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Geotechnical Design Report

FRANK J. WOOD BRIDGE NO. 2016 OVER THE ANDROSCOGGIN RIVER

MAINE DOT WIN 22603.00
BRUNSWICK-TOPSHAM, MAINE

Prepared for:
Maine Department of Transportation
Augusta, Maine

July 2019
09.0025917.02

Prepared by:
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VIA EMAIL

July 29, 2019
File No. 09.0025917.02

Ms. Laura Krusinski, P.E.
Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016

Re: Geotechnical Design Report
Frank J. Wood Bridge No. 2016
Maine Department of Transportation WIN 22603.00
Brunswick-Topsham, Maine

Dear Laura:

We are pleased to provide this Geotechnical Design Report for Maine Department of Transportation (MaineDOT) Bridge No. 2016 over the Androscoggin River connecting Brunswick and Topsham, Maine. Our work was completed under GZA GeoEnvironmental, Inc.'s (GZA's) July 22, 2015 General Consulting Agreement (GCA CTM20150608000000000793) with the MaineDOT Bridge Program, and incorporates GZA's Proposal No. 09.P000045.19, dated August 1, 2018, and the attached *Limitations* included in **Appendix A** of this report. T.Y. Lin International is serving as the bridge designer for MaineDOT.

It has been a pleasure serving the MaineDOT / T.Y. Lin International team on this project. If you have any questions regarding the report, or if we can provide further assistance, please do not hesitate to contact the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

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1.0 INTRODUCTION

GZA GeoEnvironmental, Inc. (GZA) has prepared this geotechnical design report for the proposed replacement of Maine Department of Transportation (MaineDOT) Frank J. Wood Bridge No. 2016 in Brunswick and Topsham, Maine. Our services were provided in accordance with GZA's Proposal No. 09.P000045.19, dated August 1, 2018. This report is subject to the *Limitations* included in **Appendix A**.

1.1 BACKGROUND

The existing Frank J. Wood Bridge No. 2016 carries US Route 201 and Maine Route 24B over the Androscoggin River and connects Brunswick and Topsham, Maine at the location shown on **Figure 1**. The existing bridge was constructed in 1937 and consists of an 815-foot-long, three-span, steel, through-truss bridge supported on three concrete piers and two concrete abutments, all founded on spread footings bearing on bedrock.

T.Y. Lin International is the designer for the replacement bridge. The proposed replacement bridge is an 815-foot-long, four-span bridge, the location of which is shown on **Figures 2** through **4**. Three piers and two abutments are proposed to support the replacement bridge. The new alignment follows an arc on the west (upstream) side of the existing bridge, tying back into the approaches near the existing abutments.

The bridge replacement project includes landscape improvements at both abutments. An amphitheater and scenic overlook with a cantilevered walkway are planned on the Brunswick side. The Topsham side includes a pedestrian walkway that will provide access underneath the bridge and connect to a pocket park with two overlooks adjacent to the abutment.

An existing dam (the Brunswick Dam) is located directly upstream from the bridge. The dam is approximately 15 to 30 feet high, 520 feet long and operates as a run-of-the-river dam and hydroelectric facility. The powerhouse, penstocks and tailrace are located on the Brunswick shoreline upstream from the bridge.

1.2 OBJECTIVES AND SCOPE OF SERVICES

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

- Observed subsurface explorations for borings BB-BTAR-108 through -111 during the first phase of explorations, which consisted of eleven total borings;
- Coordinated borehole geophysical testing in three (3) completed test borings to provide information on the discontinuities in bedrock;
- Conducted site visits to observe the exposed conditions, record joint discontinuity measurements, and understand how the site conditions could affect design and construction;

- Reviewed boring logs prepared by others, and rock core samples for borings observed by others to evaluate subsurface conditions;
- Reviewed results of a laboratory testing program conducted by MaineDOT to evaluate engineering properties of bedrock;
- Coordinated and observed subsurface explorations for borings BB-BTAR-201 and -202 during the second phase of explorations, which consisted of two total borings;
- Conducted geotechnical engineering analyses including evaluation of bedrock properties and joint characteristics relative to stability and foundation support; feasible retaining wall types; and bearing resistance of footings bearing on rock;
- Developed geotechnical engineering recommendations including foundation design recommendations for footings on rock, lateral earth pressures, design frost depth, and seismic design parameters; and
- Prepared this report summarizing our findings and design recommendations.

2.0 SUBSURFACE EXPLORATIONS

2.1 SUBSURFACE EXPLORATIONS

13 borings have been completed for use in this evaluation. On August 24, 2016, New England Boring Contractors (NEBC) drilled and MaineDOT logged four test borings (BB-BTAR-104 through -107). On August 25, 2016, MaineDOT drilled and logged three test borings (BB-BTAR-112 through -114). On August 30 and 31, 2016, NEBC drilled and GZA logged four test borings (BB-BTAR-108 through -111). On December 6 and 7, 2018, NEBC drilled and GZA logged two borings (BB-BTAR-201 and -201). Four of the borings (BB-BTAR-111 through -114) were drilled at the north abutment and approach retaining wall, seven were drilled at the proposed pier locations, and two (BB-BTAR-201 and -202) were drilled at the south abutment.

The borings were drilled using track- and truck-mounted drill rigs to depths of approximately 2 to 26 feet below ground surface (BGS) and were terminated approximately 2 to 26 feet into bedrock. Bedrock was typically cored 10 to 26 feet in the borings, except at boring BB-BTAR-202, where the hole was terminated after coring 2.2 feet due to the rising river level. The as-drilled boring locations and elevations were surveyed by MaineDOT and are included on the logs in **Appendix B**. The boring locations are shown on **Figures 2** through **4, Boring Location Plans** prepared by MaineDOT.

The borings were drilled using 3-inch driven casing and drive-and-wash drilling techniques. Where overburden was present, standard penetration testing (SPT) and split-spoon sampling were performed at 5-foot typical intervals in the overburden using a 24-inch-long, 1-3/8-inch inside-diameter sampler, driven with an automatic hammer with a rated hammer efficiency factor as shown on the boring logs. Bedrock cores were obtained using NQ2 wire-line coring equipment in each test boring. GZA took wet and dry photographs of the rock core specimens, which are presented in **Appendix E**.

MaineDOT developed draft boring logs and provided them to GZA for borings BB-BTAR-104 through -107 and -112 through -114. GZA reviewed and edited these logs to reflect our engineering review of draft logs, and to include laboratory soil test results and bedrock classifications. GZA prepared logs for borings BB-BTAR-108 through -111 and BB-BTAR-201 and -202. The logs are presented in **Appendix B**.

2.2 BOREHOLE TELEVIEWER SURVEY

Northeast Geophysical of Bangor, Maine conducted borehole televiewer surveys in the cored portion of three completed boreholes (BB-BTAR-108 through -110) on September 7, 2016. The purpose of the televiewer logging was to evaluate the location and orientation of discontinuities in the bedrock. The survey included Acoustic Televiewer (ATV) and Optical Televiewer (OTV) in the boreholes. The survey results included depth, apparent aperture, dip and dip direction of apparent discontinuities in the bedrock. More detailed information, along with OTV and ATV image log plots, results of the televiewer logs, and polar plots of the dip and dip direction of the interpreted features for each borehole are contained in Northeast Geophysical's reports, which are included in **Appendix C.** The interpreted dip and dip direction of apparent discontinuities used in our evaluations are summarized in **Table 1.**

2.3 GEOLOGIC FIELD MAPPING

Geologic field mapping was undertaken to provide data for evaluating characteristics of the rock mass relevant to support of the proposed foundations. On August 27, 2016 and on December 6, 2018, GZA took direct measurements and photographs of exposed outcrops along the proposed alignment. 29 readings were collected using a Brunton compass and the GeoID v1.8 phone application. A summary of joint measurements and observations is included in **Table 1**. Outcrops were not accessible at some locations due to water levels along the proposed alignment. Approximate measurement locations are shown on photographs included in **Appendix D.** The discontinuity measurements are plotted on lower hemisphere stereographic projections included in **Appendix G.**

2.4 ROCK CORE REVIEW

GZA requested access to the MaineDOT rock core samples in order to make an independent assessment of the rock type and characteristics. After receiving approval from the MaineDOT Geotechnical Group, a GZA engineer visited MaineDOT's facility in Freeport, reviewed the available rock core specimens, and prepared an independent description of core samples from borings BB-BTAR-104 through -107 and BB-BTAR-112 through -114. The GZA observations are provided on the logs in **Appendix B**. GZA also took wet and dry photographs of the rock core specimens, which are presented in **Appendix E**.

3.0 LABORATORY TESTING

MaineDOT completed a laboratory strength testing program on seven rock core specimens. MaineDOT retained GeoTesting Express of Acton, Massachusetts to complete the unconfined compressive strength / secant modulus tests on the seven bedrock core samples. GZA coordinated laboratory strength testing on three additional samples from borings BB-BTAR-201 and -202. GZA retained Thielsch Engineering to complete one unconfined compressive strength / secant modulus test and two axial and diametrical point load tests on rock core from the 200-series borings.

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

4.0 SUBSURFACE CONDITIONS

4.1 SURFICIAL AND BEDROCK GEOLOGY

Based on available surficial geologic mapping[1], the surficial unit along the river at the bridge alignment consists of fine grained glaciomarine deposits, which are described as silt, clay, sand and minor gravel. Stream alluvium deposits are mapped adjacent to these units near the bridge alignment, which are described as sand, gravel, and silt deposited in nearshore or shallow marine environments.

Bedrock in the vicinity of the site is mapped as the Cushing formation of Cambrian age. The Cushing formation is characterized as a metamorphic unit consisting primarily of gneiss and schist of varying composition with granite and pegmatite intrusions[2].

4.2 SUBSURFACE PROFILE

Soil was encountered overlying bedrock in two borings near Abutment 2 (BB-BTAR-113 and -114) and one boring near Abutment 1 (BB-BTAR-201), and bedrock was encountered at the ground surface in the remaining borings (BB-BTAR-104 through -112 and -202). The single overburden soil unit, fill, was encountered in the borings. The thickness and generalized description of the fill is presented in the following table. Detailed descriptions of the materials encountered at specific locations are provided in the boring logs in **Appendix B**. The subsurface conditions are also shown in relation to the bridge alignment on the Interpretive Subsurface Profiles prepared by MaineDOT, presented in **Figures 5** through **7**. GZA did not observe drilling at borings BB-BTAR-113 and BB-BTAR-114. We relied on classifications made by MaineDOT for our description of the soil at those locations.

GENERALIZED SUBSURFACE CONDITIONS		
Soil Unit	**Approximate Encountered Thickness (ft)**	**Generalized Description**
Fill	6.7 to 12.5	Brown to gray, loose, SAND, trace to little gravel, trace rootlets. • Encountered in borings BB-BTAR-113, BB-BTAR-114, and BB-BTAR-201 only.
Top of Bedrock Elevation	Encountered Top of Rock: EL. 39.2 to El. -0.8	

4.2.1 Bedrock

Bedrock was cored in each test boring and the two primary rock types observed, GNEISS and PEGMATITE, are consistent with the mapped units. A summary of the rock core observations is presented for each core run in **Table 2**. Generalized rock descriptions for each rock type are presented below.

[1] Thompson, Woodrow B., Lowell, Thomas V., Caldwell, Dabney, W., Borns Jr., Harold, W., 1985. *Surficial Geologic Map of Maine: Maine Geological Survey Department of Conservation*; Scale 1:500,000.

[2] Hussey II, Arthur M., 1981. *Bedrock geology of the lower Androscoggin Valley – Casco Bay Area, Maine*; Maine Geological Survey Department of Conservation; Open-file No. 81-29.

GNEISS was observed in all borings except for BB-BTAR-111 and -112. The GNEISS was described as hard, fresh to slightly weathered, gray and white, and fine to medium grained. Joints are typically low to high angle, smooth, planar, close to moderately spaced, fresh to discolored, and tight to moderately wide with biotite observed on many of the joint surfaces.

PEGMATITE was observed in borings BB-BTAR-105, -107 through -109, -111 through -114, and -201. PEGMATITE was observed as thin bands (borings BB-BTAR-108, -109, and 201) to massive intrusions (borings BB-BTAR-111 and -112) into the GNEISS. The PEGMATITE was described as hard, fresh, white and gray, and coarse to very coarse grained. Joints are typically very close to moderately spaced, horizontal to low angle, fresh to discolored, and tight to moderately wide. The encountered PEGMATITE intrusions ranged in thickness from less than 1 foot to greater than 15 feet.

The Rock Quality Designation (RQD) in the core runs ranged from 0 to 100 percent, with the GNEISS typically displaying higher RQD values than the PEGMATITE, as summarized in the table below.

SUMMARY OF RQD DATA			
Rock Type	**Minimum RQD**	**Average RQD**	**Maximum RQD**
Gneiss	0%	75%	100%
Pegmatite	15%	55%	90%

Note: RQD = Rock Quality Designation

Eight laboratory unconfined compressive strength / secant modulus tests were conducted on bedrock core samples of Gneiss and Pegmatite. The test results are included in **Appendix F**. The testing yielded unconfined compressive strengths ranging from 5.8 to 32.7 kips per square inch (ksi) and Young's modulus values at 50 percent of the failure strain ranging from 1,730 to 8,930 ksi. It should be noted that one sample from boring BB-BTAR-111 fractured on a weak plane during preparation and was unable to be tested for compressive strength. Three unconfined compression tests had strength less than 10 ksi (BB-BTAR-108, -112, and -201). Samples from BB-BTAR-108 and -111 both consisted of Gneiss and Pegmatite. Failure in the sample taken from BB-BTAR-108 occurred along the Pegmatite / Gneiss contact.

Point load testing results on samples from borings BB-BTAR-201 and -202 resulted in correlated unconfined compressive strength values in the axial direction ranging from 7.5 to 13.2 ksi, which is consistent with the results of the unconfined compressive strength test results.

Wet and dry photographs of the core boxes are presented in **Appendix E**.

4.2.2 Groundwater

Groundwater levels were not recorded on the boring logs. Considering the presence of the river adjacent to the approaches, groundwater levels in the approaches are anticipated to be at or above the river level. It was observed that river levels where water is pooled adjacent to the Brunswick shore fluctuate due to tidal action. Generally, the tide at the site lags behind the coastal tides by several hours. Fluctuations in groundwater levels will also occur due to variations in season, precipitation, river level and construction activity in the area.

5.0 GEOTECHNICAL ENGINEERING EVALUATIONS

5.1 GENERAL

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

5.2 SEISMIC DESIGN CONSIDERATIONS

Seismic site class was evaluated in accordance with the 2014 AASHTO LRFD, along with consideration of the *2011 AASHTO Guide Specifications for LRFD Bridge Design* (Seismic Guide Specification). The new abutments and piers will be supported on spread footings bearing on bedrock, as described below. In the absence of site-specific shear wave velocity data, the bridge should be assigned to Site Class B in accordance with AASHTO Table C3.10.3.1-1. Seismic design parameters are provided later herein.

5.3 EVALUATION OF FOUNDATIONS

5.3.1 Foundation Type Assessment

Considering the exposed bedrock surface across the site and based on conversations with MaineDOT and T.Y. Lin International, spread footings bearing on rock are the preferred foundation type for the bridge replacement, and other foundation options were not considered. We understand that three piers are planned with mass concrete shafts and open arch columns, and two full-height reinforced concrete abutments.

5.3.2 Load and Resistance Factors

AASHTO LRFD load factors should be applied to horizontal earth pressure (EH), vertical earth pressure (EV), earth surcharge (ES), live load surcharge (LS) loads, and components and attachments (DC) loads using the load factors for permanent loads (γ_p) provided in LRFD Tables 3.4.1-2 for strength and extreme limit state foundation design. For service limit state, a load factor of 1.0 should be applied to these loads.

Recommended LRFD resistance factors for strength limit state design of the bedrock-bearing foundations were derived from LRFD Table 10.5.5.2.2-1 and are presented in the following table.

RESISTANCE FACTORS – STRENGTH I		
Foundation Resistance Type	**Method/Condition**	**Resistance Factor (ϕ_τ)**
Bearing	Footing on Rock	0.45
Sliding	Footing or Tremie Concrete on Rock[1]	0.8

Note: Sliding resistance factor for concrete on rock or concrete is taken as equal to that for a footing on sand.

Resistance factors for service and extreme limit state design should be taken as 1.0.

5.4 SPREAD FOOTINGS BEARING ON ROCK

Nominal and factored bearing resistances were calculated for footings bearing on rock using the RMR-based empirical correlation presented in “Foundations on Rock,” by Duncan Wyllie. RMR was evaluated in accordance with Table 10.4.6.4-1 of the 2012 AASHTO LRFD Bridge Design Specifications, 6th Edition (AASHTO). The current (8th Edition) of the AASHTO Design Specifications does not include the RMR formulation included in the previous version (6th Edition). However, Articles C10.4.6.4 and 10.6.2.6.2 of the 8th Edition refer to RMR-based design procedures for footings on rock, so the 6th Edition methodology was followed.

GZA used bedrock data obtained in test borings BB-BTAR-104 through -114 and BB-BTAR-201 and -202 to develop foundation design parameters at the piers and abutments. Two rock types were observed in the core logs, Gneiss and Pegmatite. The Pegmatite generally presents itself in the form of igneous intrusions into the Gneiss. Rock was encountered at the surface in borings located at Piers 1 through 3, at the surface at the base of Abutment 1, and beneath approximately 0 to 13 feet of overburden at Abutment 2.

Rock strength test results showed a range of intact rock strengths for the rock types tested. Compared to intact Gneiss, lower strength and lower RQD rock was found close to and in the Pegmatite intrusions. Therefore, we based our bearing resistance evaluation on the strength and quality of the Pegmatite and Pegmatite / Gneiss contact zones to assess a lower-bound value of the available bearing resistance. The bedrock properties used in the bearing resistance evaluation are presented below:

DESIGN BEDROCK PROPERTIES FOR BEARING RESISTANCE EVALUATION					
Rock Type	**RQD (percent)**	**Unconfined Compressive Strength (ksi)**	**Rock Mass Rating (RMR)**	**m**	**s**
Gneiss/Pegmatite	38 to 75	9.5	38	0.3	0.0000327
Gneiss	38 to 75	5.8	43	0.46	0.00009

GZA evaluated the bearing resistance for the Gneiss / Pegmatite and the Gneiss bedrock separately since one had higher strength and lower RMR, and the other had lower strength and higher RMR. The results were fairly consistent, so we have assigned a single recommended nominal bearing capacity for spread footing bearing on either rock mass. We recommend that footings be designed for a nominal bearing resistance of 64 ksf. With a resistance factor of 0.45, this provides a factored bearing resistance of 29 ksf for the strength loading condition.

It should be noted that this bearing resistance assumes the joint orientation beneath footings will not be unfavorable. Unfavorable bedrock structure exposed beneath footings will be improved by benching or doweling to achieve a condition consistent with the design basis, as evaluated and described in **Section 5.5.3**.

LRFD Article 10.6.2.4.4 indicates that the magnitude of elastic settlement should be evaluated for footings bearing on rock with an RMR-based rock quality of Poor. The joints observed in the rock cores were generally in good condition with minor discoloration and minimal clay or silt infilling. Based on our evaluation and considering the condition of the bedrock and the joints, we estimate settlement of 1/2 inch or less for footings bearing on bedrock with a service bearing pressure of 29 ksf or less. Our evaluations were based on the currently-proposed footing configurations. If significant changes are made in the shape, location or elevation of the proposed footings we should re-evaluate the potential settlement.

5.5 BEDROCK STABILITY RELATIVE TO PROPOSED FOUNDATIONS

We anticipate that footings supporting the abutments and the piers will be bearing on fully or partially exposed bedrock. Where footings will be constructed above exposed rock slopes, the orientation of discontinuities in the rock mass have the potential to negatively influence foundation stability. A review of the available topographic information indicates that exposed rock slopes are anticipated below footing levels at Pier 1, Pier 2 and Abutment 2.

5.5.1 Evaluation of Bedrock Structure

The structural data developed from field bedrock mapping and borehole televiewer were analyzed to identify the significant sets of discontinuities used in our characterization. The process involved converting the numerical dip and dip direction data from each discontinuity into the unique pole representing the plane of that discontinuity. The poles were then plotted on lower hemisphere pole plots, included in **Appendix G**. The density of poles was contoured and plotted to assess the central tendencies and orientations of the most frequent discontinuities. Based on our evaluation of these plots, the discontinuities were grouped into representative joint sets for stability evaluations.

5.5.2 Bedrock Structure

The characteristic joint properties are summarized in the tables below.

Characteristic Joint Set Properties				
Joint Set	**Dip (Degrees)**		**Dip Direction (Degrees)**	
	Range	**Central Tendency**	**Range**	**Central Tendency**
JF	33-55	43	102-158	129
JS1	1-25	5	24-358	365
JS2a	83-90, *85-90	88	209-248, *22-56	227
JS2b	85-90	89	170-173	172

Notes: * The second range indicates members of the joint set that cross the vertical plane

The bedrock structure was generally observed to be consistent throughout the site based on the mapping and borehole geophysical data. The typical observed bedrock structure is described as follows.

- JF – A moderately dipping set representing the foliation joints of the formation, generally dipping downward to the southeast, nearly parallel to the water flow (upstream-downstream). The surfaces exposed to water were generally smooth and slightly weathered. The spacing ranged from approximately 4 inches to up to 3 feet, and these joints typically daylighted on the upstream side, and occasionally on the downhill side of outcrops where the exposed slope was steeper than the dip angle. This set defines the primary regional rock structure of the site. Where visible, the outcrops display a strong tendency to break along this joint set.

- JS1 – A horizontal to low angle joint set with a varying dip direction. This set was predominantly observed at depth in the geophysical surveys and rock cores.
- JS2a and JS2b – Near-vertical secondary sets cut through JF in a variety of orientations, typically rotated 30 (JS2b) to 120 degrees (JS2a) from JF. This set typically defines the width of slabs (from river left to river right) that may form along JS1. The spacing of JS2 joints was generally on the order of 3 to 12 feet. Most of the discontinuities in this set were observed to be continuous, through-cutting joints, but contacts between the Gneiss and Pegmatite intrusions were also observed to have this general orientation.

5.5.3 Kinematic Stability

The overall stability of a foundation-supporting rock mass is governed by: (1) the orientation of the rock discontinuities (joints) with respect to each other and near vertical exposures; (2) the continuity of the joints; (3) the slope angle of exposed faces beneath the footing level; and (4) the shear resistance along the joints. Rock slope stability analyses focus on three primary modes of potential instability: (1) two-dimensional plane instability; (2) three-dimensional wedge instability; and (3) toppling instability. Possible instability is analyzed by selecting representative joint sets and analyzing how the joints may daylight in the slopes below the proposed foundations.

We used the topography and footing limits shown on the MaineDOT Boring Location Plan, **Figures 2** through **4,** to evaluate the top of rock profile near each proposed pier location and identify steeply dipping bedrock exposures that are below proposed foundation levels. The general orientation of the foliation joints make them susceptible to planar sliding where they daylight in the downstream face of an exposure. Exposures where the slope or daylighting joints have the potential to impact the proposed pier foundations were observed at Pier 1, Pier 2, and Abutment 2, as described in the following section. Although not judged to be unfavorable, the conditions at Abutment 1 and Pier 3 are included for completeness.

5.5.3.1 Pier 1

A moderately to steeply dipping exposure that dips down to the south was evident on the south side of the proposed Pier 1 location, downstream of boring BB-BTAR-106. The exposure is approximately 60 feet long and 7 feet high. If the footing were founded above the exposed slope, both planes and wedges have the potential to form beneath the footing and daylight in this exposure. Photo 14 of **Appendix D** shows daylighting planes at the base of the exposure, typical of the foliation joints observed near Pier 1. Since the majority of the Pier footprint appears to be located at the base of the exposure, it would be possible to prevent kinematic instability by either excavating a small portion of the footing to the lower level or stepping the bottom of footing elevation to accommodate existing rock contours.

5.5.3.2 Pier 2

Steeply dipping exposures were observed on the east and south sides of the proposed Pier 2 location, directly downstream of boring BB-BTAR-108. The exposures are approximately 9 feet high, and 40 and 15 feet long, respectively. Since both planes and wedges have the potential to form beneath the footing and daylight in these exposures, additional consideration should be given to stabilization of exposures beneath the footing. Photos 8 and 9 of **Appendix D** show typical foliation joints daylighting at the base of the exposure. At this location, most of the pier appears to be at the higher level so lowering the entire pier footing to the lower level would require extensive hoe ramming and/or blasting in the river, which would be impractical and costly. Consequently, it should be assumed that the south and east ends of the pier footing subgrade will require benching or doweling to provide a stable bedrock subgrade, and that most of the footing would be constructed at the higher level.

5.5.3.3 Pier 3

The bedrock surface at Pier 3 has a fairly consistent slope dipping at approximately 2.5H:1V toward the northwest. Since the slope exceeds 4H:1V, stepping or doweling will be required to provide sufficient sliding resistance at this location.

5.5.3.4 Abutment 1

The dip direction of the foliation joints was observed to be nearly perpendicular to the alignment at the base of Abutment 1. Several near vertical joints were observed to cut nearly perpendicular to the foliation, which is consistent with the structures observed across the site. Due to this orientation instability issues are not anticipated at this location. Pegmatite was not observed to be exposed on the bedrock surface exposed beneath Abutment 1.

5.5.3.5 Abutment 2

A steeply dipping to near vertical exposure was observed on the west side of the proposed Abutment 2. The exposure is approximately 40 feet long and 6 feet high. Given its orientation, neither planes nor wedges are anticipated to form beneath the footing and daylight in this exposure. Based on the preliminary drawings we anticipate that steps will be required in the foundation bearing levels here due to variations in bedrock elevation.

5.6 RETAINING STRUCTURE EVALUATIONS

Proposed retaining structures include the abutments, and the return walls that support the approach fills for each abutment. At Abutment 1, approximately 45-degree upstream and 85-degree downstream wing walls are proposed to extend from the abutment back to meet the existing slope. Plans at Abutment 2 include a pocket park and walking path with 90-degree return walls to retain the approach roadway fills on both sides.

The bridge is located directly downstream from a run-of-the-river dam in a river known for variable flow volumes and rates. Therefore, all new substructures need to take into consideration the possibility of scour. We anticipate that the piers and both abutments will be founded directly on intact bedrock, which is not considered erodible based on the nature of the Gneiss and Pegmatite bedrock at the site.

Section 2.3.11.1 of the MaineDOT BDG requires that new bridges be designed to resist scour for the 100-year design event (Q100). Ground conditions at the proposed Abutment 2 northwest return wall range from exposed bedrock at the abutment, to 10 to 12 feet of fill (potentially erodible) at the north end. The Q100 is reported to be El. 27, and the existing ground surface elevation along the wall ranges from about El. 17 to El. 33. Based on conversations with Laura Krusinski, P.E. of MaineDOT, we understand that MaineDOT prefers not to use retaining walls with reinforced soil backfill below the Q100 level to support bridge approaches. Therefore, we anticipate the use of either gravity cantilever-type, cast-in-place, concrete walls or prefabricated modular gravity (PCMG) walls for retaining wall locations where the wall foundations will bear on bedrock or soil below El.27. At locations where the foundation will bear on soil above El. 27, additional options for wall types will include geosynthetic-reinforced soil (GRS) walls, or MSE walls with steel reinforcement. To simplify design and construction, a single wall type should be considered for the entire length.

At Abutment 1, the abutment and wing walls are anticipated to be supported directly on bedrock. Since the bedrock is not considered susceptible to scour, no special scour protection measures are anticipated. Typical riprap scour protection is expected to be placed in front of the completed structures.

We anticipate that cast-in-place gravity or cantilever type walls, or PCMG walls are the preferred wall types to retain soils supporting the approaches. Per MaineDOT BDG Section 3.6.5.1, Coulomb Theory should be used to evaluate the active earth pressure coefficient for these types of structures. Preliminary lateral earth pressure recommendations are provided in **Section 6.5** of this report.

Currently the abutments, wing walls and retaining walls along the approach roadway are anticipated to consist of cast in place concrete. If soil-supported walls are selected to support portions of the approaches, we recommend the bearing capacity and global stability of those walls be evaluated.

5.7 FROST PENETRATION

Fill soils are anticipated to be present at the abutments, as imported backfill. Based on the MaineDOT BDG, Section 5.2.1, the Freezing Index for the site is approximately 1,300, and with low to moderate moisture content (±15 percent) soils, the estimated depth of frost penetration is 6 feet. Where pier and abutment foundations bear directly on sound bedrock, there is no minimum requirement for footing embedment.

6.0 RECOMMENDATIONS

6.1 EMBANKMENT DESIGN CONSIDERATIONS

A majority of the approach side slopes are expected to use retaining walls for support. Riprap scour protection is anticipated to be utilized in conjunction with the retaining walls at Abutment 1. A maximum slope inclination of 1.75H:1V may be used for riprap-protected slopes. Riprap should be a minimum of 3 feet thick for plain riprap and 4 feet thick for heavy riprap and should be underlain by a minimum 12-inch-thick protective aggregate cushion and non-woven Erosion Control Geotextile in accordance with MaineDOT Standard Details 610(02) and/or 610(03).

Portions of the retaining structures at Abutment 2 may consist of MSE or GRS walls. However, these wall types are only acceptable at locations where the foundations will bear at or above the Q100 flood level, El. 27. Where foundations will bear below El. 27, acceptable foundations types are limited to gravity cantilever-type, cast-in-place, concrete walls or PCMG walls.

6.2 SEISMIC DESIGN

The United States Geological Survey online Design Maps Tool was used to develop parameters for bridge design. Based on the site coordinates, the software provided the recommended AASHTO Response Spectra (Site Class B) for a 7-percent probability of exceedance in 75 years. These results are summarized for the site as follows:

SITE CLASS B SEISMIC DESIGN PARAMETERS	
Parameter	**Design Value**
Fpga	1.0
Fa	1.0
Fv	1.0
As (Period = 0.0 sec)	0.079 g
SDs (Period = 0.2 sec)	0.162 g
SD1 (Period = 1.0 sec)	0.044 g

Per AASHTO Article 3.10.6, the site is assigned to Seismic Zone 1 based on a calculated SD1 of 0.044 g. Per AASHTO Article 4.7.4, bridges in Seismic Zone 1 need not be analyzed for seismic loads, but the minimum requirements specified in AASHTO Articles 4.7.4.4 and 3.10.9 apply.

6.3 SPREAD FOOTING DESIGN

Piers 1 through 3 and Abutments 1 and 2 may be supported on spread footing foundations bearing on sound, intact bedrock free of all loose soil and rock material. Footings designed to bear on intact bedrock should be designed for a nominal bearing resistance, q_n, of 64 ksf. At the strength limit state, footings should be designed for a maximum factored bearing resistance of 29 ksf. A bearing resistance of 29 ksf should be used for service limit state design.

Spread footings founded on bedrock should be checked for eccentricity based on LRFD Section 10.6.3.3. Eccentricity of the footing reaction at the strength limit state should be limited such that the resultant reaction on the base of the footing is no further than 0.45 B from the centerline of the footing, where B is the principal dimension of the footing perpendicular to the axis of rotation.

For foundations bearing on bedrock, we recommend that sliding resistance be assessed using a nominal sliding resistance coefficient (tan δ) equal to 0.7 for cast-in-place concrete on sound rock. Therefore, the nominal sliding resistance between footings and bedrock subgrades is equal to the vertical force multiplied by 0.7. The factored sliding resistance coefficient is 0.56 for the Strength Limit State, based on a geotechnical resistance factor of 0.8 as previously described.

Anchoring, doweling, benching or other means of improving sliding resistance are recommended at locations where the prepared bedrock surface is steeper than 4H:1V in any direction.

We recommend that T.Y. Lin International create multiple top of rock sections and profiles at the pier and abutment locations to assess the bedrock topography beneath footing locations. The profiles will be the basis for refining the design bottom of footing elevations. Final design should also consider benching and doweling as needed to maintain bedrock stability and sliding resistance of the footings.

6.4 ABUTMENT AND WINGWALL DESIGN

Backfill behind new abutments should consist of Maine DOT 703.19 Granular Borrow for Underwater Backfill, BDG Type 4 soil. Recommended soil properties for Type 4 soils and walls free to move at the top are as follows:

- Internal Friction Angle of Soil = 32°
- Soil Total Unit Weight = 125 pcf
- Coefficient of Active Earth Pressure, K_a = 0.28

Live load surcharge should be applied as a uniform lateral surcharge pressure using the equivalent fill height (H_{eq}) values developed in accordance with AASHTO Article 3.11.6.4 based on the abutment/wingwall height and distance from the wall backface to the edge of traffic. A minimum H_{eq} of 2 feet is recommended.

Foundation drainage should be provided in accordance with Section 5.4.1.9 of the BDG. We recommend the use of French drains on the uphill side of abutments and wing walls to prevent buildup of differential hydrostatic pressure. Foundation drains should be sloped to drain by gravity and should daylight through weep holes in the abutments and cast-in-place retaining walls.

7.0 CONSTRUCTION CONSIDERATIONS

This section describes geotechnical-related issues that have the potential to impact design and cost considerations for bridge construction.

7.1 SUPPORT OF EXCAVATION

Excavations for abutment and approach foundations will extend as deep as approximately 30 feet below existing roadway grade at Abutment 1, and up to approximately 13 feet below existing grade at Abutment 2. Sloped, open cut excavations are technically feasible given the soil types at the abutments. It is anticipated that the existing abutment and return walls could serve as temporary excavation support where needed at Abutment 1. This is also possible to some extent at Abutment 2. However, if Route 201 is to remain in service during construction, temporary excavation support (e.g., sheet piling) is expected to be necessary in some areas near Abutment 2.

Depending upon final configurations, excavations at the piers and Abutment 1 may require three- or four-sided, internally-braced, sheet pile cofferdams to complete excavation and subgrade preparation. Depending on the encountered depth to bedrock and anticipated river levels it may be necessary to install a concrete tremie seal to allow foundation construction to be completed in the dry. The new abutments tie-in near the existing abutments and it may be feasible to utilize portions of the existing abutments to reduce the sheet pile support requirements.

The contractor should be responsible for design of all temporary cofferdam structures. Design should be completed by a professional engineer registered in the State of Maine. If existing foundations will be relied on for support, shop drawings and design calculations should show the suitability of the foundations to serve the intended use.

Dewatering considerations will be related to the river level at the time of construction. If river levels are several feet above bedrock elevations, we anticipate that dewatering will be impractical, and the foundations will be constructed on tremie seals placed in the wet, potentially at Abutment 1 and Piers 1 and 3. It may be feasible to dewater excavations by pumping from sumps in low water conditions. The contractor should be responsible for controlling groundwater, surface runoff, infiltration and water from all other sources by methods which preserve the undisturbed condition of the subgrade and permit foundation construction in-the-dry. Discharge of pumped groundwater should comply with all local, State, and federal regulations.

7.2 SUBGRADE PREPARATION

As discussed previously, the river is known to have variable flow volumes and rates. We anticipate that the bedrock bearing surface preparation can be conducted in the dry at some locations, and that the bedrock surface will be variable in terms of elevation, slope and localized weathering. A combination of standard excavation equipment and/or hydraulic hoe-ramming equipment will be needed to remove the overburden and fractured/weathered rock. Blasting should not be allowed to excavate bedrock at proposed footing locations. All soil and loose, decomposed, highly weathered, and fractured bedrock should be removed from the footing bearing surface prior to placement of sub-footings or footings. The prepared bearing surfaces should be checked by the geotechnical engineer prior to concrete placement, and provisions should be made to account for variable water levels during construction. A Special Provision should be prepared to define the project-specific requirements for subgrade preparation and quality assurance/quality control.

The Geotechnical Engineer and Designer should be provided cross-sections showing the prepared rock surface geometry prior to placement of concrete to evaluate whether benching, doweling, or subfooting reinforcement are needed for that foundation location. If the exposed bedrock surface is steeper than 4 horizontal to 1 vertical (4H:1V), then anchoring, doweling, benching or other means should be employed to improving sliding resistance.

7.3 REUSE OF ON-SITE MATERIALS

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

8.0 FINAL DESIGN CONSIDERATIONS

We recommend that GZA be involved in final design development for the following elements:

- Developing Special Provisions for retaining wall types other than CIP Concrete;
- Developing design details for benching, and/or dowel designs as needed at individual footing locations.

TABLES

Date: 2/9/18
By: E. Friede

Table 1 - Summary of Bedrock Feature Measurements
Frank J. Wood Bridge

Job No:
09.0025917.01

Point	Photo No	Nearest Boring	Nearest Proposed Pier/Abut	Joint Set	Dicsontinuity Type	Dip	Corrected Dip Direction	Typical Spacing (ft)	Micro Roughness	Macro Roughness	Aperture	Infilling	Measurement Type	Notes
1	1	BTAR-110	3	JS2a	Joint	88	209	3 to 12	Sm	St	O		Mapping	
2	1	BTAR-110	3	JS2a	Joint	85	217	3 to 12	Sm	St	O		Mapping	
3	1	BTAR-110	3	JS2a	Joint	88	214	3 to 12	Sm	P	VW		Mapping	
4	2	BTAR-110	3	JF	Foliation	45	139	0.4 to 3	Sm	St	O		Mapping	
5	4	BTAR-110	3	JF	Foliation	42	144	1 to 5	Sm	P	EW		Mapping	
6	2	BTAR-110	3		Joint	71	6	3 to 8	Sm	P	O		Mapping	
7	5	BTAR-110	3		Contact	90	259	Not Observed	Sm	U	MW to EW		Mapping	
8	6	BTAR-108	3	JS2a	Contact	90	243	Not Observed	R	U	VT		Mapping	
9	7	BTAR-108/109	2	JF	Foliation	45	104	0.1 to 2	R	P	T to VW		Mapping	
10	7	BTAR-108/109	2	1	Joint	25	272	1 to 5	Sm	P	T to W		Mapping	
11	11	BTAR-109	2	JF	Foliation	46	136	0.5 to 2	Sm	P	T to W		Mapping	
12	12	BTAR-109	2	JS2a	Joint	88	22		Sm	St	T		Mapping	
13	14	BTAR-106/107	1		Contact	90	99	Not Observed	R	U			Mapping	
14	16	BTAR-107	1	JF	Foliation	35	104	<0.1 to 0.4	Sm	P	T to VW		Mapping	
15	---	---	---	JF	Foliation	43	115	---	---	---	---		Mapping	
16	---	---	---	JF	Foliation	39	111	---	---	---	---		Mapping	
17	---	---	---	JF	Foliation	37	119	---	---	---	---		Mapping	
18	---	---	---	JF	Foliation	40	110	---	---	---	---		Mapping	
19	---	---	---	JF	Foliation	43	117	---	---	---	---		Mapping	
20	---	---	---	JF	Foliation	37	116	---	---	---	---		Mapping	
21	---	---	---	JF	Joint	48	158	---	---	---	---		Mapping	
22	---	---	---	JS2b	Contact	90	172	---	---	---	---		Mapping	
23	---	---	---	JS2b	Contact	90	170	---	---	---	---		Mapping	
24	---	---	---	JS2a		87	218	---	---	---	---		Mapping	
25	---	---	---	JS2a	Joint	89	248	---	---	---	---		Mapping	
26	---	---	---	JS2a	Joint	85	56	---	---	---	---		Mapping	
27	---	---	---	JS2b	Joint	87	173	---	---	---	---		Mapping	
28	---	---	---	JS2a	Joint	90	51	---	---	---	---		Mapping	
29	19	BTAR-202	AB1	JF	Foliation	43	120	0.1 to 0.3	R	P	T to O		Mapping	
30	19	BTAR-202	AB1	JS2a	Joint	85	224	8	Sm	P	MW		Mapping	

Photo No. references outcrop photograph in Appendix B.	**Joint set:** Joint set grouping for kinematic analysis.	**Micro:** R = Rough Sm = Smooth SL = Slicken	**Macro:** St = Stepped U = Undulating P = Planar	**Aperture/Width:** VT = Very Tight (<0.004") T = Tight (0.004-0.01") PO = Partially Open (0.01-0.02") O = Open(0.02-.1")	MW = Moderately Wide (0.1-0.4") W = Wide (>0.4") VW = Very Wide (0.4-4.0") EW = Extremely Wide (7.0-40.0" C = Cavernous (>40")	**Declination:** -15.6 degrees (-) value indicates degrees west of north, (+) indicates east of north

Notes:

1. Mapping measurements were taken by GZA on August 27, 2016 and December 6, 2018.
2. Geophysical measurements were selected from geophysical survey data collected by Northeast Geophysical, Inc. on September 7, 2016.
3. Refer to Figure 2 through 4 for boring locations.
4. Dip direction shown is corrected for magnetic declination.
5. Where ranges shown for spacing, measurements indicate variations between multiple adjacent joints of similar orientation.

Date: 2/9/18
By: E. Friede

Table 1 - Summary of Bedrock Feature Measurements
Frank J. Wood Bridge

Job No:
09.0025917.01

Point	Picture No	Nearest Boring	Nearest Proposed Pier	Joint Set	Dicsontinuity Type	Dip	Corrected Dip Direction	Typical Spacing (ft)	Micro Roughness	Macro Roughness	Aperture	Infilling	Measurement Type	Notes
31	19,20	BTAR-202	AB1	JF	Foliation	41	135	0.1 to 0.3	Sm	P	T		Mapping	
32	19	BTAR-202	AB1	JF	Foliation	45	124	0.5	Sm	P	T		Mapping	
33	19	BTAR-202	AB1	JS2a	Joint	83	221	2	R	P	T		Mapping	
34	---	BTAR-202	AB1	JF	Foliation	41	132	0.1 to 0.8	Sm	P	T		Mapping	
35	---	BB-BTAR-110		JF	Foliation	45	144	---	---	---	---		Geophys	
36	---	BB-BTAR-110	3	JF	Foliation	45	146	---	---	---	---		Geophys	
37	---	BB-BTAR-110	3	JF	Foliation	44	144	---	---	---	---		Geophys	
38	---	BB-BTAR-110	3	JF	Foliation	45	148	---	---	---	---		Geophys	
39	---	BB-BTAR-110	3	JF	Foliation	47	142	---	---	---	---		Geophys	
40	---	BB-BTAR-110	3	JF	Foliation	47	148	---	---	---	---		Geophys	
41	---	BB-BTAR-110	3	JF	Foliation	46	148	---	---	---	---		Geophys	
42	---	BB-BTAR-110	3	JF	Foliation	44	142	---	---	---	---		Geophys	
43	---	BB-BTAR-110	3	JF	Foliation	46	139	---	---	---	---		Geophys	
44	---	BB-BTAR-110	3	JS1		1	159	---	---	---	---		Geophys	
45	---	BB-BTAR-110	3	JF	Foliation	44	146	---	---	---	---		Geophys	
46	---	BB-BTAR-110	3	JS1		6	236	---	---	---	---		Geophys	
47	---	BB-BTAR-110	3	JS1		1	159	---	---	---	---		Geophys	
48	---	BB-BTAR-110	3	JF	Foliation	36	151	---	---	---	---		Geophys	
49	---	BB-BTAR-110	3	JF	Foliation	43	153	---	---	---	---		Geophys	
50	---	BB-BTAR-109	2	JS1		9	254	---	---	---	---		Geophys	
51	---	BB-BTAR-109	2	JS1		15	249	---	---	---	---		Geophys	
52	---	BB-BTAR-109	2			29	277	---	---	---	---		Geophys	
53	---	BB-BTAR-109	2	JF	Foliation	39	116	---	---	---	---		Geophys	
54	---	BB-BTAR-109	2	JF	Foliation	49	116	---	---	---	---		Geophys	
55	---	BB-BTAR-109	2	JF	Foliation	38	126	---	---	---	---		Geophys	
56	---	BB-BTAR-109	2	JS1		6	95	---	---	---	---		Geophys	
57	---	BB-BTAR-109	2	JS1		22	109	---	---	---	---		Geophys	
58	---	BB-BTAR-109	2	JF	Foliation	44	119	---	---	---	---		Geophys	
59	---	BB-BTAR-109	2	JS1		1	192	---	---	---	---		Geophys	
60	---	BB-BTAR-109	2	JS1		9	298	---	---	---	---		Geophys	

Photo No. references outcrop photograph in Appendix B.

Joint set: Joint set grouping for kinematic analysis.

Micro:
R = Rough
Sm = Smooth
SL = Slicken

Macro:
St = Stepped
U = Undulating
P = Planar

Aperture/Width:
VT = Very Tight (<0.004")
T = Tight (0.004-0.01")
PO = Partially Open (0.01-0.02")
O = Open(0.02-.1")
MW = Moderately Wide (0.1-0.4")
W = Wide (>0.4")
VW = Very Wide (0.4-4.0")
EW = Extremely Wide (7.0-40.0"
C = Cavernous (>40")

Declination:
-15.6 degrees
(-) value indicates degrees west of north, (+) indicates east of north

Notes:

1. Mapping measurements were taken by GZA on August 27, 2016 and December 6, 2018.
2. Geophysical measurements were selected from geophysical survey data collected by Northeast Geophysical, Inc. on September 7, 2016.
3. Refer to Figure 2 through 4 for boring locations.
4. Dip direction shown is corrected for magnetic declination.
5. Where ranges shown for spacing, measurements indicate variations between multiple adjacent joints of similar orientation.

Point	Picture No	Nearest Boring	Nearest Proposed Pier	Joint Set	Dicsontinuity Type	Dip	Corrected Dip Direction	Typical Spacing (ft)	Micro Roughness	Macro Roughness	Aperture	Infilling	Measurement Type	Notes
61	---	BB-BTAR-109	2	JS1		13	248	---	---	---	---		Geophys	
62	---	BB-BTAR-109	2	JS1		17	57	---	---	---	---		Geophys	
63	---	BB-BTAR-109	2			49	15	---	---	---	---		Geophys	
64	---	BB-BTAR-109	2	JF	Foliation	52	115	---	---	---	---		Geophys	
65	---	BB-BTAR-109	2	JF	Foliation	51	120	---	---	---	---		Geophys	
66	---	BB-BTAR-109	2	JF	Foliation	55	118	---	---	---	---		Geophys	
67	---	BB-BTAR-109	2	JS1		4	292	---	---	---	---		Geophys	
68	---	BB-BTAR-109	2	JS1		14	248	---	---	---	---		Geophys	
69	---	BB-BTAR-109	2	JS1		3	241	---	---	---	---		Geophys	
70	---	BB-BTAR-109	2	JS1		17	265	---	---	---	---		Geophys	
71	---	BB-BTAR-109	2	JS1		25	269	---	---	---	---		Geophys	
72	---	BB-BTAR-109	2	JS1		10	358	---	---	---	---		Geophys	
73	---	BB-BTAR-109	2	JS1		24	344	---	---	---	---		Geophys	
74	---	BB-BTAR-109	2	JF	Foliation	48	117	---	---	---	---		Geophys	
75	---	BB-BTAR-108	2	JS1		17	144	---	---	---	---		Geophys	
76	---	BB-BTAR-108	2	JS1		3	24	---	---	---	---		Geophys	
77	---	BB-BTAR-108	2	JF	Foliation	33	102	---	---	---	---		Geophys	
78	---	BB-BTAR-108	2	JS1		8	157	---	---	---	---		Geophys	
79	---	BB-BTAR-108	2			28	179	---	---	---	---		Geophys	
80	---	BB-BTAR-108	2	JF	Foliation	52	118	---	---	---	---		Geophys	
81	---	BB-BTAR-108	2	JS1		6	47	---	---	---	---		Geophys	
82	---	BB-BTAR-108	2	JS1		13	32	---	---	---	---		Geophys	
83	---	BB-BTAR-108	2	JS1		13	253	---	---	---	---		Geophys	
84	---	BB-BTAR-108	2	JS1		25	258	---	---	---	---		Geophys	
85	---	BB-BTAR-108	2			34	248	---	---	---	---		Geophys	
86	---	BB-BTAR-108	2	JS1		13	320	---	---	---	---		Geophys	
87														
88														
89														
90														

Photo No. references outcrop photograph in Appendix B. Individual	**Joint set:** Joint set grouping for kinematic analysis.	**Micro:** R = Rough Sm = Smooth SL = Slicken	**Macro:** ST = Stepped U = Undulating P = Planar	**Aperture/Width:** VT = Very Tight (<0.004") T = Tight (0.004-0.01") PO = Partially Open (0.01-0.02") O = Open(0.02-.1")	MW = Moderately Wide (0.1-0.4") W = Wide (>0.4") VW = Very Wide (0.4-4.0") EW = Extremely Wide (7.0-40.0" C = Cavernous (>40")

Declination:
-15.6 degrees
(-) value indicates degrees west of north, (+) indicates east of north

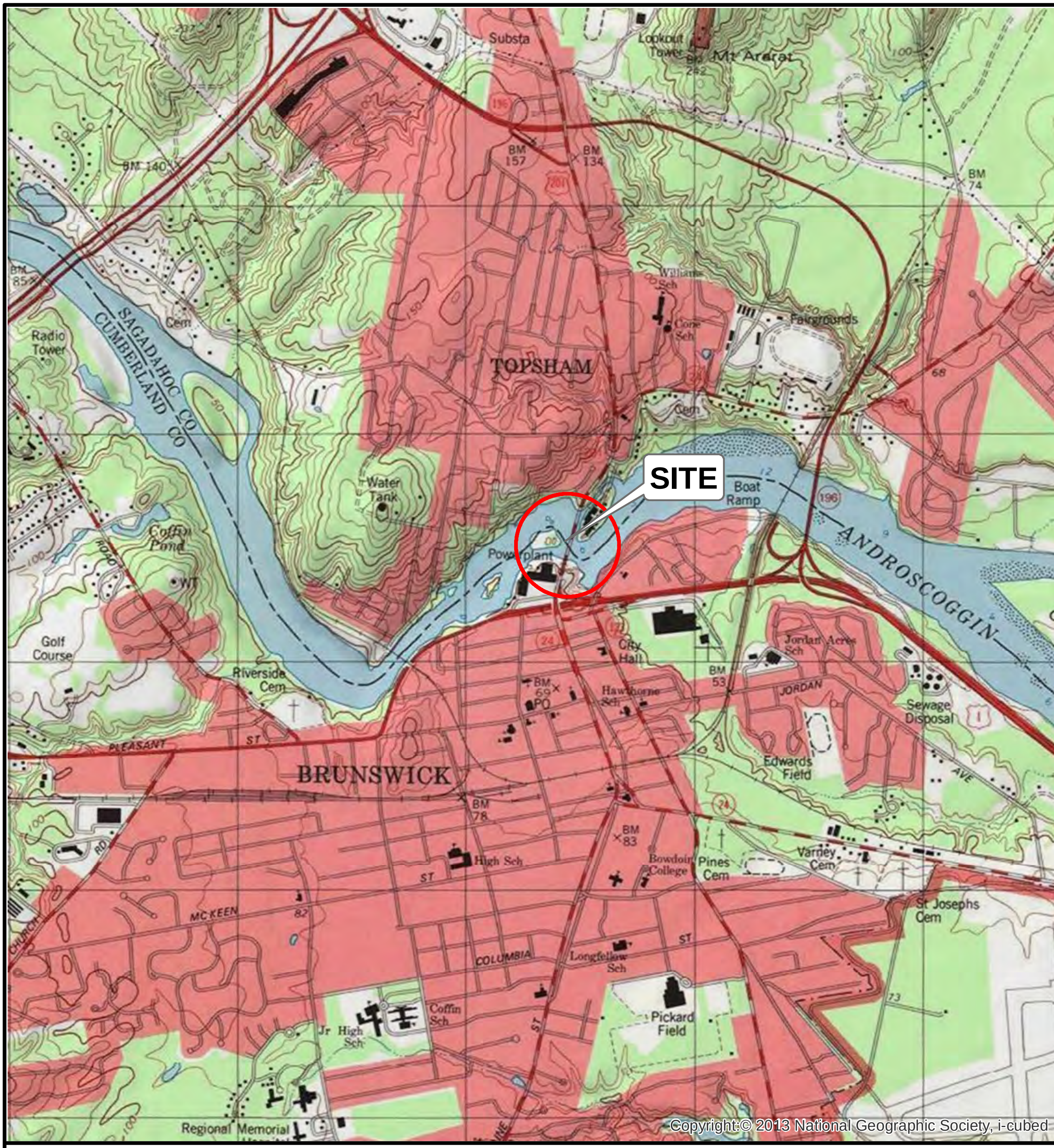
Notes:

1. Mapping measurements were taken by GZA on August 27, 2016 and December 6, 2018.
2. Geophysical measurements were selected from geophysical survey data collected by Northeast Geophysical, Inc. on September 7, 2016.
3. Refer to Figure 2 through 4 for boring locations.
4. Dip direction shown is corrected for magnetic declination.
5. Where ranges shown for spacing, measurements indicate variations between multiple adjacent joints of similar orientation.

Table 2 - Summary of Rock Core Data
Frank J. Wood Bridge #2016
Brunswick-Topsham, ME

Boring	Proposed Pier	Run	GS Elevation	Depth of Core Run below GS (ft)			Depth to Rock (ft)	Depth (ft) Below Top of Rock			Top of Rock Elevation (Ft)	Length of Core Run (ft)	Rec (in)	Rec (%)	RQD (in)	RQD %	Joint Spacing Desc.	Corr. Spacing (in)	Aperture Desc.	Corr. Aperture (in)	Rock Type
				Top		Bottom		Top		Bottom											
BB-BTAR-104		R1	-0.8	0.0	-	5.0	0.0	0.0	-	5.0	-0.8	5.0	60	100%	57	95%	Moderately Spaced	8 to 24	Tight	0.004 to 0.01	GNEISS
BB-BTAR-104	---	R2	-0.8	5.0	-	10.0	0.0	5.0	-	10.0	-0.8	5.0	60	100%	57	95%	Moderately Spaced	8 to 24	Tight	0.004 to 0.01	GNEISS
BB-BTAR-104		R3	-0.8	10.0	-	15.0	0.0	10.0	-	15.0	-0.8	5.0	54	90%	28	47%	Close	2.5 to 8	Tight	0.004 to 0.01	GNEISS
BB-BTAR-105		R1	0.1	0.0	-	2.4	0.0	0.0	-	2.4	0.1	2.4	24	83%	8	28%	Close	2.5 to 8	Open	0.02 to 0.1	PEGMATITE/GNEISS
BB-BTAR-105	---	R2	0.1	2.4	-	5.1	0.0	2.4	-	5.1	0.1	2.7	29	90%	5	16%	Very Close to Close	0.75 to 8	Tight to Open	0.004 to 0.1	GNEISS/PEGMATITE
BB-BTAR-105		R3	0.1	5.1	-	9.1	0.0	5.1	-	9.1	0.1	4.0	48	100%	23	48%	Very Close to Close	0.75 to 8	Paritally Open to Open	0.01 to 0.1	PEGMATITE
BB-BTAR-105		R4	0.1	9.1	-	14.1	0.0	9.1	-	14.1	0.1	5.0	54	90%	54	90%	Close to Moderate	2.5 to 24	Partially Open	0.01 to 0.02	PEGMATITE/GNEISS
BB-BTAR-106		R1	1.2	0.0	-	4.5	0.0	0.0	-	4.5	1.2	4.5	51	94%	37	70%	Close to Moderate	2.5 to 24	Partially Open to Moderate	0.01 to 0.4	GNEISS
BB-BTAR-106	Pier 1	R2	1.2	4.5	-	9.5	0.0	4.5	-	9.5	1.2	5.0	58	97%	35	58%	Very Close to Moderate	0.75 to 24	Open	0.02 to 0.1	GNEISS
BB-BTAR-106		R3	1.2	9.5	-	14.0	0.0	9.5	-	14.0	1.2	4.5	50	93%	25	46%	Close	2.5 to 8	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-107		R1	5.8	0.0	-	4.1	0.0	0.0	-	4.1	5.8	4.1	49	100%	20	41%	Close to Moderate	2.5 to 24	Moderately Wide	0.1 to 0.4	PEGMATITE/GNEISS
BB-BTAR-107	Pier 1	R2	5.8	4.1	-	9.1	0.0	4.1	-	9.1	5.8	5.0	54	90%	36	60%	Very Close to Moderate	0.75 to 24	Partially Open to Moderate	0.01 to 0.4	GNEISS/PEGMATITE
BB-BTAR-107		R3	5.8	9.1	-	14.1	0.0	9.1	-	14.1	5.8	5.0	55	92%	45	75%	Close to Moderate	2.5 to 24	Open to Wide	0.02 to >0.4	PEGMATITE
BB-BTAR-108		R1	11.3	0.0	-	4.6	0.0	0.0		4.6	11.3	4.6	55	100%	41	75%	Close to Moderate	2.5 to 24	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-108		R2	11.3	4.6	-	9.6	0.0	4.6		9.6	11.3	5.0	58	97%	47	78%	Very Close to Moderate	0.75 to 24	Tight to Partially Open	0.004 to 0.02	GNEISS/PEGMATITE
BB-BTAR-108	Pier 2	R3	11.3	9.6	-	14.6	0.0	9.6		14.6	11.3	5.0	60	100%	60	100%	Close to Wide	2.5 to 80	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-108		R4	11.3	14.6	-	19.6	0.0	14.6		19.6	11.3	5.0	58	96%	55	92%	Close to Wide	2.5 to 80	Tight to Partially Open	0.004 to 0.02	GNEISS
BB-BTAR-108		R5	11.3	19.6	-	24.6	0.0	19.6		24.6	11.3	5.0	60	100%	60	100%	Close to Moderate	2.5 to 24	Open to Moderately Wide	0.02 to 0.4	GNEISS
BB-BTAR-109		R1	12.6	0.0	-	2.8	0.0	0.0	-	2.8	12.6	2.8	34	101%	15	44%	Close	2.5 to 8	Partially Open to Moderate	0.01 to 0.4	GNEISS
BB-BTAR-109		R2	12.6	2.8	-	7.8	0.0	2.8	-	7.8	12.6	5.0	60	99%	42	70%	Very Close to Moderate	0.75 to 24	Open to Moderately Wide	0.02 to 0.4	GNEISS/PEGMATITE
BB-BTAR-109	Pier 2	R3	12.6	7.8	-	10.8	0.0	7.8	-	10.8	12.6	3.0	36	100%	27	75%	Close to Moderate	2.5 to 24	Open to Moderately Wide	0.02 to 0.4	PEGMATITE/GNEISS
BB-BTAR-109		R4	12.6	10.8	-	15.8	0.0	10.8	-	15.8	12.6	5.0	60	100%	59	98%	Very Close to Wide	0.75 to 80	Open	0.02 to 0.1	GNEISS
BB-BTAR-109		R5	12.6	15.8	-	20.8	0.0	15.8	-	20.8	12.6	5.0	57	95%	57	95%	Wide	24 to 80	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-109		R6	12.6	20.8	-	25.8	0.0	20.8	-	25.8	12.6	5.0	57	95%	57	95%	Moderately Spaced	8 to 24	Open to Moderately Wide	0.02 to 0.4	GNEISS
BB-BTAR-110		R1	10.9	0.0	-	4.5	0.0	0.0	-	4.5	10.9	4.5	52	96%	41	75%	Close to Moderate	2.5 to 24	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-110		R2	10.9	4.5	-	9.5	0.0	4.5	-	9.5	10.9	5.0	60	100%	60	100%	Moderately Spaced	8 to 24	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-110	Pier 3	R3	10.9	9.5	-	14.5	0.0	9.5	-	14.5	10.9	5.0	60	100%	56	93%	Moderately Spaced	8 to 24	Tight to Partially Open	0.004 to 0.02	GNEISS
BB-BTAR-110		R4	10.9	14.5	-	19.5	0.0	14.5	-	19.5	10.9	5.0	60	100%	56	93%	Very Close to Moderate	0.75 to 24	Tight to Open	0.004 to 0.1	GNEISS
BB-BTAR-110		R5	10.9	19.5	-	20.3	0.0	19.5	-	20.3	10.9	0.8	9	94%	0	0%	Close	2.5 to 8	Open	0.02 to 0.1	GNEISS/QUARTZ
BB-BTAR-110		R6	10.9	20.3	-	24.6	0.0	20.3	-	24.6	10.9	4.3	48	93%	43	84%	Very Close to Moderate	0.75 to 24	Partially Open	0.01 to 0.02	GNEISS
BB-BTAR-111		R1	24.7	0.0	-	5.0	0.0	0.0	-	5.0	24.7	5.0	60	100%	24	40%	Close	2.5 to 8	Tight to Partially Open	0.004 to 0.02	PEGMATITE
BB-BTAR-111	Abutment 2	R2	24.7	5.0	-	10.0	0.0	5.0	-	10.0	24.7	5.0	60	100%	50	83%	Close to Moderate	2.5 to 24	Moderately Wide	0.1 to 0.4	PEGMATITE
BB-BTAR-111		R3	24.7	10.0	-	15.0	0.0	10.0	-	15.0	24.7	5.0	56	93%	29	48%	Close	2.5 to 8	Moderately Wide	0.1 to 0.4	PEGMATITE
BB-BTAR-112		R1	26.9	0.0	-	5.0	0.0	0.0	-	5.0	26.9	5.0	58	97%	23	38%	Very Close to Close	0.75 to 8	Moderately Wide	0.1 to 0.4	PEGMATITE
BB-BTAR-112	Abutment 2	R2	26.9	5.0	-	10.0	0.0	5.0	-	10.0	26.9	5.0	58	97%	14	23%	Very Close to Close	0.75 to 8	Moderately Wide	0.1 to 0.4	PEGMATITE
BB-BTAR-112		R3	26.9	10.0	-	15.0	0.0	10.0	-	15.0	26.9	5.0	60	100%	33	55%	Very Close to Close	0.75 to 8	Open to Moderately Wide	0.02 to 0.4	PEGMATITE
BB-BTAR-113	Abutment 2	R1	29.5	9.2	-	15.2	9.2	0.0	-	6.0	20.3	6.0	55	76%	23	32%	Extremely Close to Close	<0.75 to 8	Open	0.02 to 0.1	GNEISS
BB-BTAR-113	(Retaining Wall)	R2	29.5	15.2	-	20.2	9.2	6.0	-	11.0	20.3	5.0	58	97%	46	76%	Moderately Spaced	8 to 24	Open	0.02 to 0.1	GNEISS/PEGMATITE
BB-BTAR-114	Abutment 2	R1	32.3	12.5	-	17.5	12.5	0.0	-	5.0	19.8	5.0	59	98%	42	70%	Close	2.5 to 8	Open to Moderately Wide	0.02 to 0.4	GNEISS/PEGMATITE
BB-BTAR-114	(Retaining Wall)	R2	32.3	17.5	-	22.5	12.5	5.0	-	10.0	19.8	5.0	57	95%	24	40%	Close	2.5 to 8	Open	0.02 to 0.1	GNEISS/PEGMATITE
BB-BTAR-201		R1	45.9	8.0	-	10.3	6.7	1.3	-	3.6	39.2	2.3	26	94%	0	0%	Very Close to Close	0.75 to 8	Open	0.02 to 0.1	PEGMATITE
BB-BTAR-201	Abutment 1	R2	45.9	10.3	-	14.3	6.7	3.6	-	7.6	39.2	4.0	48	100%	20	16%	Very Close to Close	0.75 to 8	Tight	0.004 to 0.01	GNEISS
BB-BTAR-201		R3	45.9	14.3	-	17.3	6.7	7.6	-	10.6	39.2	3.0	36	100%	19	53%	Very Close to Close	0.75 to 8	Tight	0.004 to 0.01	GNEISS
BB-BTAR-201		R4	45.9	17.3	-	18.3	6.7	10.6	-	11.6	39.2	1.0	1	8%	0	0%	N/A	N/A	N/A	N/A	GNEISS
BB-BTAR-202	Abutment 1	R1	2.0	0.0	-	0.7	0.0	0.0	-	0.7	2.0	0.7	6	75%	0	0%	Extremely Close to Very Close	<0.75 to 2.5	Open	0.02 to 0.1	GNEISS
BB-BTAR-202		R2	2.0	0.7	-	2.2	0.0	0.7	-	2.2	2.0	1.5	12	67%	0	0%	Moderately Spaced	8 to 24	Open	0.02 to 0.1	GNEISS

FIGURES



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

0 1,000 2,000 4,000 6,000
SCALE IN FEET

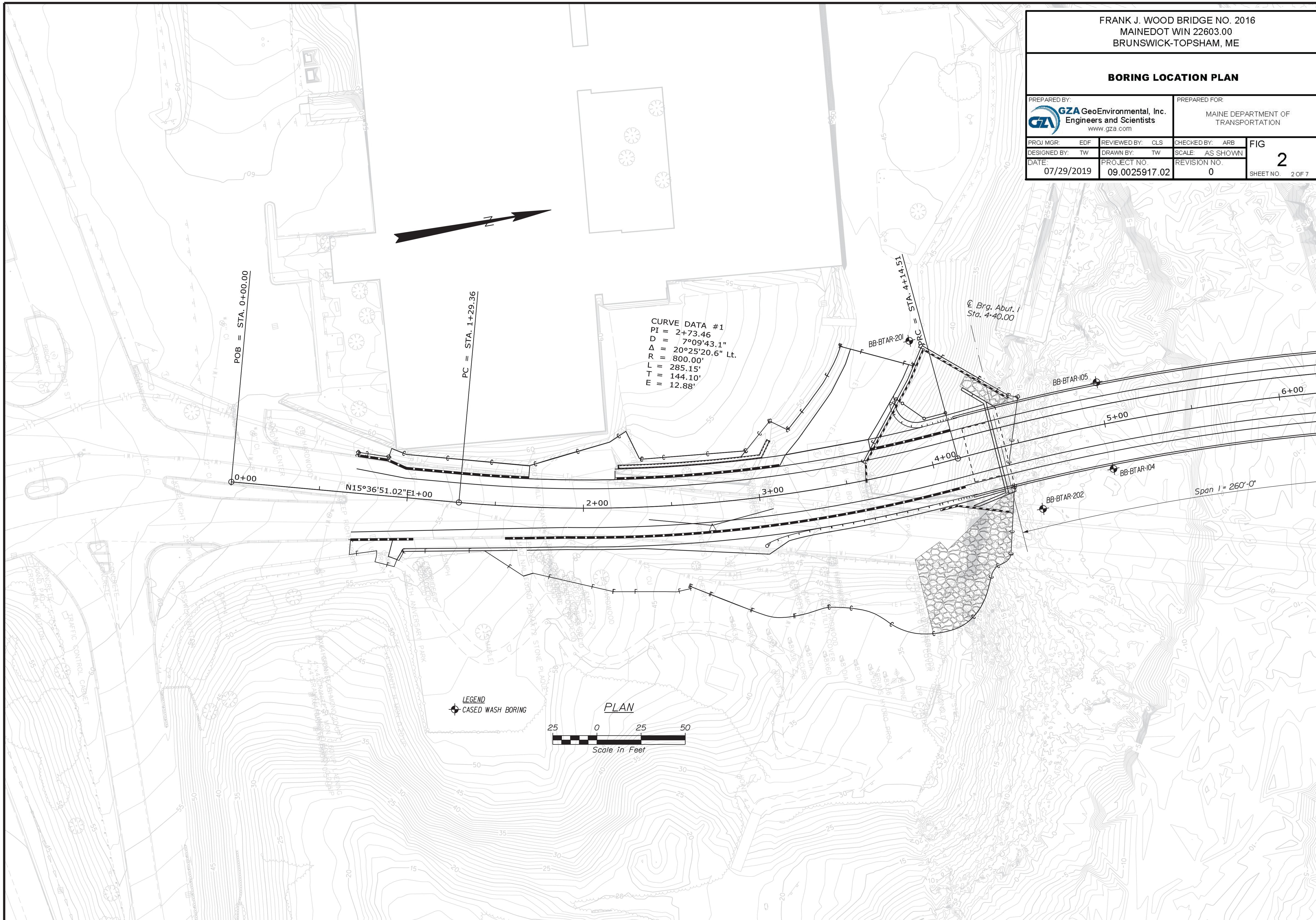
Data Supplied by :

PROJ. MGR.: EDF DESIGNED BY: EDF REVIEWED BY: CLS OPERATOR: ADM DATE: 07-29-2019	LOCUS PLAN	JOB NO. 09.0025917.02
	FRANK J. WOOD BRIDGE NO. 2016 BRUNSWICK/TOPSHAM, ME	FIGURE NO. 1

FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

BORING LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG 2
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	
DATE: 07/29/2019	PROJECT NO. 09.0025917.02	REVISION NO. 0	SHEET NO. 2 OF 7



Filename: ...\00\GEOTECH\MSTA\002_BLP1.dgn Division: GEOTECH Username: Terry.White Date:5/2/2019

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2260(300)

WIN 22603.00

BRIDGE PLANS

BRIDGE NO. 2016

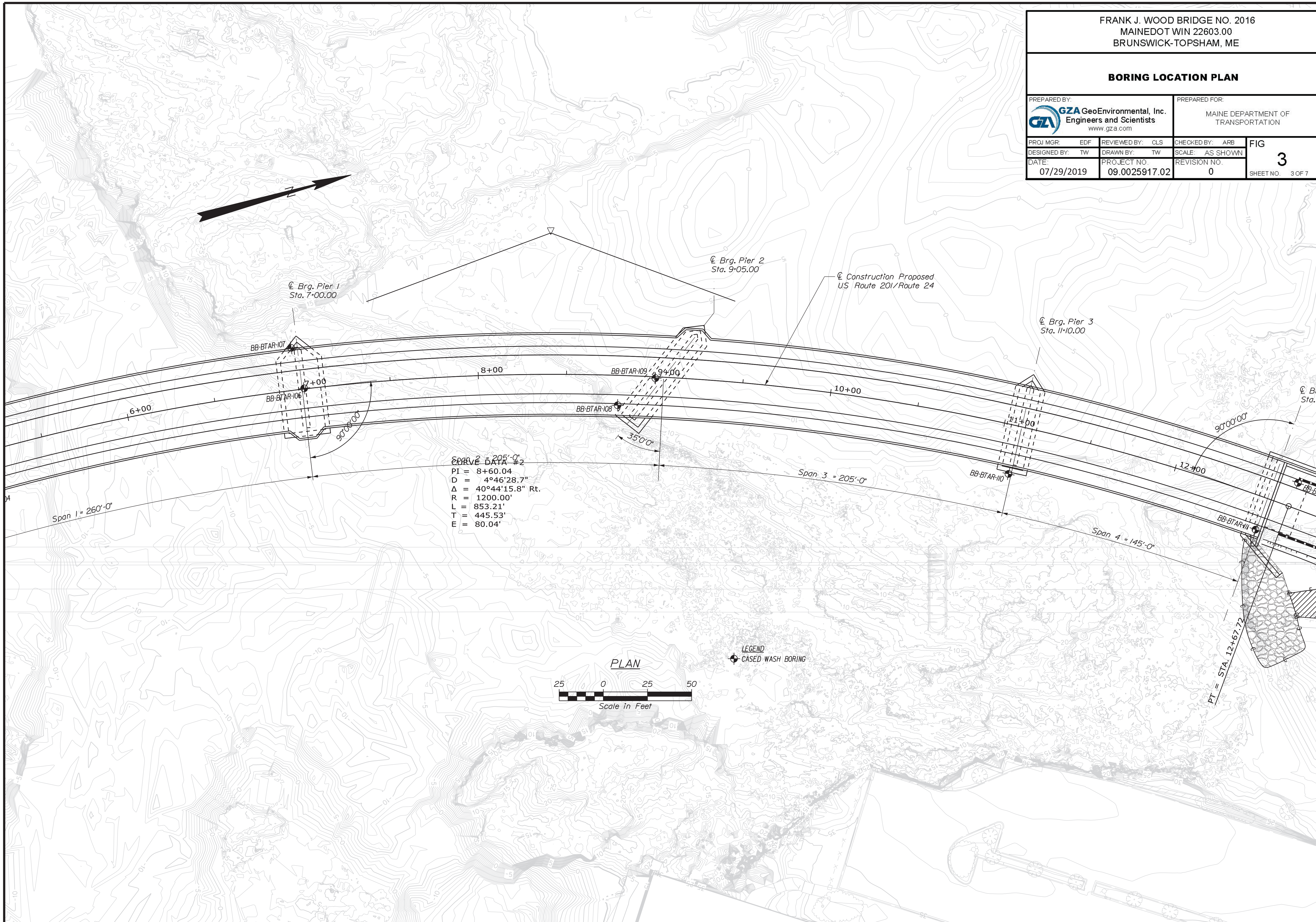
		BY	DATE
PROJ. MANAGER			
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN2-DETAILED2	N.SHERWOOD	T.WHITE	SEP 2016
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC

BORING LOCATION PLAN

FIGURE
2
OF 7



FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

BORING LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	3
DATE: 07/29/2019	PROJECT NO. 09.0025917.02	REVISION NO. 0	SHEET NO. 3 OF 7

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2260(300)

WIN 22603.00

BRIDGE PLANS

BRIDGE NO. 2016

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	N.SHERWOOD	
DESIGN3-DETAILED3	T.WHITE	SEP 2016
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC

BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE

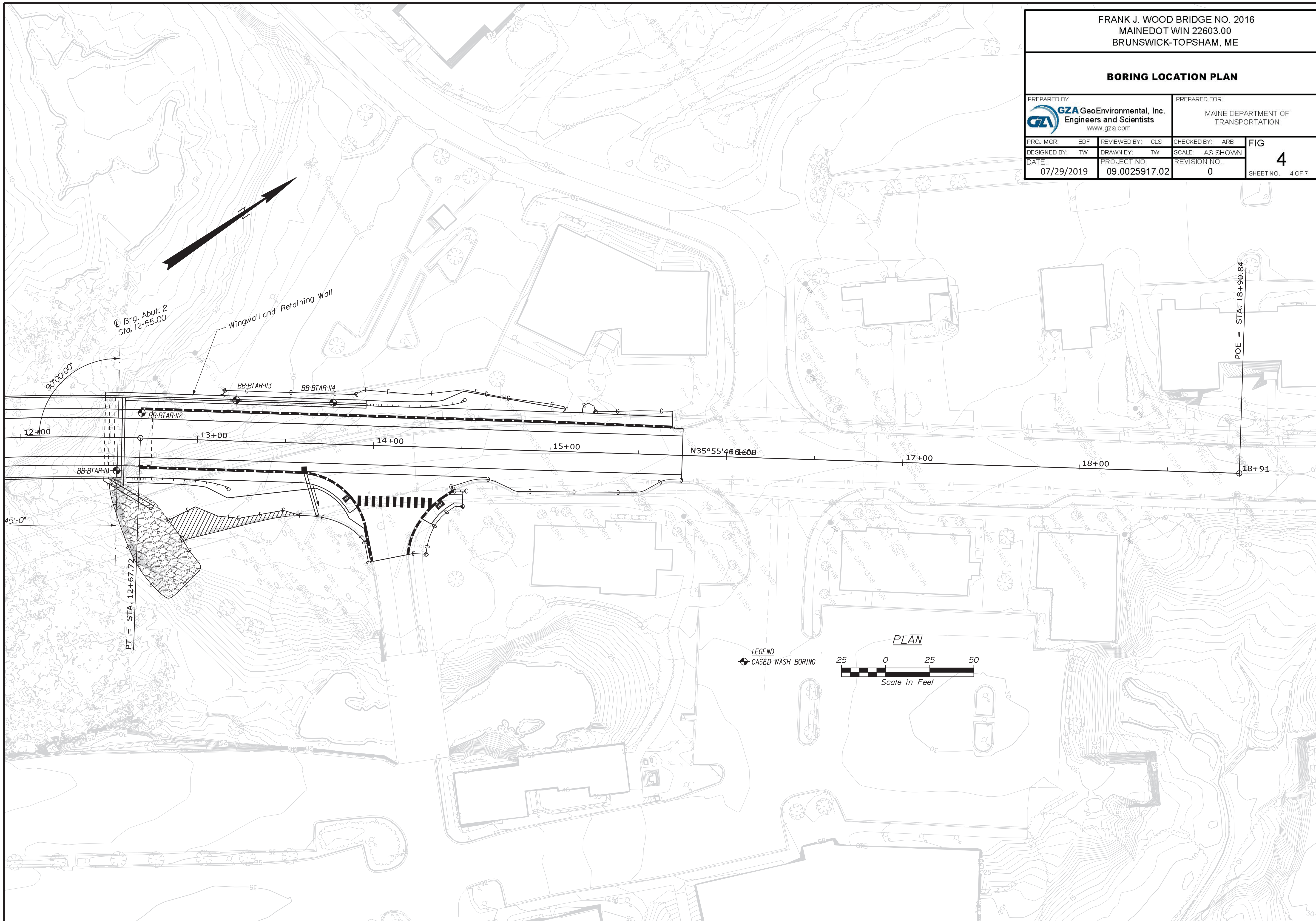
FIGURE
3
OF 7

Filename: ...\00\GEOTECH\MSTA\003_BLP2.dgn Division: GEOTECH Username: Terry.White Date:5/2/2019

FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

BORING LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG 4
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	
DATE: 07/29/2019	PROJECT NO: 09.0025917.02	REVISION NO: 0	SHEET NO. 4 OF 7



Filename: ...\OD\GEOTECH\MSTA\004_BLP3.dgn
Division: GEOTECH
Username: Terry.White
Date:5/2/2019

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2260(300)

WIN 22603.00

BRIDGE PLANS

BRIDGE NO. 2016

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	N.SHERWOOD	
DESIGN3-DETAILED3	T.WHITE	SEP 2016
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC

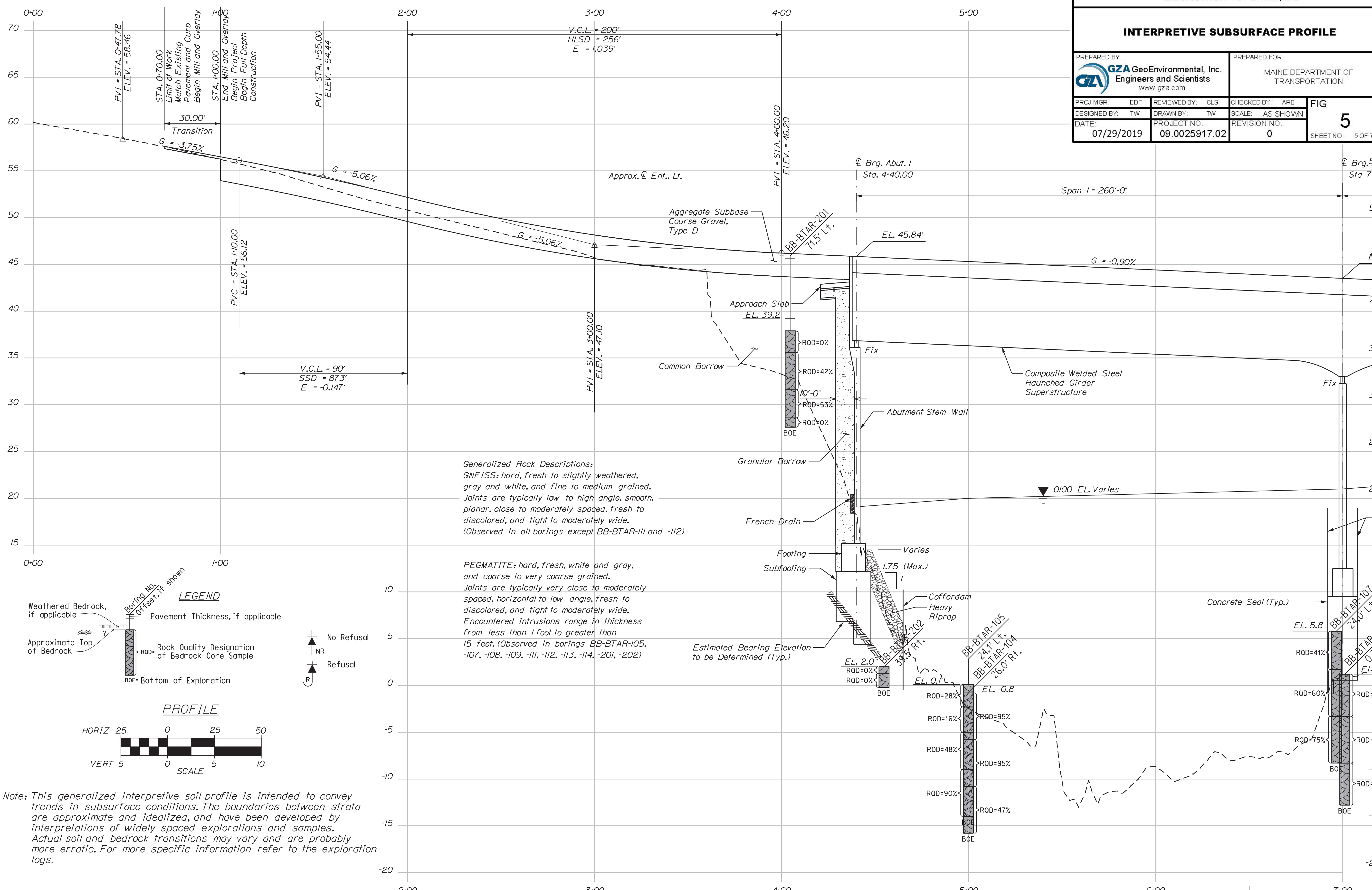
BORING LOCATION PLAN

FIGURE
4
OF 7

FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

INTERPRETIVE SUBSURFACE PROFILE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG 5
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	
DATE: 07/29/2019	PROJECT NO. 09.0025917.02	REVISION NO. 0	SHEET NO. 5 OF 7



Generalized Rock Descriptions:
GNEISS: hard, fresh to slightly weathered, gray and white, and fine to medium grained. Joints are typically low to high angle, smooth, planar, close to moderately spaced, fresh to discolored, and tight to moderately wide. (Observed in all borings except BB-BTAR-111 and -112)

PEGMATITE: hard, fresh, white and gray, and coarse to very coarse grained. Joints are typically very close to moderately spaced, horizontal to low angle, fresh to discolored, and tight to moderately wide. Encountered intrusions range in thickness from less than 1 foot to greater than 15 feet. (Observed in borings BB-BTAR-105, -107, -108, -109, -111, -112, -113, -114, -201, -202)

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

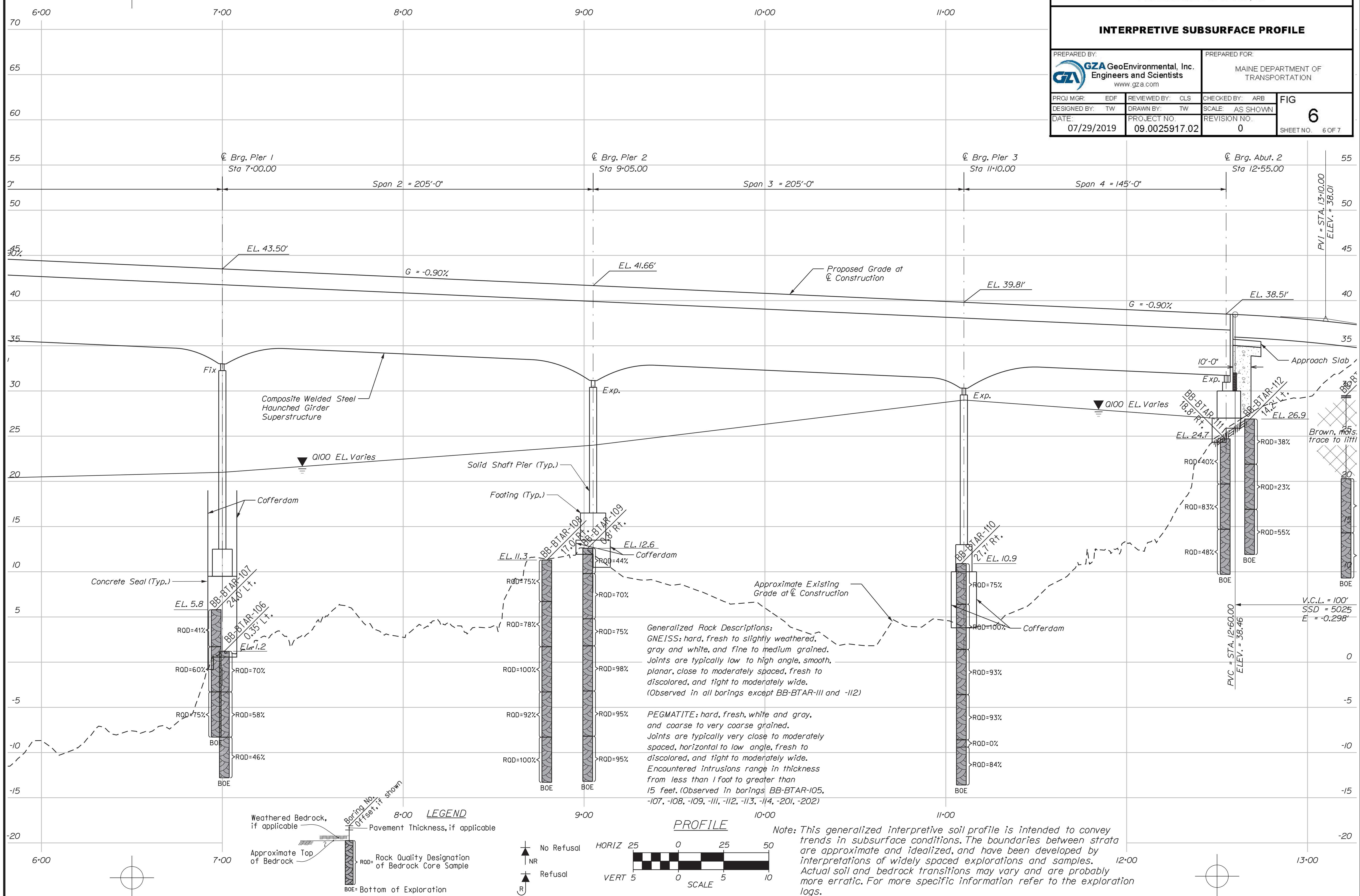
STATE OF MAINE DEPARTMENT OF TRANSPORTATION
STP-2260(300)
WIN 22603.00
BRIDGE PLANS
BRIDGE NO. 2016

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	T.WHITE	SEP 2016
DESIGN3-DETAILED3	N.SHERWOOD	
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE
P.E. NUMBER
DATE

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC
INTERPRETIVE SUBSURFACE PROFILE

FIGURE 5 OF 7



FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

INTERPRETIVE SUBSURFACE PROFILE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION

PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG 6
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	
DATE: 07/29/2019	PROJECT NO: 09.0025917.02	REVISION NO: 0	SHEET NO. 6 OF 7

STATE OF MAINE DEPARTMENT OF TRANSPORTATION

STP-2260(300)

WIN 22603.00

BRIDGE PLANS

BRIDGE NO. 2016

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC

INTERPRETIVE SUBSURFACE PROFILE

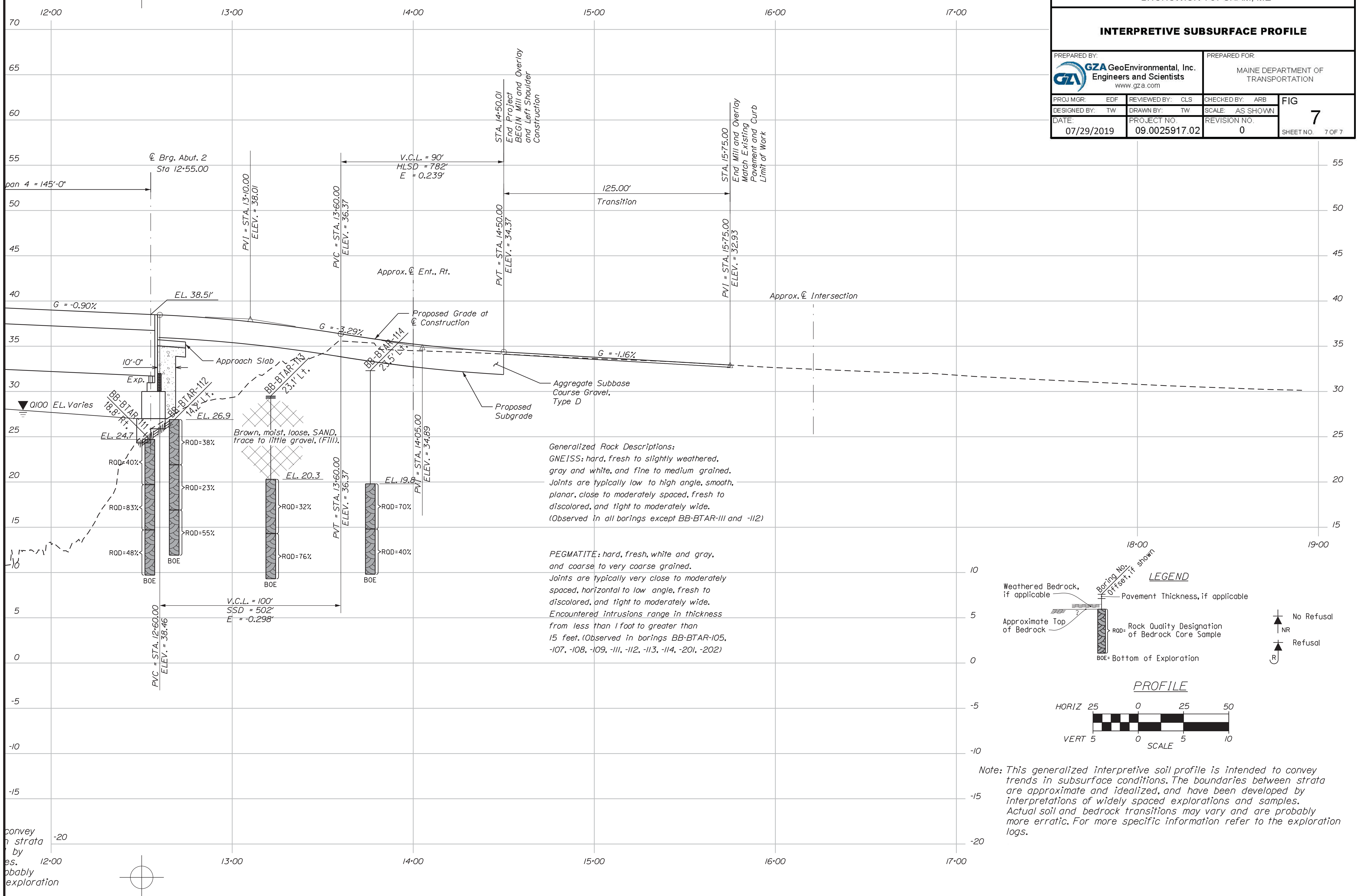
FIGURE 6 OF 7

Filename: ...\00\GEOTECH\MSTA\006_ISP2.dgn Division: GEOTECH Username: Terry.White Date: 5/2/2019

FRANK J. WOOD BRIDGE NO. 2016
MAINEDOT WIN 22603.00
BRUNSWICK-TOPSHAM, ME

INTERPRETIVE SUBSURFACE PROFILE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: EDF	REVIEWED BY: CLS	CHECKED BY: ARB	FIG 7
DESIGNED BY: TW	DRAWN BY: TW	SCALE: AS SHOWN	
DATE: 07/29/2019	PROJECT NO. 09.0025917.02	REVISION NO. 0	SHEET NO. 7 OF 7



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2260(300)

WIN 22603.00

BRIDGE PLANS

BRIDGE NO. 2016

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	N.SHERWOOD	
DESIGN3-DETAILED3	T.WHITE	SEP 2016
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

FRANK J WOOD
ANDROSCOGGIN RIVER
BRUNSWICK - TOPSHAM CUMBERLAND - SAGADAHOC

INTERPRETIVE SUBSURFACE PROFILE

FIGURE 7 OF 7

Filename: ...\00\GEOTECH\MSTA\007_ISP3.dgn Division: GEOTECH Username: Terry.White Date:5/2/2019

APPENDIX A – LIMITATIONS

GEOTECHNICAL LIMITATIONS

Use of Report

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

Standard of Care

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

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

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

Subsurface Conditions

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

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

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

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

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

Compliance with Codes and Regulations

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

Cost Estimates

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

Additional Services

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

APPENDIX B – BORING LOGS

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River Location: Brunswick-Topsham, Maine	Boring No.: BB-BTAR-104 WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	-0.8	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	Wilder/Sherwood	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/24/2016; 15:30-17:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	4+99.9, 26.0 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.9901	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	60/60	0.00 - 5.00	RQD = 95%			NQ-2			Top of Bedrock at Elev. -0.8 feet. R1: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, fresh, tight, foliated, quartz seam at 0.7', horizontal fracture at 2.3'. R1: Rock Mass Quality = Excellent R1: Core Times (min:sec): 0.0-1.0 ft (0:45), 1.0-2.0 ft (2:11), 2.0-3.0 ft (1:51), 3.0-4.0 ft (1:50), 4.0-5.0 ft (1:28) 100% Recovery	q_p=21.2 ksi
5	R2	60/60	5.00 - 10.00	RQD = 95%						R2: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, slightly discolored to fresh, tight, foliated. Pegmatite seam at 5.7' (1/4" thick) and 6.3' (3/4" thick). R2: Rock Mass Quality = Excellent R2: Core Times (min:sec): 5.0-6.0 ft (1:20), 6.0-7.0 ft (1:22), 7.0-8.0 ft (1:00), 8.0-9.0 ft (1:00), 9.0-10.0 ft (1:08) 100% Recovery	
10	R3	60/54	10.00 - 15.00	RQD = 47%						R3: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close, low to high angle (vertical fractures from 11'-12', 13', and 14'), planar, smooth, discolored, brown staining and occasional brown Clay infilling, tight. R3: Rock Mass Quality = Poor R3: Core Times (min:sec): 10.0-11.0 ft (1:17), 11.0-12.0 ft (1:37), 12.0-13.0 ft (1:29), 13.0-14.0 ft (2:11), 14.0-15.0 ft (2:00) 90% Recovery	
15								-15.80		15.00 **Bottom of Exploration at 15.00 feet below ground surface.**	
20											
25											

Remarks:

Hammer No. 283
600-800 pounds of down pressure on Core Barrel.
Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-105
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	0.1	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	Wilder/Sherwood	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/24/2016; 13:00-15:00	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	4+99.9, 24.1 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.9901	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	28.8/24	0.00 - 2.40	RQD = 28%			NQ-2			Top of Bedrock at Elev. 0.1 feet. R1: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close, low angle, planar, smooth, slightly discolored, trace gray Clay infilling, tight to open. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 0.0-1.0 ft (2:54), 1.0-2.0 ft (2:04), 2.0-2.4 ft (2:00) 83% Recovery Core Blocked	
	R2	32.4/29	2.40 - 5.10	RQD = 16%				-3.00		R2: 2.4'-3.1': Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close, low angle, planar, smooth, fresh to slightly discolored, tight to open. (3.10)	
5	R3	48/48	5.10 - 9.10	RQD = 48%				-5.00		R2: 3.1'-5.1': Hard, fresh, coarse grained, tan/white/gray, PEGMATITE. Joints are very close, horizontal to low angle, planar, rough, discolored (dull), tight to open. R2: Rock Mass Quality = Very Poor R2: Core Times (min:sec): 2.4-3.4 ft (1:10) 3.4-4.4 ft (2:38), 4.4-5.1 ft (3:00) 90% Recovery Core Blocked (5.10)	q_p=16.5 ksi
	R4	60/57	9.10 - 14.10	RQD = 90%				-9.00 -9.50		R3: Hard, fresh, coarse to very coarse grained, tan/gray/white, PEGMATITE. Joints are very close to close, horizontal, planar, smooth to rough, fresh, partially open to open. R3: Rock Mass Quality = Poor R3: Core Times (min:sec): 5.1-6.1 ft (2:36) 6.1-7.1 ft (2:31), 7.1-8.1 ft (2:04), 8.1-9.1 ft (3:08) 100% Recovery Core Blocked (9.10)	
10											
								-14.00		R4: 9.1'-9.6': Hard, fresh, coarse to very coarse grained, tan/gray/ white, PEGMATITE. Joints are very close to close, horizontal, planar, smooth to rough, fresh, partially open to open. (9.60)	
15										R4: 9.6'-14.1': Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close to moderately spaced, low angle, planar, smooth, fresh. R4: Rock Mass Quality = Good R4: Core Times (min:sec): 9.1-10.1 ft (1:59), 10.1-11.1 ft (1:34), 11.1-12.1 f t (1:31), 12.1-13.1 ft (1:33), 13.1-14.1 ft (1:44) 95% Recovery (14.10)	
20										**Bottom of Exploration at 14.10 feet below ground surface.**	
25											

Remarks:

Hammer No. 283
600-800 pounds of down pressure on Core Barrel.
Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Boring No.: BB-BTAR-105

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-106
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	1.2	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	Wilder/Sherwood	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/24/2016; 11:00-12:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	7+01.1, 0.35 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.9901	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	54/51	0.00 - 4.50	RQD = 70%			NQ-2			Top of Bedrock at Elev. 1.2 feet. R1: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close to moderately spaced, low angle, planar, smooth, mostly fresh, slightly discolored near top, partially open to moderately wide. R1: Rock Mass Quality = Fair R1: Core Times (min:sec): 0.0-1.0 ft (1:43), 1.0-2.0 ft (2:39), 2.0-3.0 ft (2:59), 3.0-4.0 ft (1:40), 4.0-5.0 ft (1:42) 96% Recovery Core Blocked	q_p=19.2 ksi
5	R2	60/58	4.50 - 9.50	RQD = 58%						R2: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are moderately spaced to very close at bottom, low angle, planar, smooth, fresh to slightly discolored at 8.0', brown Clay infilling, open. R2: Rock Mass Quality = Fair R2: Core Times (min:sec): 4.5-5.5 ft (1:28), 5.5-6.5 ft (2:01), 6.5-7.5 ft (2:02), 7.5-8.5 ft (1:24), 8.5-9.5 ft (1:25) 97% Recovery	
10	R3	54/50	9.50 - 14.00	RQD = 46%						R3: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close, low angle, planar, smooth, fresh to slightly discolored at 13.5' (brown), partially open, foliated. R3: Rock Mass Quality = Fair R3: Core Times (min:sec): 9.5-10.5 ft (1:12), 10.5-11.5 ft (1:12), 11.5-12.5 f t (1:21), 12.5-13.5 ft (1:10), 13.5-14.0 ft (1:08) 93% Recovery Core Blocked	
								-12.80		14.00 **Bottom of Exploration at 14.00 feet below ground surface.**	
15											
20											
25											

Remarks:

Hammer No. 283
600-800 pounds of down pressure on Core Barrel.
Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-107
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	5.8	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	Wilder/Sherwood	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/24/2016; 09:00-10:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	6+96.6, 24.0 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.9901	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	49/49	0.00 - 4.08	RQD = 41%			NQ-2	5.60		Top of Bedrock at Elev. 5.8 feet. R1: 0'-0.2': PEGMATITE.	
										0.20	
										R1: 0.2'-4.1': Hard, fresh (slightly weathered in top 12"), fine to medium grained, gray and white, foliated, GNEISS. Joints are close to moderately spaced, low angle, planar smooth, fresh to slightly discolored, tight. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 0.0-1.0 ft (3:13), 1.0-2.0 ft (1:40), 2.0-3.0 ft (2:11), 3.0-4.0 ft (2:25), 4.0-5.0 ft (1:00) 100% Recovery Core Blocked	
	R2	60/54	4.10 - 9.10	RQD = 60%				1.70			
5										4.10	
										R2: 4.1'-4.8': Hard, fresh (slightly weathered in top 12"), fine to medium grained, gray and white, foliated, GNEISS. Joints are close to moderately spaced, low angle, planar smooth, fresh to slightly discolored tight. Banding of GNEISS and PEGMATITE in 0.3'-0.7' thick layers from 4.8'-7.6'.	q_p=31.1 ksi
								-1.80			
										7.60	
	R3	60/55	9.10 - 14.10	RQD = 75%						R2: 7.6'-9.1': Hard, fresh, coarse to very coarse, white and gray banded, PEGMATITE. Joints are moderately spaced, low angle, planar, rough, fresh, tight. R2: Rock Mass Quality = Fair R2: Core Times (min:sec): 4.1-5.1 ft (1:50), 5.1-6.1 ft (2:53), 6.1-7.1 ft (5:02), 7.1-8.1 ft (4:12), 8.1-9.1 ft (5:33) 90% Recovery	
10										R3: Hard, fresh, coarse to very coarse grained, white and gray banded, PEGMATITE. Joints are close to moderately spaced, horizontal, planar, rough, fresh, open to wide. R3: Rock Mass Quality = Good R3: Core Times (min:sec): 9.1-10.1 ft (2:13), 10.1-11.1 ft (2:43), 11.1-12.1 ft (2:59), 12.1-13.1 ft (3:07), 13.1-14.1 ft (2:44) 92% Recovery	
								-8.30			
										14.10	
15										**Bottom of Exploration at 14.10 feet below ground surface.**	
20											
25											

Remarks:

Hammer No. 283
600-800 pounds of down pressure on Core Barrel.
Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River **Location:** Brunswick-Topsham, Maine	**Boring No.:** BB-BTAR-108 **WIN:** 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	11.3	**Auger ID/OD:**	N/A
Operator:	Mike Nadeau	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/30/2016; 08:53-10:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	8+79.4, 17.0 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor: --		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
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N-uncorrected = Raw Field SPT N-value
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WC = Water Content, percent
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C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	55/55	0.00 - 4.58	RQD = 75%						Top of Bedrock at Elev. 11.3 feet. R1: Hard, slightly weathered to fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are close to moderately spaced, low angle planar smooth, discolored (rusty), partially open. R1: Rock Mass Quality = Good R1: Core Times (min:sec): 0.0-1.0 ft (2:09), 1.0-2.0 ft (1:48), 2.0-3.0 ft (2:26), 3.0-4.0 ft (1:32), 4.0-4.6 ft (1:03) 100% Recovery	
5	R2	60/58	4.60 - 9.60	RQD = 78%				5.70 5.20		R2: 4.6'-5.6': Hard, fresh, fine to medium grained, dark gray, GNEISS. Joints are very close to moderately spaced, moderately dipping, planar, smooth, fresh, open, tight to partially open, Biotite rich. 5.60 R2: 5.6'-6.1': Hard, fresh, coarse to very coarse grained, white and light gray, PEGMATITE. 6.10 R2: 6.1'-9.6': Hard, fresh, light gray and white, foliated, GNEISS. Joints are close to moderately spaced, horizontal to moderately dipping, planar, smooth fresh, tight to open, Biotite rich. R2: Rock Mass Quality = Good R2: Core Times (min:sec): 4.6-5.6 ft (1:00), 5.6-6.6 ft (1:26), 6.6-7.6 ft (1:33), 7.6-8.6 ft (1:15), 8.6-9.6 ft (1:42) 97% Recovery	q_p=9.5 ksi
10	R3	60/60	9.60 - 14.60	RQD = 100%						R3: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are close to wide, moderately dipping, planar, smooth, fresh, moderately wide. R3: Rock Mass Quality = Excellent R3: Core Times (min:sec): 9.6-10.6 ft (1:36), 10.6-11.6 ft (2:04), 11.6-12.6 ft (2:02), 12.6-13.6 ft (2:01), 13.6-14.6 ft (2:38) 100% Recovery	
15	R4	60/58	14.60 - 19.60	RQD = 92%						R4: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are close to wide, low angle, planar, smooth, fresh, tight to partially open. R4: Rock Mass Quality = Excellent R4: Core Times (min:sec): 14.6-15.6 ft (2:36), 15.6-16.6 ft (2:43), 16.6-17.6 ft (3:11), 17.6-18.6 ft (2:28), 18.6-19.6 ft (2:12) 97% Recovery	
20	R5	60/60	19.60 - 24.60	RQD = 100%						R5: Hard, fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, fresh, open to moderately wide. R5: Rock Mass Quality = Excellent R5: Core Times (min:sec): 19.6-20.6 ft (2:18), 20.6-21.6 ft (2:17), 21.6-22.6 ft (2:38), 22.6-23.6 ft (2:17), 23.6-24.6 ft (3:09) 100% Recovery	
25								-13.30		24.60	

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-108
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	11.3	**Auger ID/OD:**	N/A
Operator:	Mike Nadeau	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/30/2016; 08:53-10:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	8+79.4, 17.0 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	--	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										**Bottom of Exploration at 24.60 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River **Location:** Brunswick-Topsham, Maine	**Boring No.:** BB-BTAR-109 **WIN:** 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	12.6	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/29/2016; 10:53-14:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	9+00.4, 0.8 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor: --		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	34/34	0.00 - 2.83	RQD = 44%						Top of Bedrock at Elev. 12.6 feet. R1: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are close, moderately dipping, planar, smooth, fresh, partially open to moderately wide. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 0.0-1.0 ft (4:37), 1.0-2.0 ft (5:04), 2.0-2.8 ft (4:49) 100% Recovery	q_p=32.7 ksi
	R2	60/60	2.80 - 7.80	RQD = 70%						R2: 2.8'-7.4': Hard, fresh, fine to medium grained, light gray, GNEISS. Joints are very close to moderately spaced, horizontal to low angle, planar, fresh, smooth, open to moderately wide.	
5											
	R3	36/36	7.80 - 10.80	RQD = 75%				5.20		7.40 R2: 7.4'-7.8': Hard, fresh, coarse grained, white, PEGMATITE. R2: Rock Mass Quality = Excellent R2: Core Times (min:sec): 2.8-3.8 ft (3:52), 3.8-4.8 ft (9:00), 4.8-5.8 ft (2:45), 5.8-6.8 ft (1:24), 6.8-7.9 ft (2:50) 99% Recovery R3: 7.8'-8.5': Hard, fresh, coarse grained, white, PEGMATITE. Joints are close, low angle, planar, rough, fresh, moderately wide.	
								4.10		8.50 R3: 8.5'-10.8': Hard fresh, fine to medium grained, gray and white, foliated, GNEISS. Joints are close to moderately s paced, horizontal, planar, smooth, fresh, open. R3: Rock Mass Quality = Good R3: Core times (min:sec): 7.8-8.8 ft (1:59), 8.8-9.8 ft (4:41), 9.8-10.8 ft (2:02) 100% Recovery	
10	R4	60/60	10.80 - 15.80	RQD = 98%						R4: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are very close to widely spaced, moderately dipping to low angle, planar, smooth, fresh, open. R4: Rock Mass Quality = Excellent R4: Core Times (min:sec): 10.8-11.8 ft (1:53), 11.8-12.8 ft (2:30), 12.8-13.8 ft (2:14), 13.8-14.8 ft 2:30), 14.8-15.8 ft (3:34) 100% Recovery	
15	R5	60/57	15.80 - 20.80	RQD = 95%						R5: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are wide, low angle, planar, smooth, fresh, partially open, Biotite rich. R5: Rock Mass Quality = Excellent R5: Core Times (min:sec): 15.8-16.8 ft (3:00), 16.8-17.8 ft (2:24), 17.8-18.8 ft (1:48), 18.8-19.8 ft (1:43), 19.8-20.8 ft (1:51) 95% Recovery.	
20	R6	60/57	20.80 - 25.80	RQD = 95%						R6: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, fresh, open to moderately wide. R6: Rock Mass Quality = Excellent R6: Core Times (min:sec): 20.8-21.8 ft (1:36), 21.8-22.8 ft (1:48), 22.8-23.8 ft (1:52), 23.8-24.8 ft (2:24), 24.8-25.8 ft (1:58) 95% Recovery	
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-109
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	12.6	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/29/2016; 10:53-14:30	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	9+00.4, 0.8 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	--	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25								-13.20		25.80 **Bottom of Exploration at 25.80 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-110
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	10.9	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/30/2016; 12:40-14:45	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	11+08.6, 27.7 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor: --		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
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WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
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N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
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WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
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G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	54/52	0.00 - 4.50	RQD = 75%						Top of Bedrock at Elev. 10.9 feet. R1: Hard, fresh, fine to medium grained, light gray, GNEISS. Joints are close to moderately spaced, low angle planar, smooth, discolored in top 1.0' to fresh, partially open. R1: Rock Mass Quality = Good R1: Core Times (min:sec): 0.0-1.0 ft (2:34), 1.0-2.0 ft (3:35), 2.0-3.0 ft (2:44), 3.0-4.0 ft (1:42), 4.0-4.5 ft (0:36) 96% Recovery	q_p=4.6 ksi
5	R2	60/60	4.50 - 9.50	RQD = 100%						R2: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are moderately spaced, moderately dipping, planar, smooth, fresh, partially open, Biotite rich. R2: Rock Mass Quality = Excellent R2: Core Times (min:sec): 4.5-5.5 ft (1:18), 5.5-6.5 ft (1:55), 6.5-7.5 ft (2:15), 7.5-8.5 ft (2:09), 8.5-9.5 ft (2:33) 100% Recovery	
10	R3	56/60	9.50 - 14.17	RQD = 93%						R3: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, fresh, tight to partially open, Biotite rich. R3: Rock Mass Quality = Excellent R3: Core Times (min:sec): 9.5-10.5 ft (2:26), 10.5-11.5 ft (2:15), 11.5-12.5 ft (2:19), 12.5-13.5 ft (2:13), 13.5-14.5 ft (2:46) 100% Recovery	
15	R4	60/60	14.50 - 19.50	RQD = 93%						R4: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, fresh, tight, Biotite rich. R4: Rock Mass Quality = Excellent R4: Core Times (min:sec): 14.5-15.5 ft (3:36), 15.5-16.5 ft (3:09), 16.5-17.5 ft (2:39), 17.5-18.5 ft (1:48), 18.5-19.5 ft (2:30) 100% Recovery	
20	R5	9/9	19.50 - 20.25	RQD = 0%						R5: 19.5'-20.0': Hard, fresh, fine to medium grained, foliated, light gray and white GNEISS. Quartz band from 20.0'-20.3'. Core blocked at 20.3'. R5: Rock Mass Quality = Very Poor R5: Core Times (min:sec): 19.5-20.3 ft (2:20) 94% Recovery	
	R6	51/48	20.30 - 24.55	RQD = 84%						R6: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are close to moderately spaced, moderately dipping, planar, smooth, fresh, partially open, Biotite rich. R6: Rock Mass Quality = Good R6: Core Times (min:sec): 20.3-20.5 ft (0:47), 20.5-21.5 ft (1:27), 21.5-22.5 ft (1:30), 22.5-23.5 ft (1:31), 23.5-24.5 ft (1:54)	
25								-13.60			

Remarks:

2" void observed at 3.8', noted by drop in drill rods. Clay observed at joint surface at bottom of the void.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-110
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	10.9	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/30/2016; 12:40-14:45	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	11+08.6, 27.7 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	--	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										94% Recovery	
										24.50 **Bottom of Exploration at 24.50 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

2" void observed at 3.8', noted by drop in drill rods. Clay observed at joint surface at bottom of the void.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-111
WIN: 22603.00

Driller:	Northern Test Boring	**Elevation (ft.)**	24.7	**Auger ID/OD:**	N/A
Operator:	Mike/Will	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	E. Friede (GZA)	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/31/2016; 08:50-10:00	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	12+54.5, 18.8 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	--	**Hammer Type:**	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
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N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
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WC = Water Content, percent
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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	60/60	0.00 - 5.00	RQD = 40%						Top of Bedrock at Elev. 24.7 feet. R1: Hard, fresh, coarse to very coarse grained, white, gray and black, PEGMATITE with Biotite. Joints are close, horizontal, planar, rough, fresh to discolored, tight to moderately tight. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 0.0-1.0 ft (2:20), 1.0-2.0 ft (1:54), 2.0-3.0 ft (2:02), 3.0-4.0 ft (2:02), 4.0-5.0 ft (2:33) 100% Recovery	
5	R2	60/60	5.00 - 10.00	RQD = 83%						R2: Hard, fresh, coarse to very coarse grained, gray and white, PEGMATITE. Joints are close to moderately close, horizontal to low angle, planar, rough, fresh to discolored, moderately wide. R2: Rock Mass Quality = Good R2: Core Times (min:sec): 5.0-6.0 ft (1:34), 6.0-7.0 ft (1:58), 7.0-8.0 ft (2:09), 8.0-9.0 ft (2:25), 9.0-10.0 ft (1:10) 100% Recovery.	
10	R3	60/56	10.00 - 15.00	RQD = 48%						R3: Hard, fresh, coarse to very coarse grained, white and gray, PEGMATITE. Joints are close, low angle, planar, rough, fresh to slightly discolored, moderately wide. R3: Rock Mass Quality = Poor R3: Core Times (min:sec): 10.0-11.0 ft (2:35), 11.0-12.0 ft (2:33), 12.0-13.0 ft (1:58), 13.0-14.0 ft (1:39), 14.0-15.0 ft (1:33) 93% Recovery.	
15								9.70		15.00 **Bottom of Exploration at 15.00 feet below ground surface.**	
20											
25											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-112
WIN: 22603.00

Driller:	MaineDOT	**Elevation (ft.)**	26.9	**Auger ID/OD:**	N/A
Operator:	Daggett/Burpee	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	N. Sherwood	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/25/2016; 08:20-11:08	**Drilling Method:**	NQ-2"	**Core Barrel:**	NQ-2"
Boring Location:	12+68.1, 14.2 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.943	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WOR/C = Weight of Rods or Casing
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S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
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PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	60/58	0.00 - 5.00	RQD = 38%			NQ-2			Top of Bedrock at Elev. 26.9 feet. R1: Hard, fresh, coarse to very coarse grained, white and gray, PEGMATITE. Joints are close to very close at 3.0'-5.0', low angle, planar, rough, fresh, moderately wide. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 0.0-1.0 ft (3:47), 1.0-2.0 ft (3:24), 2.0-3.0 ft (3:58), 3.0-4.0 ft (4:10), 4.0-5.0 ft (4:20) 97% Recovery	q_p=9.6 ksi
5	R2	60/58	5.00 - 10.00	RQD = 23%						R2: Hard, fresh, coarse to very coarse grained, white and gray, PEGMATITE. Joints are very close to close, horizontal (vertical fracture at 8.5'), planar, rough, fresh, moderately wide. 9.3'-10.0': Quartz seam. Lost water at 9.3 ft. R2: Rock Mass Quality = Very Poor R2: Core Times (min:sec): 5.0-6.0 ft (4:30), 6.0-7.0 ft (3:51), 7.0-8.0 ft (3:50), 8.0-9.0 ft (6:00), 9.0-10.0 ft (6:10) 97% Recovery	
10	R3	60/60	10.00 - 15.00	RQD = 55%						R3: Hard, fresh, coarse to very coarse grained, white and gray, PEGMATITE. Joints are close, horizontal to low angle, planar, rough, fresh, tight to open to moderately wide. Rock Mass Quality = Fair R3: Core Times (min:sec): 10.0-11.0 ft (6:50), 11.0-12.0 ft (5:38), 12.0-13.0 ft (3:53), 13.0-14.0 ft (4:08), 14.0-15.0 ft (5:25) 100% Recovery	
15								11.90		15.00 **Bottom of Exploration at 15.00 feet below ground surface.**	
20											
25											

Remarks:

400-500 pounds of down pressure on Core Barrel.
Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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-BTAR-112

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-113
WIN: 22603.00

Driller:	MaineDOT	**Elevation (ft.)**	29.5	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Burpee	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	N. Sherwood	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/25/2016; 12:20-13:47	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	13+21.3, 23.1 ft Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.943	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	29.25		3-inch-layer HMA. (0.25)	
										Brown, moist, loose, SAND, trace gravel, (Fill).	
5	1D	24/20	5.00 - 7.00	3/4/3/3	7	11					
							10	23.50		(6.00) Red-brown and light gray, moist, loose, SAND, little gravel, trace rootlets, (Fill).	
							13				
							35				
	R1	72/55	9.20 - 15.20	RQD = 32%			a145	20.30		a145 blows for 0.2 feet. (9.20)	
10							NQ-2			Top of Bedrock at Elev. 20.3 feet. R1: Hard, slightly weathered (brown, dull), fine to medium grained, light gray, GNEISS. Joints are extremely close from 9.2'-11.2' to close, horizontal to moderately dipping, planar, smooth, discolored (brown staining and Clay infilling), open.	
								16.20		(13.30) R1: 13.3'-13.8': PEGMATITE	
								15.70		(13.80) R1: 13.8'-15.2': GNEISS, same as above. R1: Rock Mass Quality = Poor R1: Core Times (min:sec): 9.2-10.2 ft (3:55), 10.2-11.2 ft (2:30), 11.2-12.2 ft (4:15), 12.2-13.2 ft (4:20), 13.2-14.2 ft (3:46), 14.2-15.2 ft (4:08) 76% Recovery	
15	R2	60/58	15.20 - 20.20	RQD = 76%						R2: Hard, fresh, fine to medium grained, light gray and white, foliated, GNEISS. Joints are moderately spaced, low angle, planar, smooth, discolored (brown staining), open. R2: Rock Mass Quality = Good R2: Core Times (min:sec): 15.2-16.2 ft (2:21), 16.2-17.2 ft (2:31), 17.2-18.2 ft (3:30), 18.2-19.2 ft (3:19), 19.2-20.2 ft (3:30) 97% Recovery	
20								9.30		(20.20) **Bottom of Exploration at 20.20 feet below ground surface.**	
25											

Remarks:

Bedrock classifications made by Erik Friede (GZA) by observing rock core specimens in boxes after drilling.
As-drilled boring locations and ground surface elevations were surveyed by MaineDOT.

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: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River
Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-201
PIN: 22603.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	45.9	**Auger ID/OD:**	
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Split Spoon
Logged By:	E. Friede	**Rig Type:**	B-53	**Hammer Wt./Fall:**	140/30
Date Start/Finish:	12/7/18 - 12/7/18	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ2
Boring Location:	N396321.0, E1091837.7	**Casing ID/OD:**	4/4.5", 3/3.5"	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.931	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/24	0.3 - 2.3	29-20-12-12	32	50	SSA	45.6		-ASPHALT- 0.3 Brown and grey, medium to coarse SAND, little Gravel, trace Silt. -FILL-	
	2D	24/24	4.5 - 6.5	3-3-7-6	10	16	34			Brown, moist, fine to coarse SAND, trace Gravel, trace Silt, trace roots, trace weathered rock fragments at bottom. -FILL-	
5							40				
							100/3 RC	39.2		6.7 Top of rock.	
	R1	26/26	8.0 - 10.2	RQD = 0%			NQ2			R1: Hard, slightly weathered, coarse to very coarse, white, PEGMATITE. Joints are extremely close to close, low to high angle, planar to undulating, discolored, trace grey Silt infilling, open. Rock Mass Quality = Very Poor Recovery = 100% Rock Core Times (min:sec): 8.0-9.0' (3:17), 9.0-10.0' (2:56), 10.0-10.3' (1: 17)	
10	R2	48/48	10.3 - 14.3	RQD = 42%				35.6		10.3 R2: Hard, fresh to slightly weathered, medium to coarse, grey and white foliated, GNEISS. Joints are very close to close, low angle to moderately dipping, discolored to slightly weathered, planar, tight. Rock Mass Quality = Poor Recovery = 100% Rock Core Times (min:sec): 10.3-11.3' (1:28), 11.3-12.3' (1:34), 12.3-13.3' (2:26), 13.3-14.3' (1:56)	
	R3	36/36	14.3 - 17.3	RQD = 53%						R3: Hard, fresh to slightly weathered, medium to coarse, grey and white foliated, GNEISS. Joints are very close to close, low angle to moderately dipping, discolored to slightly weathered, planar, tight, Silt infilling at 17.3'. Rock Mass Quality = Fair Recovery = 8% Rock Core Times (min:sec): 14.3-15.3' (2:45), 15.3-16.3' (1:25), 16.3-17.3' (1:46)	
15	R4	12/1	17.3 - 18.3	RQD = 0%				27.6		R4: 1" of recovery, remainder of core left in hole. Rock Mass Quality = Very Poor Recovery = 8% 18.3	
										Bottom of Exploration at 18.30 feet below ground surface.	
20											
25											

Remarks:

1. Casing refusal at 6.7', advance roller cone to 8.0'. Set up to core.
2. Attempt to retrieve R4 rock core unsuccessful.

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: Frank J. Wood Bridge #2016 carries Route 201 over the Androscoggin River

Location: Brunswick-Topsham, Maine

Boring No.: BB-BTAR-202

PIN: 22603.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	2.0	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Split Spoon
Logged By:	E. Friede	**Rig Type:**	B-53	**Hammer Wt./Fall:**	140/30
Date Start/Finish:	12/6/18 - 12/6/18	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ2
Boring Location:	N396378.2, E1091945.0	**Casing ID/OD:**	3/3.5"	**Water Level*:**	River Level
Hammer Efficiency Factor:	0.931	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	R1	8/6	0.0 - 0.7	RQD = 0%				1.3		R1: Hard, fresh to slightly weathered, medium grained, grey and white foliated, GNEISS. Joints are very close, low angle to moderately dipping, planar, discolored, open. Rock Mass Quality = Very Poor Recovery = 75% Rock Core Times (min:sec): 0-0.7' (4:57) — 0.7	
	R2	18/12	0.7 - 2.2	RQD = 0%				1.0		R2: 0.7'-1.0': Soft, highly weathered, grey, Rock fragments. — 1.0	
								-0.2		R2: 1.0'-2.2': Hard, slightly weathered, medium grained, grey and white foliated, GNEISS. Joints are very close, low angle, planar to undulating, fresh, open. Rock Mass Quality = Very Poor Recovery = 67% Rock Core Times (min:sec): 0.7-1.7' (6:30), 1.7-2.2' (4:50) — 2.2	
										Bottom of Exploration at 2.20 feet below ground surface.	
5											
10											
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.

APPENDIX C – GEOPHYSICAL LOGGING RESULTS

GEOPHYSICAL LOG RESULTS OF BOREHOLES BB-BTAR-108, BB-BTAR-109 AND BB-BTAR-110 BRUNSWICK-TOPSHAM SITE IN TOPSHAM, ME

Northeast Geophysical Services
Bangor, Maine
October, 2016

GEOPHYSICAL LOG RESULTS
OF BOREHOLES BB-BTAR-108,
BB-BTAR-109 AND BB-BTAR-110
BRUNSWICK-TOPSHAM SITE
IN TOPSHAM, ME

Introduction

At the request of the GZA, three bedrock boreholes (BB-BTAR-108, BB-BTAR-109 and BB-BTAR-110) located next to the Frank J. Wood Bridge in Topsham, Maine were geophysically logged on September 7, 2016 by Rudy Rawcliffe of Northeast Geophysical Services (NGS), Inc. The purpose of the geophysical logging was to determine the location and orientation of fractures, joints and cracks in the boreholes. Caliper, acoustic televiewer (ATV) and optical televiewer (OTV) were run on each borehole.

Summary of Results

Geophysical logs for the three boreholes are attached to this report as Attachments A, B and C. Attachment A contains data from BB-BTAR-108, Attachment B contains data from BB-BTAR-109 and Attachment C contains data from BB-BTAR-110. For each borehole the data are presented in a series of logs (Plates 1-3) that show the results of the geophysical measurements. Tables that provide the depth and calculated strike and dip of each identified feature are also presented in the attachments.

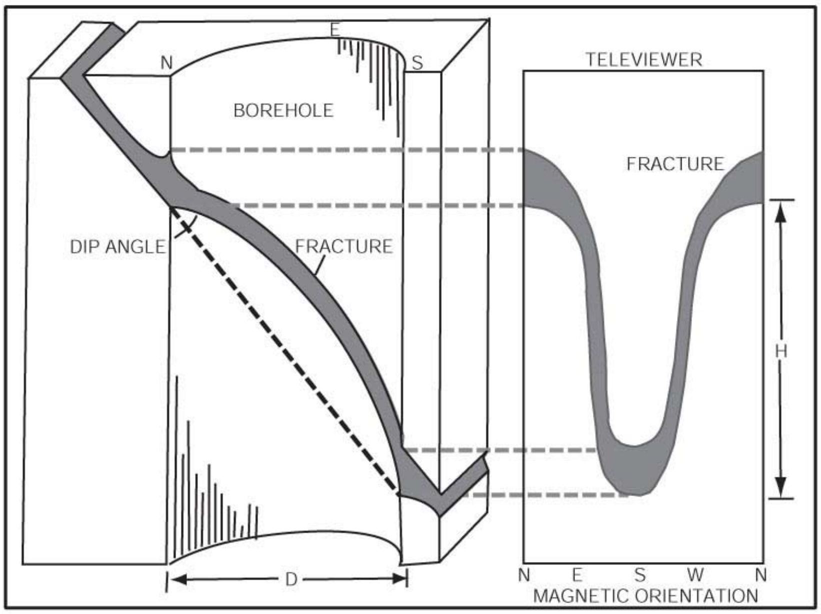
Methods and Instrumentation

The boreholes were logged with a Mount Sopris Matrix digital logger. Each borehole was first logged with an optical televiewer. The optical log provides a digital image of the borehole walls that is oriented to magnetic north. Planar features such as fractures, bedding surfaces, and joints can be identified with the optical tool and the strike, dip direction and dip angle of these features can often be determined.

Each borehole was then logged with an acoustic televiewer. The ATV log provides an acoustical image of the borehole walls. The ATV works by scanning the borehole wall with an acoustic beam that is produced by a rapidly rotating piezoelectric source. Similar to the optical televiewer, planar features such as fractures, bedding surfaces and joints can be identified with the ATV tool and the strike, dip direction and dip angle of these features can often be determined. The ATV (and OTV) data are presented as “unwrapped” images of the borehole wall that are oriented to magnetic north. The dip angle and dip direction of any planar feature that intersects the borehole can be measured from this image. Figure 1, on the following page, illustrates this.

The optical and acoustical televiewer logs are somewhat duplicative in that they both can provide similar information. However, there are advantages and disadvantages to both tools. The ATV requires the borehole to be water filled and will not provide information above the water level. The OTV can work in air or water but is not effective in cloudy, turbid water whereas the ATV will work fine in cloudy water. The ATV can be better at discerning voids, cracks and fractures whereas the OTV can be better at discerning lithology. Also, sometimes water-bearing fractures are rust stained, which can be seen by the OTV.

Borehole Televiewer Data



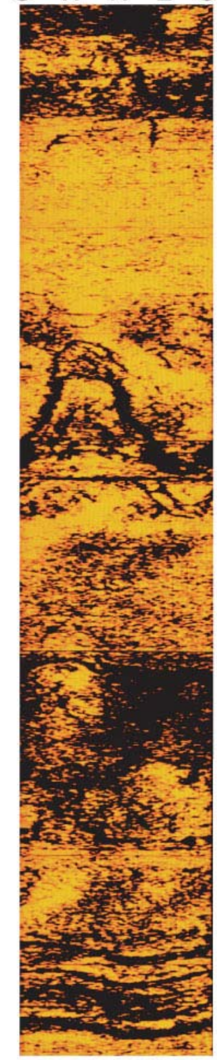


Figure 1 - ATV Unwrapped Image

Geophysical Log Results

	Attachment A BB-BTAR-108:	Attachment B BB-BTAR-109:	Attachment B BB-BTAR-110:
Total Depth (from ground):	23.8 feet	25.2 feet	23.8 feet
Casing Depth:	none	none	none
Water Level:	6.5 feet	3.6 feet	0 feet

Plate 1 in each of the attachments shows the OTV and ATV logs for that borehole. The ATV and OTV logs provide the strike and dip of planar features that intersect the borehole. These planar features may be fractures, joints, cracks or may represent cleavage or bedding planes. All of the depths on the logs are referenced from the ground surface.

Also shown on Plate 1 is a 3-D "virtual core" image of the borehole that is derived from the optical televiewer.

The two columns on the right side of Plate 1 present the interpreted structure of the planar features that intersect the borehole. The column titled, "Structure" is a projection of the interpreted structure in the borehole. It was obtained by digitizing the planar features from the ATV and OTV logs. The dip direction and dip amount (corrected for the deviation of the borehole) was obtained from this log and tabulated in the attachments. The relative aperture width of the fractures is indicated by the line width of the digitized planar features. The fractures thought to be possibly transmissive are colored light blue.

The log in the far right column entitled, "Tadpole Plot" presents the structural data as a tadpole plot. The head of the tadpole indicates the dip amount (from 0 to 90 degrees) and the tail of the tadpole indicates the dip direction.

Plate 2 for each borehole is a Rose plot of the strike and dip direction of all the interpreted planar features in each borehole.

Plate 3 for each borehole is a polar plot (lower hemisphere) showing the dip amount and dip direction of all the interpreted planar features in each borehole.

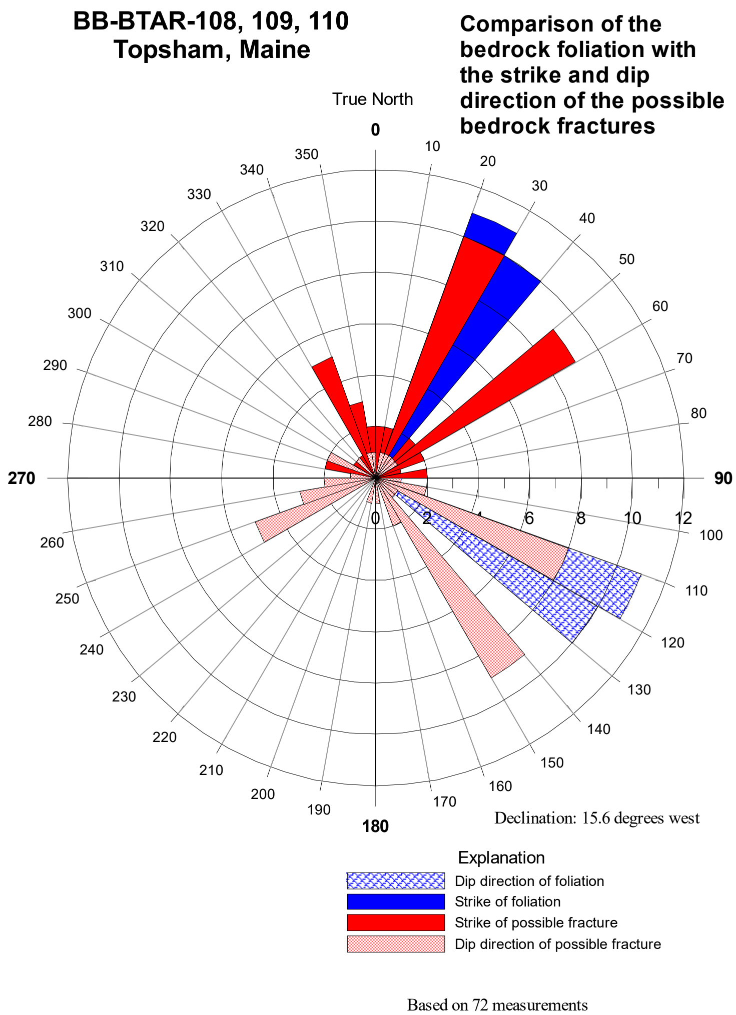
Table 1 in each attachment is a tabulation of the planar features (possible fractures, joints, bedding, foliation, etc) that were identified in each of the boreholes. Table 1 provides the depth and calculated strike and dip of the planar features in each borehole that have been interpreted from the televiewer logs. The results in Table 1 have been categorized and also have been color-coded on the logs to provide an interpretative range of what the associated feature represents as follows:

- Black symbol (category 101) - bedrock planar feature with aperture less than 1 mm interpreted represent bedding, foliation or discontinuities such as fractures, joints, cracks or mechanical breaks in the rock matrix due to drilling advancement.
- Light blue symbol (category 108) - bedrock feature with aperture width between 1 and 10 mm interpreted represent discontinuities such as fractures, joints, cracks or mechanical breaks in the rock matrix due to drilling advancement.
- Dark blue symbol (category 107) - bedrock feature with aperture width greater than 10 mm interpreted represent discontinuities such as fractures, joints, cracks or mechanical breaks in the rock matrix due to drilling advancement.

Discussion of Geophysical Log Results

The objective of the televiewer logging was to map the discontinuities (fractures, joints and cracks) in the boreholes. In general, the bedrock in the boreholes appeared to be fairly competent with no large cracks or fractures. A total of 47 planar features (possible joints, fractures, cracks, etc.) were measured in the three boreholes which collectively had about 73 lineal feet of length. Of these, nine were estimated to have an aperture of between 1and 10 mm (Category 108) and none of the features were estimated to have an aperture of over 10 mm (Category 107). The features that have wider apertures are more likely to represent planes of weakness in the bedrock.

The predominant strike of the foliation or bedding of the bedrock in these three boreholes is to the northeast at about 30° and dipping 45° to the southeast. Slightly over 20% of the 47 planar features (possible joints, fractures, cracks, etc.) had a similar orientation. About 23% had a strike of about 55° and dip towards the southeast and about 17% had a strike of about 335° and dip towards the southwest. The remainder of the features were nearly horizontal with dips of less than 10°. The Rose plot below compares the strike and dip direction of the bedrock foliation (shown in blue) with the strike and dip direction of the possible joints and fractures (shown in red).



ATTACHMENTS

BOREHOLE TELEVIEWER LOGS AND GRAPHS

ATTACHMENT A
BOREHOLE BB-BTAR-108
GEOPHYSICAL LOGS

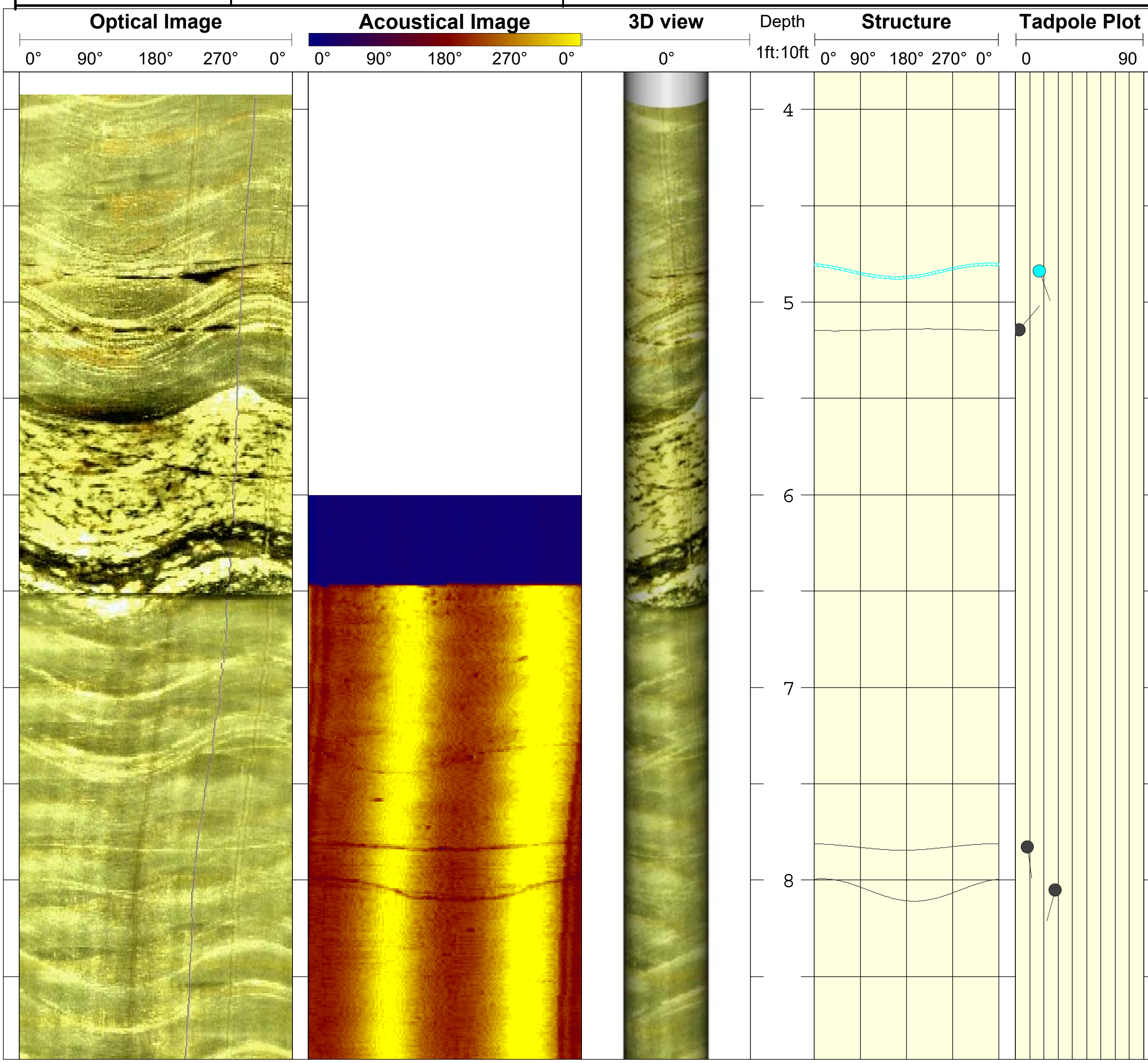
Northeast Geophysical Services
4 Union Street Bangor, Maine 04401
Tel. 207-942-2700
email: ngsinc@negeophysical.com

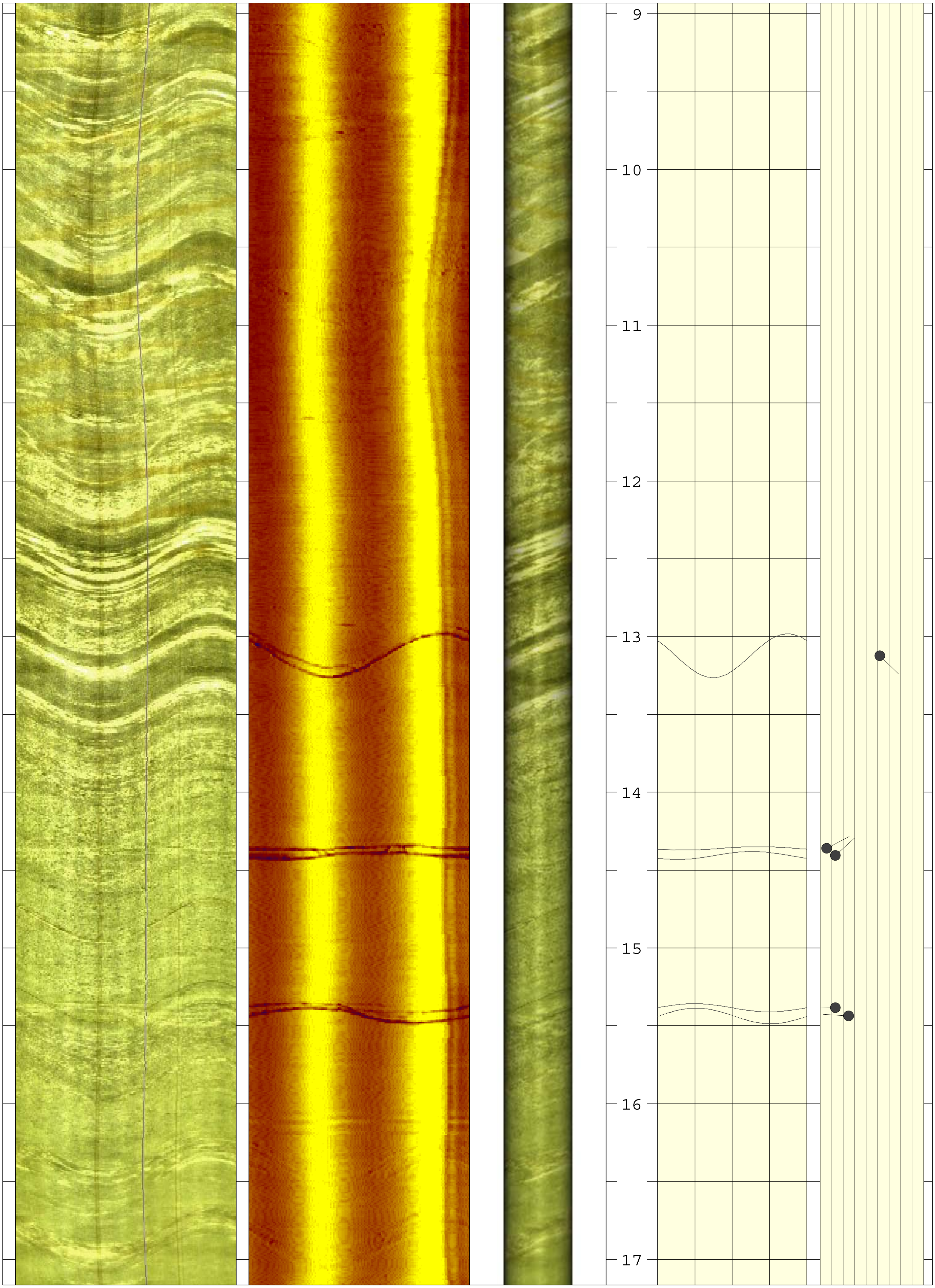
Log: Plate A-1 Televiewer Logs

Well: **BB-BTAR-108**

Site: Brunswick-Topsham Bridge

Date:	9-7-2016	Location:	Topsham, Maine
Casing Depth:	0	For:	GZA
Casing Type:	none	Logged by:	R. Rawcliffe
Boring Depth:	23.8 ft	Orientation:	magnetic
Meas. From:	ground	Structure Plots:	black = planar feature (bedding, foliation, fracture, joint) < 1 mm light blue = fracure with aperture between 1 and 10 mm dark blue = fracture with aperute > 10 mm
Stickup:	0		
Water Level:	6.5 ft		

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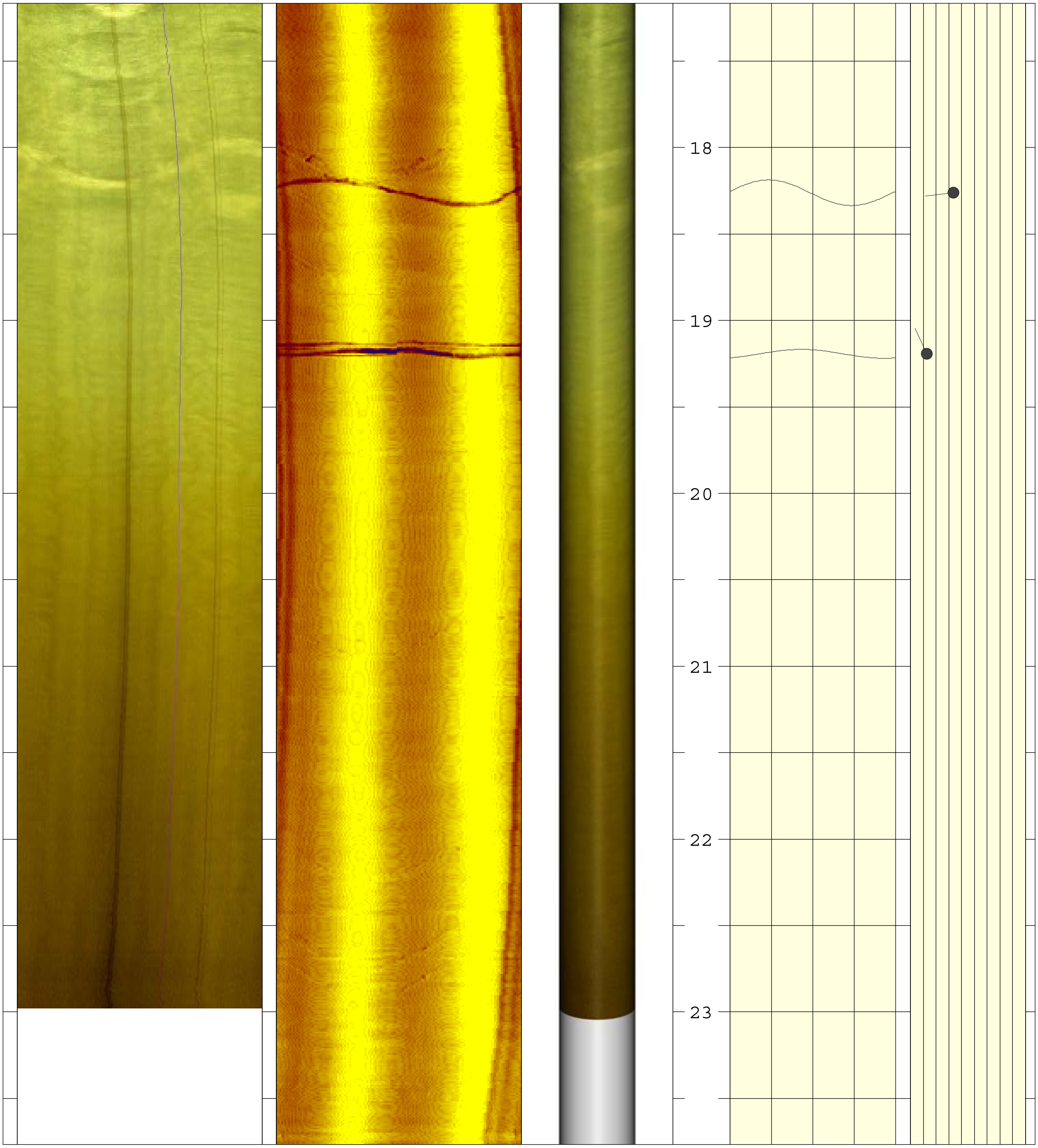
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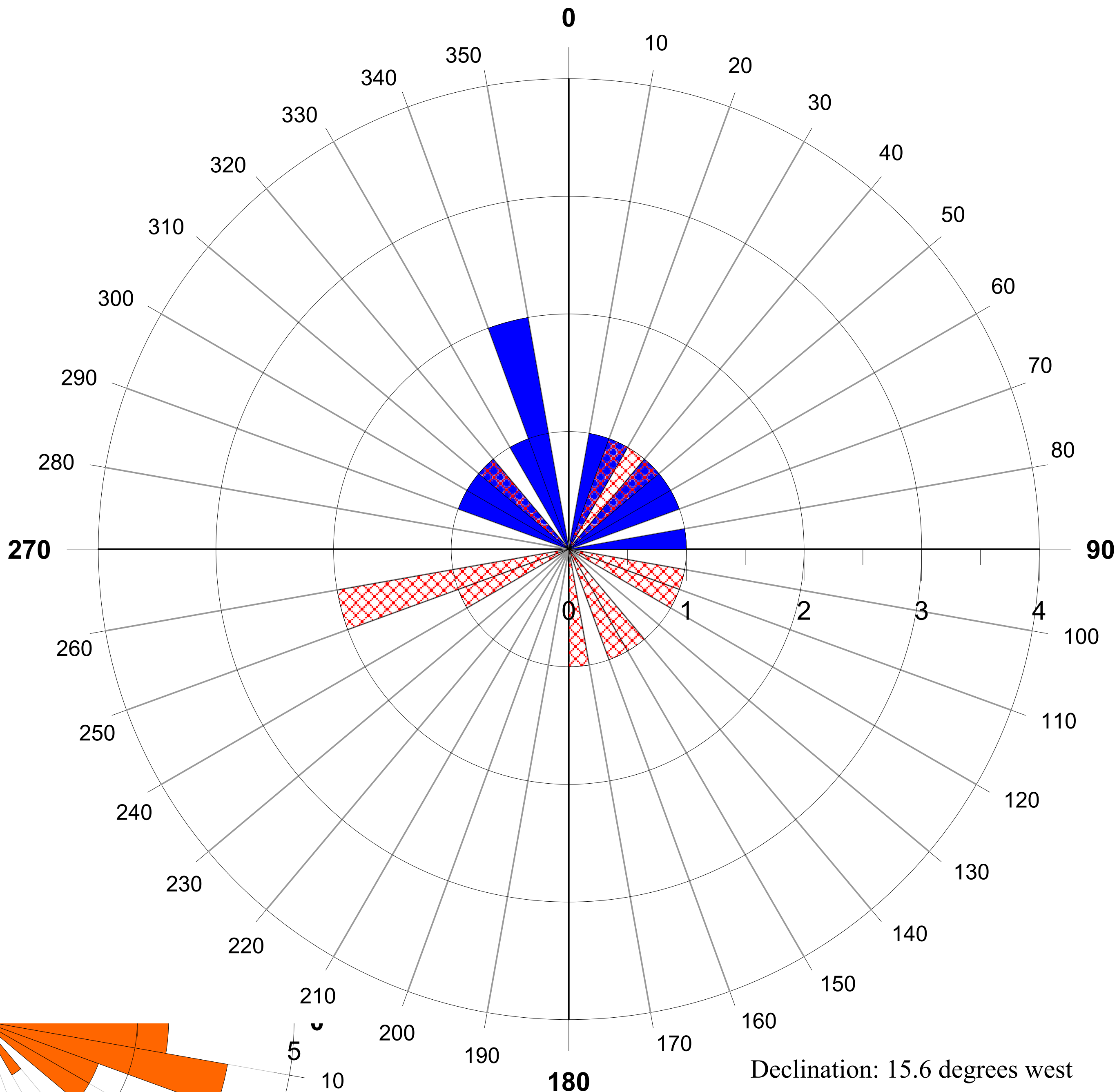
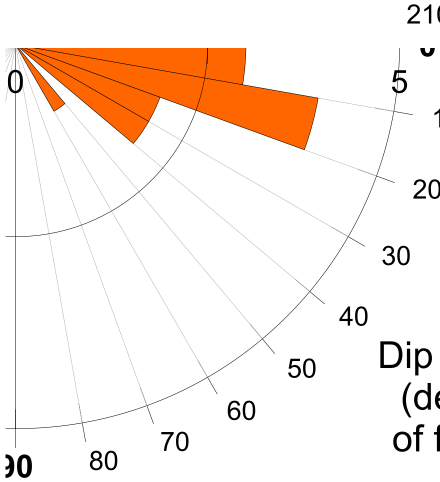
Northeast Geophysical Services

BB-BTAR-108
Topsham, Maine

PLATE A-2
Strike and Dip Direction of all features





Dip Amount (degrees) of features

Declination: 15.6 degrees west

Explanation

Dip direction of feature

Strike of feature

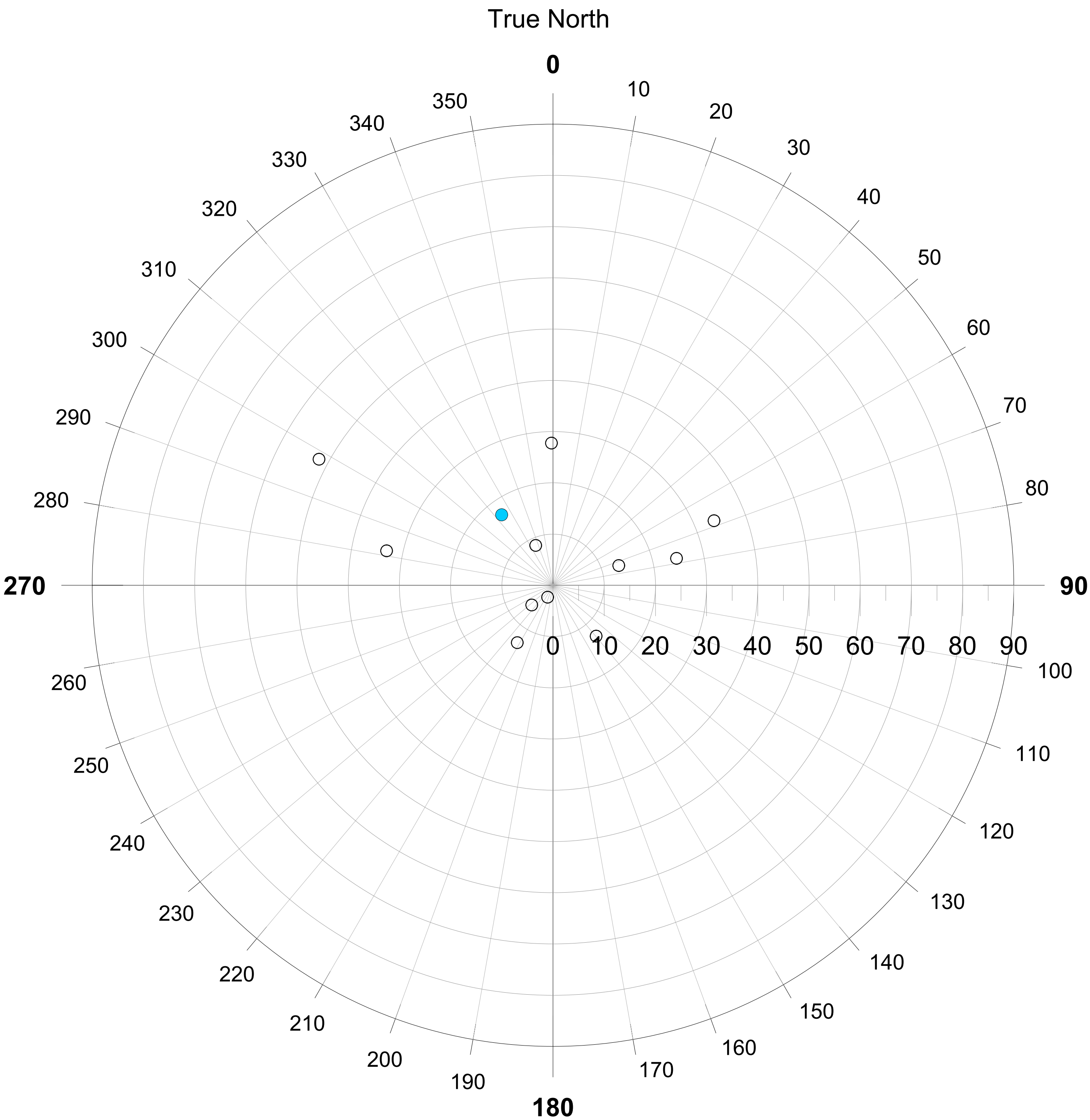
Dip Amount (Tilt)

Based on 12 measurements

Northeast Geophysical Services

BB-BTAR-108 Borehole
Topsham, Maine

PLATE A-3
Dip Amount and Dip Azimuth of planar features (lower hemisphere plot)



Explanation - Fracture widths

- ○ Aperture < 1 mm
- ● Aperture width 1 to 10 mm
- ● Aperture > 10 mm

Declination: 15.6 degrees west

Based on 12 measurements

TABLE A-1 Planar features interpreted from acoustical and optical televiewers
BB-BTAR-108 - Brunswick-Topsham Site - Topsham, ME **Logged: 9/07/2016**

Borehole	Feature # Number	Feature depth Feet	Dip Degrees	Dip Azimuth magnetic	Strike magnetic	Dip Azimuth True	Strike True	Aperture width (mm)	Category
BB-BTAR-108	1	4.8	17	160	70	144	54	4	108
BB-BTAR-108	2	5.2	3	40	310	24	294	<1 mm	101
BB-BTAR-108	3	7.4	33	117	27	102	12	<1 mm	101
BB-BTAR-108	4	7.8	8	172	82	157	67	<1 mm	101
BB-BTAR-108	5	8.1	28	195	285	179	89	<1 mm	101
BB-BTAR-108	6	13.1	52	134	44	118	28	<1 mm	101
BB-BTAR-108	7	14.4	6	63	333	47	317	<1 mm	101
BB-BTAR-108	8	14.4	13	47	317	32	302	<1 mm	101
BB-BTAR-108	9	15.4	13	269	359	253	343	<1 mm	101
BB-BTAR-108	10	15.4	25	273	3	258	348	<1 mm	101
BB-BTAR-108	11	18.3	34	264	354	248	338	<1 mm	101
BB-BTAR-108	12	19.2	13	335	65	320	50	<1 mm	101

Category Explanation:

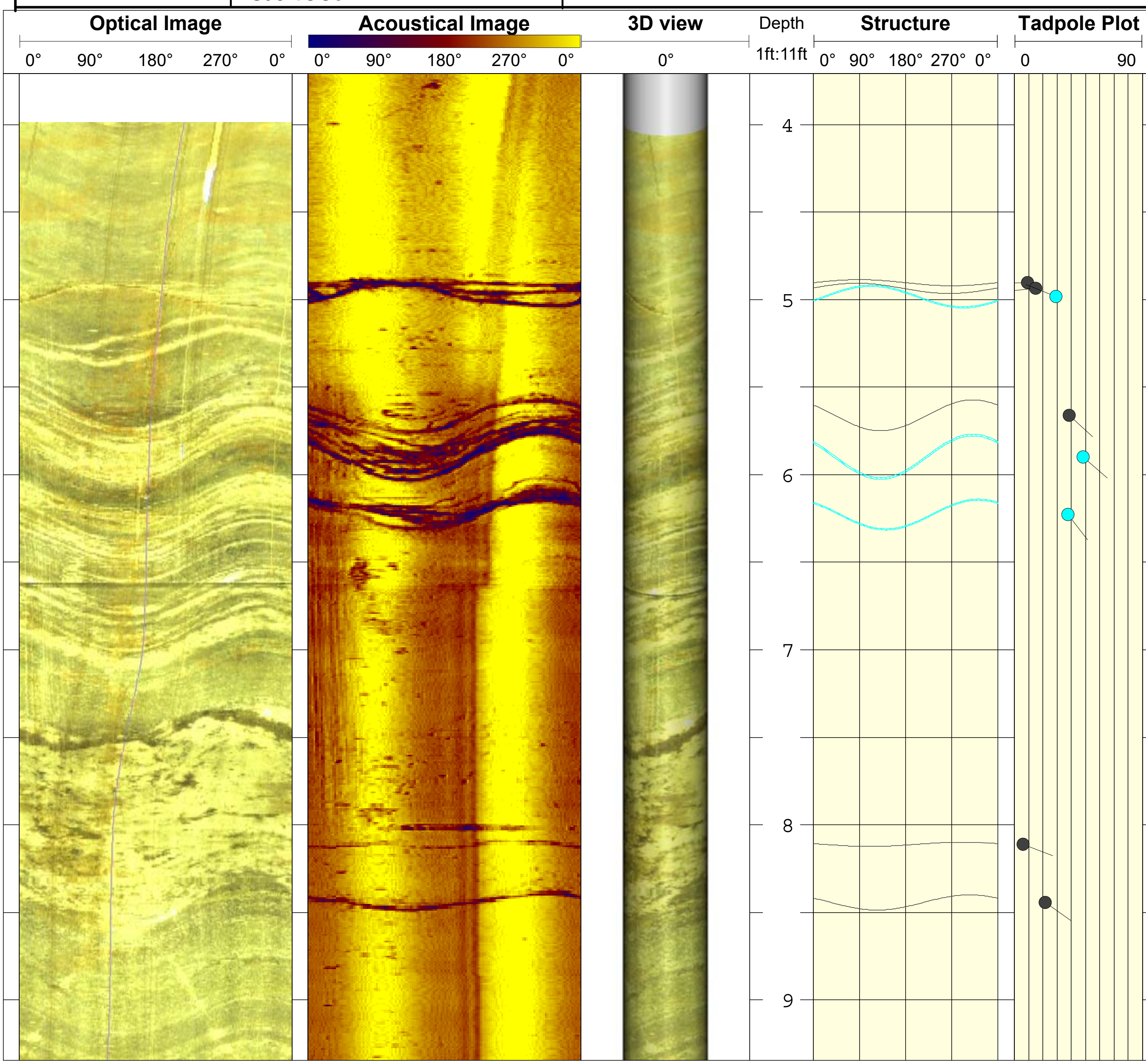
	101	planar feature such as foliation, bedding, joint, fracture, etc. with aperture < 1 mm
	108	planar feature - possible joint, fracture or crack with aperture width 1 to 10 mm
	107	planar feature - likely joint, fracture or crack with aperture width > 10 mm

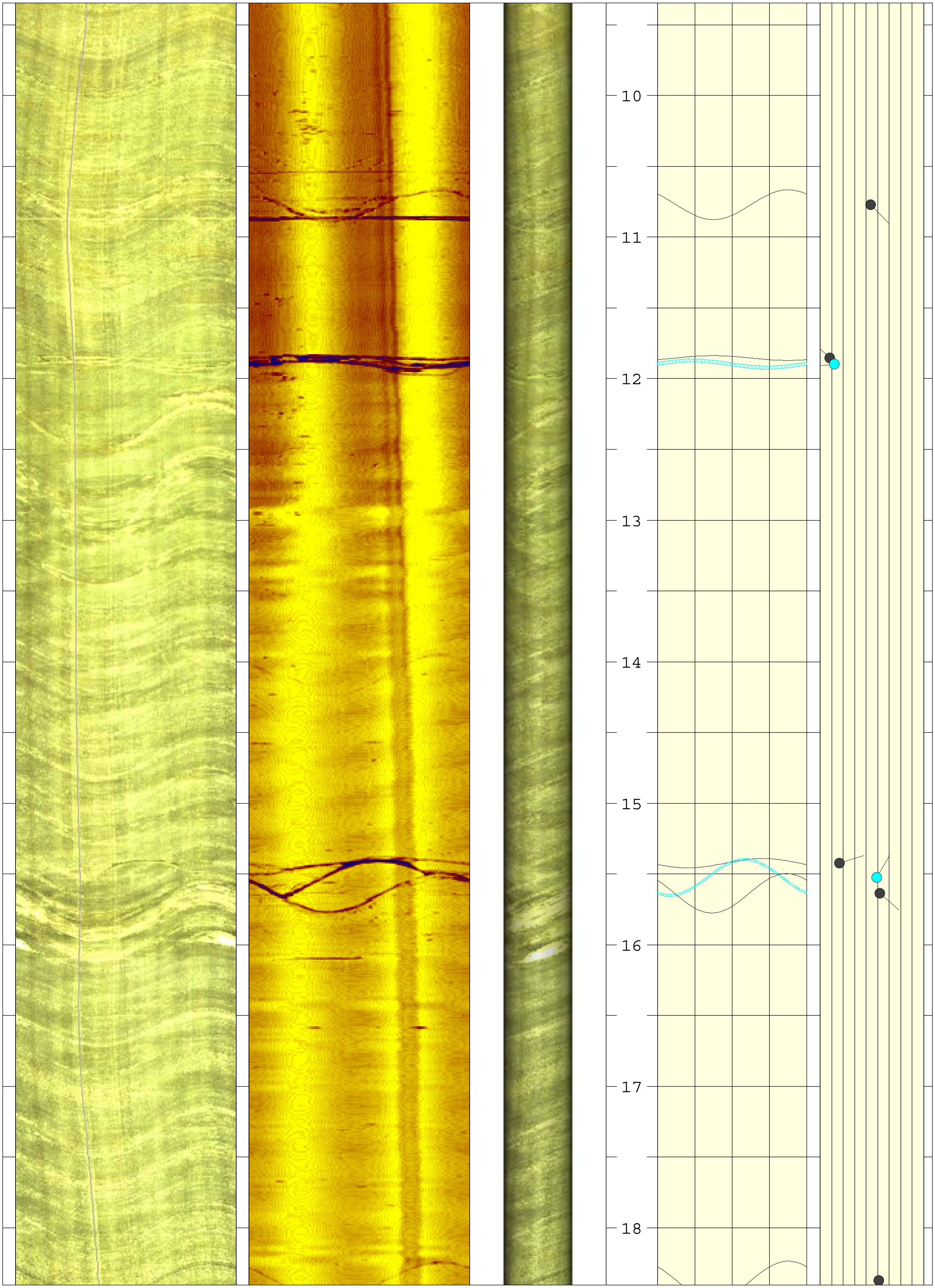
ATTACHMENT B
BOREHOLE BB-BTAR-109
GEOPHYSICAL LOGS

Northeast Geophysical Services
4 Union Street Bangor, Maine 04401
Tel. 207-942-2700
email: ngsinc@negeophysical.com

Log:	**Plate B-1 Televiewer Plots**
Well:	**BB-BTAR-109**
Site:	Brunswick-Topsham Bridge
Date:	9-7-2016
Location:	Topsham, Maine
Casing Depth:	none
For:	GZA
Casing Type:	none
Logged by:	R. Rawcliffe
Boring Depth:	25.2
Orientation:	magnetic
Meas. From:	ground
Stickup:	0
Water Level:	3.6 feet

Structure Plots:
black = planar feature (bedding, foliation, fracture, joint) < 1 mm
light blue = fracure with aperture between 1 and 10 mm
dark blue = fracture with aperute > 10 mm

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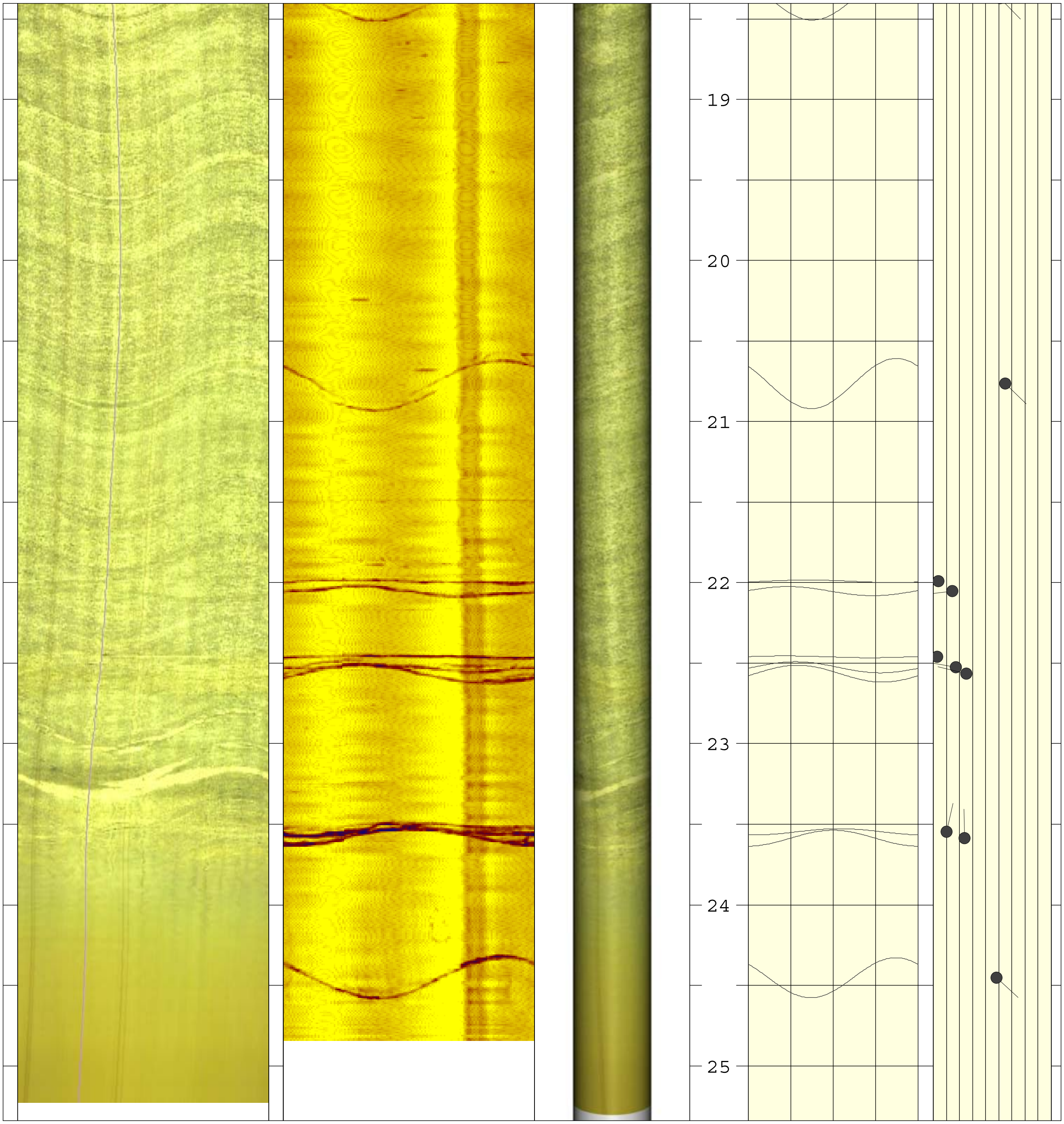
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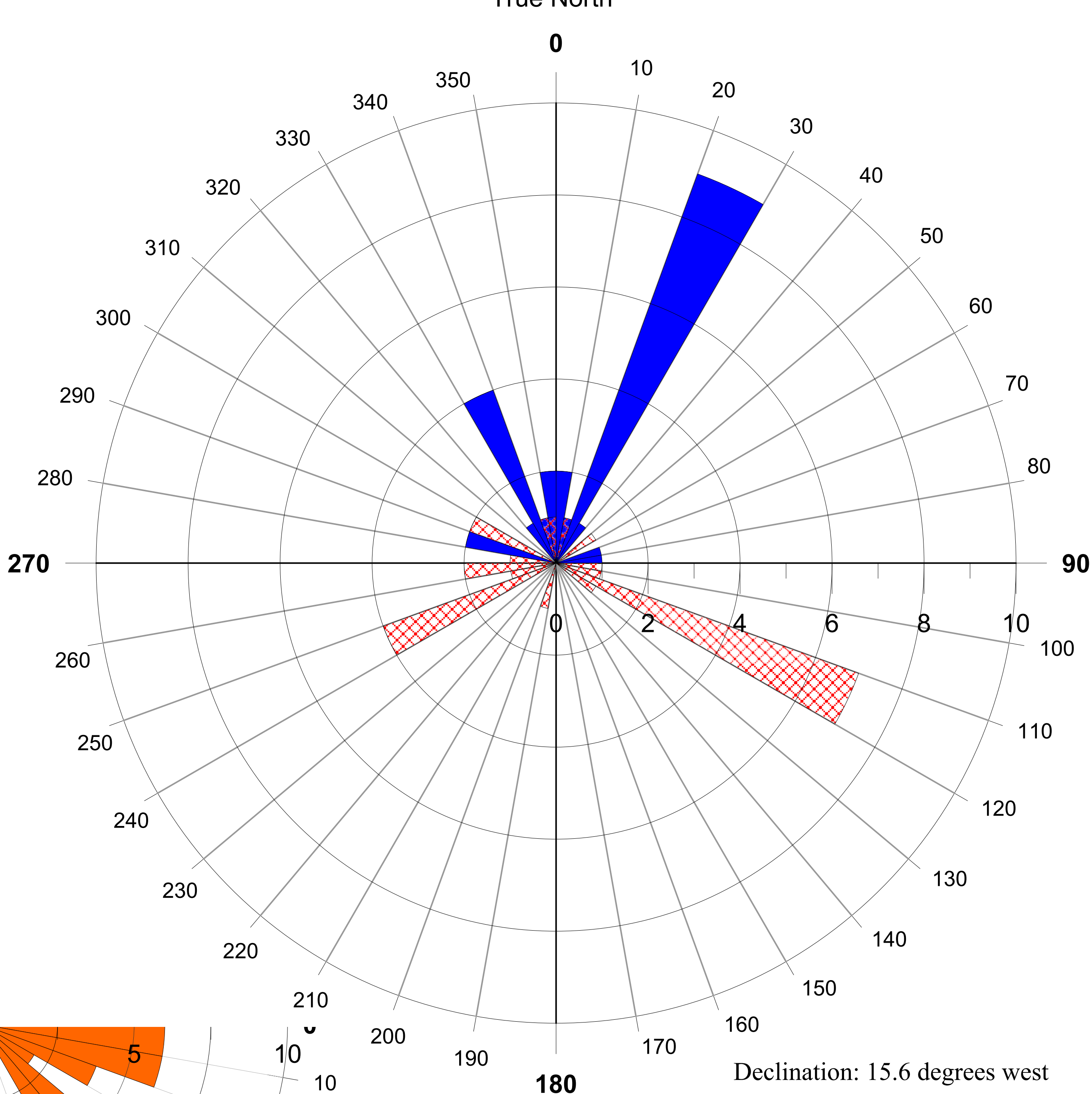
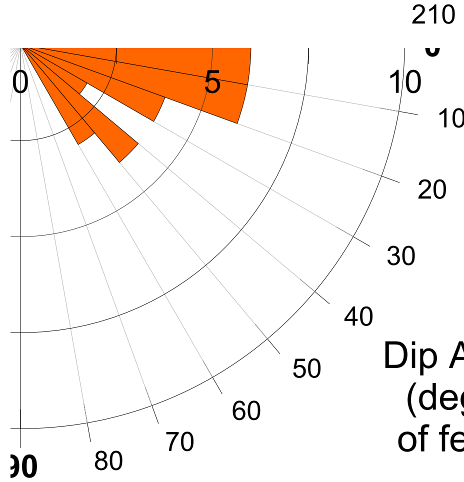
Northeast Geophysical Services

BB-BTAR-109
Topsham, Maine

PLATE B-2
Strike and Dip Direction of all features





Dip Amount (degrees) of features

Declination: 15.6 degrees west

Explanation

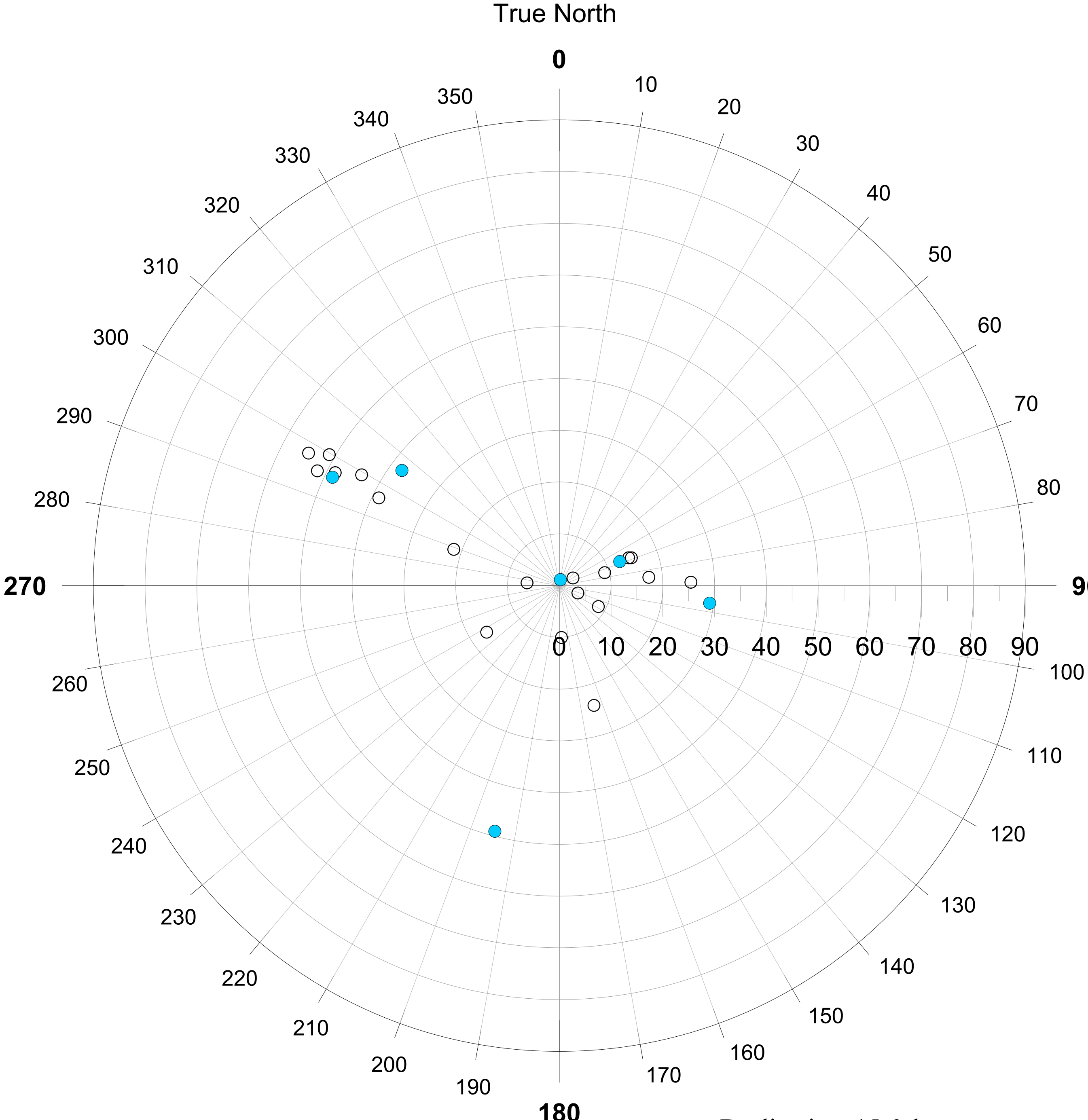
- Dip direction of feature
- Strike of feature
- Dip Amount (Tilt)

Based on 25 measurements

Northeast Geophysical Services

BB-BTAR-109 Borehole
Topsham, Maine

PLATE B-3
Dip Amount and Dip Azimuth of planar features (lower hemisphere plot)



Explanation - Fracture widths

- Aperture < 1 mm
- Aperture width 1 to 10 mm
- Aperture > 10 mm

Declination: 15.6 degrees west

Based on 25 measurements

TABLE B-1 Planar features interpreted from acoustical and optical televiewers
BB-BTAR-109 - Brunswick-Topsham Bridge Site - Topsham, ME **Logged: 9/07/2016**

Borehole	Feature # Number	Feature depth Feet	Dip Degrees	Dip Azimuth magnetic	Strike magnetic	Dip Azimuth True	Strike True	Aperture width (mm)	Category
BB-BTAR-109	1	4.9	9	270	360	254	344	<1 mm	101
BB-BTAR-109	2	4.9	15	265	355	249	339	<1 mm	101
BB-BTAR-109	3	5.0	29	292	22	277	7	1	108
BB-BTAR-109	4	5.7	39	132	42	116	26	<1 mm	101
BB-BTAR-109	5	5.9	49	131	41	116	26	2	108
BB-BTAR-109	6	6.2	38	142	52	126	36	2	108
BB-BTAR-109	7	8.1	6	110	20	95	5	<1 mm	101
BB-BTAR-109	8	8.4	22	125	35	109	19	<1 mm	101
BB-BTAR-109	9	10.8	44	135	45	119	29	<1 mm	101
BB-BTAR-109	10	10.9	1	208	298	192	282	4	108
BB-BTAR-109	11	11.9	9	314	44	298	28	<1 mm	101
BB-BTAR-109	12	11.9	13	264	354	248	338	6	108
BB-BTAR-109	13	15.4	17	73	343	57	327	<1 mm	101
BB-BTAR-109	14	15.5	49	30	300	15	285	3	108
BB-BTAR-109	15	15.6	52	131	41	115	25	<1 mm	101
BB-BTAR-109	16	18.4	51	135	45	120	30	<1 mm	101
BB-BTAR-109	17	20.8	55	133	43	118	28	<1 mm	101
BB-BTAR-109	18	22.0	4	307	37	292	22	<1 mm	101
BB-BTAR-109	19	22.1	14	264	354	248	338	<1 mm	101
BB-BTAR-109	20	22.5	3	257	347	241	331	<1 mm	101
BB-BTAR-109	21	22.5	17	280	10	265	355	<1 mm	101
BB-BTAR-109	22	22.6	25	284	14	269	359	<1 mm	101
BB-BTAR-109	23	23.6	10	13	283	358	88	<1 mm	101
BB-BTAR-109	24	23.6	24	359	89	344	74	<1 mm	101
BB-BTAR-109	25	24.5	48	132	42	117	27	<1 mm	101

Category Explanation:

(white)	101	planar feature such as foliation, bedding, joint, fracture, etc. with aperture < 1 mm
(light yellow)	108	planar feature - possible joint, fracture or crack with aperture width 1 to 10 mm
(yellow)	107	planar feature - likely joint, fracture or crack with aperture width > 10 mm

ATTACHMENT C
BOREHOLE BB-BTAR-110
GEOPHYSICAL LOGS

Northeast Geophysical Services
4 Union Street Bangor, Maine 04401
Tel. 207-942-2700
email: ngsinc@negeophysical.com

Log: Plate C-1 Televiewer Plots

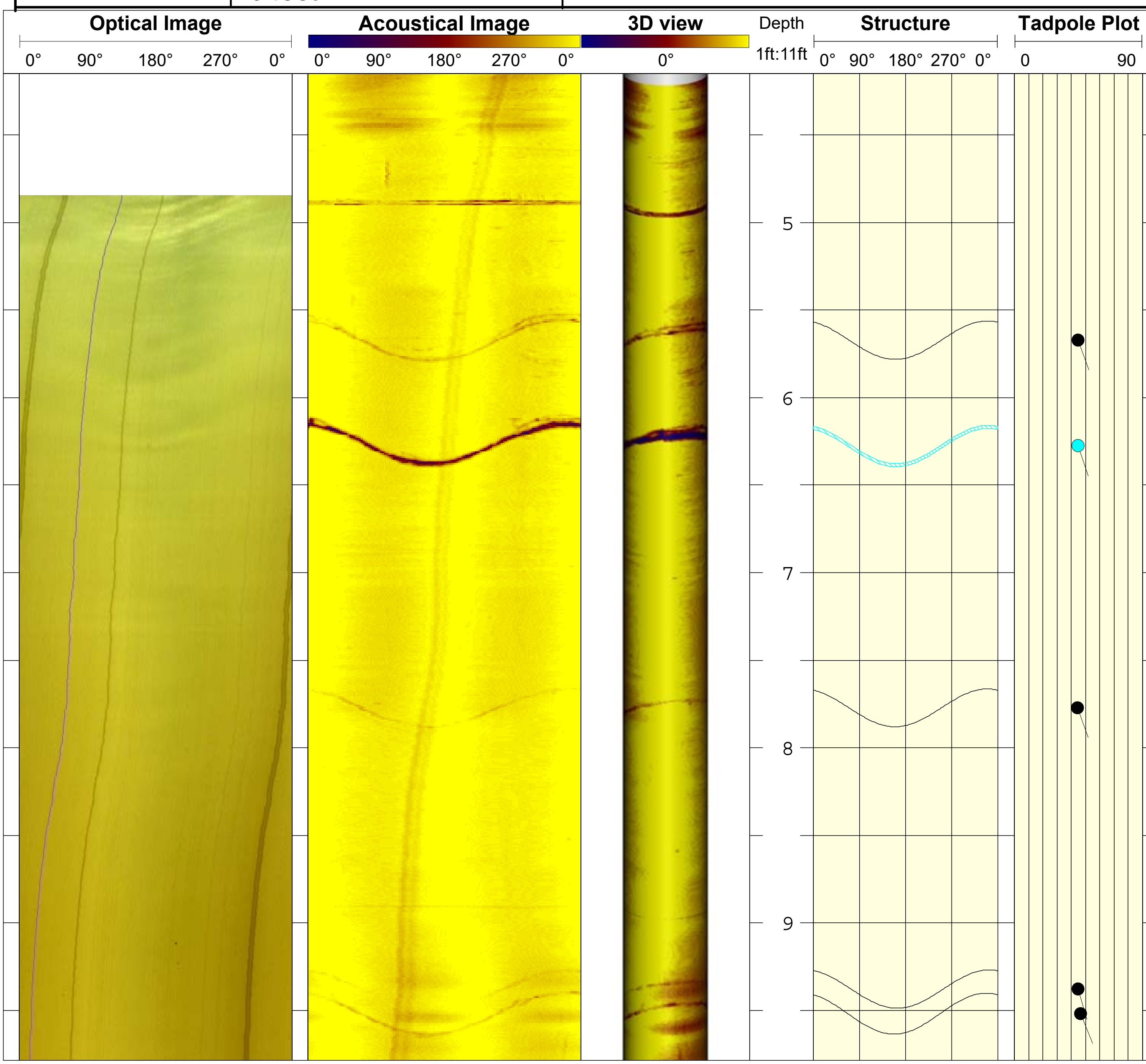
Well: BB-BTAR-110

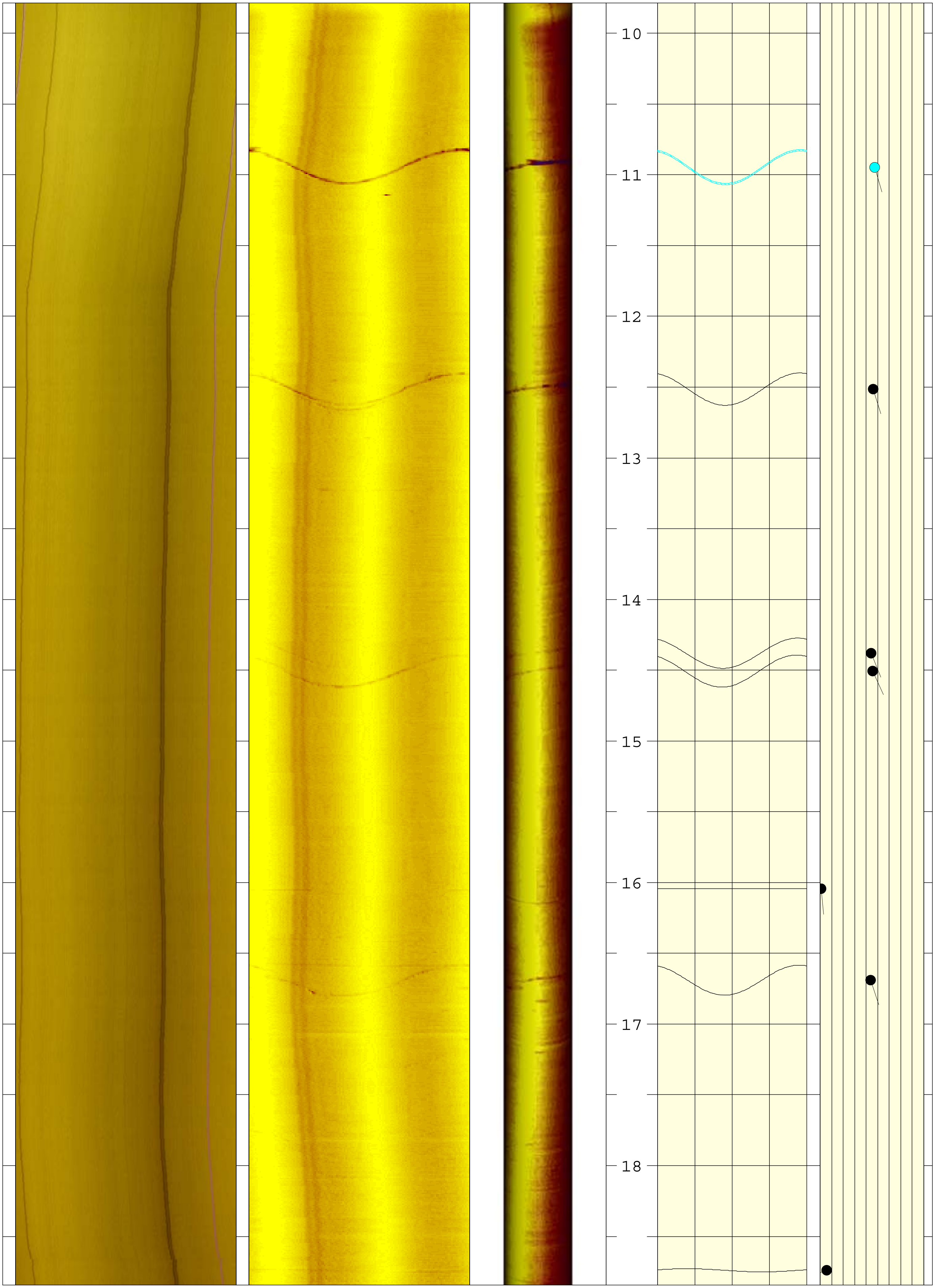
Site: Brunswick-Topsham Bridge

Date:	9-7-2016
Location:	Topsham, Maine
Casing Depth:	none
For:	GZA
Casing Type:	none
Logged by:	R. Rawcliffe
Boring Depth:	23.8 ft
Orientation:	magnetic
Meas. From:	ground
Stickup:	none
Water Level:	0 feet

Structure Plots:

black = planar feature (bedding, foliation, fracture, joint) < 1 mm
light blue = fracure with aperture between 1 and 10 mm
dark blue = fracture with aperute > 10 mm

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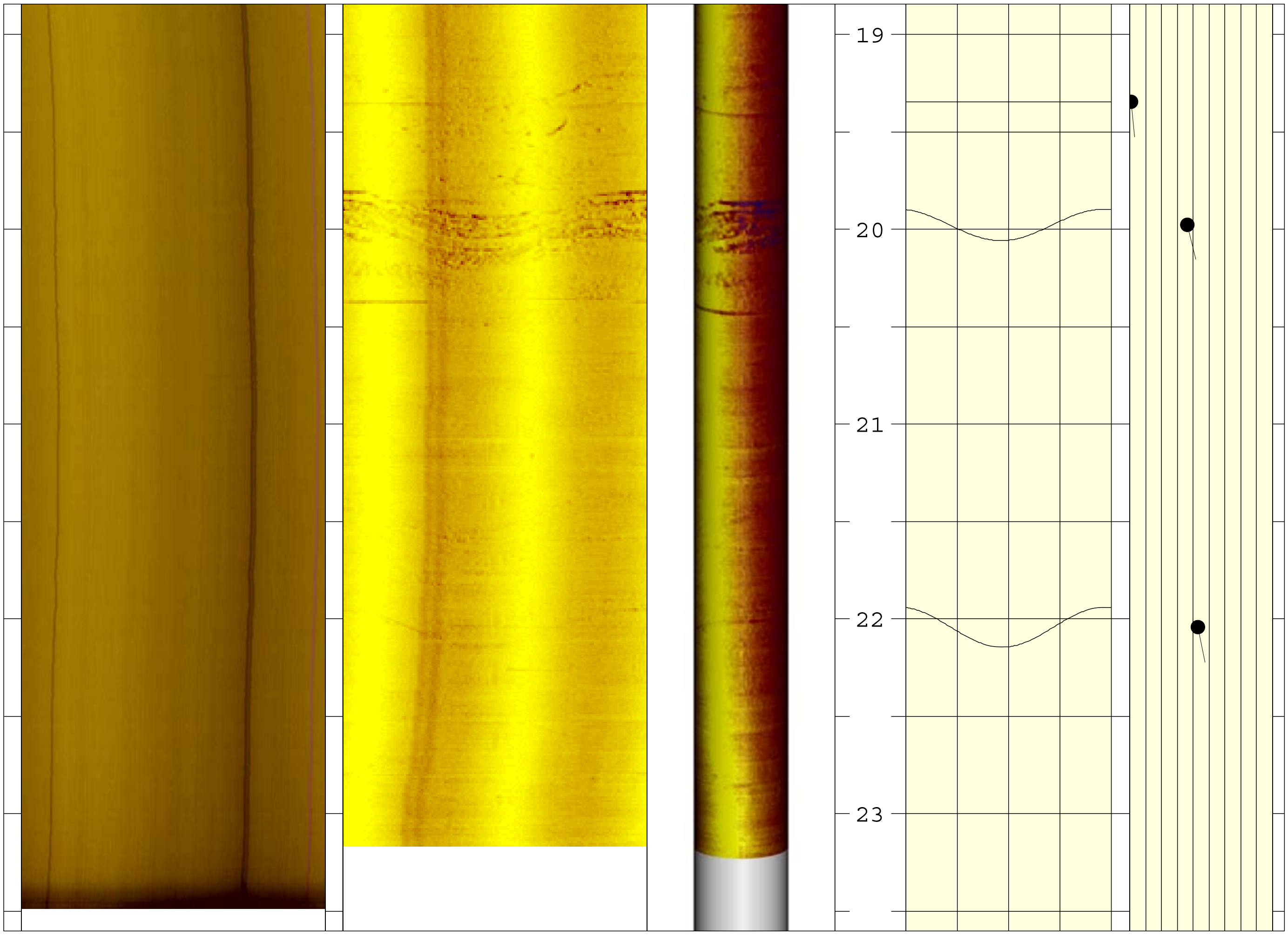
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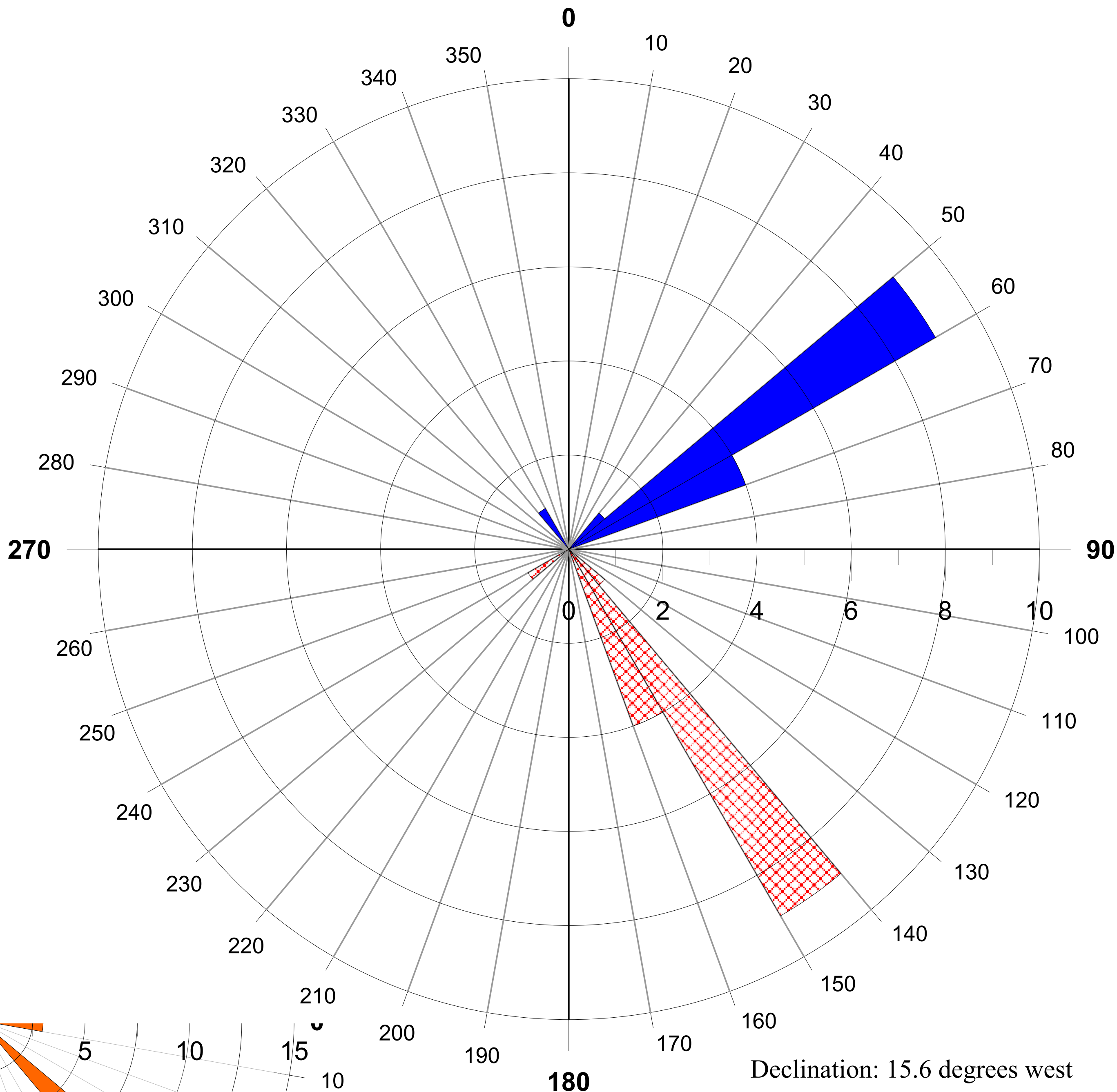
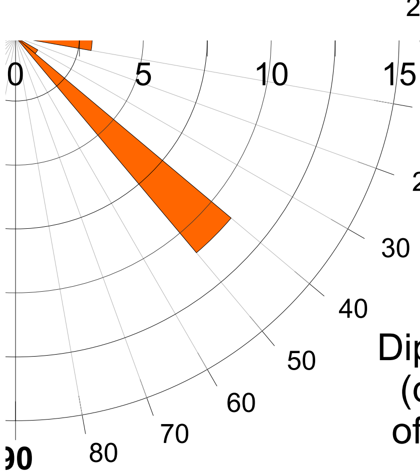
Northeast Geophysical Services

BB-BTAR-110
Topsham, Maine

PLATE C-2
Strike and Dip Direction of all features





Dip Amount (degrees) of features

Declination: 15.6 degrees west

Explanation

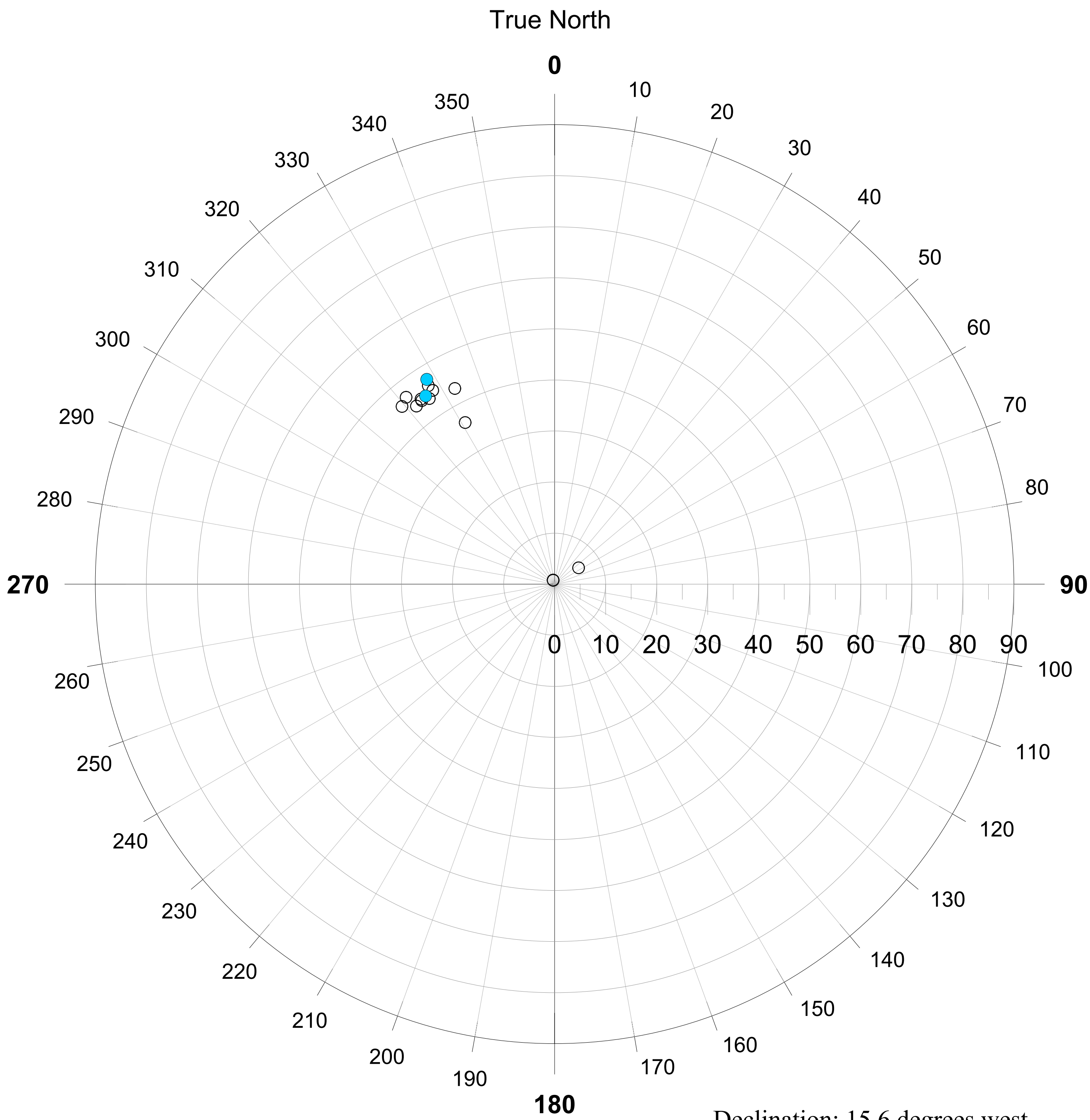
- Dip direction of feature
- Strike of feature
- Dip Amount (Tilt)

Based on 15 measurements

Northeast Geophysical Services

BB-BTAR-110 Borehole
Topsham, Maine

PLATE C-3
Dip Amount and Dip Azimuth of planar features (lower hemisphere plot)



Declination: 15.6 degrees west

Based on 15 measurements

Explanation - Fracture widths

○ Aperture < 1 mm

● Aperture width 1 to 10 mm

● Aperture > 10 mm

TABLE C-1 Planar features interpreted from acoustical and optical televiewers
BB-BTAR-110 - Brunswick-Topsham Bridge Site - Topsham, ME **Logged: 9/07/2016**

Borehole	Feature # Number	Feature depth Feet	Dip Degrees	Dip Azimuth magnetic	Strike magnetic	Dip Azimuth True	Strike True	Aperture width (mm)	Category
BB-BTAR-110	1	5.7	45	160	70	144	54	<1 mm	100
BB-BTAR-110	2	6.3	45	161	71	146	56	4	108
BB-BTAR-110	3	7.8	44	160	70	144	54	<1 mm	100
BB-BTAR-110	4	9.4	45	163	73	148	58	<1 mm	100
BB-BTAR-110	5	9.5	47	157	67	142	52	<1 mm	100
BB-BTAR-110	6	10.9	47	164	74	148	58	2	108
BB-BTAR-110	7	12.5	46	163	73	148	58	<1 mm	100
BB-BTAR-110	8	14.4	44	158	68	142	52	<1 mm	100
BB-BTAR-110	9	14.5	46	155	65	139	49	<1 mm	100
BB-BTAR-110	10	16.1	1	175	85	159	69	<1 mm	100
BB-BTAR-110	11	16.7	44	162	72	146	56	<1 mm	100
BB-BTAR-110	12	18.7	6	251	341	236	326	<1 mm	100
BB-BTAR-110	13	19.4	1	174	84	159	69	<1 mm	100
BB-BTAR-110	14	20.0	36	167	77	151	61	<1 mm	100
BB-BTAR-110	15	22.0	43	169	79	153	63	<1 mm	100

Category Explanation:

	101	planar feature such as foliation, bedding, joint, fracture, etc. with aperture < 1 mm
	108	planar feature - possible joint, fracture or crack with aperture width 1 to 10 mm
	107	planar feature - likely joint, fracture or crack with aperture width > 10 mm

APPENDIX D – BEDROCK OUTCROP PHOTOGRAPH MARKUP

Looking NW across downstream end of Pier 3 subgrade. BB-BTAR-110 visible.

Looking NW across downstream end of Pier 3 subgrade. Downstream of BB-BTAR-110.

Looking SE downstream of Pier 3 subgrade. Standing at BB-BTAR-110.

Looking NE across downstream end of Pier 3 subgrade. BB-BTAR-110 visible.

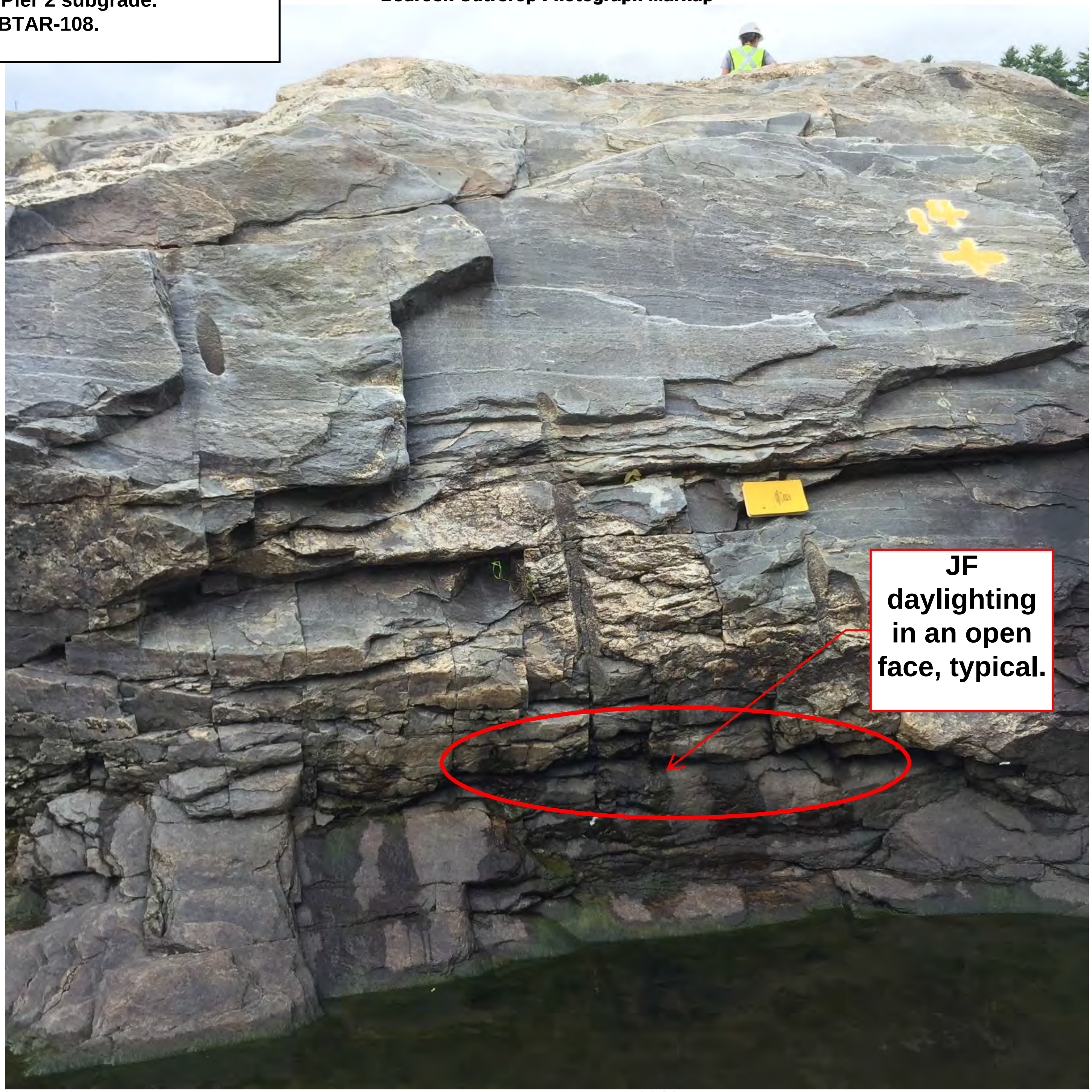
Looking S across downstream end of Pier 3. BB-BTAR-110 visible.

Looking S across downstream end of Pier 2 subgrade. BB-BTAR-108 visible.

Looking N at outcrops on the downstream end of Pier 2 subgrade. BB-BTAR-108 visible

Looking NE at the outcrops on the downstream end of Pier 2 subgrade.

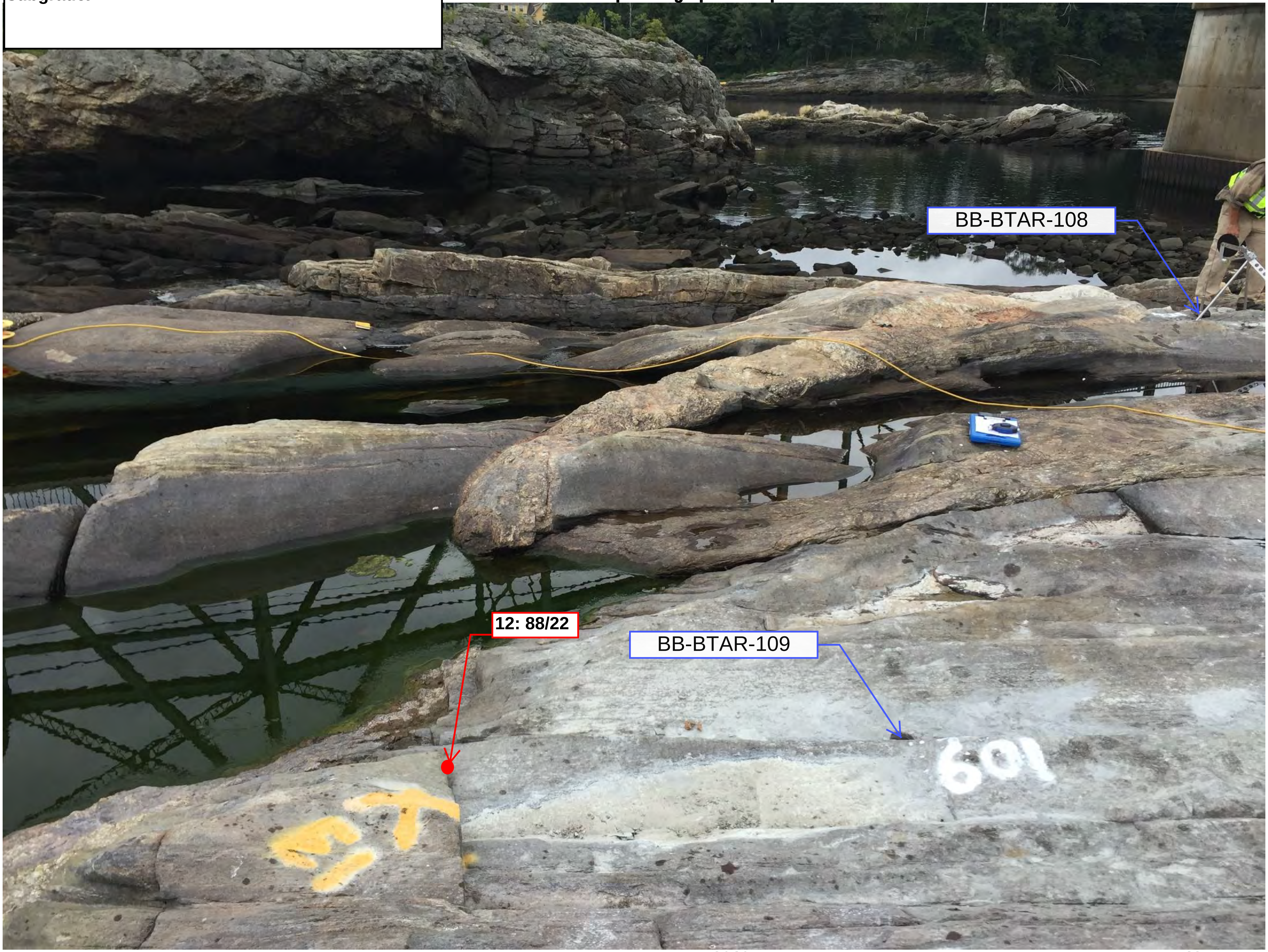
Looking W at outcrop exposed near the downstream end of Pier 2 subgrade. Downstream of BB-BTAR-108.



Looking W at outcrop exposed near the downstream end of Pier 2 subgrade. Downstream of BB-BTAR-108

Looking NE across upstream end of Pier 2 subgrade. BB-BTAR-109 visible.

Looking SE across downstream end of Pier 2 subgrade.



Looking South across outcrop exposed downstream of Pier 2 subgrade.
Standing at BB-BTAR-108.

Looking NW across upstream end of Pier 1 subgrade. Standing at BB-BTAR107.

Looking N across upstream end of Pier 1 subgrade (lower right of photograph).

Looking NE across upstream end of Pier 1 subgrade.

Typical foliation near Pier 1 looking E.
North of BB-BTAR-107.

Looking NE across downstream end of Pier 1 Subgrade. Standing at BB-BTAR-106.

Looking NW downstream of Abutment 1
Subgrade. Standing 20' SW of BB-BTAR-202.

Looking SE downstream of Abutment 1 Subgrade. Standing 10' SE of BB-BTAR-202.

APPENDIX E – ROCK CORE PHOTOGRAPH LOG

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-104	R1	0.0 - 5.0	60	100%	57	95%	GNEISS	1
BB-BTAR-104	R2	5.0 - 10.0	60	100%	57	95%	GNEISS	2
BB-BTAR-104	R3	10.0 - 15.0	54	90%	28	47%	GNEISS	3

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-105	R1	0.0	-	2.4	24	83%	8	28%	GNEISS	1
BB-BTAR-105	R2	2.4	-	5.1	29	90%	5	16%	GNEISS/PEGMATITE	2
BB-BTAR-105	R3	5.1	-	9.1	48	100%	23	48%	PEGMATITE	3
BB-BTAR-105	R4	9.1	-	14.1	57	95%	54	90%	PEGMATITE/GNEISS	4

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 3=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-106	R1	0.0	-	4.5	51	96%	38	70%	GNEISS	1
BB-BTAR-106	R2	4.5	-	9.5	58	97%	35	58%	GNEISS	2
BB-BTAR-106	R3	9.5	-	14.0	50	93%	25	46%	GNEISS	3

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 3=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

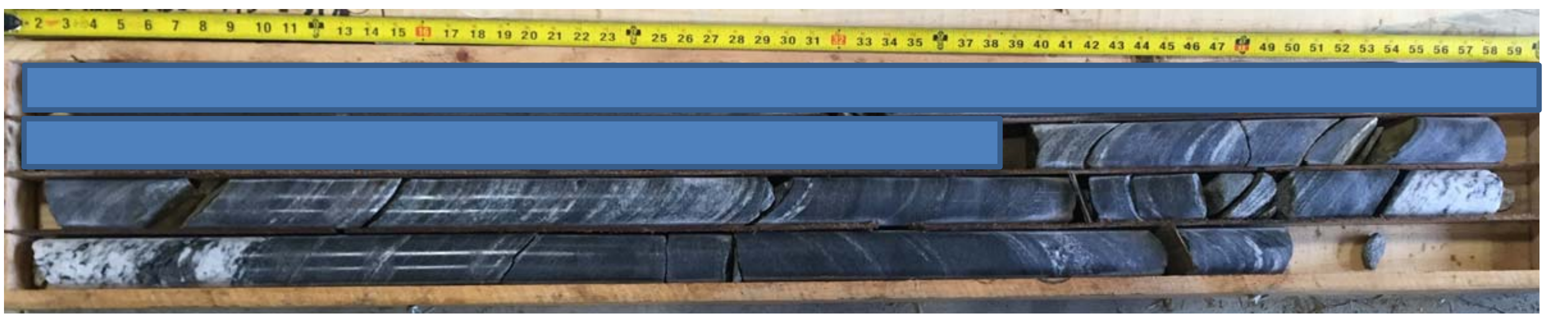
MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-107	R1	0.0 - 4.1	49	100%	20	41%	PEGMATITE/GNEISS	1
BB-BTAR-107	R2	4.1 - 9.1	54	90%	36	60%	GNEISS/PEGMATITE	2
BB-BTAR-107	R3	9.1 - 14.1	55	92%	45	75%	PEGMATITE	3

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

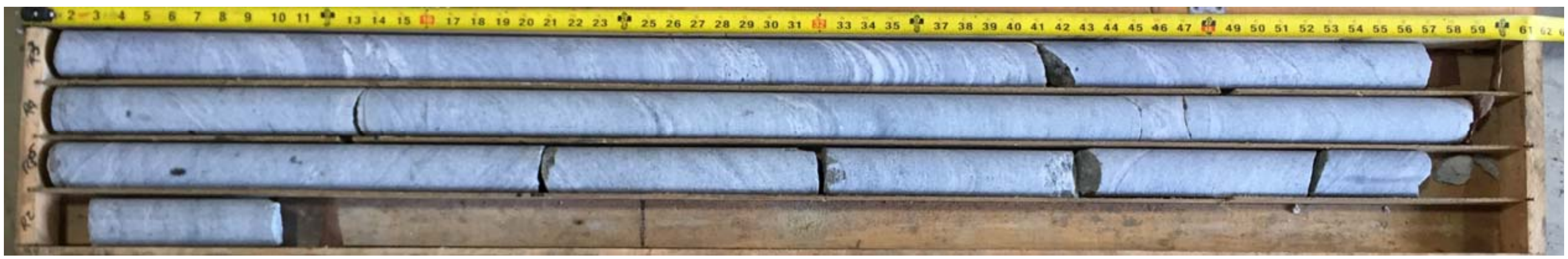
Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-108	R1	0.0 - 4.6	55	100%	41	75%	GNEISS	2,3
BB-BTAR-108	R2	4.6 - 9.6	58	97%	47	78%	GNEISS/PEGMATITE/ GNEISS	3,4
BB-BTAR-108	R3 (Top 4")	9.6 - 14.6	60	100%	60	100%	GNEISS	4

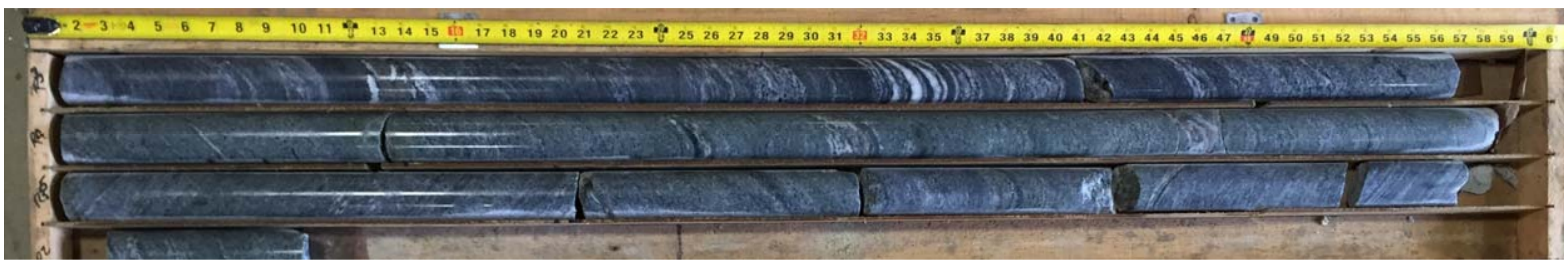


Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-108	R3 (Bot 56")	9.6	-	14.6	60	100%	60	100%	GNEISS	1
BB-BTAR-108	R4	14.6	-	19.6	58	97%	55	92%	GNEISS	2
BB-BTAR-108	R5	19.6	-	24.6	60	100%	60	100%	GNEISS	3,4





Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

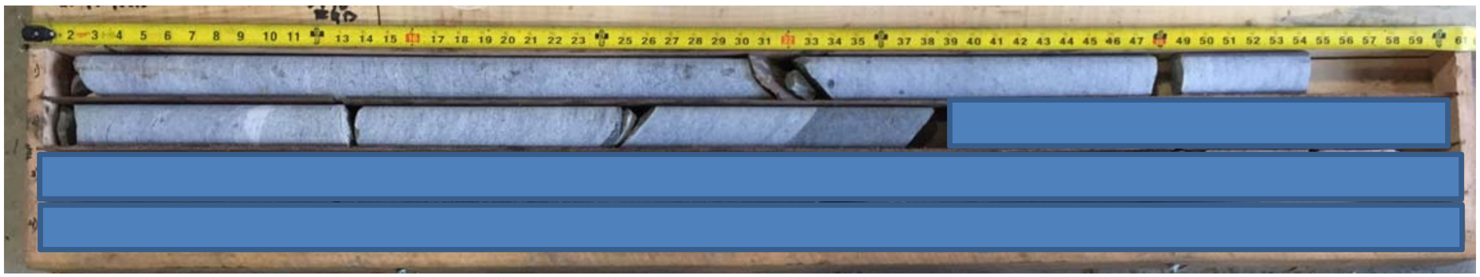
MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

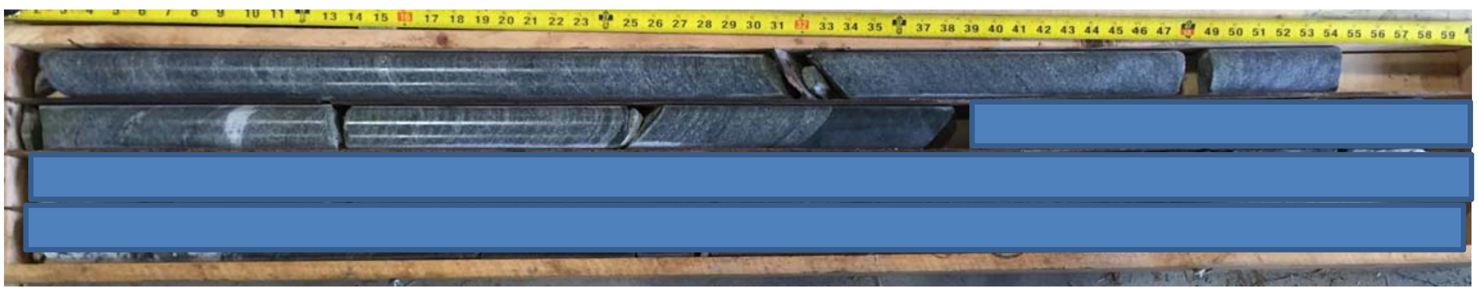
Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-109	R1	0.0	-	2.8	34	100%	15	44%	GNEISS	1
BB-BTAR-109	R2	2.8	-	7.8	59.5	99%	42	70%	GNEISS/PEGMATITE	1, 2
BB-BTAR-109	R3	7.8	-	10.8	36	100%	27	75%	PEGMATITE/GNEISS	2, 3
BB-BTAR-109	R4	10.8	-	15.8	60	100%	59	98%	GNEISS	3, 4
BB-BTAR-109	R5 (Top 30")	15.8	-	20.8	57	95%	57	95%	GNEISS	4

Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-109	R5	15.8 - 20.8	57	95%	57	95%	GNEISS	1
BB-BTAR-109	R6	20.8 - 25.8	57	95%	57	95%	GNEISS	1, 2





Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-110	R1	0.0	-	4.5	52	96%	41	75%	GNEISS	1
BB-BTAR-110	R2	4.5	-	9.5	60	100%	60	100%	GNEISS	1, 2
BB-BTAR-110	R3	9.5	-	14.5	60	100%	56	93%	GNEISS	3
BB-BTAR-110	R4	14.5	-	19.5	60	100%	56	93%	GNEISS	4

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-110	R5	19.5 - 20.3	9	94%	0	0%	GNEISS/QUARTZ	1
BB-BTAR-110	R6	20.3 - 24.6	48	94%	43	84%	GNEISS	1

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-111	R1	0.0 - 5.0	60	100%	24	40%	PEGMATITE	2
BB-BTAR-111	R2	5.0 - 10.0	60	100%	50	83%	PEGMATITE	3
BB-BTAR-111	R3	10.0 - 15.0	56	93%	29	48%	PEGMATITE	4

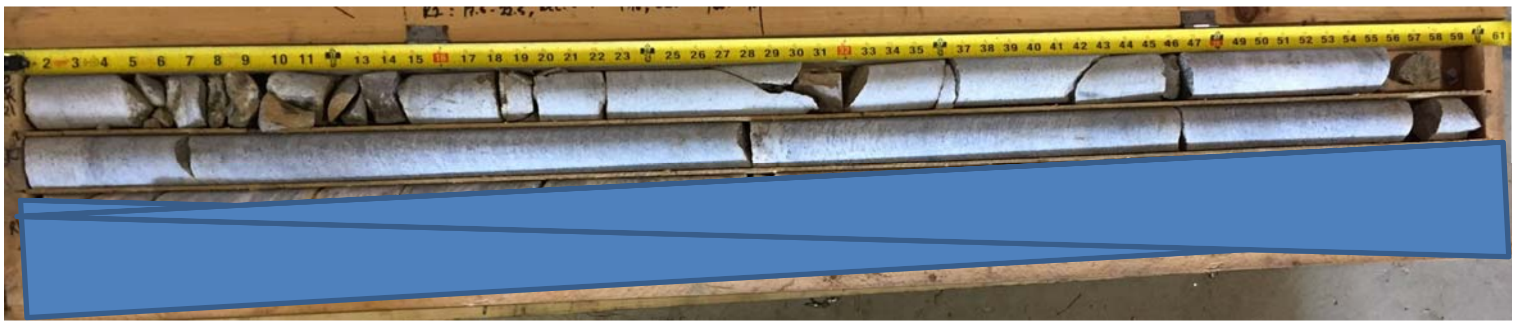
Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-112	R1	0.0	-	5.0	58	97%	23	38%	PEGMATITE	1
BB-BTAR-112	R2	5.0	-	10.0	58	97%	14	23%	PEGMATITE	2
BB-BTAR-112	R3	10.0	-	15.0	60	100%	33	55%	PEGMATITE	3

Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-113	R1	9.2 - 15.2	55	76%	23	32%	GNEISS/PEGMATITE/ GNEISS	1
BB-BTAR-113	R2	15.2 - 20.2	58	97%	46	76%	GNEISS	2

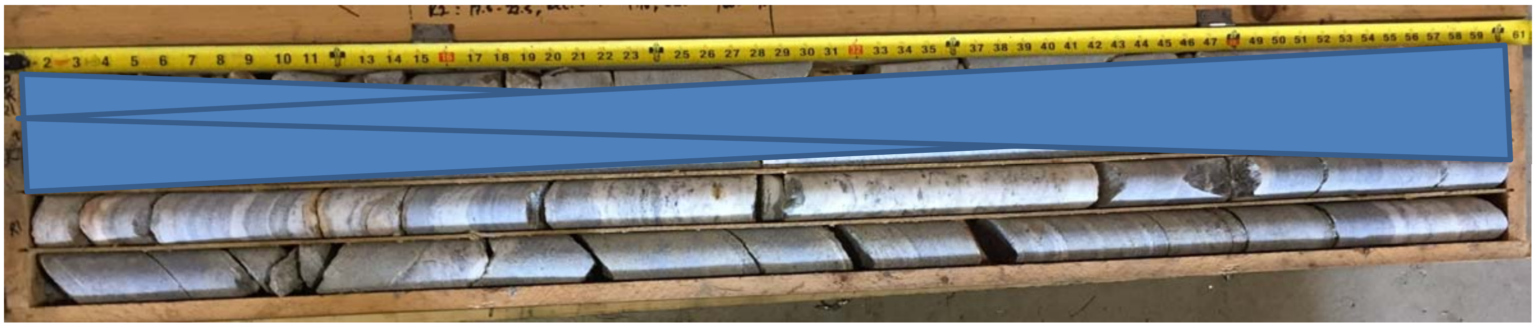


Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-114	R1	12.5 - 17.5	59	98%	42	70%	GNEISS/PEGMATITE/ GNEISS	3
BB-BTAR-114	R2	17.5 - 22.5	57	95%	24	40%	GNEISS/PEGMATITE	4



Notes:
1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.
3. Transition between core runs within a row are marked by red lines.

MaineDOT Frank J. Wood
Bridge #2016 over the Androscoggin River
Brunswick-Topsham, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)			Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-BTAR-202	R1	0	-	0.7	6	75%	0	0%	GNEISS	1
BB-BTAR-202	R1	0.7	-	2.2	12	67%	0	0%	GNEISS	1
BB-BTAR-201	R1	8	-	10.3	26	100%	0	0%	PEGMATITE	2
BB-BTAR-201	R2	10.3	-	14.3	48	100%	20	42%	GNEISS	2,3
BB-BTAR-201	R3	14.3	-	17.3	36	100%	19	53%	GNEISS	3
BB-BTAR-201	R4	17.3	-	18.3	1	8%	0	0%	GNEISS	4

Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom.
2. Top photo is dry, bottom photo is wet.

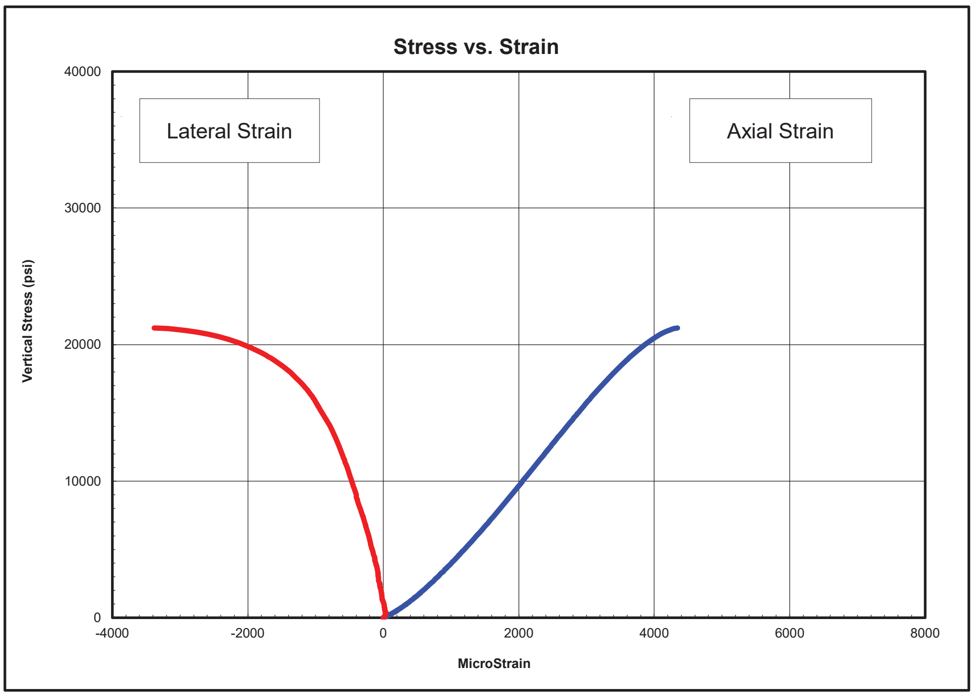
APPENDIX F – LABORATORY TEST RESULTS

FRANK J. WOOD BRIDGE REPLACEMENT - BEDROCK COMPRESSIVE STRENGTH TEST RESULTS

Boring No.	Type of Bedrock	Near Proposed Substructure	Run No.	Depth Below Top of Bedrock	Recovery	RQD	Stress Range	Young's Modulus	Poisson's Ratio	Peak Compressive Stress	Description of Failure	Notes from Lab
				feet	%	%	ksi	ksi	unitless	ksi		
BB-BTAR-104	Gneiss	Eastern Side of Pier No. 1	1	0.08 to 0.45	100	95	2.1 to 7.8	5700	0.34	21.222	Several transverse fractures	One axial strain gauge didn't record meaningful data; therefore, data is based on one strain gauge
							7.8 to 13.4	6160	0.49			
							13.4 to 19.1	5050	--			
BB-BTAR-105	Pegmatite	Western Side of Pier No. 1	3	5.10 to 5.90	100	48	1.6 to 6.0	7700	0.09	16.463	Vertical fractures with crushing near bottom of specimen	--
							6.0 to 10.4	8930	0.16			
							10.4 to 14.8	10400	0.45			
BB-BTAR-106	Gneiss	Middle of Pier No. 2	1	0.00 to 0.75	96	70	1.9 to 7.1	4950	0.17	19.231	Transverse with near vertical fractures	--
							7.1 to 12.2	5820	0.23			
							12.2 to 17.3	5610	0.35			
BB-BTAR-107	Pegmatite	Western Side of Pier No. 2	2	7.81 to 8.18	90	60	3.1 to 11.4	--	--	31.065	Mostly crushed with one transverse fracture	Young's Modulus and Poisson's Ratio could not be determined from strain gauge readings
							7.1 to 12.2	--	--			
							12.2 to 17.3	--	--			
BB-BTAR-108	Gneiss/Pegmatite	Eastern Side of Pier No. 3	2	5.00 to 5.37	97	78	0.9 to 3.5	4420	0.16	9.468	Discontinuity failure near Gneiss and Pegmatite contact	--
							3.5 to 6.0	5150	0.30			
							6.0 to 8.5	4760	0.38			
BB-BTAR-109	Gneiss	Middle of Pier No. 3	1	1.91 to 2.29	100	44	3.3 to 12.0	7330	0.23	32.677	Transverse with near vertical fractures	--
							12.0 to 20.7	8270	0.34			
							20.7 to 29.4	8180	--			
BB-BTAR-110	Gneiss	Eastern side of Pier No. 4	1	0.04 to 0.41	96	75	1.5 to 5.4	3670	0.15	14.615	Vertical fractures with crushing near bottom of specimen	--
							5.4 to 9.3	5860	0.29			
							9.3 to 13.2	6990	--			
BB-BTAR-111	The lab informed MaineDOT on 31 October 2016 that specimen BB-BTAR-111 (R1, 2.9 to 3.4 feet) fell apart during compressive strength testing preparation											
BB-BTAR-112	Pegmatite	Western Side of Abutment No. 2	1	1.68 to 2.05	97	38	1.0 to 3.5	1710	0.13	9.603	Transverse fractures with crushing near bottom of specimen	--
							3.5 to 6.1	2420	0.25			
							6.1 to 8.6	2100	--			
BB-BTAR-201	Gneiss	West of Abutment 1	2	13.2 to 13.7	100	42	--	--	--	5.835	Discontinuity failure along the foliation.	Minor break occurred at 6ksi and did not affect Secant Modulus or Poisson's Ratio
							2.9	1730	0.04			
							--	--	--			
BB-BTAR-201	Gneiss	West of Abutment 1	2	13.7 to 14.3	100	42	--	--	--	Axial 13.200	Fresh Break	Correlated UCS from ASTM D5731 for NX cores for Axial/Diametrical Testing, Respectively
							--	--	--	Diametrical 7.920		
							--	--	--			
BB-BTAR-202	Gneiss	Toe of Abutment 1	2	1.0 to 1.4	75	0	--	--	--	Axial 7.500	Fresh Break	Correlated UCS from ASTM D5731 for NX cores for Axial/Diametrical Testing, Respectively
							--	--	--	Diametrical 12.300		
							--	--	--			

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-104
Sample ID:	R1
Depth, ft:	0.08-0.45
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 21,222 psi

One axial strain gauge failed to record meaningful data. Young's Modulus and Poisson's Ratio reported based on results of a single axial strain gauge.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
2100-7800	5,700,000	0.34
7800-13400	6,160,000	0.49
13400-19100	5,050,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-104		
Sample ID:	R1		
Depth:	0.08-0.45 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.21	4.21	4.21		
Specimen Diameter, in:	1.98	1.99	1.99		
Specimen Mass, g:	593.85				
Bulk Density, lb/ft^3	173			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00030	-0.00030	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00020	0.00020	0.00010	0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00020	0.00000	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00000	-0.00020

Difference between max and min readings, in:

0° = 0.00050 90° = 0.00040

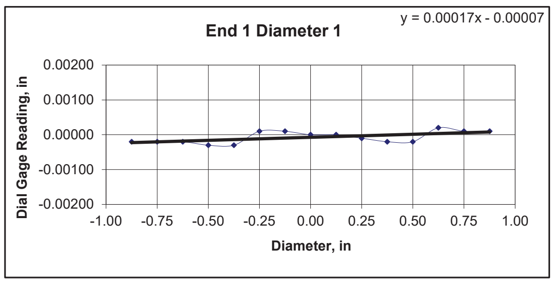
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00010	0.00000	0.00000	0.00000	0.00000	0.00020	0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00000	0.00010

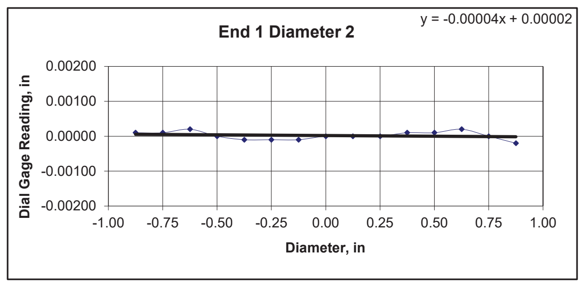
Difference between max and min readings, in:

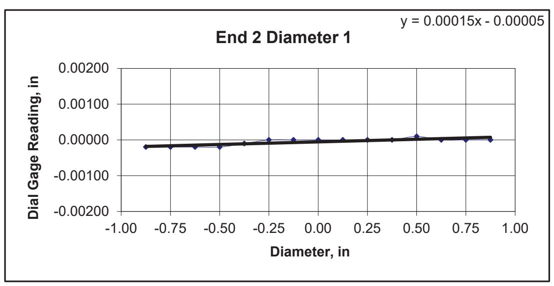
0° = 0.0003 90° = 0.0002

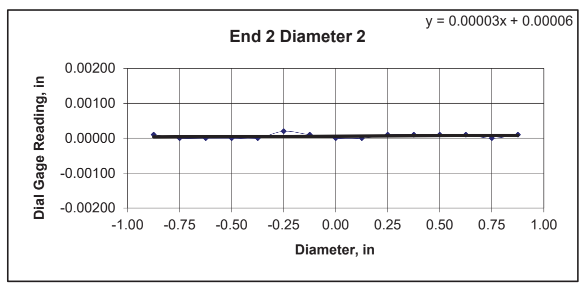
Maximum difference must be < 0.0020 in. Difference = ± 0.00025

Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00017
	Angle of Best Fit Line:	0.00974
End 2:	Slope of Best Fit Line	0.00015
	Angle of Best Fit Line:	0.00859
Maximum Angular Difference:		0.00115

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00004
	Angle of Best Fit Line:	-0.00229
End 2:	Slope of Best Fit Line	0.00003
	Angle of Best Fit Line:	0.00172
Maximum Angular Difference:		0.00401

Parallelism Tolerance Met? YES
Spherically Seated

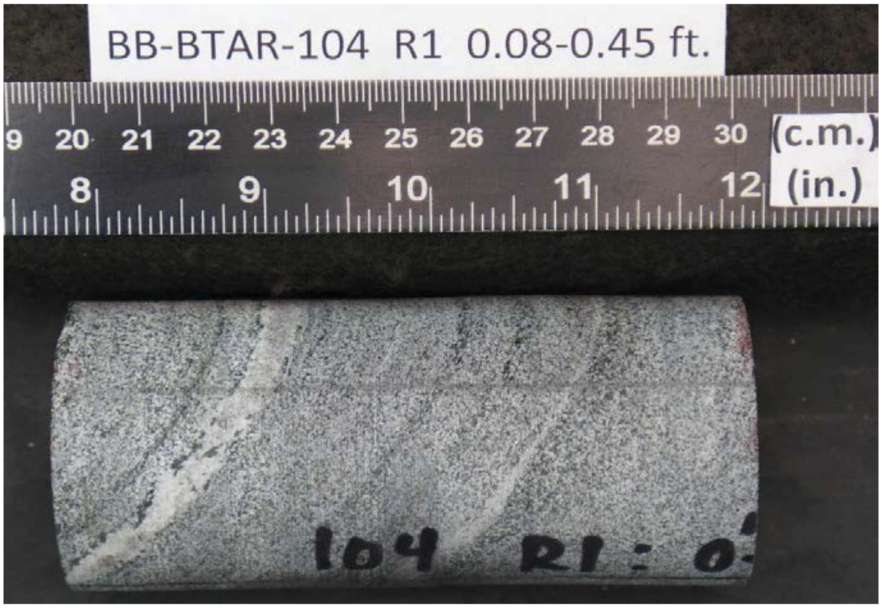
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.985	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00040	1.985	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00030	1.985	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00020	1.985	0.00010	0.006	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-104
Sample ID:	R1
Depth, ft:	0.08-0.45

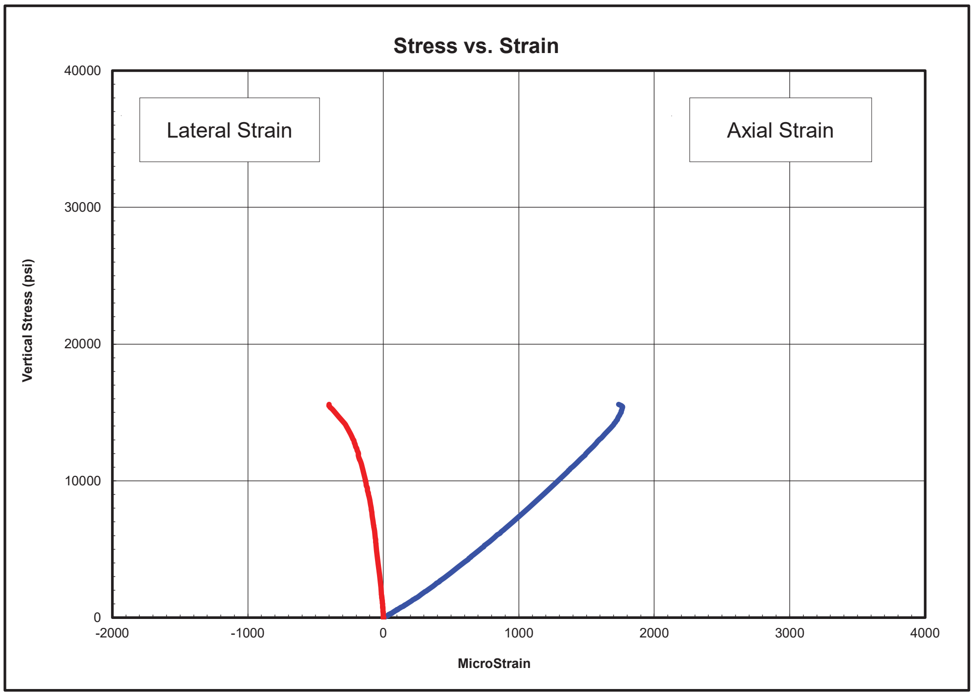


After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-105
Sample ID:	R3
Depth, ft:	5.1-5.9
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Diameter < Ten times maximum particle size

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 16,463 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1600-6000	7,700,000	0.09
6000-10400	8,930,000	0.16
10400-14800	10,400,000	0.45

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-105		
Sample ID:	R3		
Depth:	5.1-5.9 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.13	4.13	4.13		
Specimen Diameter, in:	1.98	1.99	1.99		
Specimen Mass, g:	544.19				
Bulk Density, lb/ft^3	162			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00020	0.00030	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00010	0.00010
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00010	0.00010

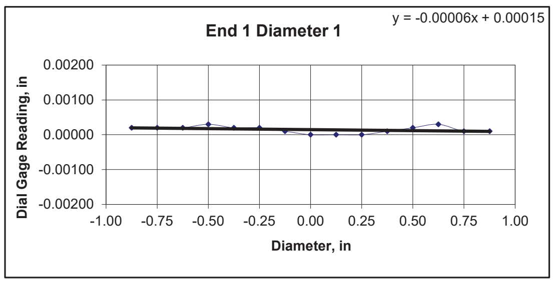
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00030

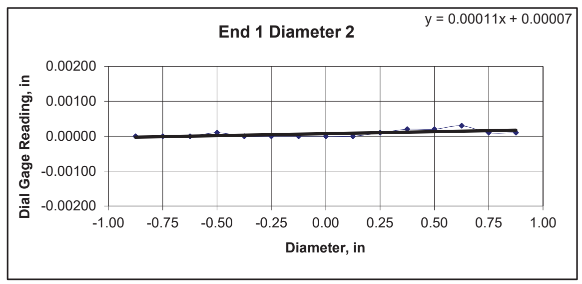
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00030	-0.00030	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00040	-0.00040	-0.00010
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00040	-0.00050	-0.00050	-0.00050	-0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00030	-0.00030

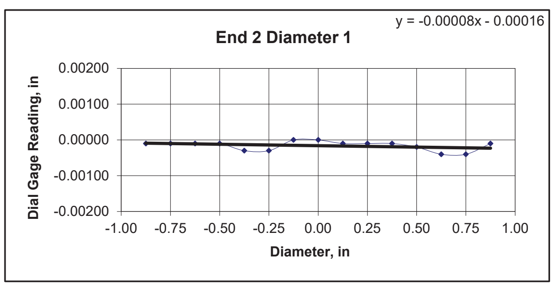
Difference between max and min readings, in:
0° = 0.0004 90° = 0.0005

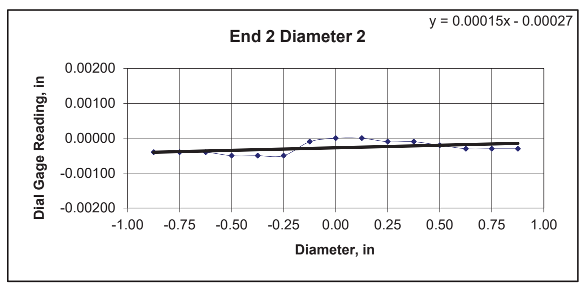
Maximum difference must be < 0.0020 in. Difference = ± 0.00025

Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	-0.00006
	Angle of Best Fit Line:	-0.00344
End 2:	Slope of Best Fit Line	-0.00008
	Angle of Best Fit Line:	-0.00458
Maximum Angular Difference:		0.00115

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00011
	Angle of Best Fit Line:	0.00630
End 2:	Slope of Best Fit Line	0.00015
	Angle of Best Fit Line:	0.00859
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.985	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00030	1.985	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00040	1.985	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00050	1.985	0.00025	0.014	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

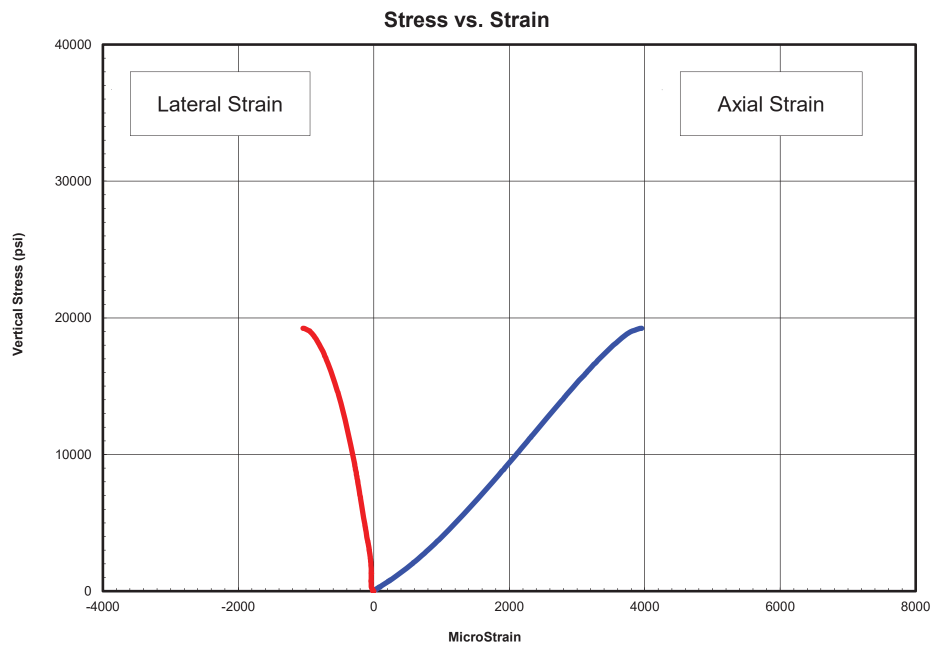
Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-105
Sample ID:	R3
Depth, ft:	5.1-5.9

After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-106
Sample ID:	R1
Depth, ft:	0-0.75
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 19,231 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1900-7100	4,950,000	0.17
7100-12200	5,820,000	0.23
12200-17300	5,610,000	0.35

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-106		
Sample ID:	R1		
Depth:	0-0.75 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.16	4.16	4.16		
Specimen Diameter, in:	1.98	1.99	1.99		
Specimen Mass, g:	579.82				
Bulk Density, lb/ft^3	171			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00020	0.00020	0.00060	0.00060	0.00010	0.00010	0.00000	0.00000	0.00010	0.00020	0.00040	-0.00020	-0.00020	-0.00010
Diameter 2, in (rotated 90°)	-0.00020	-0.00010	-0.00010	0.00000	0.00030	0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00060	0.00060	0.00020	0.00020

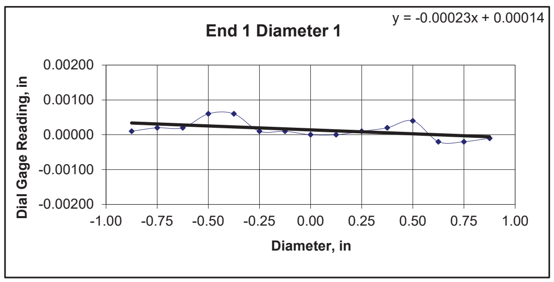
Difference between max and min readings, in:
0° = 0.00080 90° = 0.00080

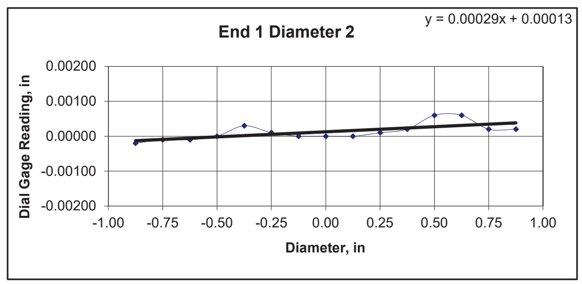
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00000	-0.00010	-0.00010	-0.00010	0.00020	0.00020	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00040	-0.00010	-0.00030
Diameter 2, in (rotated 90°)	-0.00030	-0.00030	-0.00030	-0.00040	-0.00030	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	0.00000	0.00030	0.00030	0.00020

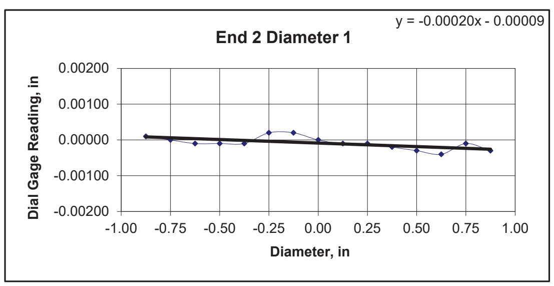
Difference between max and min readings, in:
0° = 0.0006 90° = 0.0007

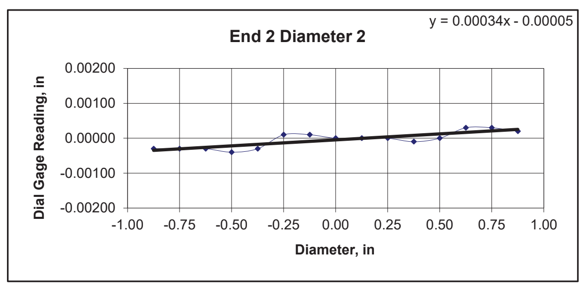
Maximum difference must be < 0.0020 in. Difference = ± 0.00040

Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00023
Angle of Best Fit Line: -0.01318

End 2:
Slope of Best Fit Line -0.00020
Angle of Best Fit Line: -0.01146

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00029
Angle of Best Fit Line: 0.01662

End 2:
Slope of Best Fit Line 0.00034
Angle of Best Fit Line: 0.01948

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00080	1.985	0.00040	0.023	YES
Diameter 2, in (rotated 90°)	0.00080	1.985	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00060	1.985	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00070	1.985	0.00035	0.020	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

GeoTesting EXPRESS

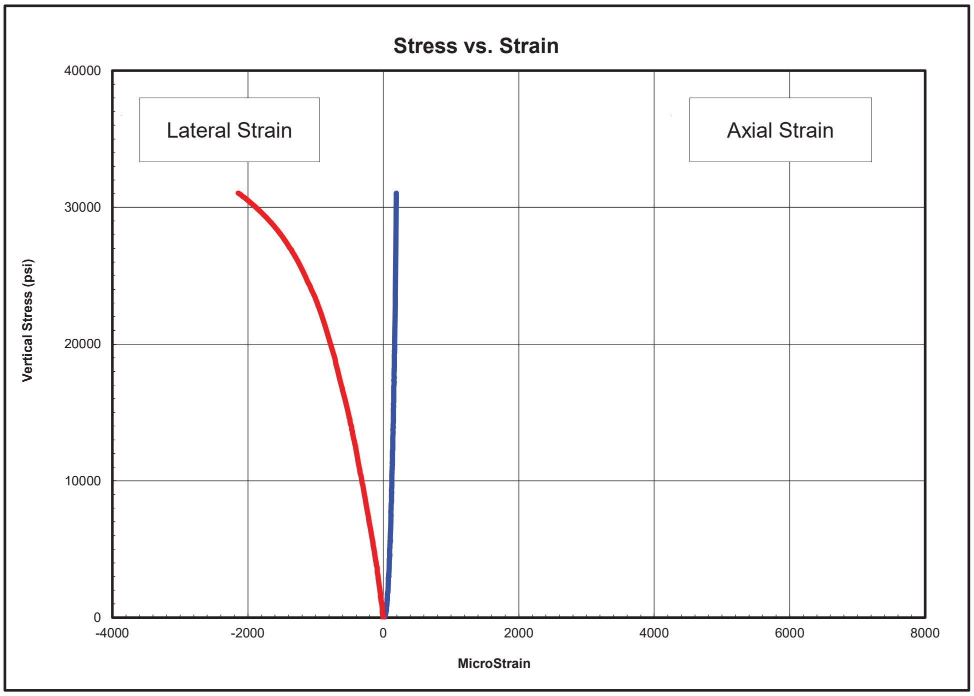
Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-106
Sample ID:	R1
Depth, ft:	0-0.75

After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-107
Sample ID:	R2
Depth, ft:	7.81-8.18
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 31,065 psi

Young's Modulus and Poisson's Ratio could not be determined from strain gauge readings.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
3100-11400	---	---
11400-19700	---	---
19700-27900	---	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-107		
Sample ID:	R2		
Depth:	7.81-8.18 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.24	4.24	4.24
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	557.07		
Bulk Density, lb/ft^3	161		
Length to Diameter Ratio:	2.1		

Minimum Diameter Tolerence Met? YES

Length to Diameter Ratio Tolerance Met? YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00000	0.00000	0.00000	0.00050	0.00050	0.00050	0.00030	0.00030
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00020	0.00020	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	0.00010	0.00040	0.00040	0.00040	0.00030

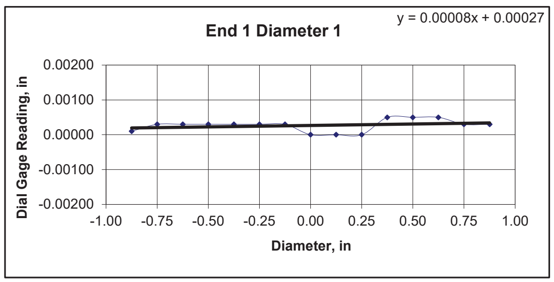
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00040

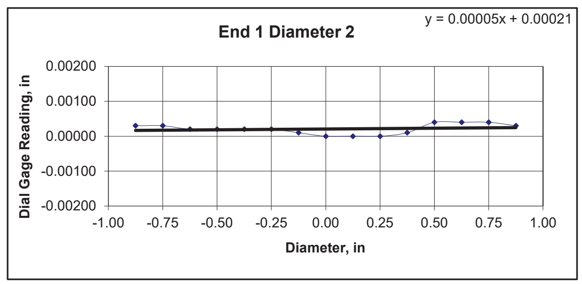
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00020
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	0.00020	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	0.00010

Difference between max and min readings, in:
0° = 0.0003 90° = 0.0004

Maximum difference must be < 0.0020 in. Difference = ± 0.00025

Flatness Tolerance Met? YES

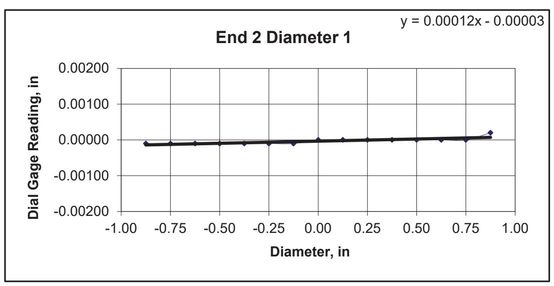


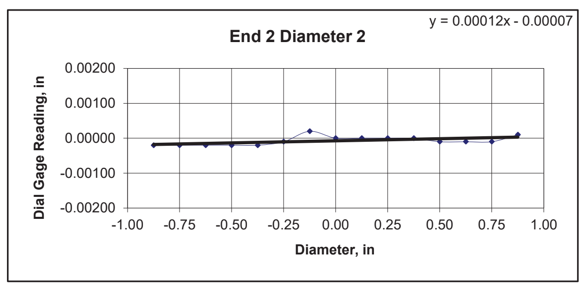


DIAMETER 1

End 1:	Slope of Best Fit Line	0.00008
	Angle of Best Fit Line:	0.00458
End 2:	Slope of Best Fit Line	0.00012
	Angle of Best Fit Line:	0.00688
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:	Slope of Best Fit Line	0.00005
	Angle of Best Fit Line:	0.00286
End 2:	Slope of Best Fit Line	0.00012
	Angle of Best Fit Line:	0.00688
Maximum Angular Difference:		0.00401

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1)

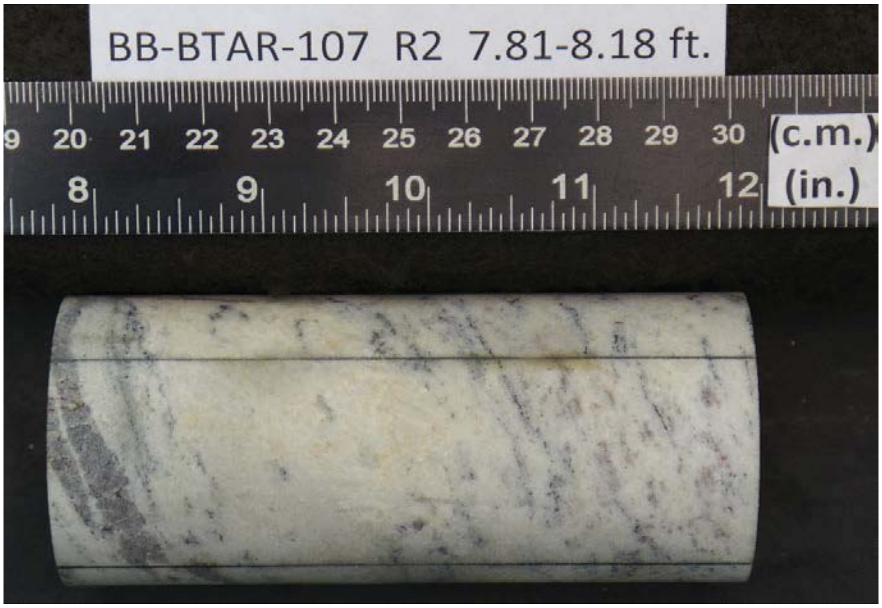
(Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00040	1.990	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00030	1.990	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00040	1.990	0.00020	0.012	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-107
Sample ID:	R2
Depth, ft:	7.81-8.18

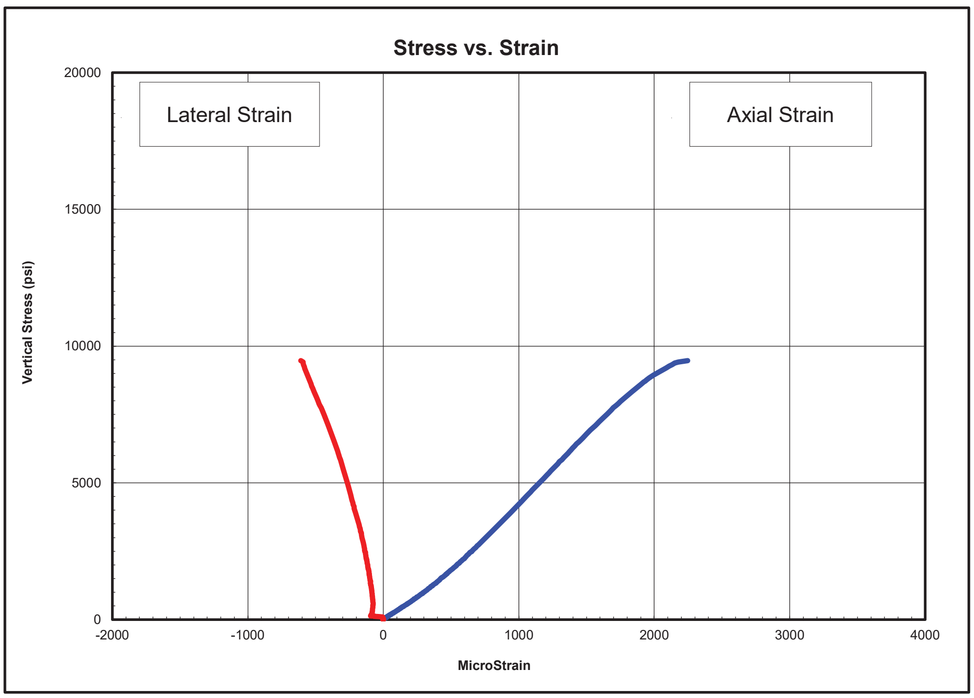


After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-108
Sample ID:	R2
Depth, ft:	5.00-5.37
Sample Type:	rock core
Sample Description:	See photographs Discontinuity failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 9,468 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
900-3500	4,420,000	0.16
3500-6000	5,150,000	0.30
6000-8500	4,760,000	0.38

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-108		
Sample ID:	R2		
Depth:	5.00-5.37 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.16	4.16	4.16
Specimen Diameter, in:	1.96	1.97	1.97
Specimen Mass, g:	547.52		
Bulk Density, lb/ft^3	165	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00020	0.00010
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00000	-0.00010

Difference between max and min readings, in:

0° = 0.00030 90° = 0.00030

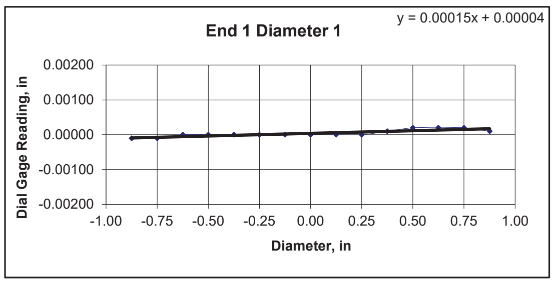
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000	0.00010	0.00020	0.00020	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010

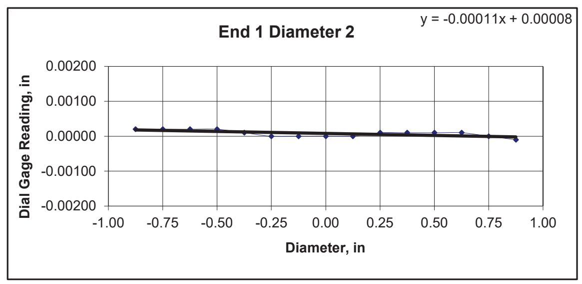
Difference between max and min readings, in:

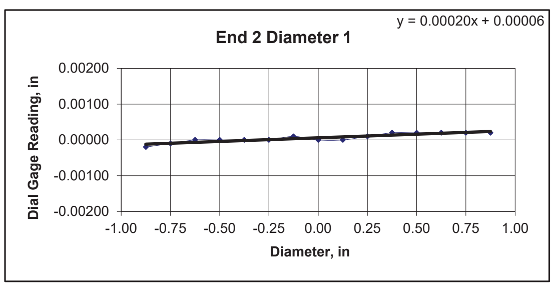
0° = 0.0004 90° = 0.0002

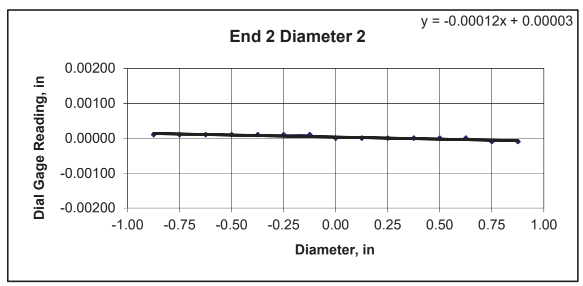
Maximum difference must be < 0.0020 in. Difference = ± 0.00020

Flatness Tolerance Met? YES









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00015
Angle of Best Fit Line:	0.00859

End 2:

Slope of Best Fit Line	0.00020
Angle of Best Fit Line:	0.01146

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00011
Angle of Best Fit Line:	-0.00630

End 2:

Slope of Best Fit Line	-0.00012
Angle of Best Fit Line:	-0.00688

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? YES

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.965	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00030	1.965	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00040	1.965	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00020	1.965	0.00010	0.006	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

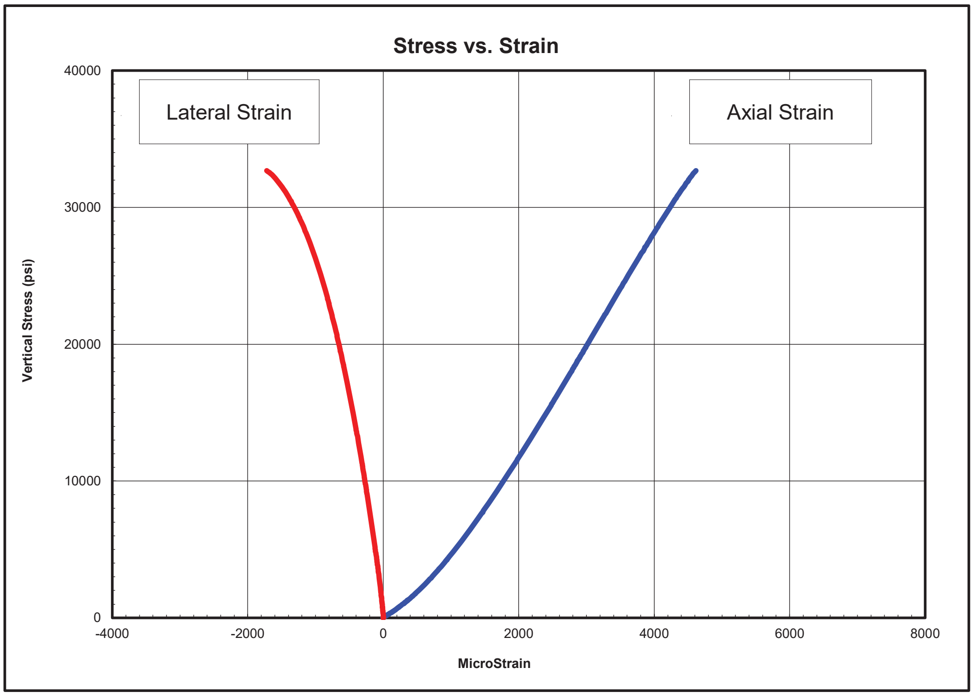
Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-108
Sample ID:	R2
Depth, ft:	5.00-5.37

After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-109
Sample ID:	R1
Depth, ft:	1.91-2.29
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 32,677 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
3300-12000	7,330,000	0.23
12000-20700	8,270,000	0.34
20700-29400	8,180,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-109		
Sample ID:	R1		
Depth:	1.91-2.29 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.23	4.23	4.23		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	581.91				
Bulk Density, lb/ft^3	168			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

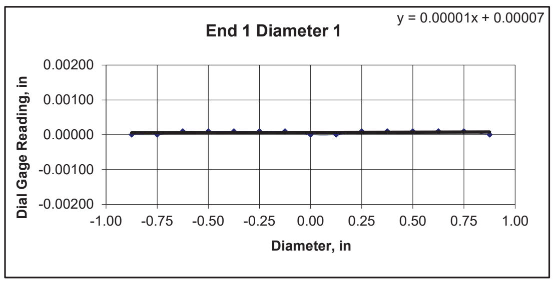
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00010

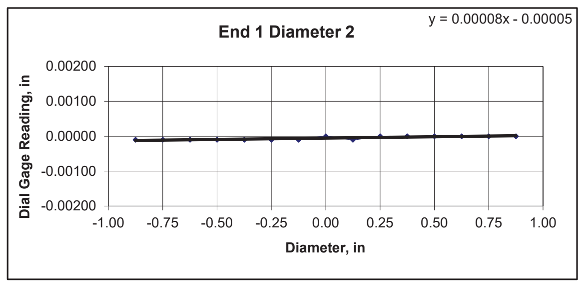
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00020	0.00030

Difference between max and min readings, in:
0° = 0.0002 90° = 0.0003

Maximum difference must be < 0.0020 in. Difference = ± 0.00015

Flatness Tolerance Met? YES





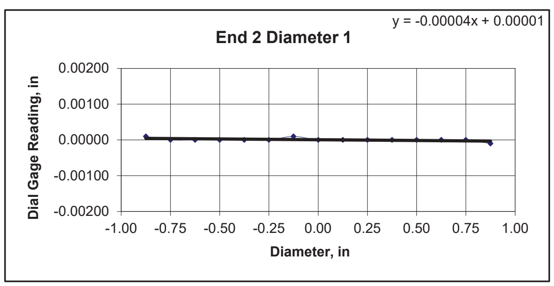
DIAMETER 1

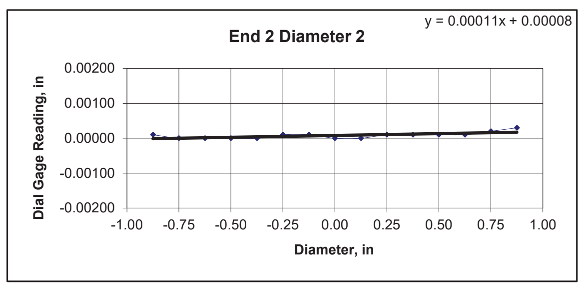
End 1:
Slope of Best Fit Line 0.00001
Angle of Best Fit Line: 0.00057

End 2:
Slope of Best Fit Line -0.00004
Angle of Best Fit Line: -0.00229

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line 0.00008
Angle of Best Fit Line: 0.00458

End 2:
Slope of Best Fit Line 0.00011
Angle of Best Fit Line: 0.00630

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? YES
Spherically Seated

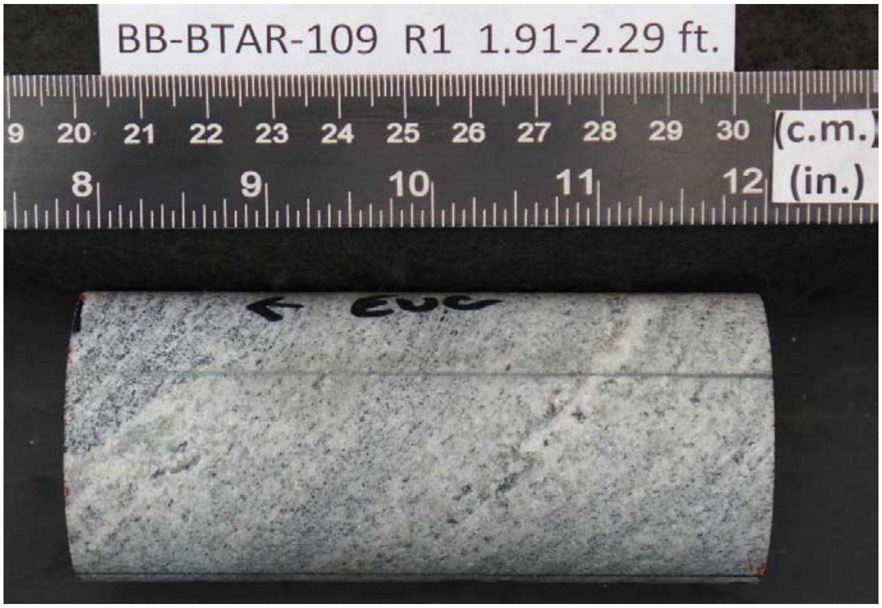
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00030	1.990	0.00015	0.009	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/26/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-109
Sample ID:	R1
Depth, ft:	1.91-2.29

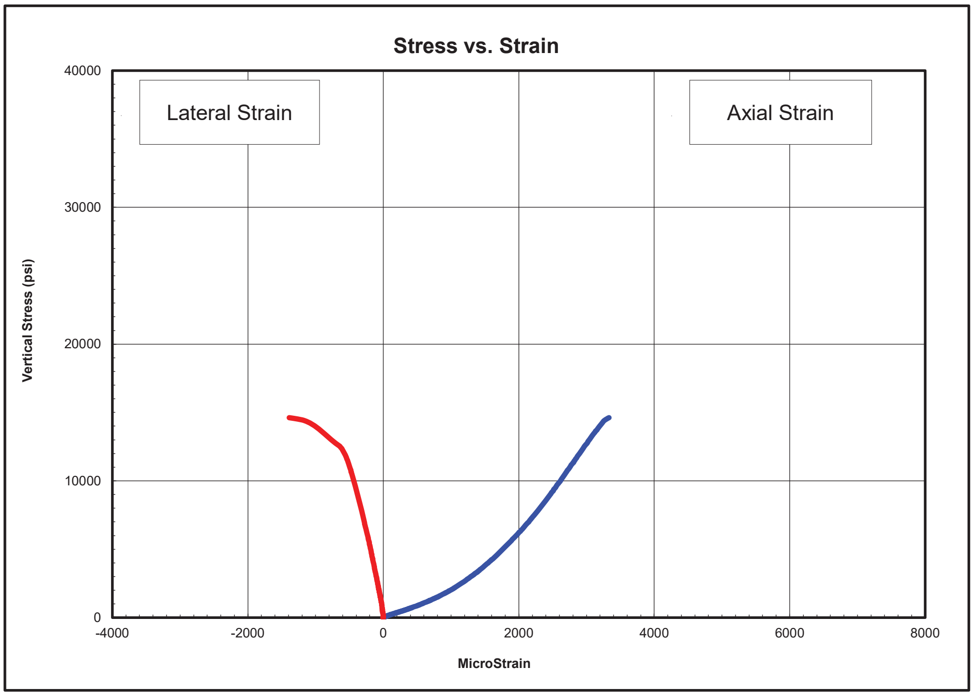


After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-110
Sample ID:	R1
Depth, ft:	0.04-0.41
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 14,615 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1500-5400	3,670,000	0.15
5400-9300	5,860,000	0.29
9300-13200	6,990,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-110		
Sample ID:	R1		
Depth:	0.04-0.41 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.04	4.04	4.04		
Specimen Diameter, in:	1.97	1.97	1.97		
Specimen Mass, g:	539.82				
Bulk Density, lb/ft^3	167			**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	-0.00010	-0.00010	0.00000	0.00020	0.00010	0.00000	0.00000	0.00010	0.00020	0.00010	0.00010	0.00030	0.00020
Diameter 2, in (rotated 90^o)	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00000	-0.00010	-0.00010	0.00000	0.00000	-0.00020	-0.00030	-0.00030

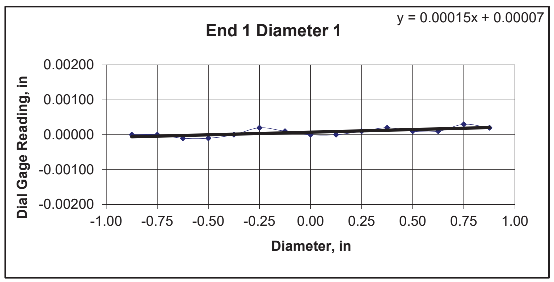
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00030

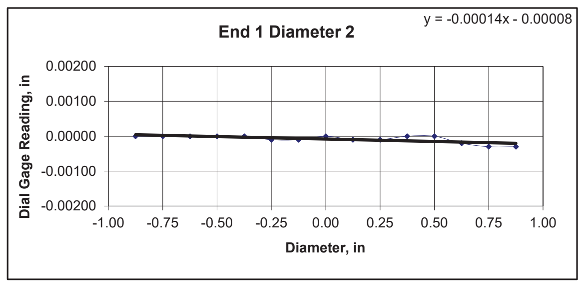
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00010	0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00020	0.00010	-0.00020	-0.00010	-0.00010
Diameter 2, in (rotated 90^o)	-0.00010	0.00000	0.00020	0.00020	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00000	0.00000	0.00000

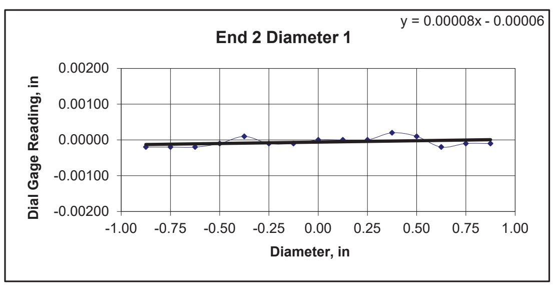
Difference between max and min readings, in:
0° = 0.0004 90° = 0.0003

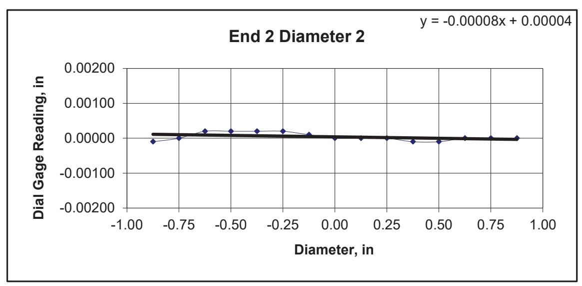
Maximum difference must be < 0.0020 in. Difference = ± 0.00020

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00015
	Angle of Best Fit Line:	0.00859
End 2:	Slope of Best Fit Line	0.00008
	Angle of Best Fit Line:	0.00458
Maximum Angular Difference:		0.00401

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00014
	Angle of Best Fit Line:	-0.00802
End 2:	Slope of Best Fit Line	-0.00008
	Angle of Best Fit Line:	-0.00458
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	1.970	0.00020	0.012	YES
Diameter 2, in (rotated 90^o)	0.00030	1.970	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00040	1.970	0.00020	0.012	YES
Diameter 2, in (rotated 90^o)	0.00030	1.970	0.00015	0.009	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

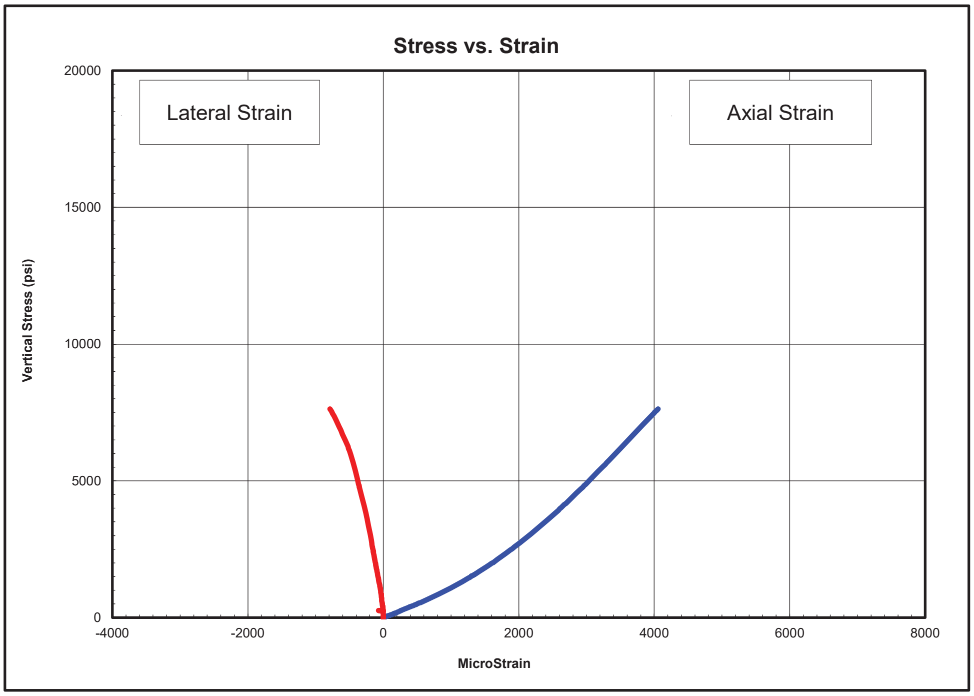
Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-110
Sample ID:	R1
Depth, ft:	0.04-0.41

After cutting and grinding

After break

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-112
Sample ID:	R1
Depth, ft:	1.68-2.05
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 9,603 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1000-3500	1,710,000	0.13
3500-6100	2,420,000	0.25
6100-8600	2,100,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Maine DOT	Test Date:	10/20/2016
Project Name:	Frank J. Wood Bridge	Tested By:	daa
Project Location:	Brunswick-Topsham, ME	Checked By:	jsc
GTX #:	305456		
Boring ID:	BB-BTAR-112		
Sample ID:	R1		
Depth:	1.68-2.05 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.10	4.10	4.10		
Specimen Diameter, in:	1.96	1.96	1.96		
Specimen Mass, g:	525.55				
Bulk Density, lb/ft^3	162			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.1			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010
Diameter 2, in (rotated 90^o)	0.00010	0.00010	0.00010	0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00010	-0.00010

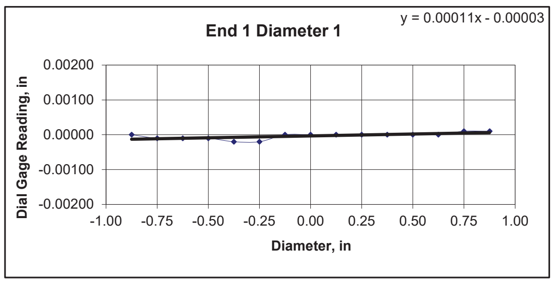
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00030

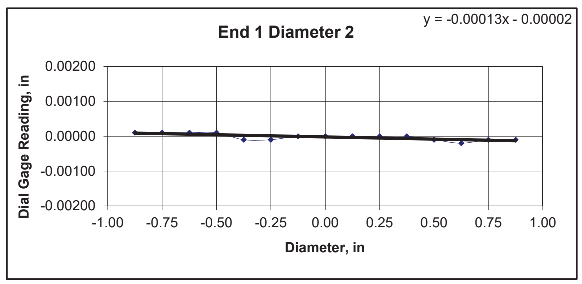
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	0.00000	0.00010	0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00030

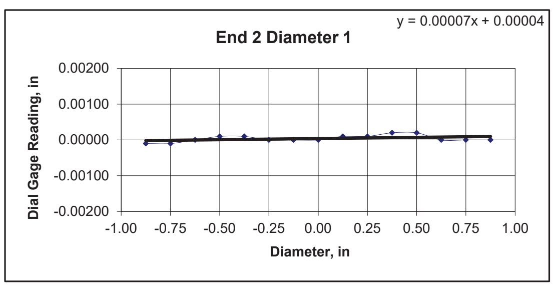
Difference between max and min readings, in:
0° = 0.0003 90° = 0.0005

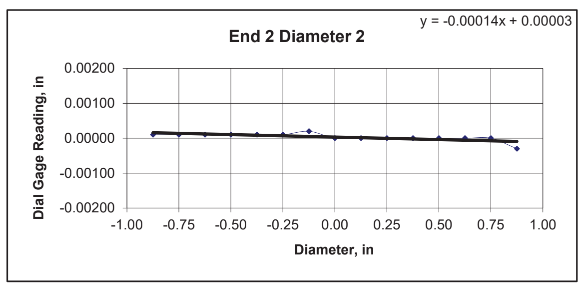
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00025

Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00011
	Angle of Best Fit Line:	0.00630
End 2:	Slope of Best Fit Line	0.00007
	Angle of Best Fit Line:	0.00401
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00013
	Angle of Best Fit Line:	-0.00745
End 2:	Slope of Best Fit Line	-0.00014
	Angle of Best Fit Line:	-0.00802
Maximum Angular Difference:		0.00057

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.960	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00030	1.960	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00030	1.960	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00050	1.960	0.00026	0.015	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Maine DOT
Project Name:	Frank J. Wood Bridge
Project Location:	Brunswick-Topsham, ME
GTX #:	305456
Test Date:	10/27/2016
Tested By:	daa
Checked By:	jsc
Boring ID:	BB-BTAR-112
Sample ID:	R1
Depth, ft:	1.68-2.05

After cutting and grinding

After break

THIELSCH ENGINEERING	195 Frances Avenue Cranston RI, 02910 Phone: (401)-467-6454 Fax: (401)-467-2398 http://www.thielsch.com *Let's Build a Solid Foundation*	Client Information: GZA GeoEnvironmental Portland, ME PM: EDF Assigned By: E. Friede Collected By: Client	Project Information: **Frank J. Wood Bridge** **Brunswich-Topsham, ME** GZA Project Number: 09.0025917.01 Summary Page: 1 of 1 Report Date: 01.03.19

LABORATORY TESTING DATA SHEET

Boring No.	Sample No.	Depth (ft)	Laboratory No.	Specimen Data						Compressive Strength Tests								Rock Formation or Description or Remarks
				Mohs Hard-ness	Diameter (in)	Length (in)	(1) Unit Weight (PCF)	(2) Wet Density (PCF)	Bulk G_s	(3) Other Tests	(4) Strength PSI	(5) Strain %	(6) E sec PSI EE+06	(7) Poisson's Ratio	στ PSI	Is PSI	(8) s_c PSI	
BB-BTAR-201	R2	13.2-13.7	S-1		1.983	4.726	173.8				5835	0.36	1.73	0.04				Gneiss - Fresh Break
Notes: Minor break occour at roughly 6ksi and did not affect Secant Modulus and Poisson's Ratio.																		
BB-BTAR-201	R2	13.7-14.0	S-2D		1.984	1.828	168.9			PLD						330	7920	Gneiss - Fresh Break
BB-BTAR-201	R2	14.1-14.3	S2A		1.977	1.301	171.3			PLA						550	13200	Gneiss- Fresh Break
BB-BTAR-202	R2	1.0-1.2	S-3D		1.974	1.059	172.0			PLD						513	12312	Gneiss- Fresh Break
BB-BTAR-202	R2	1.2-1.4	S-3A		1.964	0.791				PLA						311	7464	Gneiss- Fresh Break

Notes

(1) Volume Determined By Measuring Dimensions

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

(3) PLD=Point Load (diametrical), PLA= Point Load (Axial) ST= Splitting Tensile U= Unconfined Compressive Strength

(4) Taken at Peak Deviator Stress

(5) Strain at Peak Deviator Stress

(6) Represents Secant Modulus at 50% of Total Failure Stress

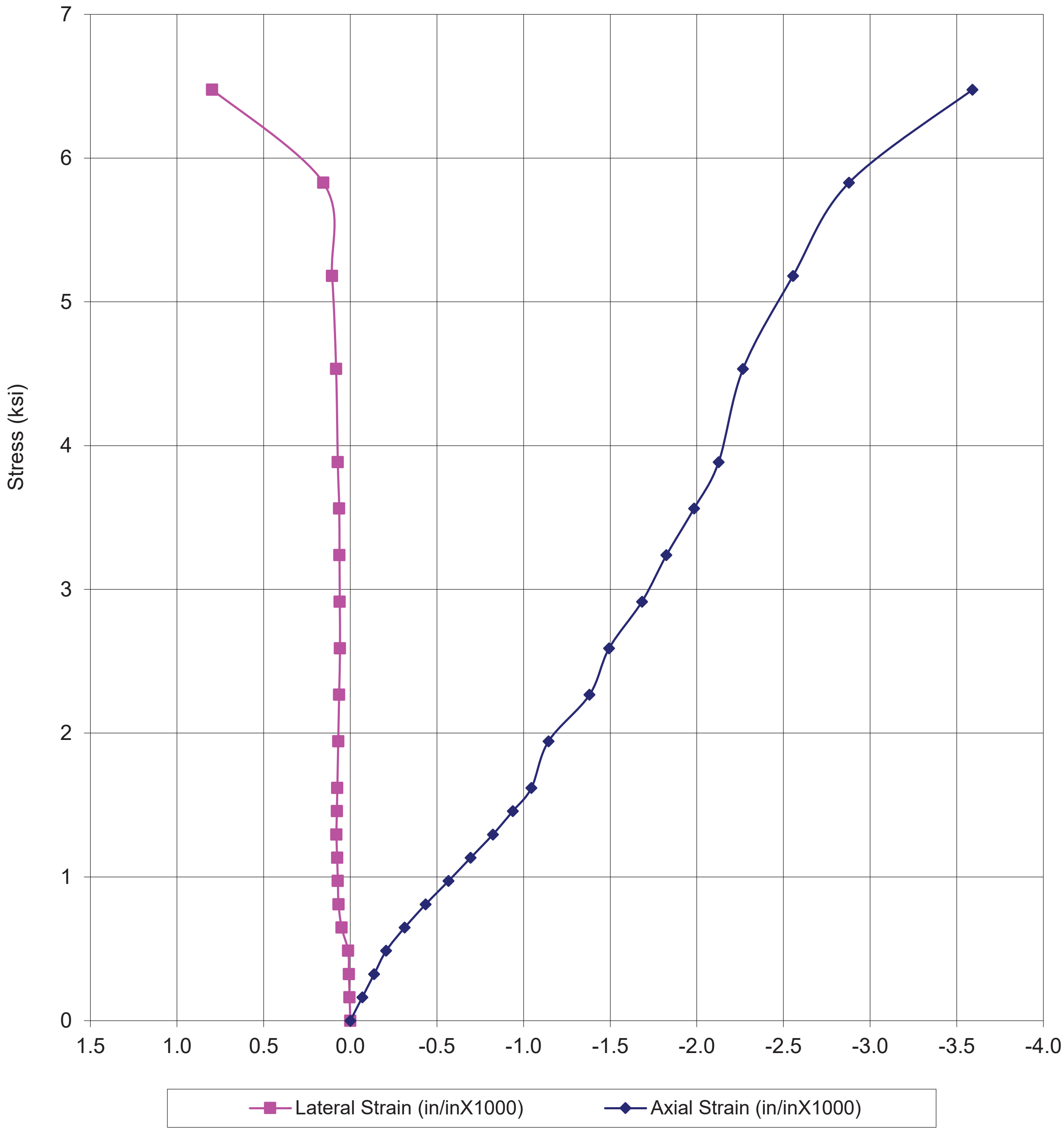
(7) Represents Secant Poisson's Ratio at 50% of Total Failure Stress

(8) Estimated UCS from Table 1 of ASTM D5731 for NX cores (Is x 24)

Reviewed By ______________

01.05.2019

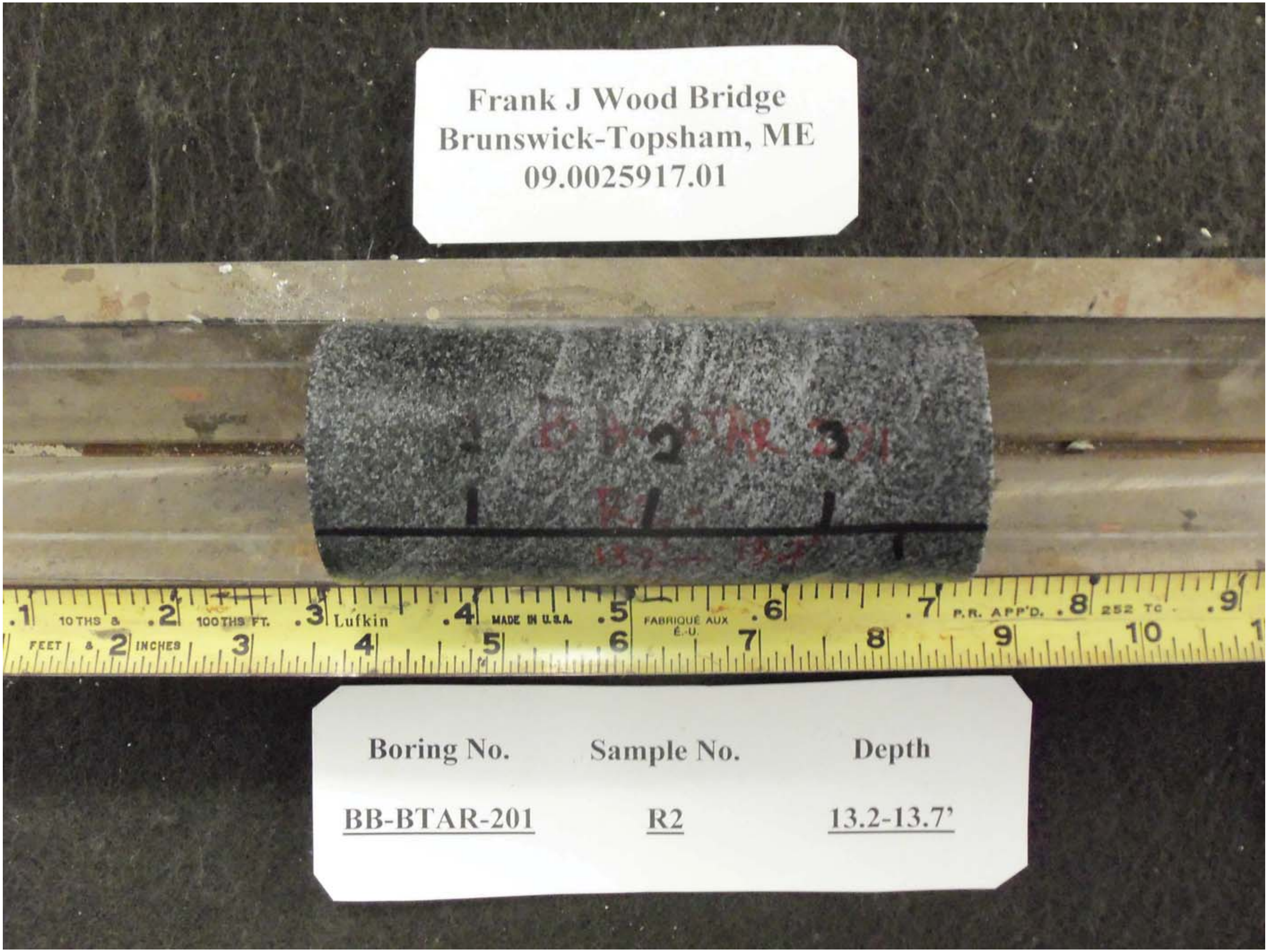
Frank J. Wood Bridge
Brunswick-Topsham, ME



Rock Unconfined Compression Testing - ASTM D7012

Boring No.	BB-BTAR-201	File No.	09.0025917.01
Sample No.	R2	Date:	01.03.19
Depth:	13.2-13.7	Test No.	R-1

THIELSCH ENGINEERING


Frank J Wood Bridge
Brunswick-Topsham, ME
09.0025917.01
Boring No.
Sample No.
Depth
BB-BTAR-201
R2
13.2-13.7'


Frank J Wood Bridge
Brunswick-Topsham, ME
09.0025917.01
Boring No.
BB-BTAR-201
Sample No.
R2
Depth
13.2-13.7'

APPENDIX G – ENGINEERING CALCULATIONS

Bedrock Bearing Resistance Evaluation

Objective

Assess nominal and factored bearing resistance of a foundation on rock based on support in GNEISS and PEGMATITE from borings BB-BTAR-104, -105, -106, -107, -108, and -109, -110, -111, and -112. For Abutments and Piers 1 through 3.

Methodology

Use data from test borings and evaluate the nominal bearing resistance as follows:

1. Bedrock Properties From Test Borings
2. Calculation of Rock Mass Rating
3. Determine Rock Property Constants s and m
4. Calculate Nominal Bearing Resistance of Bedrock q_n

References

1. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 6th edition, 2012. (AASHTO LRFD).

Note: AASHTO 7th Edition is now in effect, but the coefficients used in the bedrock bearing evaluations are understood to be correlated relative to the older Hoek and Brown 1988 methodology. Therefore, RMR is used for the evaluation per LRFD 6th Edition rather than GSI per LRFD 7th Edition.

2. Wyllie, Duncan C., "Foundations on Rock", Second edition, 1992.

1. Rock Properties

Bedrock properties were obtained from rock core specimens and logs completed for the Frank Wood Bridge #2016 Project in Topsham, ME. This calculation is based on the data from borings BB-BTAR-104, -105, -106, -107, -108, and -109.

Bedrock Quality

Representative RQD's are shown in the table below. Summary of all rock core data included in Table 1.

BB-BTAR-107	R1	4.1	100%	41%	Close to Moderate	2.5-24	Moderately Wide	0.1-0.4	Pier 1
BB-BTAR-108	R1	4.6	100%	74%	Close to Moderate	2.5-24	Tight to Partially Open	0.004-0.1	Pier 2
BB-BTAR-109	R1	2.8	100%	45%	Close	8	rtially Open to Modera	0.01-0.4	Pier 2
BB-BTAR-109	R2	5.0	99%	70%	Very Close to Moderate	0.75-24	pen to Moderately Wid	0.02-0.4	Pier 2
BB-BTAR-110	R1	4.5	96%	75%	Close to Moderate	2.5-24	Partially Open	0.01-0.02	Pier 3
BB-BTAR-111	R1	5.0	100%	40%	Close	8	Tight to Partially Open	0.004-0.1	Abutment 2
BB-BTAR-112	R1	5.0	97%	38%	Very Close to Close	0.75-8	Moderately Wide	0.1-0.4	Abutment 2
			RQD Avg	59%					
			RQD STD	16%					

RQD between 38% and 74% for upper core runs at each Pier. Representative RQD of 40% chosen for piers Piers 1 through 3 (mean-1 std deviation to mean).

Bedrock Strength

Boring	Run	LAB						Rock Type
		Depth of Sample (ft)	Depth of Sample into Rock (ft)	Elev Top of Sample (ft)	UCS (psi)	Modulus (ksi)	Poissons's Ratio	
BB-BTAR-105	R3	5.1	5.1	-4.8	16,463	8,930	0.16	PEGMATITE
BB-BTAR-108	R2	7.8	7.8	3.4	9,468	5,150	0.3	GNEISS/PEGMATITE Interface
BB-BTAR-109	R1	5.0	5.0	6.9	32,677	8,270	0.34	GNEISS
BB-BTAR-112	R1	1.7	1.7	26.2	9,603	2,420	0.25	PEGMATITE

Testing values in the table above shown the range in compressive strength results across the site. See Appendix F for complete lab testing results summary. Lower compressive strength results typically associated with pegmatite intrusions. Select design unconfined compressive strength of 9,500 psi.

2. Calculation of Rock Mass Rating (RMR)

From AASHTO LRFD 6th Ed. Table 10.4.6.4-1, determine the RMR.

Parameter 1- Uniaxial Compressive Strength

$\sigma_{u.r} := 9.5\text{ksi} = 1368 \cdot \text{ksf}$

Unconfined compressive strength of samples from these borings ranges from 9,468 psi to 32,677; 9,500 psi was selected for design.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_1 := 7$ for $\sigma_{u.r}$= 1080 - 2160 ksf

Parameter 2- Drill Core Quality

Representative RQD from table above: 15-70%; choose 25-50%

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_2 := 8$

Parameter 3- Spacing of Joints

From Boring Logs, generally very close to moderately spaced = 0.75 in to 2 feet, Typical spacing was 3 in. to 8 in. However, joints typically very tight. Spacing between open joints was observed to range from 1 to 3 feet.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating

$RR_3 := 20$

Parameter 4- Condition of Joints

From boring logs, hard joint walls and appeared smooth on surface, with typical partially open to moderately wide joint separation between 0.01 to 0.4 inches., and described fresh to discolored.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_4 := 6$

Parameter 5- Ground Water Conditions

Hydrostatic Conditions- Water under moderate pressure considering bottom of tremie seal may be below static water level

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_5 := 4$

Parameter 6-Adjustment for joint orientation

The joint sets are generally low angle and generally smooth and open. Orientation of low angle joints is unlikely to be unfavorable considering that steep, exposed rock faces near a proposed footing will require additional reinforcement.. Therefore the joint orientation is considered Fair.

From AASHTO LRFD Table 10.4.6.4-2

Relative Rating $RR_6 := -7$

Total RMR Rating

$$RMR := RR_1 + RR_2 + RR_3 + RR_4 + RR_5 + RR_6$$

$$RMR = 38$$

From AASHTO LRFD Table 10.4.6.4-3 RMR= 21 to 40 is indicative of Poor Rock Quality

3. Determine Rock Property Constants s and m

Use AASHTO LRFD 6th Ed. Table 10.4.6.4-4 to develop empirircal rock property constants

Gneiss is categorized as rock type E, Coarse grained polyminerallic metamorphic, using s and m values interpolated from the logarithmic trend of plotted values from AASHTO Table 10.4.6.4-4 (plots on sheet 8).

$m := 0.30$

$s := 0.0000327$

4. Calculate Nominal and Factored Bearing Resistance of Bedrock q_n and q_R

From Wyllie "Foundations on Rock"

Eq. 5.4 Pg.138

$$q_n := C_{f1} \cdot \sqrt{s} \cdot \sigma_{u.r} \cdot \left[1 + \sqrt{m \cdot \left(s^{-\frac{1}{2}} \right) + 1} \right]$$

Where

$C_{f1} := 1.0$ From Wyllie Table 5.4 Pg. 138 Correction factor for foundation shape for rectangular foundation:

$s = 0.000033$ For L/B>6, use factor C_{fl}=1.0,

$m = 0.3$ For L/B=1, use factor C_{fl}=1.12, therefore,

$\sigma_{u.r} = 9.5 \cdot ksi$ For conservatism, assume long strip, lowest C_{fl}.

Nominal Bearing Resistance

$$q_n := C_{f1} \cdot \sqrt{s} \cdot \sigma_{u.r} \cdot \left[1 + \sqrt{m \cdot \left(s^{-\frac{1}{2}} \right) + 1} \right]$$

$q_n = 65 \cdot ksf$ Say 65ksf

Factored Bearing Resistance (Strength Condition)

Bearing Resistance Factor is specified in Table 10.5.5.2.2-1

$\phi_b := 0.45$ Footing on rock

$q_R := \phi_b \cdot q_n$

$q_R = 29.3 \cdot ksf$ Say 29 ksf

Reference:I:\Mathcad\units.xmcd

10-22 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 10.4.6.4-1 Geomechanics Classification of Rock Masses.

	Parameter		Ranges of Values						
1	Strength of intact rock material	Point load strength index	>175 ksf	85–175 ksf	45–85 ksf	20–45 ksf	For this low range, uniaxial compressive test is preferred		
		Uniaxial compressive strength	>4320 ksf	2160–4320 ksf	1080–2160 ksf	520–1080 ksf	215–520 ksf	70–215 ksf	20–70 ksf
	Relative Rating		15	12	7	4	2	1	0
2	Drill core quality RQD		90% to 100%	75% to 90%	50% to 75%	25% to 50%	<25%		
	Relative Rating		20	17	13	8	3		
3	Spacing of joints		>10 ft.	3–10 ft.	1–3 ft.	2 in.–1 ft.	<2 in.		
	Relative Rating		30	25	20	10	5		
4	Condition of joints		• Very rough surfaces • Not continuous • No separation • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Soft joint wall rock	• Slicken-sided surfaces or • Gouge <0.2 in. thick or • Joints open 0.05–0.2 in. • Continuous joints	• Soft gouge >0.2 in. thick or • Joints open >0.2 in. • Continuous joints		
	Relative Rating		25	20	12	6	0		
5	Ground water conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft. tunnel length	None	<400 gal./hr.	400–2000 gal./hr.	>2000 gal./hr.			
		Ratio = joint water pressure/ major principal stress	0	0.0–0.2	0.2–0.5	>0.5			
		General Conditions	Completely Dry	Moist only (interstitial water)	Water under moderate pressure	Severe water problems			
	Relative Rating		10	7	4	0			

Table 10.4.6.4-2 Geomechanics Rating Adjustment for Joint Orientations.

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable
Ratings	Tunnels	0	–2	–5	–10	–12
	Foundations	0	–2	–7	–15	–25
	Slopes	0	–5	–25	–50	–60

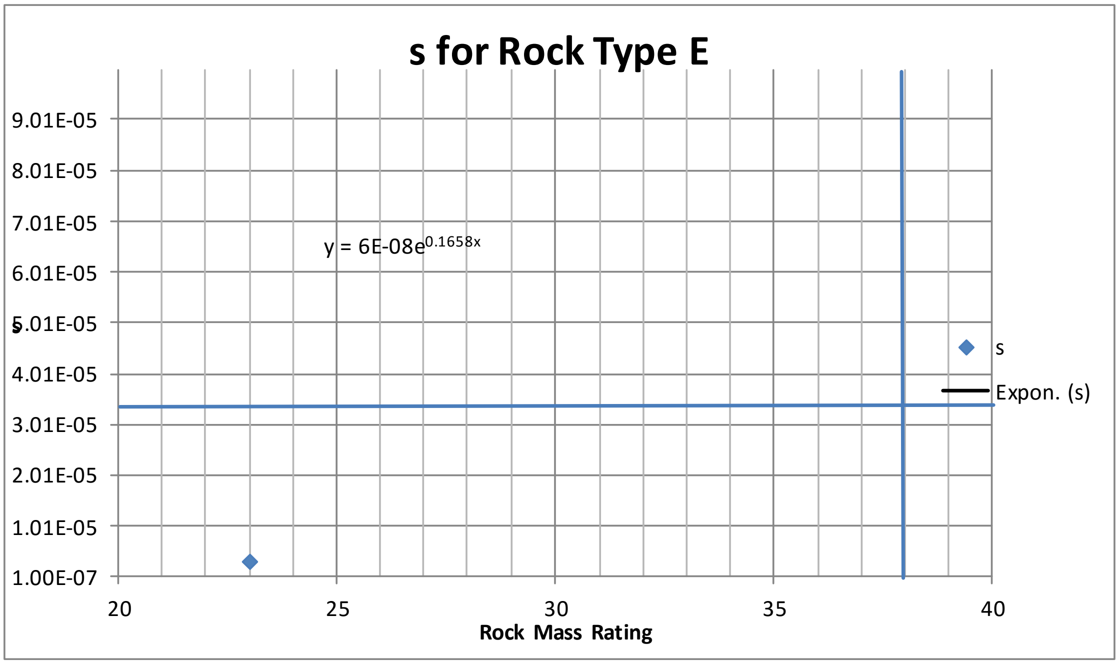
Table 10.4.6.4-3 Geomechanics Rock Mass Classes Determined From Total Ratings.

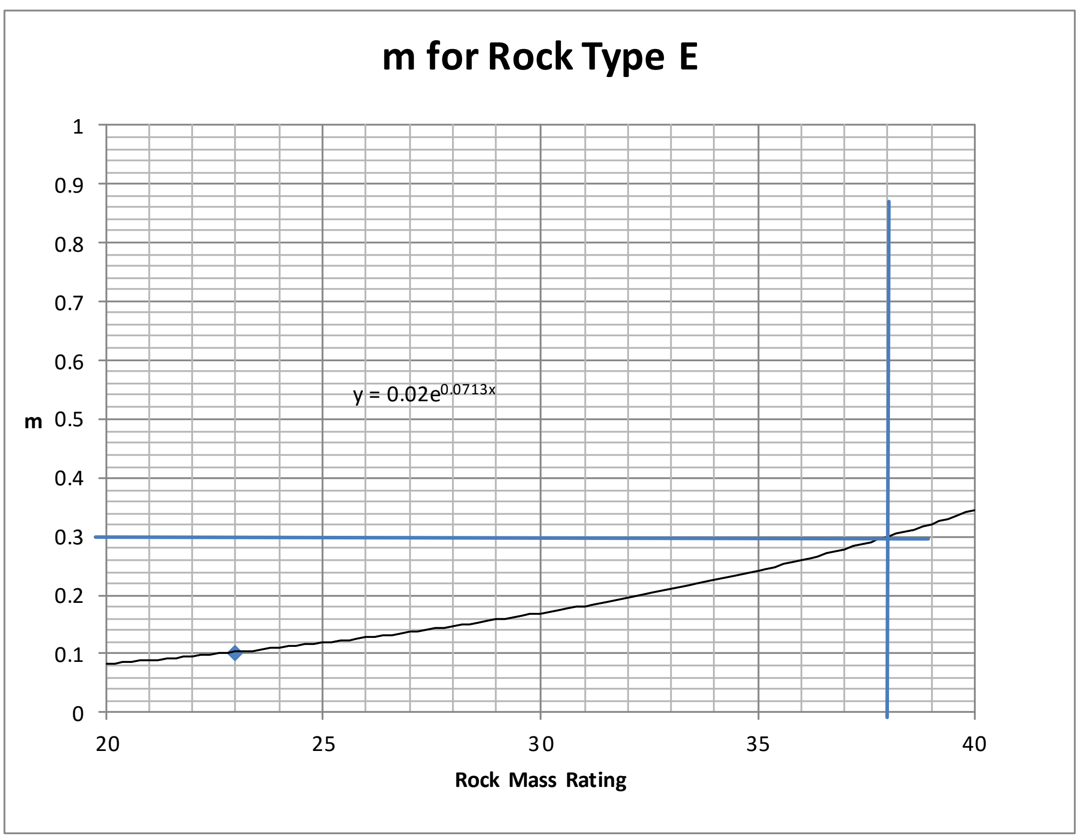
RMR Rating	100–81	80–61	60–41	40–21	<20
Class No.	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

Table 10.4.6.4-4 Approximate relationship between rock-mass quality and material constants used in defining nonlinear strength (*Hoek and Brown, 1988*)

Rock Quality	Constants	Rock Type: A = Carbonate rocks with well developed crystal cleavage—*dolomite, limestone and marble*; B = Lithified argrillaceous rocks—*mudstone, siltstone, shale and slate (normal to cleavage)*; C = Arenaceous rocks with strong crystals and poorly developed crystal cleavage—*sandstone and quartzite*; D = Fine grained polyminerallic igneous crystalline rocks—*andesite, dolerite, diabase and rhyolite*; E = Coarse grained polyminerallic igneous & metamorphic crystalline rocks—*amphibolite, gabbro gneiss, granite, norite, quartz-diorite*				
		A	B	C	D	E
INTACT ROCK SAMPLES Laboratory size specimens free from discontinuities CSIR rating: *RMR* = 100	*m* *s*	7.00 1.00	10.00 1.00	15.00 1.00	17.00 1.00	25.00 1.00
VERY GOOD QUALITY ROCK MASS Tightly interlocking undisturbed rock with unweathered joints at 3–10 ft. CSIR rating: *RMR* = 85	*m* *s*	2.40 0.082	3.43 0.082	5.14 0.082	5.82 0.082	8.567 0.082
GOOD QUALITY ROCK MASS Fresh to slightly weathered rock, slightly disturbed with joints at 3–10 ft. CSIR rating: *RMR* = 65	*m* *s*	0.575 0.00293	0.821 0.00293	1.231 0.00293	1.395 0.00293	2.052 0.00293
FAIR QUALITY ROCK MASS Several sets of moderately weathered joints spaced at 1–3 ft. CSIR rating: *RMR* = 44	*m* *s*	0.128 0.00009	0.183 0.00009	0.275 0.00009	0.311 0.00009	0.458 0.00009
POOR QUALITY ROCK MASS Numerous weathered joints at 2 to 12 in.; some gouge. Clean compacted waste rock. CSIR rating: *RMR* = 23	*m* *s*	0.029 3×10^{-6}	0.041 3×10^{-6}	0.061 3×10^{-6}	0.069 3×10^{-6}	0.102 3×10^{-6}
VERY POOR QUALITY ROCK MASS Numerous heavily weathered joints spaced <2 in. with gouge. Waste rock with fines. CSIR rating: *RMR* = 3	*m* *s*	0.007 1×10^{-7}	0.010 1×10^{-7}	0.015 1×10^{-7}	0.017 1×10^{-7}	0.025 1×10^{-7}

s for Rock Type E


s for Rock Type E
9.01E-05
8.01E-05
7.01E-05
6.01E-05
5.01E-05
4.01E-05
3.01E-05
2.01E-05
1.01E-05
1.00E-07
s
y = 6E-08e^0.1658x
s
Expon. (s)
20
25
30
35
40
Rock Mass Rating


m for Rock Type E
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
m
y = 0.02e^0.0713x
20
25
30
35
40
Rock Mass Rating

Objective

Assess nominal and factored bearing resistance of a foundation on rock based on support in GNEISS and PEGMATITE from borings BB-BTAR-201 and -202. Brunswick Abutment.

Methodology

Use data from test borings and evaluate the nominal bearing resistance as follows:

1. Bedrock Properties From Test Borings
2. Calculation of Rock Mass Rating
3. Determine Rock Property Constants s and m
4. Calculate Nominal Bearing Resistance of Bedrock q_n

References

1. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 6th edition, 2012. (AASHTO LRFD).

   Note: AASHTO 7th Edition is now in effect, but the coefficients used in the bedrock bearing evaluations are understood to be correlated relative to the older Hoek and Brown 1988 methodology. Therefore, RMR is used for the evaluation per LRFD 6th Edition rather than GSI per LRFD 7th Edition.

2. Wyllie, Duncan C., "Foundations on Rock", Second edition, 1992.

1. Rock Properties

Bedrock properties were obtained from rock core specimens and logs completed for the Frank Wood Bridge #2016 Project in Topsham, ME. This calculation is based on the data from borings BB-BTAR-104, -105, -106, -107, -108, -109, and -202.

Bedrock Quality

Representative RQD's are shown in the table below. Summary of all rock core data included in Table 2.

Boring	Run	Length of Core Run (ft)	Rec (%)	RQD %	Joint Spacing Desc.	Corr. Spacing (in)	Aperture Desc.	Corr. Aperture (in)	Pier
BB-BTAR-106	R1	4.5	94%	69%	Close to Moderate	2.5-24	rtially Open to Modera	0.01-0.4	Pier 1
BB-BTAR-107	R1	4.1	100%	41%	Close to Moderate	2.5-24	Moderately Wide	0.1-0.4	Pier 1
BB-BTAR-108	R1	4.6	100%	74%	Close to Moderate	2.5-24	Tight to Partially Open	0.004-0.1	Pier 2
BB-BTAR-109	R1	2.8	100%	45%	Close	8	rtially Open to Modera	0.01-0.4	Pier 2
BB-BTAR-109	R2	5.0	99%	70%	Very Close to Moderate	0.75-24	pen to Moderately Wid	0.02-0.4	Pier 2
BB-BTAR-110	R1	4.5	96%	75%	Close to Moderate	2.5-24	Partially Open	0.01-0.02	Pier 3
BB-BTAR-111	R1	5.0	100%	40%	Close	8	Tight to Partially Open	0.004-0.1	Abutment 2
BB-BTAR-112	R1	5.0	97%	38%	Very Close to Close	0.75-8	Moderately Wide	0.1-0.4	Abutment 2
BB-BTAR-201	R3	3.0	100%	53%	Very Close to Close	0.75-8	Tight	0.004-0.01	Abutment 1
			RQD Avg	55%					
			RQD STD	16%					

RQD between 38% and 74% for upper core runs at each location. R3 was chosen for Boring -201 due to the surface elevation near the road level. Representative RQD of 40% chosen for piers Piers 1 through 3 (mean-1 std deviation to mean).

Bedrock Strength

Boring	Run	LAB						Rock Type
		Depth of Sample (ft)	Depth of Sample into Rock (ft)	Elev Top of Sample (ft)	UCS (psi)	Modulus (ksi)	Poissons's Ratio	
BB-BTAR-105	R3	5.1	5.1	-4.8	16,463	8,930	0.16	PEGMATITE
BB-BTAR-108	R2	7.8	7.8	3.4	9,468	5,150	0.3	GNEISS/PEGMATITE Interface
BB-BTAR-109	R1	5.0	5.0	6.9	32,677	8,270	0.34	GNEISS
BB-BTAR-112	R1	1.7	1.7	26.2	9,603	2,420	0.25	PEGMATITE
BB-BTAR-201	R2	13.2	6.5	---	5,835	1,730	0.04	GNEISS

Testing values in the table above shown the range in compressive strength results across the site. See Appendix F for complete lab testing results summary. Lower compressive strength results typically associated within or near pegmatite intrusions. Select design unconfined compressive strength of 5,835 psi.

2. Calculation of Rock Mass Rating (RMR)

From AASHTO LRFD 6th Ed. Table 10.4.6.4-1, determine the RMR.

Parameter 1- Uniaxial Compressive Strength

$\sigma_{u.r} := 5.83\text{ksi} = 839.52 \cdot \text{ksf}$ Unconfined compressive strength of samples from BB-BTAR-201, -202. Lowest UCS 5,830 psi.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_1 := 7$ for $\sigma_{u.r}$ = 1080 - 2160 ksf

Parameter 2- Drill Core Quality

Representative RQD from table above: 38-75%; choose 25-50%

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_2 := 8$

Parameter 3- Spacing of Joints

From Boring Logs, generally very close to moderately spaced = 0.75 in to 2 feet, Typical spacing was 3 in. to 8 in. However, joints typically very tight. Spacing between open joints was observed to range from 1 to 3 feet.

From AASHTO LRFD Table 10.4.6.4-1
Relative Rating

$RR_3 := 20$

Parameter 4- Condition of Joints

From boring logs, hard joint walls and appeared smooth on surface, with typical partially open to moderately wide joint separation between 0.01 to 0.4 inches., and described fresh to discolored.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_4 := 6$

Parameter 5- Ground Water Conditions

Hydrostatic Conditions- Water under moderate pressure considering bottom of tremie seal may be below static water level

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_5 := 4$

Parameter 6-Adjustment for joint orientation

The joint sets are generally low angle and generally smooth and open. Orientation of low angle joints is unlikely to be unfavorable considering that steep, exposed rock faces near a proposed footing will require additional reinforcement.. Therefore the joint orientation is considered Fair.

From AASHTO LRFD Table 10.4.6.4-2

Relative Rating $RR_6 := -2$

Total RMR Rating

$$RMR := RR_1 + RR_2 + RR_3 + RR_4 + RR_5 + RR_6$$

$$RMR = 43$$

From AASHTO LRFD Table 10.4.6.4-3 RMR is indicative of fair Rock Quality

3. Determine Rock Property Constants s and m

Use AASHTO LRFD 6th Ed. Table 10.4.6.4-4 to develop empirircal rock property constants

Gneiss is categorized as rock type E, Coarse grained polymminerallic metamorphic, using s and m values interpolated from the logarithmic trend of plotted values from AASHTO Table 10.4.6.4-4 (plots on sheet 8).

$m := .458$

$s := .00009$

4. Calculate Nominal and Factored Bearing Resistance of Bedrock q_n and q_R

From Wyllie "Foundations on Rock"

Eq. 5.4 Pg.138

$$q_n := C_{f1} \cdot \sqrt{s} \cdot \sigma_{u.r} \cdot \left[1 + \sqrt{m \cdot \left(s^{-\frac{1}{2}} \right) + 1} \right]$$

Where

$C_{f1} := 1.0$ — From Wyllie Table 5.4 Pg. 138 Correction factor for foundation shape for rectangular foundation:

$s = 0.00009$ — For L/B>6, use factor C_{fl}=1.0,

$m = 0.458$ — For L/B=1, use factor C_{fl}=1.12, therefore,

$\sigma_{u.r} = 5.83 \cdot ksi$ — For conservatism, assume long strip, lowest C_{fl}.

Nominal Bearing Resistance

$$q_n := C_{f1} \cdot \sqrt{s} \cdot \sigma_{u.r} \cdot \left[1 + \sqrt{m \cdot \left(s^{-\frac{1}{2}} \right) + 1} \right]$$

$q_n = 63.9 \cdot ksf$ — Say 64 ksf

Factored Bearing Resistance (Strength Condition)

Bearing Resistance Factor is specified in Table 10.5.5.2.2-1

$\phi_b := 0.45$ — Footing on rock

$q_R := \phi_b \cdot q_n$

$q_R = 28.7 \cdot ksf$ — Say 29 ksf

Earth Pressure Coefficient Evaluation

Subject:

Evaluate lateral earth pressure coefficients

References:

1. MaineDOT Bridge Design Guide, Chapter 3
2. AASHTO LRFD Bridge Design Specifications, 7th Edition (2014, with 2015 and 2016 Interims)

Input Parameters:

$\beta := 0\text{deg}$ — Angle of backfill to the horizontal

$\theta := 90\text{deg}$ — Angle of backface of wall to the horizontal

$\phi := 32\text{deg}$ — Effective angle of internal friction *(Granular borrow, Soil Type 4, BDG Table 3-3)*

$\delta_f := 20\text{deg}$ — Average value, precast concrete against clean sand/silty sand-gravel mixture *(AASHTO LRFD Table 3.11.5.3-1)*

Earth Pressure Coefficients:

MaineDOT BDG, Chapter 3 specifies that the Coulomb Theory should be used to estimate earth pressures against the following types of retaining walls: Gravity Walls and Abutments, Prefabricated modular walls with steep faces, and cantilever walls and abutments with short heeled walls, and the Rankine Theory be used for long heeled walls.

Coulomb Theory

Per BDG Section 3.6.5.1, interface friction bewteen along the back face of the wall should be accounted for.

Coloumb Active Earth Pressure Coefficient (Short-Heeled Wall)

$$\Gamma := \left[1 + \sqrt{\left[\frac{\sin(\phi + \delta_f)\cdot(\sin(\phi - \beta))}{\sin(\theta - \delta_f)\cdot\sin(\theta + \beta)}\right]}\right]^2 = 2.78$$

$$K_{ac} := \frac{(\sin(\theta + \phi))^2}{\Gamma\cdot\left[(\sin(\theta))^2\cdot\sin(\theta - \delta_f)\right]}$$

$K_{ac} = 0.28$

Seismic Site Class Evaluation

Design Maps Summary Report USGS

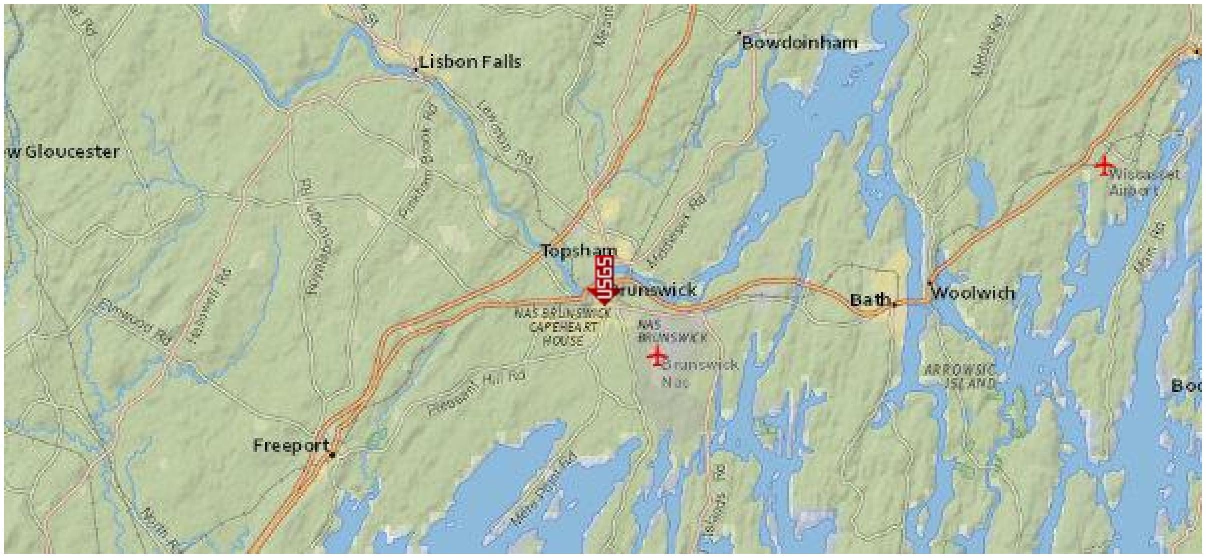
User–Specified Input

Report Title Frank J. Wood Bridge No. 2016
Thu January 18, 2018 16:54:52 UTC

Building Code Reference Document 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design
(which utilizes USGS hazard data available in 2002)

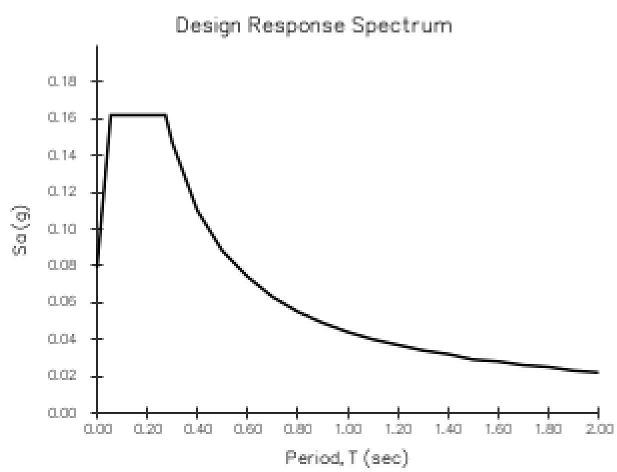
Site Coordinates 43.92008°N, 69.96616°W

Site Soil Classification Site Class B – "Rock"



USGS–Provided Output

PGA =	0.079 g	**A_s =**	0.079 g
S_S =	0.162 g	**S_{DS} =**	0.162 g
S_1 =	0.044 g	**S_{D1} =**	0.044 g



Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (43.92008°N, 69.96616°W)

Site Class B – "Rock"

Article 3.4.1 — Design Spectra Based on General Procedure

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

From Figure 3.4.1-2 [1]	PGA = 0.079 g
From Figure 3.4.1-3 [2]	S_S = 0.162 g
From Figure 3.4.1-4 [3]	S_1 = 0.044 g

Article 3.4.2.1 — Site Class Definitions

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

Table 3.4.2.1–1 Site Class Definitions

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

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

Article 3.4.2.3 — Site Coefficients

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

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

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

For Site Class = B and PGA = 0.079 g, F_{PGA} = 1.000

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

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

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

For Site Class = B and S_S = 0.162 g, F_a = 1.000

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

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

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

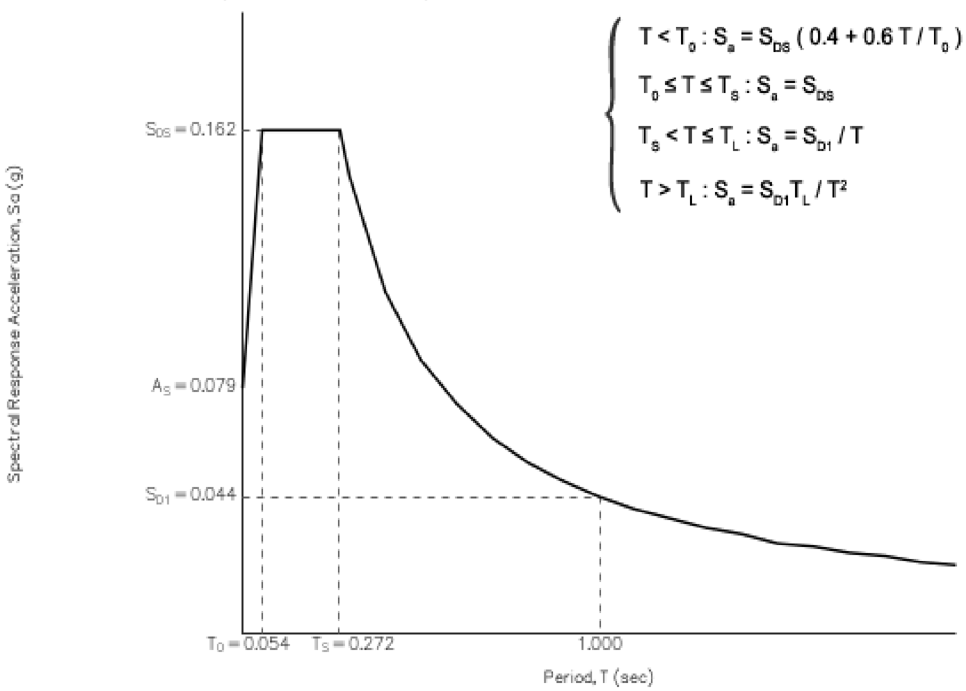
For Site Class = B and S_1 = 0.044 g, F_v = 1.000

Equation (3.4.1-1): $A_S = F_{PGA}$ PGA = 1.000 x 0.079 = 0.079 g

Equation (3.4.1-2): $S_{DS} = F_a S_S$ = 1.000 x 0.162 = 0.162 g

Equation (3.4.1-3): $S_{D1} = F_v S_1$ = 1.000 x 0.044 = 0.044 g

Figure 3.4.1-1: Design Response Spectrum



Article 3.5 - Selection of Seismic Design Category (SDC)

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

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

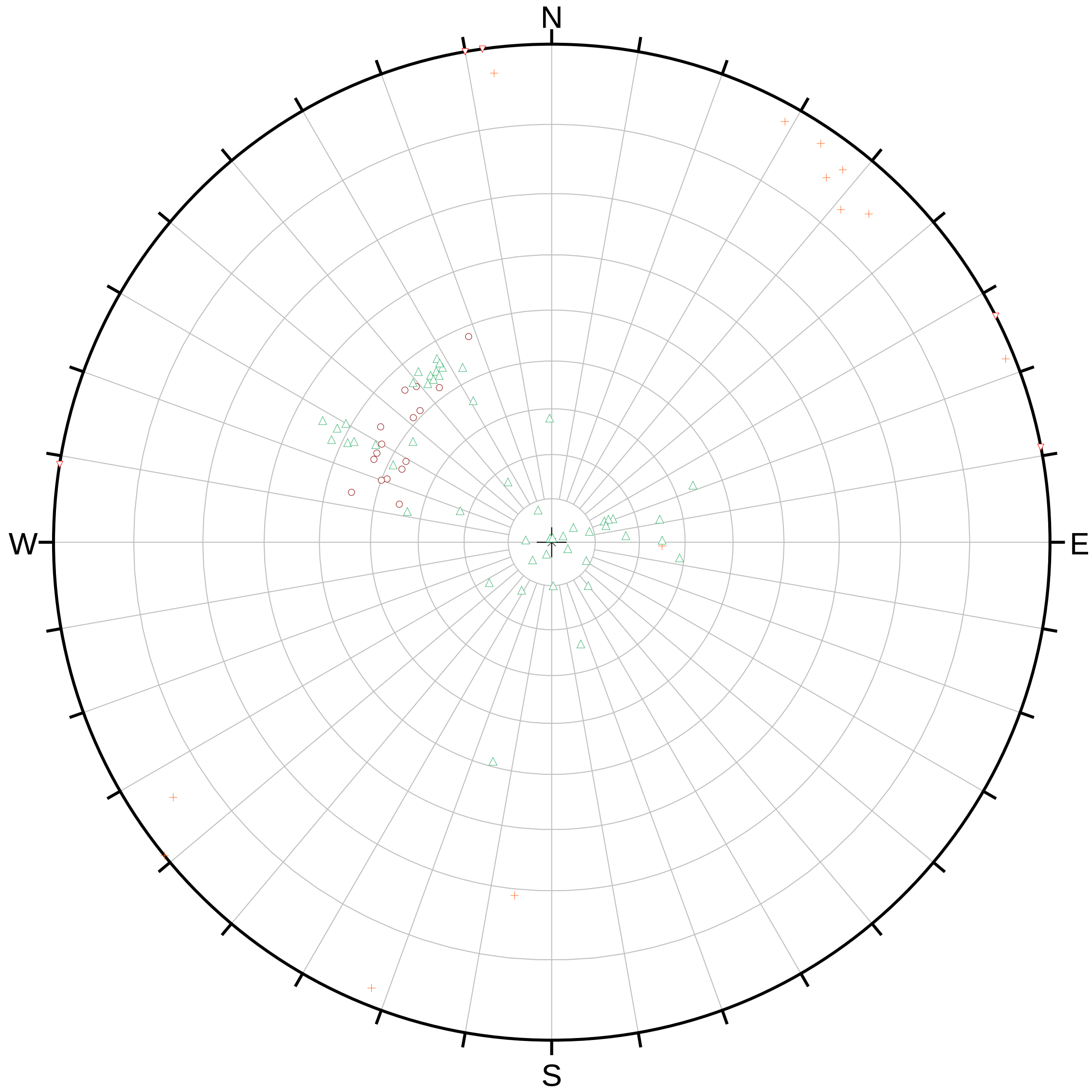
For S_{D1} = 0.044 g, Seismic Design Category = A

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

References

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

Bedrock Assessment - Joint Set Characterization



Symbol	FEATURE	Quantity
▽	Contact	5
○	Foliation	16
△	Geophys	52
+	Joint	13

Plot Mode	Pole Vectors
Vector Count	86 (86 Entries)
Hemisphere	Lower
Projection	Equal Angle

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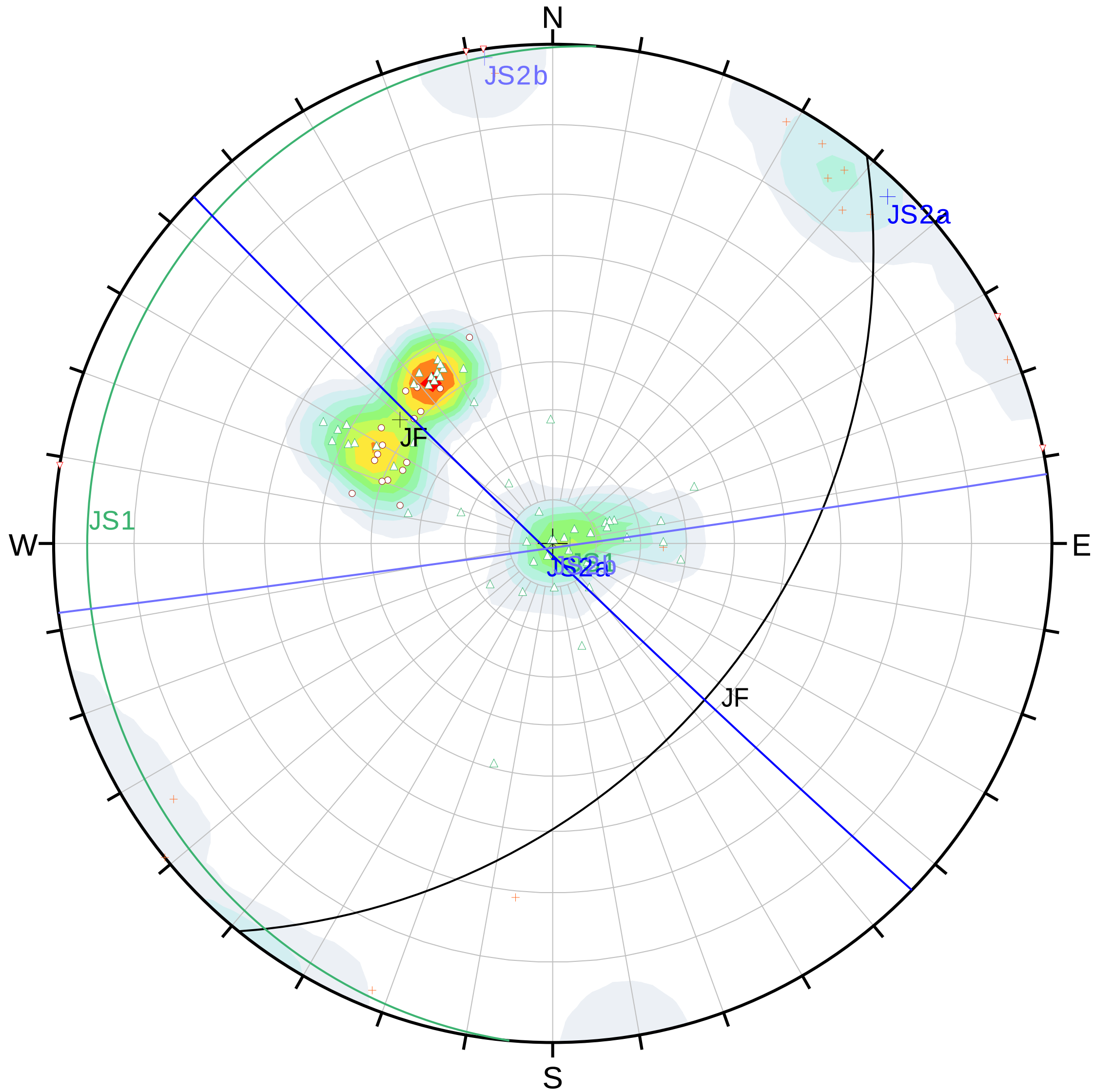
DIPS 7.014

Project	Frank J. Wood Bridge No. 2016		
Analysis Description	Lower Hemisphere Pole Plot		
Drawn By	E. Friede	*Company*	GZA GeoEnvironmental
Date		*File Name*	FJW Bridge_V3.dips7



Symbol	FEATURE	Quantity
▽	Contact	5
○	Foliation	16
△	Geophys	52
+	Joint	13

Color	Density Concentrations
	0.00 - 1.80
	1.80 - 3.60
	3.60 - 5.40
	5.40 - 7.20
	7.20 - 9.00
	9.00 - 10.80
	10.80 - 12.60
	12.60 - 14.40
	14.40 - 16.20
	16.20 - 18.00
Contour Data	Pole Vectors
Maximum Density	17.17%
Contour Distribution	Fisher
Counting Circle Size	1.0%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		43	129	JF
2m		4	275	JS1
3m		88	224	JS2a
7m		89	172	JS2b

Plot Mode	Pole Vectors
Vector Count	86 (86 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Frank J. Wood Bridge No. 2016		
Analysis Description	Joint Set Characterization - Contour and Major Planes Plot		
Drawn By	E. Friede	*Company*	GZA GeoEnvironmental
Date		*File Name*	FJW Bridge_V3.dips7