended 4 feet to the south. Data analysis and interpretation were completed at the Hager-Richter offices. Original data and field notes will be retained in the Hager-Richter files for a minimum of three years.

The geophysical survey consisted of seismic refraction along four lines totaling approximately 970 linear feet. The positions of the seismic refraction lines were tied to stakes surveyed by MaineDOT. The locations of the transects are shown in Figure 2. Photographs 1 and 2, following page, show typical conditions at the site.

Photograph 1. Photograph along Seismic Line 2, view to the east. The seismic line was located along the white tapeline and extends through the cleared pathway in the top center. The borrow pit is located beyond the stumps in the center of the photograph. Route 4 can be seen on the upper right of the photograph.

Photograph 2. Photograph along Seismic Line 3, view to the west. Seismic Line 3 is located part way up a steep slope, which increases in height to the west. Wing Bridge is located near the center of the photograph, near the guardrails.

Seismic Lines 1 and 2 were located in a generally flat elevated area northeast of the Wing Bridge, with the exception of an approximately 60-foot wide, 12-foot deep borrow pit near the middle of Seismic Line 2. Seismic Line 3 was approximately parallel to Seismic Lines 1 and 2, but was located part way down the steep slope on its west end and along the highway ditch on its east end. Seismic Line 4 was oriented perpendicular to Route 4 and Seismic Lines 2 and 3.

EQUIPMENT & PROCEDURES

For the seismic refraction survey, we used a 48-channel seismograph (two 24-channel Geometrics Geodes) coupled to up to 48 14-Hz geophones to acquire seismic refraction records. The seismograph was connected to, and controlled by, a notebook PC computer. The software provides for the acquisition, display, plotting, filtering, and storage of seismic data. Seismic refraction data were acquired along 4 transects totaling approximately 970 linear feet. Geophone spacing varied between 2.5 to 5 feet for this project.

Seismic Lines 1 and 4 consisted of a single seismic spread while Seismic Lines 2 and 3 consisted of two seismic spreads configured end to end. Seven shot points were used for most seismic spreads - three located internal to the spread, one at each end of the spread, and, where possible, two offset shots located in-line with but beyond the ends of the spread of geophones. This configuration allows for providing reversed profiles. It was not possible to conduct an offset shot for the south end of Seismic Line 4 because it would have required stretching a wire across U.S. Route 4.

The seismic source was a 12-pound sledgehammer striking a metal plate. The number of stacks per shot point was variable, and the quality of the stacked seismic signal for each shot point was verified in the field. The data were recorded digitally.

The seismic data were interpreted with the Generalized Reciprocal Method, commonly referred to as GRM. GRM allows the depth to bedrock to be determined for *each* geophone location (i.e., generally every 2.5 to 5 feet at this site), rather than only at the shot points as for most other methods, and it is less sensitive than are most other methods to the presence of dipping interfaces and hidden layers.

LIMITATIONS OF THE METHOD

HAGER-RICHTER GEOSCIENCE, INC. MAKES NO GUARANTEE THAT THE DEPTH OF BEDROCK WAS ACCURATELY DETERMINED IN THIS SURVEY. HAGER-RICHTER GEOSCIENCE, INC. IS NOT RESPONSIBLE FOR DETERMINING THE DEPTH OF BEDROCK WHERE THE INTERFACE CANNOT BE DETECTED BECAUSE OF SITE CONDITIONS. THE BEDROCK

MODEL LISTED AS TABULAR DATA SHOULD NOT BE RELIED ON FOR BEDROCK REMOVAL QUANTITIES

As with all geophysical methods, the seismic refraction method is based on the assumption that the local geology is relatively uncomplicated. In particular, the seismic refraction method assumes that interfaces between geologic materials correlate with sharp increases in seismic velocity and that the interfaces between geologic units are relatively flat-lying. The method is not very sensitive to lateral variations within layers, and relatively subtle features such as fracture zones within bedrock generally cannot be detected unless there is a topographic expression of the feature and/or a significant drop in bedrock velocity. The accuracy of the method is degraded in areas with strong topographic relief and/or where the interfaces have apparent dips greater than about 20°. *In general, the accuracy of depths determined is stated to be about 10% or 2 feet, whichever is greater.*

Where two materials do not exhibit contrasting velocities, or where velocities gradually increase with depth, a clear refracted signal is not generated, and the seismic refraction method cannot be used to distinguish the two materials. In some cases, the "geophysical contact" between materials with contrasting velocities does not correlate exactly with the "geologic contact." For example, where a highly weathered bedrock is overlain by a dense material such as till, the velocity range of the weathered bedrock might overlap or approach the velocity range of the till, and the two materials cannot be distinguished seismically. In such cases, the depth determined by seismic refraction is the depth of *competent* bedrock, which might be located at some depth below the geologic contact.

The depth relations of the water table and bedrock may constitute a significant problem for the seismic refraction technique. This problem is that of a "blind layer." A blind layer occurs where the thickness of the saturated overburden is less than about half the depth of bedrock. In such cases, the water-saturated material immediately above bedrock is "blind" in the sense that no refracted seismic energy from it will be received as a first arrival of seismic energy, and all methods used to reduce the seismic data to determine the depth of bedrock, the objective of this survey, use *only* first arrivals. Thus, the saturated layer will not be detected where it is close to bedrock, and most methods of seismic data reduction will indicate that bedrock is considerably shallower than it actually is. Although GRM, the method used by Hager-Richter to reduce the seismic refraction data, does not use first arrivals through the water saturated zone (because there is none to use) in such cases, GRM determines the depth of bedrock correctly by using the *average* velocity of the saturated and unsaturated zones.

A "hidden layer" occurs where a lower velocity material underlies a higher velocity material, a common situation in stratified sediments. An example is where sands are present under layers of clay or till. As in the case of a "blind layer," most methods of seismic refraction data reduction will indicate that bedrock is deeper than it actually is, if a hidden layer is present but not detected. Internal tests in the seismic refraction data reduction software that we use (IXRefraX by Interpex) indicate that such layers might be present, and an average velocity of the two layers is used to determine the depth of bedrock.

RESULTS

General. The seismic refraction survey consisted of four transects designated as Seismic Lines 1 through 4. The results of the seismic refraction survey are shown in profile form in Figures 3 through 6 and as a bedrock elevation contour plot in Figure 7, and are listed in Table 1.

Data Quality. The quality of the seismic refraction data ranges from fair to excellent. The quality of he data in the area of the borrow pit are considered fair while the remainder of the data are considered good to very good. A measure of the accuracy of the data can be obtained by comparing the bedrock depths determined seismically with depths reported from nearby borings that encountered bedrock, or by comparing bedrock depths at the intersections of seismic refraction lines. Only borings HB-PM-156 and HB-PM-157 are located close enough to a seismic line for a direct comparison, approximately 20 feet from the 1+05 and 3+76-foot stations, respectively, on Seismic Line 3. HB-PM-156 and HB-PM-157 met refusal at elevations of approximately 780 to 793 feet, which is 8 to 15 feet higher than the interpreted depths of competent bedrock determined seismically at the closest locations on Seismic Line 3. Rock coring was not completed in either of these highway test borings to ascertain the character of the refusal. Boring refusal depths may represent boulders, weathered bedrock or very dense tills, and do not serve as good points of comparison for assessing the accuracy of the seismic data.

Seismic Line 2 and Seismic Line 3 were each composed of two spreads, and the seismically determined depths of competent bedrock at the ends of spreads at the junction point on each line differed by 1 foot. It was not possible to compare the intersections of Seismic Lines 2 and 3 with Seismic Line 4 because it was only possible to determine minimum depths for competent bedrock for Seismic Line 4 (see below).

Based on the results of comparing seismically determined elevations at intersecting seismic lines and with nearby borings, and on the results from other similar seismic refraction surveys, we estimate the accuracy (standard deviation) of the *depths* of competent bedrock determined by the seismic refraction survey to be about ± 10% of the depth of bedrock, or ± 2 feet), whichever is greater.

Velocities. Materials with two distinct velocity ranges were detected at the Site. The upper material exhibits a velocity range of 2,000 to 3,100 feet per second (fps) and is interpreted to consist of mostly unsaturated sediments. The lower material exhibits a velocity range of 9,500 to 13,900 fps and is interpreted to be bedrock. Where the top of bedrock is highly fractured and/or deeply weathered, it might exhibit lower velocities that cannot be detected as a distinct layer on the basis of the seismic refraction data. Thus, the top of rock determined on the basis of seismic refraction data generally is the top of competent bedrock, which might be located somewhat below the geologic contact between the overburden and bedrock.

The bedrock velocities detected by this survey are relatively consistent with those detected by the 2014 survey. The overburden velocities for the 2016 survey (2,000-3,100 fps) are somewhat higher than those detected for the 2014 survey (1,350-1,600 fps). The seismic lines for the 2014 survey were located on the roadbed in fill that is not likely as compact/dense as the natural in-place soils. The higher velocities (2,000 - 3,100 fps) may indicate increased density in the unsaturated sediments, however, the velocities are not high enough to indicate significant cementation of the sediment.

Bedrock Model. The depth of competent bedrock along Seismic Lines 1 through 3 varies between about 14 feet and 35 feet below ground surface, and the elevation of competent bedrock varies between approximately 790 feet and 770 feet, an *apparent* total relief about of 20 feet.

Seismic Line 4 was the shortest line at 100 feet long. Because the first arrivals for bedrock refractions at this location were received at about 50 feet from the shot points, there was little to no overlap of bedrock refractions from opposite ends of the line. In addition, the lack of offset data from the south end of Seismic Line 4 (because of U.S. Route 4) further limited data analysis. As a result, only a *minimum* bedrock depth could be determined for Seismic Line 4.

Figure 7 is a color contour plot of the bedrock elevation model generated from the seismic survey and the logs for borings BB-PSR-102 and BB-PSR-103 provided by SchonewaldEA. The contours shown on Figure 7 represent interpolations based on the seismic data and available boring information relative to NAVD88. The contours shown represent non-unique models for bedrock elevation (i.e., different valid conceptual models can be developed to fit the data set), and the elevation of competent bedrock at any particular location may differ from that shown. Bedrock elevations based on additional data, such as borings or seismic data, may differ significantly from those shown on Figure 7.

Examination of the seismic profiles and the bedrock topographic model shows bedrock is lowest in the southwest, adjacent to the bridge, and highest to the northeast, in the area of higher ground surface elevation. Data from Seismic Line 4 were not used in the bedrock topographic model.

CONCLUSIONS

Based upon the results of the geophysical survey conducted by Hager-Richter Geoscience, Inc. at the Wing Bridge, U.S. Route 4 over Sandy River in Phillips, Maine in November, 2016, we conclude:

- The depth of competent bedrock along Seismic Lines 1 through 3 varies between about 14 feet and 35 feet below ground surface, and the elevation of competent bedrock varies between approximately 790 feet and 770 feet, an *apparent* total relief of about 20 feet.

- Materials with two distinct velocity ranges were detected. The upper material exhibits a velocity range of 2,000 to 3,100 feet per second (fps) and is interpreted to consist of mostly unsaturated sediments. The lower material exhibits a velocity range of 9,500 to 13,900 fps and is interpreted to be bedrock.

- Bedrock is lower in the southwest, adjacent to the bridge, and higher to the northeast.

LIMITATIONS

This report was prepared for the exclusive use of Schonewald Engineering Associates, Inc. No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by Client or any third party shall be at Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the performance of' its services for this project consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

If you have any questions or comments on this report, please contact us at your convenience. It has been a pleasure to work with you on this project. We look forward to working with you again in the future.

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Steven Grant, P.G.
Senior Geophysicist

Dorothy Richter, P.G.
President

Attachments: Table 1, Figures 1-7, Appendix 1

TABLE 1
SEISMIC REFRACTION RESULTS
MAINEDOT WING BRIDGE - U.S. ROUTE 4
PHILLIPS, MAINE

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
1	0+00	965552.37	737225.86	814	30	784
1	0+03	965554.26	737223.54	814	31	784
1	0+06	965556.16	737221.21	814	29	785
1	0+09	965558.05	737218.89	814	29	785
1	0+12	965559.95	737216.56	814	29	785
1	0+15	965561.84	737214.24	814	29	785
1	0+18	965563.74	737211.91	814	29	785
1	0+21	965565.63	737209.58	814	29	785
1	0+24	965567.52	737207.26	814	28	786
1	0+27	965569.42	737204.93	814	28	786
1	0+30	965571.31	737202.61	814	28	786
1	0+33	965573.21	737200.28	814	27	787
1	0+36	965575.10	737197.95	814	28	786
1	0+39	965577.00	737195.63	814	29	785
1	0+42	965578.89	737193.30	814	29	785
1	0+45	965580.79	737190.98	814	29	785
1	0+48	965582.68	737188.65	814	28	786
1	0+51	965584.58	737186.33	813	25	789
1	0+54	965586.47	737184.00	813	24	790
1	0+57	965588.37	737181.67	813	24	789
1	0+60	965590.26	737179.35	813	24	789
1	0+63	965592.16	737177.02	813	26	788
1	0+66	965594.05	737174.70	813	26	787
1	0+69	965595.95	737172.37	813	27	787
1	0+72	965597.84	737170.05	813	25	788
1	0+75	965599.74	737167.72	813	25	788
1	0+78	965601.63	737165.39	813	25	789
1	0+81	965603.53	737163.07	813	24	789
1	0+84	965605.42	737160.74	813	25	788
1	0+87	965607.32	737158.42	813	26	787
1	0+90	965609.21	737156.09	813	27	786
1	0+93	965611.11	737153.76	813	27	786

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
1	0+96	965613.00	737151.44	813	28	785
1	0+99	965614.90	737149.11	813	26	787
1	1+02	965616.79	737146.79	813	26	787
1	1+05	965618.69	737144.46	813	28	785
1	1+08	965620.58	737142.14	813	28	785
1	1+11	965622.48	737139.81	813	29	784
1	1+14	965624.37	737137.48	813	30	782
1	1+17	965626.27	737135.16	812	30	783
1	1+20	965628.16	737132.83	812	29	783
1	1+23	965630.06	737130.51	812	29	783
1	1+26	965631.95	737128.18	812	29	783
1	1+29	965633.85	737125.86	812	29	783
1	1+32	965635.74	737123.53	812	29	783
1	1+35	965637.64	737121.20	812	29	783
1	1+38	965639.53	737118.88	812	30	782
1	1+41	965641.43	737116.55	812	30	782
2	0+00	965530.30	737207.34	815	32	783
2	0+02.5	965531.86	737205.38	815	32	783

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	0+05	965533.42	737203.43	815	32	783
2	0+07.5	965534.98	737201.48	815	32	783
2	0+10	965536.55	737199.52	815	32	783
2	0+12.5	965538.11	737197.57	815	32	783
2	0+15	965539.67	737195.62	815	32	783
2	0+17.5	965541.23	737193.67	815	32	783
2	0+20	965542.79	737191.71	815	33	783
2	0+22.5	965544.35	737189.76	815	33	782
2	0+25	965545.91	737187.81	815	33	782
2	0+27.5	965547.47	737185.85	815	33	782
2	0+30	965549.03	737183.90	815	33	782
2	0+32.5	965550.59	737181.95	815	33	782
2	0+35	965552.15	737180.00	815	34	781
2	0+37.5	965553.72	737178.04	815	34	781
2	0+40	965555.28	737176.09	815	34	781
2	0+42.5	965556.84	737174.14	815	33	781
2	0+45	965558.40	737172.18	815	31	784
2	0+47.5	965559.96	737170.23	815	31	784

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

HAGER-RICHTER
GEOSCIENCE, INC.

Geophysical Survey
Wing Bridge - US Route 4 Over Sandy River
Phillips, Maine
MaineDOT WIN 22616.00
File 16J74 Table 1

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	0+50	965561.52	737168.28	815	32	782
2	0+52.5	965563.08	737166.33	815	33	781
2	0+55	965564.64	737164.37	815	33	782
2	0+57.5	965566.20	737162.42	815	32	783
2	0+60	965567.76	737160.47	815	33	782
2	0+62.5	965569.32	737158.51	815	31	784
2	0+65	965570.89	737156.56	815	31	784
2	0+67.5	965572.45	737154.61	814	31	784
2	0+70	965574.01	737152.66	814	31	784
2	0+72.5	965575.57	737150.70	814	31	783
2	0+75	965577.13	737148.75	814	31	783
2	0+77.5	965578.69	737146.80	814	31	783
2	0+80	965580.25	737144.84	814	31	783
2	0+82.5	965581.81	737142.89	814	31	783
2	0+85	965583.37	737140.94	814	31	783
2	0+87.5	965584.93	737138.99	814	31	783
2	0+90	965586.50	737137.03	814	31	783
2	0+92.5	965588.06	737135.08	814	31	783

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	0+95	965589.62	737133.13	814	31	783
2	0+97.5	965591.18	737131.18	814	31	783
2	1+00	965592.74	737129.22	814	31	783
2	1+02.5	965594.30	737127.27	814	31	783
2	1+05	965595.86	737125.32	813	31	783
2	1+07.5	965597.42	737123.36	813	31	782
2	1+10	965598.98	737121.41	813	31	782
2	1+12.5	965600.54	737119.46	813	31	782
2	1+15	965602.10	737117.51	813	30	783
2	1+20	965606.27	737114.74	813	30	783
2	1+25	965610.43	737111.97	812	30	783
2	1+30	965614.59	737109.20	810	30	780
2	1+35	965618.76	737106.43	810	29	780
2	1+40	965622.92	737103.66	810	29	781
2	1+45	965627.08	737100.89	810	27	783
2	1+50	965631.25	737098.12	810	27	783
2	1+55	965635.41	737095.35	810	26	784
2	1+60	965639.57	737092.59	804	21	783

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

Geophysical Survey
Wing Bridge - US Route 4 Over Sandy River
Phillips, Maine
MaineDOT WIN 22616.00
File 16J74 Table 1

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	1+65	965643.74	737089.82	801	16	785
2	1+70	965647.90	737087.05	798	14	784
2	1+75	965652.06	737084.28	798	14	785
2	1+80	965656.23	737081.51	799	15	784
2	1+85	965660.39	737078.74	800	14	786
2	1+90	965664.55	737075.97	801	16	785
2	1+95	965668.72	737073.20	803	20	783
2	2+00	965672.88	737070.43	805	23	782
2	2+05	965677.04	737067.67	807	26	781
2	2+10	965681.21	737064.90	809	27	782
2	2+15	965685.37	737062.13	810	27	783
2	2+20	965689.53	737059.36	810	29	782
2	2+25	965693.70	737056.59	811	32	779
2	2+30	965697.86	737053.82	811	30	781
2	2+35	965702.02	737051.05	811	32	780
2	2+40	965706.19	737048.28	812	30	782
2	2+45	965710.35	737045.51	812	29	783
2	2+50	965714.51	737042.75	812	30	782
2	2+55	965718.68	737039.98	813	34	778
2	2+60	965722.84	737037.21	813	34	779
2	2+65	965727.00	737034.44	813	31	782
2	2+70	965731.17	737031.67	813	32	781
2	2+75	965735.33	737028.90	813	34	779
2	2+80	965739.49	737026.13	813	34	779
2	2+85	965743.66	737023.36	813	35	778
2	2+90	965747.82	737020.59	813	34	779
2	2+95	965751.98	737017.83	813	31	782
2	3+00	965756.15	737015.06	813	29	784
2	3+05	965760.31	737012.29	813	29	784
2	3+10	965764.47	737009.52	813	29	784
2	3+15	965768.64	737006.75	813	29	784
2	3+20	965772.80	737003.98	813	29	784
2	3+25	965776.96	737001.21	813	29	784
2	3+30	965781.13	736998.44	813	29	784
2	3+35	965785.29	736995.67	813	28	785
2	3+40	965789.45	736992.91	813	28	785

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
2	3+45	965793.62	736990.14	813	28	785
2	3+50	965797.78	736987.37	813	28	785
3	0+00	965506.24	737187.72	802	25	777
3	0+03	965508.06	737185.34	803	25	778
3	0+06	965509.87	737182.95	803	27	777
3	0+09	965511.69	737180.57	804	26	778
3	0+12	965513.51	737178.18	804	28	777
3	0+15	965515.33	737175.80	804	27	777
3	0+18	965517.15	737173.42	805	28	777
3	0+21	965518.97	737171.03	805	28	777
3	0+24	965520.79	737168.65	805	28	777
3	0+27	965522.61	737166.26	806	26	779
3	0+30	965524.43	737163.88	806	27	779
3	0+33	965526.25	737161.50	806	30	776
3	0+36	965528.07	737159.11	806	31	775
3	0+39	965529.89	737156.73	806	30	775
3	0+42	965531.71	737154.34	806	31	775
3	0+45	965533.53	737151.96	806	29	776

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
3	0+48	965535.35	737149.58	806	29	776
3	0+51	965537.17	737147.19	806	30	776
3	0+54	965538.99	737144.81	806	31	775
3	0+57	965540.81	737142.42	806	30	775
3	0+60	965542.63	737140.04	806	30	775
3	0+63	965544.45	737137.66	806	31	774
3	0+66	965546.27	737135.27	806	32	774
3	0+69	965548.09	737132.89	806	32	774
3	0+72	965549.91	737130.50	806	33	773
3	0+75	965551.73	737128.12	806	33	773
3	0+78	965553.55	737125.74	806	31	775
3	0+81	965555.37	737123.35	806	32	774
3	0+84	965557.19	737120.97	806	31	774
3	0+87	965559.01	737118.58	805	31	775
3	0+90	965560.83	737116.20	805	30	775
3	0+93	965562.65	737113.82	805	28	777
3	0+96	965564.47	737111.43	805	28	777
3	0+99	965566.29	737109.05	804	27	777

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

Geophysical Survey
Wing Bridge - US Route 4 Over Sandy River
Phillips, Maine
MaineDOT WIN 22616.00
File 16J74 Table 1

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
3	1+02	965568.11	737106.66	802	26	776
3	1+05	965569.93	737104.28	800	27	772
3	1+08	965571.75	737101.89	798	26	772
3	1+11	965573.57	737099.51	797	27	770
3	1+14	965575.39	737097.13	797	26	770
3	1+17	965577.21	737094.74	797	25	772
3	1+20	965579.03	737092.36	797	23	774
3	1+23	965580.85	737089.97	796	23	773
3	1+26	965582.67	737087.59	796	25	772
3	1+29	965584.49	737085.21	796	25	772
3	1+32	965586.31	737082.82	796	25	772
3	1+35	965588.13	737080.44	796	25	772
3	1+38	965589.95	737078.05	796	25	772
3	1+41	965591.77	737075.67	796	25	772
3	1+46	965596.00	737073.02	797	25	772
3	1+51	965600.24	737070.36	797	23	774
3	1+56	965604.48	737067.71	797	24	773
3	1+61	965608.72	737065.05	797	24	773

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
3	1+66	965612.96	737062.40	797	25	773
3	1+71	965617.19	737059.74	798	24	774
3	1+76	965621.43	737057.09	798	24	774
3	1+81	965625.67	737054.43	799	25	774
3	1+86	965629.91	737051.78	799	24	775
3	1+91	965634.15	737049.13	800	25	774
3	1+96	965638.38	737046.47	800	26	775
3	2+01	965642.62	737043.82	801	26	775
3	2+06	965646.86	737041.16	802	26	776
3	2+11	965651.10	737038.51	802	25	778
3	2+16	965655.34	737035.85	803	24	779
3	2+21	965659.58	737033.20	803	25	778
3	2+26	965663.81	737030.54	804	27	777
3	2+31	965668.05	737027.89	804	26	778
3	2+36	965672.29	737025.24	805	26	779
3	2+41	965676.53	737022.58	805	26	779
3	2+46	965680.77	737019.93	805	25	780
3	2+51	965685.00	737017.27	805	25	780

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.

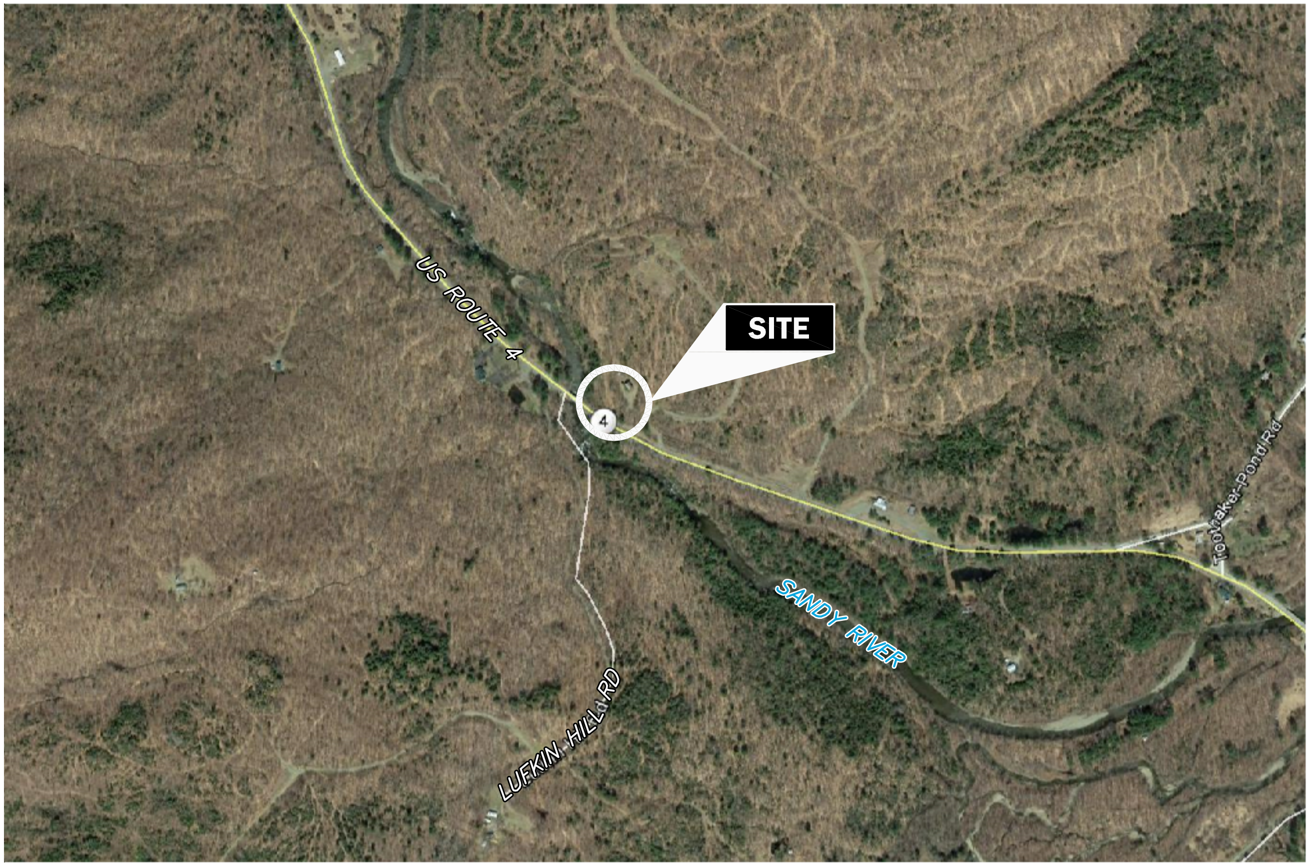
Geophysical Survey
Wing Bridge - US Route 4 Over Sandy River
Phillips, Maine
MaineDOT WIN 22616.00
File 16J74 Table 1

TABLE 1 (CONTINUED)
SEISMIC REFRACTION RESULTS

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
3	2+56	965689.24	737014.62	805	25	780
3	2+61	965693.48	737011.96	805	26	779
3	2+66	965697.72	737009.31	805	26	779
3	2+71	965701.96	737006.65	805	26	779
3	2+76	965706.19	737004.00	805	25	780
3	2+81	965710.43	737001.35	805	25	780
3	2+86	965714.67	736998.69	805	26	779
3	2+91	965718.91	736996.04	805	25	780
3	2+96	965723.15	736993.38	805	26	779
3	3+01	965727.38	736990.73	805	26	779
3	3+06	965731.62	736988.07	805	25	780
3	3+11	965735.86	736985.42	805	24	781
3	3+16	965740.10	736982.76	805	25	780
3	3+21	965744.34	736980.11	805	26	779
3	3+26	965748.57	736977.46	805	27	779
3	3+31	965752.81	736974.80	806	27	779
3	3+36	965757.05	736972.15	806	26	780
3	3+41	965761.29	736969.49	806	26	780

Line	Station (ft)	Easting (ft)	Northing (ft)	Surface Elevation (ft)	Bedrock Depth (ft)	Bedrock Elevation (ft)
3	3+46	965765.53	736966.84	806	27	779
3	3+51	965769.76	736964.18	806	27	779
3	3+56	965774.00	736961.53	806	28	778
3	3+61	965778.24	736958.87	806	29	777
3	3+66	965782.48	736956.22	806	29	777
3	3+71	965786.72	736953.57	806	29	777
3	3+76	965790.95	736950.91	806	29	777
4	Minimum depth determined - see text and Figure 6					

Estimated standard deviation of depth of interfaces for seismic lines is normally taken as 10% or 2 feet, whichever is greater. Depths and elevations of bedrock determined here are for competent bedrock. Heavily weathered or highly fractured bedrock may occur at shallower depths. The easting and northing coordinates are relative to Maine State Plane NAD83 (CORS96) in US survey feet. Elevations along the seismic lines were determined from plans provided by Schonewald Engineering, Inc.



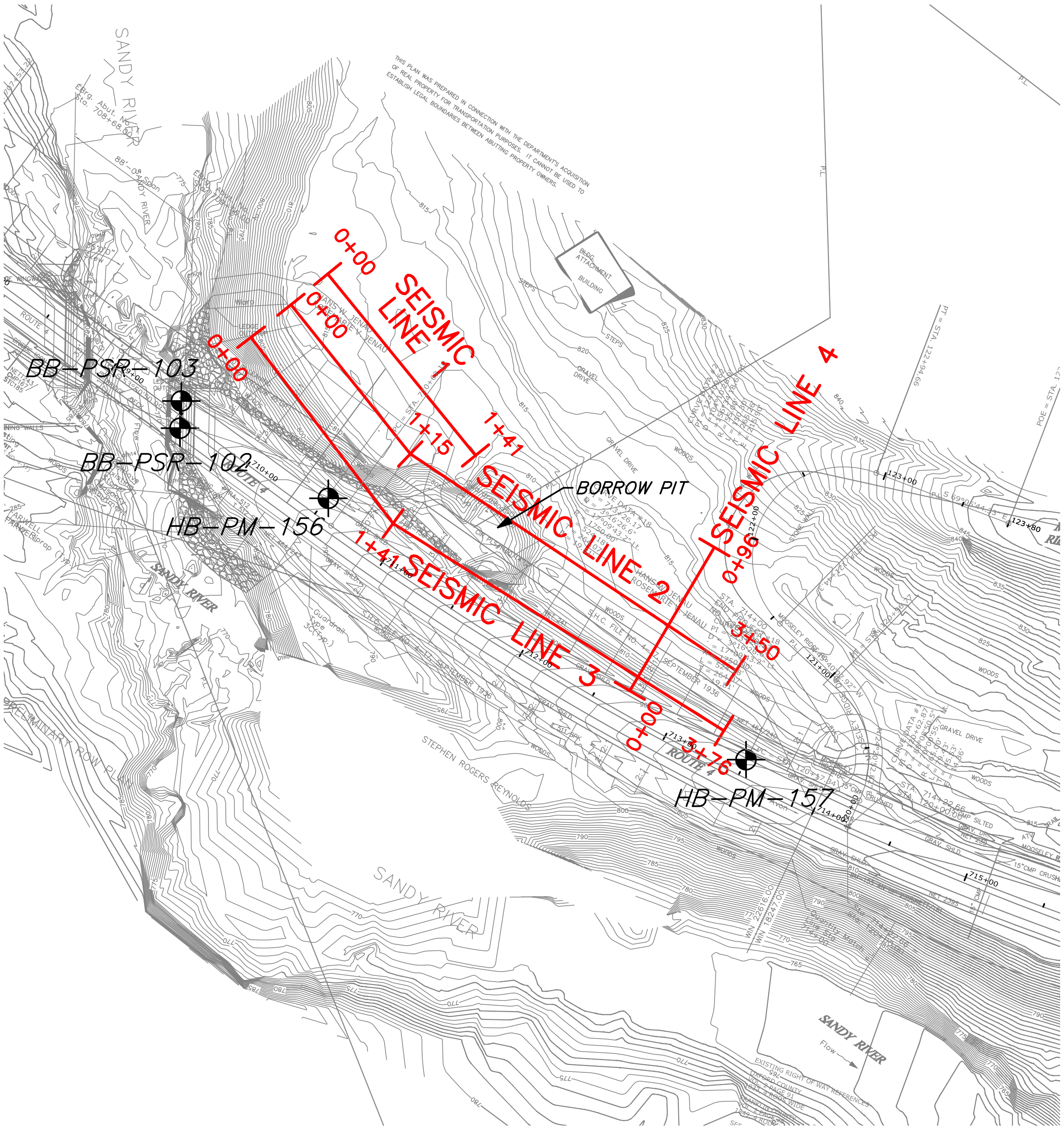
NOTE:

Modified from Google Earth Pro aerial photograph.

Figure 1
General Site Location
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



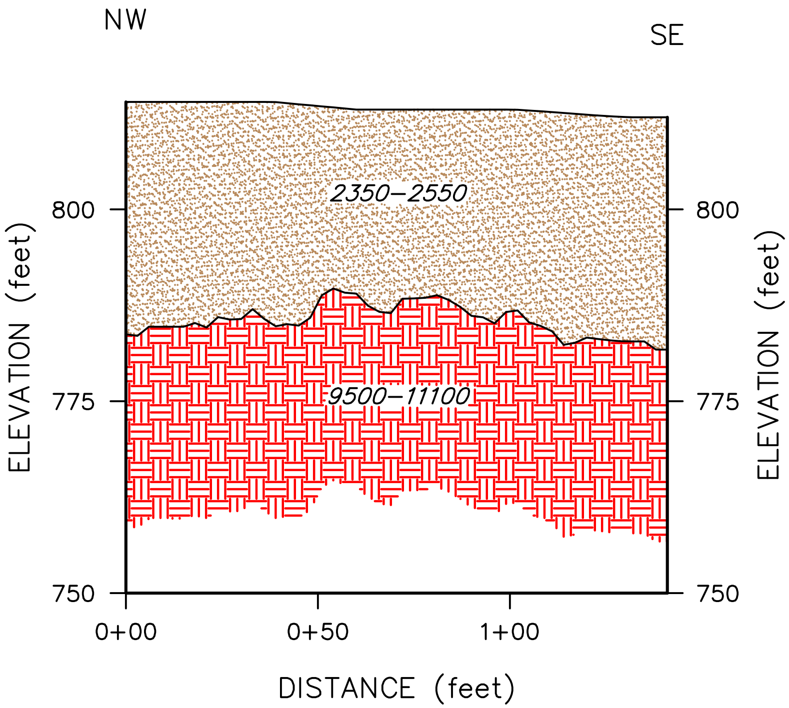
NOTE:

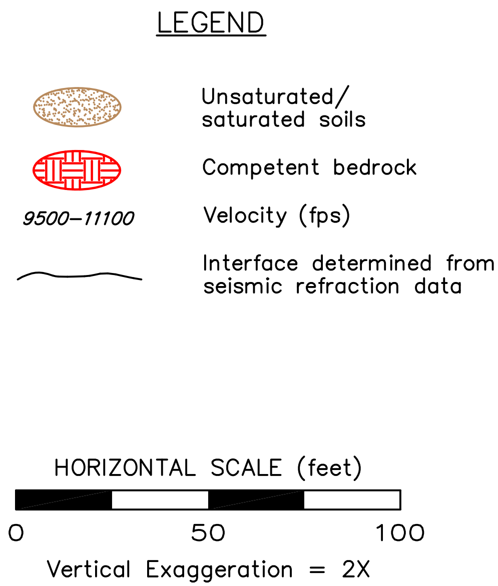
Modified from site plan provided by Schonewald Engineering Associates, Inc., identified as Bridge.dwg.

Figure 2
Site Plan
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER-RICHTER GEOSCIENCE, INC.
Salem, New Hampshire





NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.

2. The depths determined for bedrock are depths of competent rock; weathered and/or fractured bedrock might occur at shallower depths.

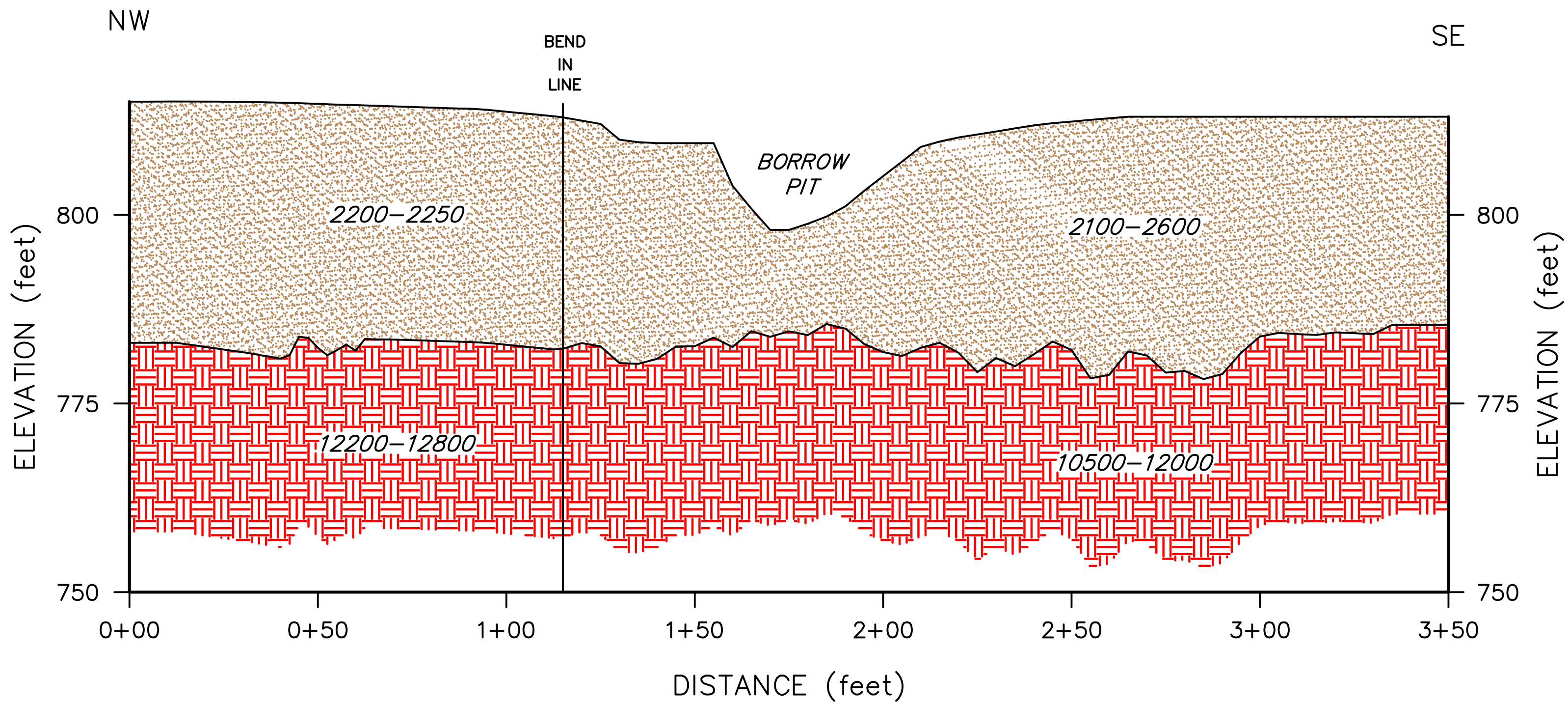
3. Surface elevations determined from plans provided by Schonewald Engineering Associates, Inc.

4. Data were analyzed using the Generalized Reciprocal Method.

Figure 3
Seismic Line 1
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

Unsaturated/ saturated soils

Competent bedrock

9500–11100 Velocity (fps)

Interface determined from seismic refraction data

HORIZONTAL SCALE (feet)

0 50 100

Vertical Exaggeration = 2X

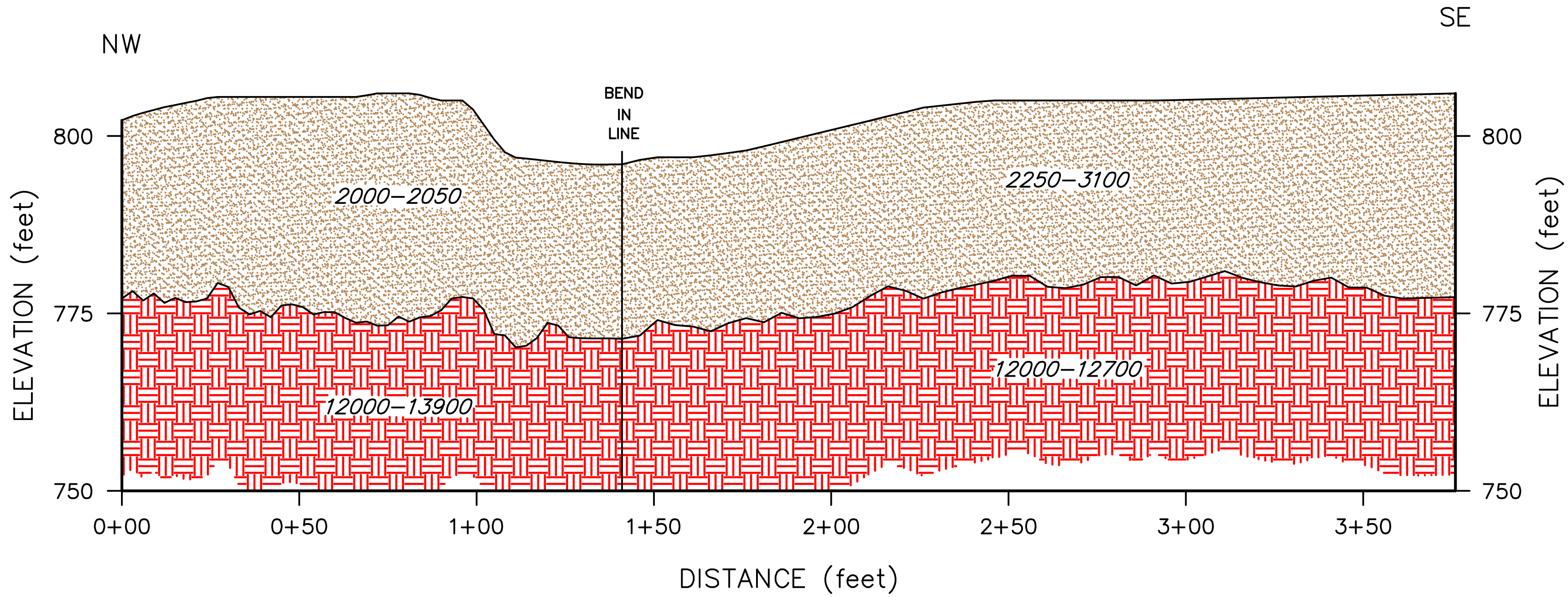
NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by Schonewald Engineering Associates, Inc.
4. Data were analyzed using the Generalized Reciprocal Method.

Figure 4
Seismic Line 2
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

Unsaturated/ saturated soils

Competent bedrock

9500–11100 Velocity (fps)

Interface determined from seismic refraction data

HORIZONTAL SCALE (feet)

0 50 100

Vertical Exaggeration = 2X

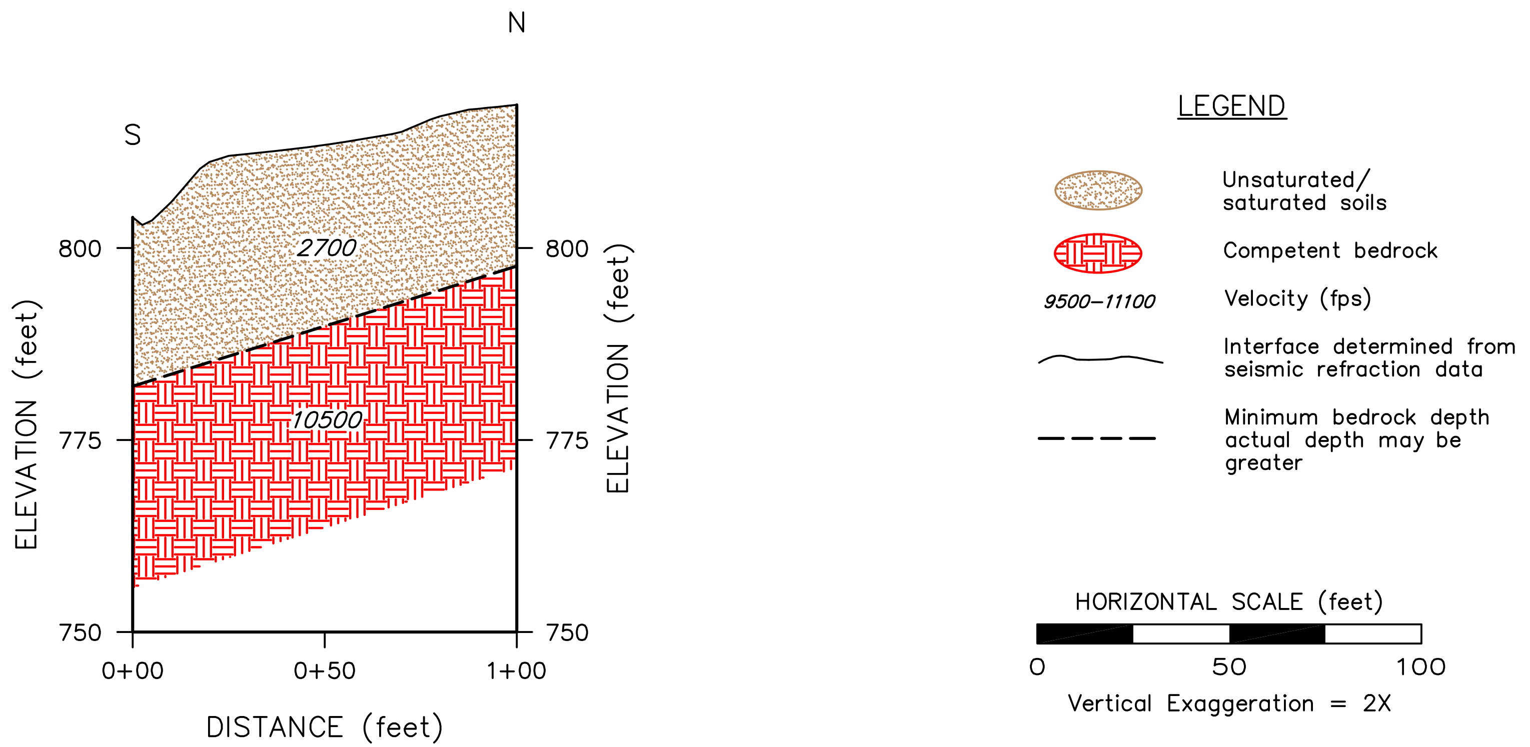
NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by Schonewald Engineering Associates, Inc.
4. Data were analyzed using the Generalized Reciprocal Method.

Figure 5
Seismic Line 3
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



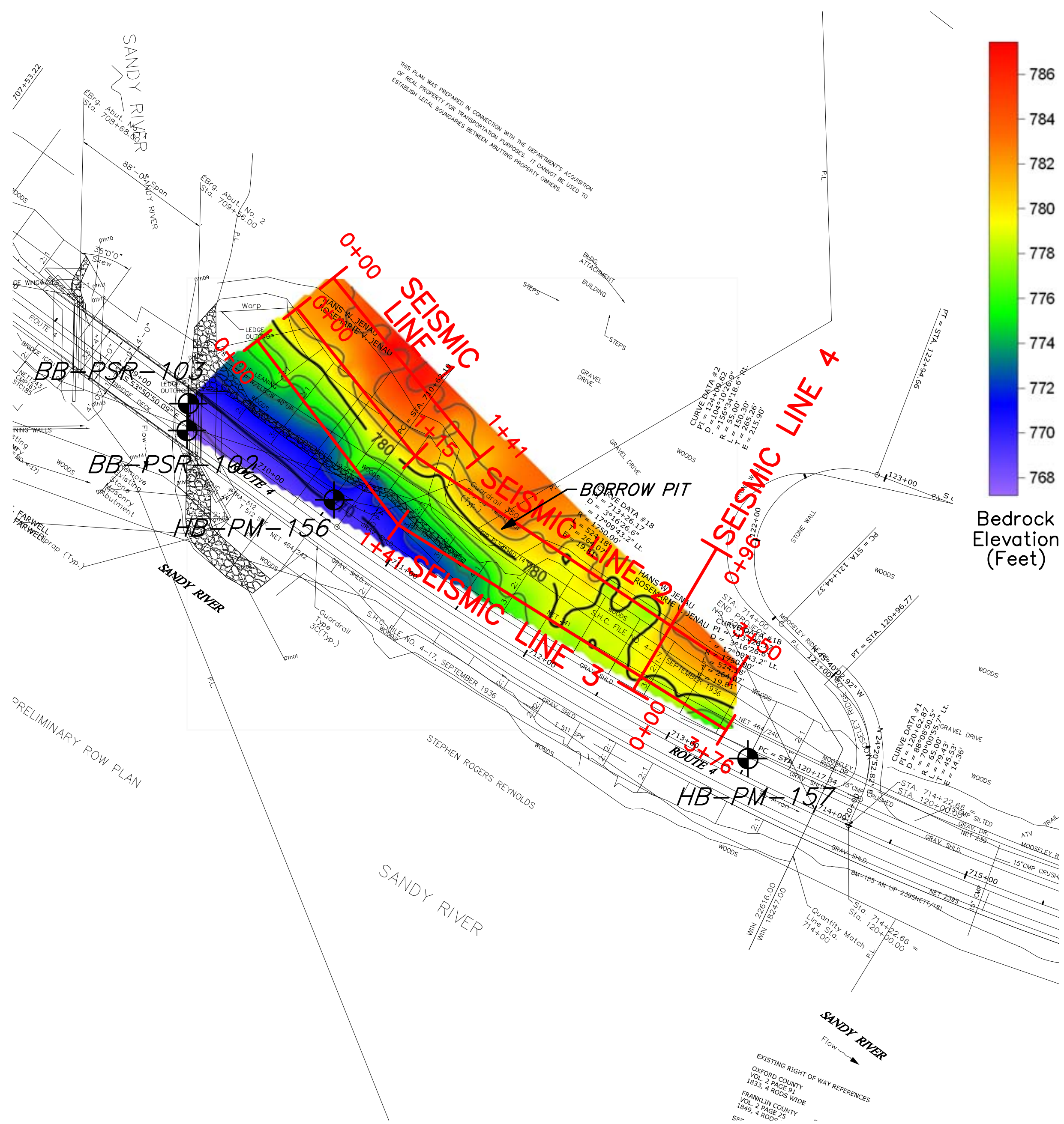
NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by Schonewald Engineering Associates, Inc.
4. Data were analyzed using the Generalized Reciprocal Method.

Figure 6
Seismic Line 4
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

SEISMIC LINE

BORING

SCALE (feet)

0 100 200

NOTE:

1. Modified from site plan provided by Schonewald Engineering Associates, Inc., identified as Bridge.dwg.
2. Contour Interval = 2 Foot.
3. The bedrock elevations shown on this plot are a non-unique model. The contours represent interpolations based on the available data, including seismic refraction data and boring information. The elevations of the bedrock surface at any particular location may differ from that shown. Bedrock elevations based on additional data differ significantly.

Figure 7
Bedrock Elevation
MaineDOT Wing Bridge
US Route 4
Phillips, Maine

File 16J74	December, 2016

HAGER-RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

APPENDIX
BORING LOGS

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-101 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	790.1	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/26/14; 1500 / 8/27/14; 1025	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+68, 6.2 RT	**Casing ID/OD:**	HW to 16.9'; NW to 20.0'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone
LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			9 inches HMA	
	1D	24/13	1.0 - 3.0	12-17-12-8	29		789.3		0.8 — 1D: Brown, dry, m. dense, Gravelly fine to coarse SAND, trace Silt. GRANULAR FILL	
							787.1		3.0 — Numerous cobbles below 3 feet.	
	2D	24/7	4.0 - 6.0	5-6-3-4	9				2D: Dark brown, damp, loose, Gravelly fine to coarse SAND, trace to little Silt. TILL FILL	
5										
	3D	24/9	9.0 - 11.0	3-5-3-4	8	--			3D: Brown, damp, loose, fine to medium SAND, some Gravel, little Silt, trace coarse Sand. TILL FILL	
10						30				
						36				
						16	777.1		13.0	
						42				
						--				
15	4D	22/12	15.0 - 16.8	4-20-69-50/4"	89				4D: Brownish-rgay, v. dense, GRAVEL, some fine to coarse Sand, little Silt. TILL	
							771.3		18.8 — Top of rock at 18.8 ft; roller cone and set casing to 20.0	
20	R1	21/19	20.0 - 21.8	RQD = 24%					R1: Medium to hard, slightly weathered to fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Very close to close, predominately horizontal breaks; undulating, rough, typically discolored and open with mud infilling.	
	R2	59/55	21.8 - 26.7	RQD = 34%					R2: same as R1, except close, predominately high angle with lesser horizontal breaks. Highly broken and weathered from 24.5 to 25.4 feet.	
			22.9 - 23.3							UCT qp = 7,795 psi
25										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-101

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	790.1	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/26/14; 1500 / 8/27/14; 1025	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+68, 6.2 RT	**Casing ID/OD:**	HW to 16.9'; NW to 20.0'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_U = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25										
	R3	60/54	26.7 - 31.7	RQD = 67%					R3: same as R1, except moderate to widely spaced, high-angle breaks. Highly broken and weathered from 26.7 to 27.3 feet.	
30										
							758.4		31.7	
									Bottom of Exploration at 31.7 feet below ground surface.	
35										
40										
45										
50										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-102

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.2	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1030 / 8/27/14; 1420	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+54, 6.3 RT	**Casing ID/OD:**	NW to 23.8'(pull); HW spun to 24.2'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			10 inches HMA	
							790.4		0.8	
	1D	24/13	1.0 - 3.0	14-14-19-11	33				1D: Brown, damp, dense, fine to medium Sandy GRAVEL, trace to little Silt, trace coarse Sand. GRANULAR FILL	
							787.7		3.5	
5	2D	24/14	4.0 - 6.0	5-4-3-3	7				2D: Brown, damp, loose, Gravelly fine to medium SAND, little Silt, trace coarse Sand. TILL FILL	
10	3D	24/10	9.0 - 11.0	2-3-4-3	7	--			3D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
						14				
						9				
						17				
						13				
15	MD	24/0	14.0 - 16.0	4-3-4-9	7	3			No recovery.	
						19				
						26				
						43				
						34				
20	4D	24/5	19.0 - 21.0	8-4-4-5	8	13			4D: Brown-gray, loose, GRAVEL, little fine to coarse Sand, trace Silt. TILL FILL	
						17				
						40				
						60				
							767.3		23.9	
25	R1	60/60	24.4 - 29.4	RQD = 85%					Top of rock at 23.9 ft; spin HW casing to 24.2 ft; roller cone to 24.4 ft R1: Hard, slightly weathered, aphanitic, light gray,	

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

Schonewald Engineering Associates, Inc.	PROJECT: Wing Bridge Route 4 over Sandy River LOCATION: Phillips, Maine	Boring No.: BB-PSR-102 WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.2	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1030 / 8/27/14; 1420	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+54, 6.3 RT	**Casing ID/OD:**	NW to 23.8'(pull); HW spun to 24.2'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25									PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; near vertical relic bedding. Close to wide, horizontal and high angle breaks; undulating, rough, typically discolored and open with occasional mud infilling.	
	R2	60/60	29.4 - 34.4	RQD = 70%					R2: same as R1	
30										
							756.8		34.4	
35									**Bottom of Exploration at 34.4 feet below ground surface.** Noted drill water seeping out from behind southerly end of wing wall, apparently at ledge interface	
40										
45										
50										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

Schonewald Engineering Associates, Inc.

PROJECT: Wing Bridge
Route 4 over Sandy River

LOCATION: Phillips, Maine

Boring No.: BB-PSR-103

WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.3	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1445 / 8/28/14; 0850	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+45, 7.4 LT	**Casing ID/OD:**	HW to 17.3'; NW to 22.5'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA			10.5 inches HMA	
							790.4		0.9	
	1D	24/14	1.0 - 3.0	15-16-14-14	30				1D: Brown, dry, m. dense, fine to coarse Sandy GRAVEL, trace Silt. GRANULAR FILL	
							787.8		3.5	
5	2D	24/11	4.0 - 6.0	3-3-2-3	5				2D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
10	3D	24/8	9.0 - 11.0	3-4-3-4	7	RC			3D: Brown, damp, loose, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. TILL FILL	
15	4D	24/6	14.0 - 16.0	4-5-5-3	10				4D: Brown, loose, fine to medium Sandy GRAVEL, little Silt, trace coarse Sand. TILL FILL	
							774.3		17.0	
	R1	35/15	17.3 - 20.2						Apparent top of weathered rock. R1: Appear to be in near vertical seam of highly weathered rock (PHYLLITE). Short piece of core with high angle breaks top and bottom. Bottom open fracture includes significant thickness of very fine Sandy SILT with roots infilling.	
20	5D	6/6	20.2 - 20.7	50/6"					5D: Gray, Silty very fine SAND, trace Gravel. Broken rock in tip of spoon. Roller cone ahead - no pressure, rapid penetration. Fetch up at 22.5 ft. Drive NW to 22.5 ft.	
							768.8		22.5	
	R2	53/47	22.5 - 26.9	RQD = 53%					R2: Medium to hard, slightly weathered from 22.5 to 24.8 feet, otherwise fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with distinct white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Highly weathered high-angle mica-rich seam from 22.5 to 23.5 feet; phenocrysts appear altered; talc-like material Close to	
25										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

Schonewald Engineering Associates, Inc.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-103 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	791.3	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/27/14; 1445 / 8/28/14; 0850	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 709+45, 7.4 LT	**Casing ID/OD:**	HW to 17.3'; NW to 22.5'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone
LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25			25.0 - 25.4						moderately spaced, moderate to high angle breaks; undulating, smooth (mica) to rough, typically discolored and open with mud infilling (1/8 inch thick). Significant fracture zone from 24.2 to 24.8 feet.	UCT qp = 1,657 psi
	R3	60/57	26.9 - 31.9	RQD = 72%					R3: same as R2, except slightly weathered where mica-rich seams intersect core surface; horizontal and moderately dipping breaks. Highly fractured (v. close spacing) below 31.1 feet.	
30										
							759.4		31.9 **Bottom of Exploration at 31.9 feet below ground surface.**	
35										
40										
45										
50										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

Schonewald Engineering Associates, Inc.	PROJECT: Wing Bridge, Route 4 over Sandy River LOCATION: Phillips, Maine	Boring No.: BB-PSR-104 WIN: 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	789.9	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/28/14; 0855 / 8/28/14; 1135	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+59, 7.7 LT	**Casing ID/OD:**	HW and NW (telescoped) to 16.4'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
0						SSA	789.0		11 inches HMA ——— 0.9	
	1D	24/14	1.0 - 3.0	12-13-8-29	21		786.4		1D: Brown, dry, m. dense, Gravelly fine to medium SAND, trace to little Silt, trace coarse Sand. (GRANULAR) FILL — — — 3.5	
5	2D	24/4	4.0 - 6.0	4-4-3-2	7		780.9		2D: Brown, damp, loose, Gravelly fine to medium SAND, little Silt, trace coarse Sand. (TILL) FILL — — — 9.0	
10	3D	24/10	9.5 - 11.5	10-7-4-4	11	RC			3D: Top 2": Brown, damp, fine to medium SAND, some Gravel, little Silt, trace coarse Sand. Btm 8": Gray, damp, fine Sandy GRAVEL, little Silt; appears to be decomposed cobble. TILL	
15	4D	24/10	14.0 - 16.0	6-11-33-10	44		774.9		4D: Top 2": Brown, damp, Gravelly fine to medium SAND, little Silt, trace coarse Sand. Btm 8": Gray, damp, fine Sandy GRAVEL, little to some Silt; appears to be crushed/weathered rock. TILL changing to WEATHERED ROCK — — — 15.0	
	R1	60/60	16.4 - 21.4	RQD = 77%			773.5		——— 16.4 R1: Hard, fresh, aphanitic, light gray, PORPHYROBLASTIC PHYLLITE, with white mica (muscovite) bands and plagioclase phenocrysts; high angle relic bedding. Fewer and less well defined phenocrysts than in BB-PSR-101 through -103. Top 0.3 feet weathered and broken, otherwise moderately spaced (2), high angle breaks; undulating, smooth (silvery, mica), slightly discolored and open; no infilling observed.	
20	R2	60/60	21.4 - 26.4	RQD = 80%					R2: same as R1, except only 1 horizontal discolored fracture and 1 high angle fracture along a mica-rich zone.	
25										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.	**PROJECT:** Wing Bridge Route 4 over Sandy River **LOCATION:** Phillips, Maine	**Boring No.:** BB-PSR-104 **WIN:** 22616.00

Driller:	Maine Test Borings	**Elevation (ft.)**	789.9	**Auger ID/OD:**	SSA to 9'
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	standard split spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-51	**Hammer Wt./Fall:**	rope and cathead; 140#/30"
Date Start/Finish:	8/28/14; 0855 / 8/28/14; 1135	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta 708+59, 7.7 LT	**Casing ID/OD:**	HW and NW (telescoped) to 16.4'	**Water Level*:**	

IN-SITU SAMPLING AND TESTING:
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
MV = Unsuccessful Insitu Vane Shear Test attempt

ADDITIONAL DEFINITIONS:
S_u = Insitu Field Vane Shear Strength (psf)
R = Rock Core Sample
RQD = Rock Quality Designation (%)
WOH = weight of 140lb. hammer
WOR = weight of rods
-- = not recorded

BOREHOLE ADVANCEMENT METHOD:
SSA= solid stem auger / RC=roller cone

LABORATORY TEST RESULTS:
LL=Liquid Limit / PL=Plastic Limit / PI=Plasticity Index
WC = water content, percent
-#200 = percent fines from grain size analysis
UCT qp = peak compressive strength of rock

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Lab. Testing Results
25										
							763.5		26.4 **Bottom of Exploration at 26.4 feet below ground surface.**	
30										
35										
40										
45										
50										

Remarks:

Station, Offset, and Elevation listed above were provided by MaineDOT survey. Offset is based on existing centerline.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 4 Reconstruction
Location: Phillips-Madrid, Maine

Boring No.: HB-PM-156
WIN: 18247.00

Driller:	New England Boring	**Elevation (ft.)**	793.7	**Auger ID/OD:**	3.5" Dia.
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	Mobile Drill B-47 (Trailer)	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	9/9/2014; 13:55-14:50	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	710+51, 12.3 ft Lt., Gravel Shoulder	**Casing ID/OD:**	N/A	**Water Level*:**	6.2 ft Open Hole

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 WOC = weight of casing

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.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA				
	1D	24/9	1.00 - 3.00	5/7/8/5	15				Brown, damp to moist, medium dense, Gravelly fine to medium SAND, little silt, trace coarse sand, (Fill).	G#271218 A-2-4 SM
5	2D	24/12	5.00 - 7.00	6/8/10/15	18				Reddish-brown, damp to moist, medium dense, fine to coarse Sandy GRAVEL, little silt, (Fill).	G#271219 A-1-a GM
							785.20		8.50	
10	3D	24/17	10.00 - 12.00	42/35/38/61	73				Reddish-brown, wet, very dense, fine to coarse Sandy GRAVEL, trace to little silt, (Till).	G#271220 A-1-a SW-SM
							781.10		12.60	
									Possible Weathered Rock or Brown Cemented Till based on auger cuttings and drilling behavior.	
							779.70		14.00	
									Bottom of Exploration at 14.00 feet below ground surface. Auger REFUSAL	
15										
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: Route 4 Reconstruction
Location: Phillips-Madrid, Maine

Boring No.: HB-PM-157
WIN: 18247.00

Driller:	New England Boring	**Elevation (ft.)**	808.1	**Auger ID/OD:**	3.5" Dia.
Operator:	Enos/Dube	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	Be Schonewald	**Rig Type:**	Mobile Drill B-47 (Trailer)	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	9/9/2014; 115:00-16:35	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	713+49.8, 10.0 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	14.0 ft Open Hole

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 WOC = weight of casing

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.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	807.50		7" HMA 0.60	
	1D	24/13	1.00 - 3.00	14/14/14/21	28				Brown, damp, medium dense, Gravelly fine to coarse SAND, trace to little silt, (Fill).	G#271221 A-1-a SW-SM
5							803.10		5.00	
	2D	4/4	5.00 - 5.33	75(4")	---				Greyish-brown, damp, Gravelly fine to coarse SAND, trace to little silt, (Till). Very difficult drilling; not rock or boulders; possibly boney or cemented till.	G#271222 A-1-b SM
	3D	14/8	9.80 - 10.97	58/110/100(2")	>210					
10									Greyish-brown with orange particles, damp, very dense, Gravelly fine to coarse SAND, trace to little silt, (Brown Cemented Till).	G#271223 A-1-b GM
	4D	5/3	14.90 - 15.32	100(4")	---					
15							792.80		Able to penetrate to 14.9 ft bgs; very slow; augers and cuttings smoking hot. Greyish-brown, wet, fine to coarse Sandy GRAVEL, trace to little silt, (Brown Cemented Till). 15.30	G#271224 A-1-b SC-SM
									Bottom of Exploration at 15.30 feet below ground surface. Practicable 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.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

APPENDIX F

ROCK MASS RATING AND ROCK MASS BEARING CAPACITY CALCULATIONS

Project: MaineDOT Wing Bridge Replacement	WIN 22616.00		**Proj. No.**	14-113
Location: Phillips, ME	**Last updated:**	9/1/15	**By**	IVS
Subject: Geotechnical Calculations	**Checked:**	9/2/15	**By**	SJR
Rock Mass Rating			**By**	

Objective:

Evaluate the strength and rating of the bedrock underlying the site.

Reference:

2010 LRFD Manual - Section 10.4.6.4 "Rock Mass Strength", including Tables 10.6.4.4-1 and 10.6.4.4-3
NAVFAC DM 7.1 - Chapter 1, Figure 3 (Strength Classification)
FHWA Geotechnical Engineering Circular No. 5, Section 6 "Interpretation of Rock Properties"

Data Sources:

Published bedrock geological information
Site-specific test boring logs, specifically rock core descriptions and RQDs.
Site-specific laboratory test results: unconfined compression tests on rock core samples.

TEST BORINGS: Rock observed underlying the Wing Bridge site is a medium to hard, slightly weathered to fresh, aphanitic PORPHYROBLASTIC PHYLLITE, with muscovite bands and plagioclase phenocrysts; high-angle relic bedding.

LABORATORY TESTS: 2 laboratory uniaxial compressive strength tests, as follows

BB-PSR-101	22.9 to 23.3 ft BGS	UCT q_p = 1,122 ksf
BB-PSR-103	25.0 to 25.4 ft BGS	UCT q_p = 239 ksf

average peak uniaxial compressive strength: 681 ksf
strength is classified as " MODERATELY STRONG" per NAVFAC DM7.1-33 (Fig 3)

Because of anomolously low test result, consider laboratory uniaxial compressive strength test results from bridge site underlain by similar rock:
Mill Bridge in Isleboro - PHYLLITE
UCT q_p = 975 ksf
UCT q_p = 1,117 ksf

Average of test results from both projects results in a reasonable peak uniaxial compressive strength:
863 ksf
strength is classified as " MODERATELY STRONG" per NAVFAC DM7.1-33 (Fig 3)

RQDs FROM ROCK CORES OBTAINED AT WING BRIDGE:

BORING	ROCK CORE NO.	RQD
BB-PSR-101	R1	24
	R2	34
	R3	67
BB-PSR-102	R1	85
	R2	70
BB-PSR-103	R2	53
	R3	72
BB-PSR-104	R1	77
	R2	80
	$RQD_{average}$ =	62

Project: MaineDOT Wing Bridge Replacement	WIN 22616.00		**Proj. No.**	14-113	
Location: Phillips, ME	**Last updated:**	9/1/15	**By**	IVS	
Subject: Geotechnical Calculations	**Checked:**	9/2/15	**By**	SJR	
Rock Mass Rating			**By**		

ROCK MASS RATING MATRIX (2010 LRFD Manual, Table 10.4.6.4-1)

ITEM #	DESCRIPTION	VALUE	REL RATING
1	strength of intact rock	avg uniaxial compressive strength: 863 ksf	6
2	drill core quality (RQD)	average RQD of 9 core runs = 62%	12
3	spacing of joints	typ. close to moderately spaced	13
4	condition of joints	typically hard joint wall rock	15
		typically rough and undulating	
5	groundwater conditions	typically interstitial water	7
		RAW RMR (sum):	53

RMR ADJUSTMENT FOR JOINT ORIENTATION (Table 10.4.6.4-2)

-11 about half joints are high angle = fair to unfavorable with respect to foundations

ADJUSTED ROCK CLASS NUMBER (Table 10.4.6.4-3)

RMR 42

Class No. III-IV

Description Fair to Poor

Project: MaineDOT Wing Bridge Replacement	WIN 22616.00			**Proj. No.**	14-113
Location: Phillips, ME	**Last updated:**	7/7/15	**By**	IVS	
Subject: Geotechnical Calculations	**Checked:**	9/2/15	**By**	SJR	
Bearing Resistance of CIP Footing on Fractured Rock			**By**		

Service Limit State Bearing Resistance

Nominal Bearing Resistance = Factored Bearing Resistance (2014 LRFD Manual Section 10.5.5.1)
(resistance factor = 1.0 for service limit states)

Presumptive Bearing Resistance for Service Limit State ONLY
2014 LRFD Manual Table C10.6.2.6.1-1 with:

Type of Bearing Material - weathered or broken bedrock of any kind
Consistency in Place - medium hard rock

Bearing Resistance (ordinary range): 16 to 24 ksf
Recommended Bearing Resistance: **20 ksf** SERVICE LIMIT STATE ONLY

(Note: use lesser of Recommended Bearing Resistance or Nominal Resistance of Concrete ($0.3f'_c$))

Project: MaineDOT Wing Bridge Replacement	WIN 22616.00			**Proj. No.**	14-113
Location: Phillips, ME	**Last updated:**	9/1/15	**By**	IVS	
Subject: Geotechnical Calculations	**Checked:**	9/2/15	**By**	SJR	
Bearing Resistance of CIP Footing on Fractured Rock (cont'd)			**By**		

Strength Limit State Bearing Resistance

Resistance Factor (φ_b) = 0.45 (2014 LRFD Manual Table 10.5.5.2.2-1 for footings on rock)

C_o (uniaxial compressive strength) = 863 ksf

Determine Rock Mass Rating: refer to Rock Mass Rating worksheets

ROCK CLASS NUMBER (2010 LRFD Manual Table 10.4.6.4-3)

RMR: 42

Class No.: III-IV

Description: Fair to Poor

Determine Rock Type (2010 LRFD Manual Table 10.4.6.4-4)

PORPHYROBLASTIC PHYLLITE, with muscovite bands and plagioclase phenocrysts; high-angle relic bedding

PHYLLITE is best characterized as Rock Type B (lithified argillaceous rocks)

For use in 2014 LRFD Manual T10.4.6.4-1: metamorphic, foliated, phyllite

Determine Rock Mass Material Parameters (2014 LRFD Manual T10.4.6.4-1)

$m = m_i$ exp((RMR-100)/14), where m_i = 7 for Intact Rock Type B — m = 0.111

s = exp ((RMR-100)/6) — s = 0.00006

Determine Rock Mass Nominal Bearing Resistance (q_{nom})

using LRFD methodology (Reference: Wyllie "Foundations on Rock" Eq. 5.4, Pg 138)

q_{nom} = C_{f1} * s^0.5 * C_o * [1 + (ms^-0.5 + 1)^0.5], where

q_{nom} is the ultimate bearing capacity of footings on broken or jointed rock

C_{f1} is a correction factor for the shape of the foundation (Wyllie Table 5.4) = 1.0 for strip

m and s are functions of rock type (B) and rock mass quality (Fair to Poor) (see above)

q_{nom} = 1.0 * (0.00006)^0.5 * 863 * [1 + ((0.111*(0.00006)^-0.5 + 1)^0.5)]

q_{nom} = 33.4 ksf

Determine Rock Mass Factored Bearing Resistance

q_{nom}= 33 ksf and φ_b = 0.45

qr = 15 ksf

Recommended Bearing Resistance: **15 ksf** STRENGTH LIMIT STATE