GEOTECHNICAL DESIGN REPORT
REPLACEMENT OF MARTIN MEMORIAL BRIDGE
MAINEDOT WIN 15105.00
ROUTE 232 - RUMFORD, MAINE

by

Haley & Aldrich, Inc.
Portland, Maine

for

Maine Department of Transportation
Augusta, Maine

File No. 38799-000
24 May 2013

HALEY & ALDRICH

Haley & Aldrich, Inc.
75 Washington Avenue
Suite 203
Portland, ME 04101

Tel: 207.482.4600
Fax: 207.775.7666
HaleyAldrich.com

HALEY & ALDRICH

24 May 2013
File No. 38799-000

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

Attention: Kate Maguire, P.E.

Subject: Geotechnical Design Report
Replacement of Martin Memorial Bridge
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Ladies and Gentlemen:

We are pleased to submit herewith our report titled, "Geotechnical Design Report, Martin Memorial Bridge Replacement, MaineDOT WIN 15105.00, Route 232-Rumford, Maine," prepared in accordance with our proposal, dated 11 April 2012 and with the provisions of our GCA Agreement with the Maine Department of Transportation (MaineDOT), No. CT20110614000000006492.

This Geotechnical Design Report (GDR) provides the results of subsurface investigation and geotechnical laboratory testing programs and summarizes geotechnical design recommendations and construction considerations in support of the subject project.

Thank you for the opportunity to help support MaineDOT on this significant project. We look forward to providing continued assistance to MaineDOT during the bidding and construction phases of the project.

Sincerely yours,
HALEY & ALDRICH, INC.

Bryan C. Steinert, P.E.
Senior Geotechnical Engineer

Wayne A. Chadbourne, P.E.
Lead Geotechnical Engineer / Vice President

Enclosures

STATE OF MAINE
BRYAN C. STEINERT
No. 12008
LICENSED
PROFESSIONAL ENGINEER

STATE OF MAINE
WAYNE A. CHADBOURNE
No. 10620
LICENSED
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

		Page
LIST OF TABLES		**iii**
LIST OF FIGURES		**iii**
1.	**INTRODUCTION**	**1**
1.1	Horizontal Coordinate System, Elevation Datum and Baseline Stationing	1
1.2	Existing Bridge Structure	1
1.3	Proposed Bridge Structure	1
1.4	Terrain and River Hydraulics	2
2.	**GEOLOGIC SETTING**	**4**
3.	**SUBSURFACE EXPLORATION PROGRAM**	**5**
4.	**GENERALIZED SUBSURFACE CONDITIONS**	**7**
4.1	Soil Unit and Bedrock Descriptions	7
4.1.1	Bituminous Concrete / Man-Placed Fill	7
4.1.2	Topsoil	7
4.1.3	Alluvial Deposit	8
4.1.4	Glaciolacustrine Deposit	8
4.1.5	Glaciofluvial Deposit	9
4.1.6	Glacial Till	9
4.1.7	Bedrock	9
4.2	Groundwater Conditions	10
5.	**LABORATORY TESTING PROGRAM**	**11**
6.	**GEOTECHNICAL EVALUATIONS AND DESIGN RECOMMENDATIONS**	**12**
6.1	Pavement Design	12
6.1.1	Cut/Fill Areas and Anticipated Subgrade Conditions	12
6.1.2	Subgrade Resilient Modulus	12
6.1.3	Frost Penetration	13
6.2	Seismic Design	14
6.2.1	Initial Liquefaction Susceptibility Evaluation and Results	14
6.2.2	Site-Specific Liquefaction Susceptibility Evaluation and Results	16
6.2.3	Comparison between Simplified and Site-Specific Liquefaction Susceptibility Results	18
6.3	Approach Embankment Stability	19
6.3.1	General	19
6.3.2	Input Parameters	20
6.3.3	Results	22
6.4	Approach Embankment Stability and Liquefaction Mitigation Remedial Measures	23
6.4.1	Improved Strength Parameters and Slope Stability Evaluation Results	25
6.4.2	Post Ground Improvement Requirements	25
6.5	Bridge Abutment and Pier Foundation Recommendations	26

TABLE OF CONTENTS

		Page
6.5.1	Corrosion and Deterioration	27
6.5.2	Liquefaction Induced Downdrag	27
6.5.3	Axial Compression Pile Resistance	28
6.5.4	Axial Uplift Pile Resistance	28
6.5.5	Lateral Pile Group Evaluations	29
6.5.6	Nominal Pile Driving Resistance	30
6.5.7	Pile Tip Elevations	31
6.5.8	Driveability Evaluation	31
6.5.9	Pile Settlement and Elastic Pile Compression	32
6.5.10	Pile Embedment, Spacing, Clearance and Pile Material	33
7.	**CONSTRUCTION CONSIDERATIONS**	**34**
7.1	Temporary Earth Support	34
7.2	Vibro-Replacement Ground Improvement	34
7.3	Dynamic Pile Load Testing Program	35
7.4	Reuse of Excavated On-Site Soils	36
7.5	Submittal Reviews	36
7.6	Construction Monitoring	36
8.	**LIMITATIONS OF RECOMMENDATIONS**	**37**
9.	**REFERENCES**	**38**

TABLES
FIGURES
APPENDIX A - **Test Boring Logs**
APPENDIX B – **Observation Well Installation and Groundwater Monitoring Reports**
APPENDIX C – **Laboratory Test Results**
APPENDIX D - **Existing Bridge Drawings**
APPENDIX E - **Design Memoranda**
APPENDIX F - **Calculations**

LIST OF TABLES

Table No.	Title
I	Design Phase Exploration Location Data
II	Design Phase Exploration Subsurface Data
III	Cut/Fill Depths and Anticipated Subgrade Conditions
IV	Abutment 1 Factored Pile Cap Loads
V	Abutment 2 Factored Pile Cap Loads
VI	Pier 1 and Pier 2 Factored Pile Cap Loads
VII	FB-MultiPier Pile Group Evaluation Results
VIII	Preliminary Geotechnical Quantity and Cost Comparison - Simplified vs. Site Specific Liquefaction Evaluation Results

LIST OF FIGURES

Figure No.	Title
1	Project Locus
2-3	Site and Subsurface Exploration Location Plan
4	Interpretive Subsurface Profile

1. INTRODUCTION

This report presents the results of design phase subsurface and laboratory testing programs, engineering evaluations, and geotechnical design recommendations conducted by Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of the Maine Department of Transportation (MaineDOT) for the proposed replacement of Martin Memorial Bridge (Route 232) over the Androscoggin River (river) in Rumford, Maine (see Figure 1, Project Locus). We coordinated our technical evaluations with TranSystems, the lead bridge designer, throughout the design development phase of the project. TranSystems also conducted the hydrology and hydraulics evaluation for the project.

1.1 Horizontal Coordinate System, Elevation Datum and Baseline Stationing

Plan locations of test borings are reported as northing and easting coordinates relative to the Maine State Plane Coordinate System, North American Datum of 1983 (NAD 83), Maine 2000 West Zone. The project elevation datum and elevations referenced herein are in feet and reference the North American Vertical Datum of 1988 (NAVD 88). Several baselines were developed by TranSystems (for the multiple alignments as summarized below.

- Proposed Route 232: Sta. 1+00
- Existing Route 232: Sta. 30+00
- Existing Route 2: Sta. 50+00

1.2 Existing Bridge Structure

The existing Martin Memorial Bridge carries Route 232 from the southeast over the Androscoggin River (river) and intersects with U.S. Route 2 in Rumford Point, Maine. The existing three-span steel truss bridge was originally constructed in the mid-1950s. Based on our review of the historic bridge plans provided by MaineDOT, we understand that the existing bridge is supported on two abutments and two piers. Both piers are located within the limits of the river. The abutments and piers are founded on untreated timber piles of unknown diameter that range between roughly 30 and 40-ft long (from cutoff to tip elevation). The tips of the piles supporting Pier 1, Pier 2 and Abutment 2 appear to be embedded in loose to medium dense SAND and likely generate their load-carrying capacity through side frictional resistance. The tips of the piles supporting Abutment 1 (east abutment) appear to be located in the vicinity of bedrock and likely generate the majority of their load-carrying capacity through end bearing resistance. The existing piles were designed for a maximum pile load of 20 tons. Existing bridge drawings are provided for reference in Appendix D.

1.3 Proposed Bridge Structure

The replacement bridge and approach roadway alignment will be offset to the north (upstream) of the existing bridge alignment by approximately 600 feet as shown on Figures 2 and 3, Site and Subsurface Exploration Location Plans. The total length of the proposed project alignment is approximately 2,100 linear feet (lf), which consists of a 500-ft long bridge structure and 1,600 lf of approach roadway/embankment.

The bridge superstructure will be approximately 35-ft wide (curb to curb) and will consist of two 16-ft wide travel lanes. The bridge superstructure will be constructed using composite welded steel beams (five beam lines) running parallel to the long dimension of the bridge, with an 8½-in. thick cast-in-place (CIP) concrete deck and a 3-in. thick bituminous concrete wearing surface separated by a ¼-in.

thick high performance waterproofing membrane. The bridge superstructure will be supported on two full-height abutments and two piers at the stations summarized below.

Substructure	Station at Centerline Of Alignment (ft)
Abutment 1	15+15.00
Pier 1	16+71.50
Pier 2	18+63.50
Abutment 2	20+20.00

The bridge approach roadways will be approximately 28 to 32-ft wide (shoulder-to-shoulder) and will consist of two, 11-ft wide travel lanes and two outside shoulders ranging from 3 to 5-ft wide. Existing grades along the proposed roadway alignment will be raised up to 25 ft (relative to existing site grades) to meet the design vertical profile for the bridge/roadway.

The project also includes the removal of the existing Route 232 / U.S. Route 2 intersection and construction of a new intersection. It is our understanding that demolition/removal of the existing bridge will also be completed as part of this project.

1.4 Terrain and River Hydraulics

The existing ground surface varies significantly within the project limits, between Sta. 0+00 and Sta. 21+00 (see Figures 2 and 3). The existing ground surface is relatively flat between Sta. 0+00 and Sta. 4+00, ranging between approximately El. 625 and El. 627. At Sta. 4+00, the ground surface slopes down to El. 620 to a lower terrace that extends to approximately Sta. 10+00. At approximately Sta. 10+00, the ground surface slopes down again to an even lower terrace that extends to the west bank of the river (approximately Sta. 15+50). The ground surface in this area generally ranges between El. 613 and El. 616. The limits of the river, as defined and referenced herein, are generally between Sta. 15+50 and Sta. 20+00. The west river bank slopes down between Sta. 15+50 and Sta. 16+75 from El. 615 to El. 596. The bottom of the river is generally flat (approximately El. 596) between Sta. 16+75 to Sta. 18+75 before sloping up to El. 614 at the east bank of river (Sta. 20+00). A narrow terrace exists in the vicinity of Sta. 20+00 before the ground surface slopes steeply upward to Route 2 (El. 637; Sta. 21+00). Flood levels in the river, as determined by TranSystems, are summarized below.

Discharge	Headwater (ft, NAVD 88)
$Q_{1.1}$	El. 613.1
Q_{25}	El. 622.8
Q_{50}	El. 623.9
Q_{100}	El. 625.7
Record Flood (1936)	El. 630.7

As part of the hydraulic evaluation, TranSystems also considered the effects of scour at the proposed bridge location. The results of their evaluation are summarized below. It is our understanding that scour is not anticipated at Abutments 1 or 2.

Substructure Location	Approximate Existing Mudline Elevation (ft, NAVD 88)	Scour Depth (ft)		Design Scour Elevation (ft, NAVD 88)		
		100-yr	500-yr	100-yr	50% of 500-yr	500-yr
Pier 1	596	35.1	41.6	560.9	575.2	554.4
Pier 2						

2. GEOLOGIC SETTING

During glacial retreat of the Laurentide Ice Sheet between approximately 16,000 and 12,000 years ago, glacial meltwater streams carried and deposited sediment as layered accumulations in river valleys, lake basins and coastal lowlands. These deposits were primarily composed of sands and gravels with finer silts and clays in the coastal lowlands.

Glacial Lake Hanover was formed during glacial melting within the Androscoggin River Valley between Bethel and Rumford Center. It is likely that glacial till sediment temporarily dammed narrow portions of the river valley between Rumford Point and Rumford Center resulting in continued formation of Glacial Lake Hanover. The accumulated glacial lake sediment consisted of sand, gravel, silt and clay and included deltaic deposits and fine grained lake bottom sediments. In many areas post glacial streams partially eroded these formations. Surficial geologic units encountered in recent explorations at the project site consist of Alluvial Deposits composed primarily of sand and silt with minor amounts of gravel, Glaciolacustrine Deposits composed primarily of fine sand and silt, Glaciofluvial Deposits composed of sand and gravel, trace silt, overlying Glacial Till sediments consisting of a heterogeneous mixture of sand, silt and gravel.

Bedrock within the project limits is mapped as Devonian age rocks of the Littleton Formation. This formation consists of medium to fine grained schist, coarse grained gneiss to migmatitic gneiss and biotite granulite, and coarse grained quartz pegmatite. A thrust fault is mapped within the regional site vicinity.

3. SUBSURFACE EXPLORATION PROGRAM

Haley & Aldrich completed a design phase subsurface exploration program at the site in June and July 2012. A total of 23 test borings, designated BB-RAR-101 through BB-RAR-123, were drilled along the proposed approach roadway and bridge alignment, including two test borings at the extreme ends (north and south) of the proposed Abutment 1 and bridge pier substructures). Please note that test borings drilled to determine the design requirements for the Abutment 2 substructure (BB-RAR-119 and BB-RAR-120) were drilled within the limits of the river since the proposed Abutment 2 location could not be accessed by drilling equipment. The test boring locations were laid out in the field by Haley & Aldrich using global positioning system (GPS) survey equipment prior the start of drilling. "As-drilled" test boring locations and ground surface/mudline elevations at test boring locations were determined in the field by MaineDOT using GPS survey equipment upon the completion of drilling and were provided to Haley & Aldrich. The "as-drilled" coordinates of each test boring were related to station and offset distance and direction relative to the proposed baseline(s) by TranSystems and was provided to Haley & Aldrich (as shown on the borings logs in Appendix A). The plan locations of the explorations are summarized in Table I and are shown on Figures 2 and 3.

The test borings were drilled by Maine Test Borings of Hermon, Maine using a CME 45 trailer-mounted drill rig and a CME 45 drill rig placed on an anchored barge. Test borings were advanced to depths ranging from approximately 10 to 146 ft below existing ground surface/mudline (BGS) using either 2.5 in. inside diameter (ID) hollow stem augers (for shallow borings drilled along the proposed approach roadways) or cased-washed drilling methods using a combination of 3 in. (NW-size) and 4 in. (HW-size) outside diameter (OD) steel casing (for deeper borings at the proposed embankment and substructure locations).

Soil samples were generally collected continuously and/or at standard, 5-ft intervals, by driving a 1-3/8-in. ID split-spoon sampler with a 140-lb hammer dropped from a height of 30 in., as indicated on the test boring logs. A bentonite drilling mud was used in select boreholes to aid in maintaining borehole stability and collection of quality standard penetration test (SPT) data. The number of hammer blows required to advance the sampler through each 6 in. interval was recorded and is provided on the logs. The uncorrected SPT N-value (N-uncorrected) is defined as the total number of blows required to advance the sampler through the middle 12 in. of the 24-in. sampling interval.

The drill rig was equipped with a standard rope and cathead pulley system and a safety hammer per MaineDOT requirements. A theoretical hammer efficiency factor of 0.6 was assumed for the rope and cathead/safety hammer system. The energy-corrected SPT N-value (N_{60}) is equal to N-uncorrected multiplied by the hammer efficiency factor (0.6 for a standard rope and cathead pulley system and a safety hammer per MaineDOT requirements). Test borings drilled at proposed bridge substructure locations (i.e., abutments, piers) were advanced approximately 2 to 19 ft into bedrock using a 2.0-in. (NQ-size) ID diamond-tipped core barrel.

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

One observation well was installed in completed borehole BB-RAR-109 to provide information on the static groundwater level on the west side of the river. The observation well consisted of 2-in. ID,

machine-slotted PVC pipe and solid PVC riser pipe extending approximately 3 ft above existing ground surface. The observation well was outfitted with a steel guard pipe and steel lock/cap assembly.

All drilling and sampling was performed in accordance with MaineDOT specifications.

4. GENERALIZED SUBSURFACE CONDITIONS

The subsurface conditions encountered at the site were somewhat "dynamic" along the length of the bridge alignment and consist of the following geologic units presented in order of increasing depth below ground surface: bituminous concrete/topsoil, man-placed fill, alluvial deposits, glaciolacustrine deposits, glaciofluvial deposits, glacial till and bedrock. We attribute this dynamic geologic setting to the occurrence of intermittent damming of the river valley during glacial melting, deposition of glacial lake sediments and subsequent post glacial erosion of the lake sediments. Refer to Table II and Figure 4 for a summary of the soil units and encountered thicknesses at each test boring location and a graphic representation of subsurface conditions along the proposed bridge alignment, respectively. A description of each soil/bedrock unit is provided separately, below. Detailed soil and bedrock descriptions are provided on the test boring logs included Appendix A. The conditions documented in the existing bridge subsurface profile (see Appendix D) are similar to the conditions encountered along the proposed bridge alignment.

Please note that soil descriptions provided on the test boring logs and summarized below do not represent actual field conditions other than at the specific test boring locations. The actual conditions will likely vary from those described herein.

4.1 Soil Unit and Bedrock Descriptions

4.1.1 Bituminous Concrete / Man-Placed Fill

Bituminous concrete and man-placed fill soils were encountered in test borings drilled within the limits of existing roadways (Route 232 and Route 2). The bituminous concrete ranged in thickness from approximately 0.4 to 0.7 ft. The man-placed fill soil was encountered directly beneath the bituminous concrete and ranged in thickness from approximately 1.3 to 8.7 ft but was typically between 1.3 and 2.1 ft.

The man-placed fill soil was variable and generally consisted of the following:

- Fine to medium SAND, trace coarse sand, trace to little silt, little fine gravel
- Fine to coarse SAND, trace silt, trace to little gravel

The man-placed fill soil was typically loose to dense with SPT N_{60} values ranging from 2 to 49 blows per foot (bpf).

4.1.2 Topsoil

A surficial layer of topsoil was encountered in test borings drilled along the proposed roadway on the west side of the river (i.e., BB-RAR-103 through BB-RAR-114). The topsoil ranged in thickness from approximately 2 to 6 ft but was typically between 2 and 4 ft. The topsoil typically consisted of the following:

- SILT (MH), trace fine to medium sand with rootlets
- SILT (ML), trace clay, little to some fine sand, trace medium sand, occasionally stratified with rootlets
- Fine sandy SILT (ML) to silty fine SAND (SM), with rootlets and occasional seams of black organic soil

The topsoil was typically very soft/very loose to medium stiff/loose with SPT N_{60} values ranging from 1 to 7 bpf.

4.1.3 Alluvial Deposit

Alluvial soils were encountered underlying either the man-placed fill or topsoil layer in each test boring. Where the deposit was fully penetrated (test borings BB-RAR-110 through BB-RAR-121), the thickness ranged from approximately 15 to 126 ft. Greater thicknesses were typically encountered in test borings drilled outside the limits of the river, particularly west of the river in borings BB-RAR-110 and BB-RAR-111.

In general, the deposit was uniform in nature and consisted of the following:

- SILT (ML) with variable amounts of fine sand and organic matter (plant fibers)
- Fine to coarse SAND (SM, SP-SM, SW-SM, SP, SW), stratified, with variable amounts of silt, gravel and organic matter

The fine-grained (silt) portions of the deposit were typically located within the upper 5 to 10 ft of the layer and transitioned into the coarser (sand) material with increasing depth. The deposit is typically very loose to dense with SPT N_{60} values ranging from 0 to 43 bpf. In general, SPT N_{60} values within the deposit increased with depth below ground surface/mudline.

4.1.4 Glaciolacustrine Deposit

Glaciolacustrine soils were encountered underlying the alluvial deposit in the majoring of the test borings drilled within the limits of the river and in the test boring drilled along the proposed approach roadway on the east side of the river (i.e., BB-RAR-115 through BB-RAR-118, BB-RAR-120 and BB-RAR-121). Where encountered, the thickness ranged from approximately 5 to 80 ft. The greatest thickness (approximately 51 to 80 ft) was encountered in the test borings drilled within the limits of the river.

In general, the deposit was uniform in nature and consisted of the following:

- Sandy SILT (ML)
- Fine SAND (SP, SM, SP-SM) with varying amounts of clay and silt.

The amount of medium to coarse sand, gravel and the presence of layers containing cobbles/boulders generally increased with depth below ground surface/mudline.

SPT N_{60} values ranged from 4 to 48 bpf indicating the soil is loose to dense.

4.1.5 Glaciofluvial Deposit

Glaciofluvial soils were encountered underlying either glaciolacustrine or alluvial soils in borings drilled in the eastern portion of the river (i.e., BB-RAR-117, BB-RAR-119 and BB-RAR-120). Where encountered, the thickness ranged from approximately 21 to 30 ft.

The deposit consisted of fine to coarse SAND (SM, SW, SW-SM), with varying amounts of silt and gravel and generally became coarser with increasing depth below ground surface/mudline. SPT N_{60} values ranged from 17 to in excess of 100 bpf indicating the soil is medium to very dense.

4.1.6 Glacial Till

Glacial till was encountered overlying bedrock in test borings BB-RAR-110, BB-RAR-111, BB-RAR-115 and BB-RAR-117 through BB-RAR-121. Where encountered, the thickness of the deposit ranged from approximately 1 to 22 ft.

The glacial till consisted of a heterogeneous mixture of sand, silt/clay and gravel and frequently contained weathered/decomposed rock fragments. The deposit is very dense with SPT N_{60} values ranging from 66 to in excess of 100 bpf.

4.1.7 Bedrock

Test borings drilled at proposed bridge substructure locations were advanced approximately 2 to 19 ft into bedrock. A summary of top of bedrock elevations is provided below.

Substructure Location	Test Boring No.	Approx. Ground Surface/ Mudline Elev. (ft, NAVD 88)	Approx. Depth to Top of Bedrock (ft)	Approx. Elev. of Top of Bedrock (ft, NAVD 88)	Horizontal Distance Between Test Borings (ft)	Approx. Slope of Rock Surface
Abutment 1	BB-RAR-110	615.8	136.5	479.3	26	4.4 H:1V
	BB-RAR-111	615.7	130.5	485.2		
Pier 1	BB-RAR-115	597.1	116.0	481.1	30	1.2 H:1V
	BB-RAR-116	597.1	91.5	505.6		
Pier 2	BB-RAR-117	596.1	119.5	476.6	56	1.1 H:1V
	BB-RAR-118	596.8	70.0	526.8		
Abutment 2*	BB-RAR-119	599.6	88.3	511.3	47	16.8 H:1V
	BB-RAR-120	600.1	86.0	514.1		

Note: * indicates that the test borings drilled for Abutment 2 were drilled within the limits of the river since the proposed Abutment 2 location could not be accessed by drilling equipment.

In general, the bedrock surface slopes down from east to west (i.e., away from Route 2) and from south to north (away from the existing bridge). As summarized above, significant variations in the top of the bedrock surface were observed between the test borings drilled at both Pier 1 and Pier 2 with the bedrock surface sloping at approximately 1H:1V across the plan width of the proposed substructure (in a north-south direction). In addition, the bedrock surface between test boring BB-RAR-121 (drilled in the shoulder of Route 2) and the two test borings drilled near the proposed Abutment 2 location (BB-RAR-119 and BB-RAR-120) slopes downward from east to west at approximately 2H:1V.

The cored and recovered bedrock along the project alignment was variable and is described as:

- Moderately hard to very hard, slightly to severely weathered, fine to coarse grained GNEISS
- Hard to very hard, fresh to slightly weathered, micaceous quartz PEGMATITE
- Moderately hard, fresh to severely weathered, fine to medium grained SCHIST

Rock quality designation (RQD) is a common parameter that is used to help assess the competency of sampled bedrock. RQD is defined as the sum of pieces of recovered bedrock greater than 4 in. in length divided by the total length of bedrock core run. RQD values for bedrock encountered at the site ranged are summarized below.

Substructure Location	Test Boring No.	Range in RQD (%)	Average RQD (%)
Abutment 1	BB-RAR-110	80 to 97	89
	BB-RAR-111	82 to 92	87
Pier 1	BB-RAR-115	38 to 73	56
	BB-RAR-116	0 to 80	29
Pier 2	BB-RAR-117	22	22
	BB-RAR-118	40 to 65	53
Abutment 2*	BB-RAR-119	55 to 84	69
	BB-RAR-120	0 to 12	3

Note: * indicates that the test borings drilled for Abutment 2 were drilled within the limits of the river since the proposed Abutment 2 location could not be accessed by drilling equipment.

Please note that some portions of the cored and recovered bedrock were severely fractured and contained frequent soil-filled joints as indicated on the test boring logs.

4.2 Groundwater Conditions

One groundwater observation well was installed in completed borehole BB-RAR-109. Water levels measured during the subsurface exploration program (13 June to 13 July 2012) were generally measured between El. 604 and El. 607, approximately 5 to 8 ft below the $Q_{1.1}$ river level. It should be noted that there was very little precipitation observed during the subsurface exploration program, which may have impacted the water levels measured in the observation well. Observation well installation and groundwater monitoring reports are included in Appendix B.

Groundwater levels can be expected to fluctuate, subject to seasonal variation, local soil conditions, topography and precipitation. Water levels encountered during construction may differ from those observed in the test borings during drilling or the observation well.

5. LABORATORY TESTING PROGRAM

A geotechnical laboratory testing program was undertaken on representative soil samples collected during the subsurface exploration program to assist in soil classification, determine engineering soil properties needed for final design and to evaluate the reuse potential of soil excavated from the Pier 1 and Pier 2 cofferdams. In general, laboratory testing was performed on disturbed soil samples collected during SPT sampling. All laboratory testing was performed in accordance with applicable American Society for Testing Materials (ASTM) testing procedures by GeoTesting Express of Acton, Massachusetts. Assigned laboratory testing and results are summarized below.

Laboratory Test	ASTM Test Designation	No. of Tests Completed	Range in Test Results
Natural Water Content	ASTM D 2216	28	4.4% to 38.4%
Atterberg Limits	ASTM D 4318	5	$23\% \leq LL \leq 55\%$ $17\% \leq PL \leq 40\%$ $6\% \leq PI \leq 15\%$
Grain Size	ASTM D 422	46	AASHTO Classification: A-1-b, A-2-4, A-3, A-4, A-7-5, A-7-6 USCS Classification: MH, ML, SC-SM, SP, SP-SM, SM, SW-SM, SW
Direct Shear	ASTM D 3080	14	Cohesion – 0 to 534 psf Friction Angle - 28.9° to 41.5°

All laboratory test results are provided on the test boring logs included in Appendix A with complete results provided in Appendix C.

6. GEOTECHNICAL EVALUATIONS AND DESIGN RECOMMENDATIONS

Geotechnical design recommendations for the subject project, as discussed and provided herein, were developed in accordance with the following documents:

- AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition, 2012 with Interim Revisions through 2012, referred to herein as AASHTO LRFD,
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, Second Edition, 2011, referred to herein as Guide Specification, and
- MaineDOT Bridge Design Guide (BDG), August 2003, with Interim Revisions through August 2008, referred to herein as Bridge Design Guide.

Engineering calculations that support the recommendations outlined in this section are provided for reference in Appendix F.

6.1 Pavement Design

This section summarizes the results of our technical evaluations related to pavement design. This information was provided to TranSystems as the basis for the pavement design analysis, which is being conducted by TranSystems.

6.1.1 Cut/Fill Areas and Anticipated Subgrade Conditions

Based on discussions with TranSystems as well as our experience on past MaineDOT bridge/highway projects, we anticipate that the proposed pavement section for the approach roadways/embankments will be approximately 30-in thick. Based on the assumed pavement section thickness, the subsurface soil conditions encountered in the design phase explorations, and our review of proposed grading information provided by TranSystems, we anticipate that the pavement section subgrade conditions will vary along the roadway alignment and will consist of either man-placed fill, topsoil, alluvial deposits or proposed fill. Material types and approximate station limits over which the materials are likely to be encountered at the design subgrade level are summarized in Table III.

It is our opinion that alluvial soils and in-situ granular fill material are suitable for support of a properly designed and constructed pavement section. We recommend that all topsoil, organic matter, debris and other unsuitable material encountered at pavement section subgrade be removed from within the limits of the roadway prior to subgrade preparation and placement of proposed fill or pavement section (base, subbase) materials.

6.1.2 Subgrade Resilient Modulus

Current American Association of State Highway and Transportation Officials (AASHTO) flexible pavement design procedures utilize material properties to define support characteristics of roadway subgrade soils. Specifically, subgrade resilient modulus is a critical soil property input value and is defined as the ratio of the applied cyclic stress to the recoverable (elastic) strain after repeated loading. In areas of seasonal frost, thaw weakening can have a significant impact on the magnitude of resilient modulus (i.e., resilient modulus values may vary seasonally).

As summarized above, we anticipate that subgrade conditions along the proposed roadway alignment will be variable. Values of resilient modulus were estimated for each soil type based on correlations with soil classification, gradation, index properties and structural layer coefficients as well as our experience on similar projects in similar geographic locations and soil/groundwater conditions. A summary of recommended resilient modulus values for the different soil types anticipated to be present along different portions of the roadway alignment are summarized in Table III.

It is our opinion that the pavement design should be based on a single value of resilient modulus since it is not practical to design, and more difficult to construct, different pavement sections for different portions (lengths, widths) of the roadway. Therefore, we recommend that pavement design be based on a resilient modulus value equal to 5,000 pounds per square inch (psi), indicative of an alluvial deposit/man-placed fill subgrade. This recommendation assumes that all topsoil, organic matter and other unsuitable material is excavated (removed) prior to subbase placement (e.g., up to 3 ft of over-excavation will likely be required between the roadway shoulders and along the length of roadway between approximately Sta. 4+33 and Sta. 6+55). We recommend that the excavated material be replaced with systematically-placed and compacted granular borrow in areas where over-excavation is required. The material quantities included on the construction drawings should reflect the over-excavation and replacement in this area as recommended herein.

6.1.3 Frost Penetration

Three basic requirements must be met simultaneously in order for frost-induced movements (heave) to occur: 1) the soil must meet certain grain size requirements in order to be frost susceptible, 2) freezing temperatures must penetrate into the ground and 3) a source of water must be present (e.g., groundwater, surface water infiltration, capillary rise). A summary of the subsurface conditions at the site as they relate to these requirements is provided below.

- Soil Type – Laboratory grain size analyses were conducted on soil samples recovered during the subsurface exploration programs in part to assess the frost susceptibility of the soil. Based on the laboratory test results, a frost susceptibility classification was assigned to each of the soil types anticipated to be present at pavement section subgrade level. Frost susceptibility classifications were determined based on MaineDOT frost susceptibility criteria that were developed, in part, based on the Corps of Engineers method. Frost ratings range from 0 (non-frost susceptible) to IV (highly frost susceptible). A summary of the frost susceptibility classifications for each soil type is provided below.

Subgrade Material	Frost Susceptibility Classification
Proposed Fill	II
Alluvial Deposit	II-III
Topsoil	IV

- Temperature – Based on the State of Maine Design Freezing Index, the design freezing index for the Rumford, Maine area is approximately 1,630 freezing degree days (°F-days). Freezing temperatures must penetrate the pavement section and subgrade soil down to the capillary zone (zone where water is present) because the phase change

from water to ice is largely responsible for drawing additional water from the surrounding soil toward the growing ice mass.

- Water – An uninterrupted source of water must be available to the zone of freezing. Typically, the source will be the underlying groundwater table, a perched water source, infiltration through overlying layers and/or by capillary rise. Groundwater levels measured in the observation well installed along the proposed west approach roadway (BB-RAR-109) ranged from approximately 9 to 12 ft BGS (El. 604 to El. 607). Natural water content laboratory tests indicate that there is between 8 and 36 percent (by weight) water present in the soil nearest to the proposed subgrade level. Along some portions of the approach roadways, where raises in grade are planned, the supply of water to the freezing zone is restricted by distance. In other areas where raises in grade are less, water may be drawn from the static groundwater level as well as from voids in the soil adjacent to the growing ice lens, resulting in potential heave.

Based on the information summarized above, we evaluated the maximum depth of seasonal frost penetration into the ground. Our evaluations were conducted using the computer program ModBerg version 99.2. The program calculates the maximum depth of frost penetration for a given geographic location using input from its built-in long-term weather database and pavement/soil layer information provided by the user. ModBerg's primary algorithm is based on the Modified Berggren Equation. Multiple iterations were completed for various 30-in. thick pavement sections overlying different subgrade materials and weather data from Rumford, Maine. Based on the information summarized above, we recommend that a maximum depth of frost penetration equal to approximately 5 ft (2.5 ft into subgrade for a 30-in. thick pavement section) be considered for pavement design. In addition, we consider the potential for frost-induced heave to be low to moderate.

6.2 Seismic Design

The liquefaction susceptibility of the granular soil deposits at the subject site was evaluated based on the subsurface conditions encountered in the design phase test borings. The liquefaction evaluations discussed herein were conducted in general accordance with the requirements of the Guide Specification.

An initial liquefaction evaluation was conducted based on simplified empirical methodology, which indicated that significant zones of soil were susceptible to liquefaction and loss of strength during the design earthquake. As a result of the potential impact on the cost to design/construct the bridge approach embankments and bridge abutment foundations, a more detailed site-specific liquefaction evaluation was conducted in an attempt to reduce the horizontal and vertical extent of soil susceptible to liquefaction and overall impact on the project. Each evaluation is briefly summarized in the following sections.

6.2.1 Initial Liquefaction Susceptibility Evaluation and Results

An initial liquefaction susceptibility evaluation was conducted based on the simplified procedures presented in the Guide Specification. The primary purpose of this initial evaluation was to determine whether the in-situ soils present along the proposed roadway/bridge alignment were susceptible to liquefaction during the design earthquake event. Specific details regarding methodology and results of the initial liquefaction susceptibility evaluation are provided in the

design memorandum, dated 9 November 2012 included in Appendix E. Engineering calculations are provided in Appendix F.

The initial liquefaction susceptibility evaluation generally included the following steps:

1. Determine site class and design response spectra in accordance with Sections 3.4.1 and 3.4.2, respectively.

2. Based on the design response spectra, select the Seismic Design Category (SDC) in accordance with Section 3.5.

3. Determine the magnitude of the design earthquake at the site using earthquake deaggregation data obtained from the United States Geological Survey (USGS) for a seismic event having a five percent probability of exceedance in 50 years (1,000-year return period).

4. Determine the liquefaction susceptibility of the granular soils at the site by comparing the equivalent uniform cyclic stress ratio (CSR) imposed by the design earthquake to the cyclic resistance ratio (CRR) of the in-situ soils at each soil sample location. CRR was estimated using the simplified methodology originally developed by Seed et al. (1985) and more recently updated by Youd and Idriss (2001). Liquefaction of the in-situ granular soils will occur when the CRR is less than or equal to the CSR. In the instance where the CRR equals the CSR, the factor of safety against liquefaction is equal to 1.0.

Please note that simplified procedures presented by Idriss and Boulanger (2008) were also used and compared to the results determined from the Youd and Idriss (2001) methodology to see what, if any, differences there were in the calculated factor of safety.

The results of the initial liquefaction susceptibility evaluation are summarized below.

- In-situ granular soils present beneath the west approach embankment and immediately adjacent to Abutment 1 were judged to be susceptible to liquefaction ($FS < 1.0$) down to approximately El. 575 within the core of the proposed approach embankment and were judged to be susceptible to liquefaction down to approximately El. 565 outside the limits of the embankment (existing ground surface elevations vary from between El. 615 to El. 616).

- In-situ granular soils present within the limits of Pier 1 and Pier 2 were judged to be susceptible to liquefaction down to approximately El. 565 (existing mudline elevations vary from between El. 595 and El. 600.

- In-situ granular soils present beneath the east approach embankment and Abutment 2 were judged to be susceptible to liquefaction down to approximately El. 560 (existing ground surface elevations vary from between El. 615 to El. 620).

- Liquefaction evaluation using methodology presented by Idriss and Boulanger (2008) generally resulted in factors of safety greater than those predicted by Youd and Idriss

(2001). However, the increase was not sufficient enough to change the thickness of soil that is susceptible to liquefaction at each substructure location, as summarized above.

- The bridge should be designed based on a response spectrum at the ground surface equal to Site Class E.

- Based on the recommended ground surface design spectrum (Site Class E), the seismic spectral acceleration at 1.0-sec period (S_{D1}) is equal to 0.218 g. Therefore, in accordance with Guide Specification Section 3.5.1, the bridge should be designed based on the requirements of SDC B, assuming that liquefaction of the in-situ soils present in the immediate vicinity of the bridge abutments is mitigated. If liquefaction is not mitigated, the bridge should be designed in accordance with the requirement of SDC D and the bridge abutment piles should be designed to accommodate a reduction in lateral resistance (from existing ground surface to the bottom of the liquefiable zone) and additional lateral loading as a result of approach embankment instability

Based on the results of the initial liquefaction susceptibility evaluation and the potential impact to the design and performance of the approach embankments and bridge abutment substructures, it was decided by MaineDOT, TranSystems and Haley & Aldrich that a site-specific liquefaction susceptibility evaluation should be conducted in an attempt to reduce or eliminate liquefaction-induced impacts to the project. A summary of the site-specific liquefaction susceptibility evaluation is provided in the following section.

6.2.2 Site-Specific Liquefaction Susceptibility Evaluation and Results

A site-specific liquefaction evaluation was conducted by performing site-specific response analyses (SSRA) for representative subsurface profiles. The results of the SSRA were used to directly calculate maximum shear stresses in the soil resulting from an approximate 1,000-year earthquake event, which were converted to CSR values for use in the liquefaction evaluations. The SSRA conducted for the liquefaction evaluation included the following steps:

1. Preparation of two subsurface models, one at each proposed bridge abutment location, representing the spatial variability in the subsurface conditions at each proposed bridge abutment location.

2. For the two subsurface models, establishment of lower bound, average and upper bound shear wave velocities for use in ground motion analysis using empirical correlations based on soil type and strength.

   The empirical correlations were used to estimate shear wave velocity because site-specific shear wave velocity data was not available. The empirical correlations were first used to estimate the shear wave velocity of a similar soil profile at a site where in-situ shear wave velocity measurements (seismic cone penetration testing) were made. The correlated values were compared to the in-situ measurements to assess how closely they predicted the actual values (as measured by seismic cone penetration testing).

3. Development of a target spectrum (for an earthquake with an approximate 1,000-year return period) appropriate for bedrock at the site, compatible with the Guide Specification and selection and scaling of seven “design earthquake” rock input motions

appropriate for the site from existing earthquake records. The design rock motions were selected such that their response spectra, after scaling, matched well with the target spectrum between periods of 0.3 and 1.2 seconds (range covers the fundamental periods of the bridge, as determined by TranSystems for various modes of vibration and soil profiles at the proposed bridge abutment and locations).

4. Use the computer software DeepSoil to perform one-dimensional equivalent linear ground response analyses to determine spectral response accelerations at the ground surface, peak ground acceleration with depth, and peak shear stress values with depth for each subsurface model using lower bound, average and upper bound values of shear wave velocity, and using the seven rock input motions.

5. Use the results from the site response analyses to establish a design acceleration response spectrum for the site and develop site-specific CSR values developed using lower-bound, average and upper-bound shear wave velocity profiles, and develop a mean CSR profile for comparison to CRR values and determination of liquefaction potential.

The results of the site-specific liquefaction susceptibility evaluation are summarized below.

- Liquefaction is likely to occur to various depths below ground surface within the limits of the approach embankments as summarized in the table below. Please refer to the plan limits of the liquefiable soils in the vicinity of Abutment 1 and Abutment 2 as shown in Figures 2 and 3, respectively.

Location	Elevation of Top of Liquefied Zone	Elevation of Bottom of Liquefied Zone
West Approach/Abutment 1 Area		
Down-station of Sta. 12+00	NA	NA
Sta. 12+00 to Sta. 12+50	El. 613.1	El. 610
Sta. 12+50 to Sta. 13+00	El. 613.1	El. 605
Sta. 13+00 to Sta. 13+50	El. 613.1	El. 600
Sta. 13+50 to Sta. 15+00	El. 613.1	El. 595
Sta. 15+00 to Sta. 15+25	El. 613.1	El. 590
Sta. 15+25 to Sta. 15+55	El. 613.1	El. 580
East Approach/Abutment 2 Area		
Sta. 19+80 to Sta. 20+40	El. 613.1	El. 595
Up-station of Sta. 20+40	NA	NA

- Recommended ground surface design response spectrum for the site that is, in general, equal to or less than the Site Class E design values but greater than 2/3 Site Class E design values (maximum permissible reduction for performing a SSRA).

- Based on the recommended ground surface design spectrum, the seismic spectral acceleration at 1.0-sec period (S_{D1}) is equal to 0.180 g. Therefore, in accordance with Guide Specification Section 3.5.1, the bridge should be designed based on the requirements of SDC A, assuming that liquefaction of the in-situ soils present in the immediate vicinity of the bridge abutments is mitigated. If liquefaction is not mitigated, the bridge should be designed in accordance with the requirement of SDC D and the bridge abutment piles should be designed to accommodate a reduction in lateral resistance (from existing ground surface to the bottom of the liquefiable zone) and additional lateral loading as a result of approach embankment instability.

Overall, performing the SSRA resulted in a substantial reduction to the thickness (approximately 20 to 30 ft) of in-situ soil that is susceptible to liquefaction during the design seismic event in the vicinity of each proposed bridge abutment. In addition, a reduction in the design response spectrum reduced demands (loads) on foundation piles (by up to approximately 25 percent as estimated by TranSystems) as well as allowed the bridge to be designed in accordance with SDC A (versus SDC B) assuming liquefaction is mitigated. Please refer to SSRA report, dated 10 May 2013 (Reference 1) for detailed results of the SSRA evaluation, including engineering calculations.

Liquefaction impacts on approach embankment global stability as well as liquefaction mitigation remedial measures are discussed in the following sections of this report.

6.2.3 Comparison between Simplified and Site-Specific Liquefaction Susceptibility Results

The results of the site-specific liquefaction analyses show that the bottom of the liquefiable zone (i.e., where FS < 1.0) is much shallower compared to the bottom of the liquefiable zone as determined by the simplified analysis as summarized in the table below.

Location	Bottom of Liquefied Zone Simplified Evaluation	Bottom of Liquefied Zone Site-Specific Evaluation
Immediately adjacent to and east of Abutment 1	varies between El. 565 and El. 575	varies between El. 580 and El. 595
Within limits of west approach embankment	El. 575	varies between El. 595 and El. 610
Outside of limits of west approach embankment	El. 565	El. 580
Adjacent to Piers 1 and 2	El. 565	NA; evaluation not conducted at piers as scour depth controls
Immediately adjacent to Abutment 2	El. 560	El. 595
Within limits of east approach embankment	El. 560	El. 595
Outside of limits of east approach embankment	El. 560	El. 595

As shown in the table, the results of the site-specific evaluation significantly reduce the vertical limits of the liquefiable soils at the site. This will ultimately result in a smaller volume of soil that will be mitigated/improved in order to prevent liquefaction from occurring adjacent to the abutment substructures.

The site-specific liquefaction analyses will also allow the bridge to be designed based on less stringent seismic requirements as summarized below. This information was previously provided to TranSystems for their use in determining the final design of the bridge.

Design Element	Result of Simplified Evaluation	Result of Site-Specific Evaluation
Response Spectrum	Site Class E	less than Site Class E and greater than 2/3 of Site Class E
Seismic Design Category (liquefaction mitigation not completed)	SDC D	SDC D
Seismic Design Category (assuming liquefaction mitigation completed)	SDC B	SDC A

As the table shows, if techniques are not used to mitigate liquefaction of the soils adjacent to the proposed bridge abutments, AASHTO LRFD requires that the bridge be designed based on the requirements of Seismic Design Category D. This will impact the substructure design as the lateral loads for Seismic Design Category D are approximately 25 percent greater than loads for Seismic Design Category A and will require us to design the abutment foundation piles to resist the additional lateral forces caused by slope instability in the transverse and longitudinal directions (through the abutment foundation soils).

6.3 Approach Embankment Stability

6.3.1 General

As discussed in previous sections of this report, construction of the approach roadways will require fill placement up to approximately 25 ft above existing site grades. Approach embankments of this height could cause excessive vertical and lateral strains during static and/or pseudo-static (seismic) loading conditions, eventually resulting in a shear failure of the foundation soil and subsequent failure of the roadway.

As a result, limit equilibrium method slope stability analyses were conducted using the computer program Slide v 6.0 by Rocscience, Inc. to evaluate the likelihood of embankment failures at the site during static and pseudo-static loading conditions. The evaluations were conducted modeling the existing and proposed grades along each approach embankment in the transverse and longitudinal directions (relative to the project baseline). The embankment stability evaluations were completed assuming circular failure surfaces. The selected embankment cross sections were analyzed under the following cases:

- Case 1 – Static: The static method utilizes undrained soil strength properties.
- Case 2 - Pseudo-Static: The pseudo-static method assumes that the earthquake causes additional horizontal forces in the direction of the potential failure. This model uses the

seismic acceleration coefficient determined from the site-specific liquefaction susceptibility evaluations (modified to take into account embankment height). The same undrained soil strength properties used in the static analysis were used in the pseudo-static analysis.

- Case 3 - Post-Liquefaction: The post-liquefaction analysis utilizes residual soil strength properties assigned to soil layers that were identified as being susceptible to liquefaction, as discussed in previous sections of this report. The seismic acceleration coefficient was not used in this analysis.

In accordance with AASHTO LRFD and the Bridge Design Guide, the minimum acceptable factors of safety for each case are summarized below. Please note that in instances where the minimum acceptable factors of safety differ between AASHTO LRFD and the Bridge Design Guide, the greater of the two values was used.

Case	Strength Limit State			Extreme Event Limit State		
	AASHTO LRFD[1]	Bridge Design Guide[2]	Design Basis	AASHTO LRFD	Bridge Design Guide[2]	Design Basis
1	1.3/1.5	1.25/1.3	1.3/1.5	NA	NA	NA
2	NA	NA	NA	1.0	1.0	1.0
3	NA	NA	NA	1.0	1.0	1.0

[1] – Refer to AASHTO LRFD Section 11.6.2.3. FS=1.5 used for portions of embankment that contain a structural element; FS=1.3 used for portions of embankment that do not contain a structural element.

[2] - Refer to Bridge Design Guide Section 5.9.2 and 5.9.4. FS=1.25 used for embankments; FS=1.3 for embankments whose failure would cause significant damage, such as slopes supporting bridge abutments and retaining walls.

6.3.2 Input Parameters

6.3.2.1 Strength Parameters and Groundwater Conditions

Typical soil profiles were developed based on the subsurface conditions encountered in the design phase test borings at Abutment 1 (west approach embankment) and Abutment 2 (east approach embankment).

Soil descriptions, sieve analyses results and SPT N_{60} values were used as input parameters in multiple published correlations to estimate friction angle values with depth at each abutment location. Average and average plus/minus one standard deviation values were determined and were used to develop a design strength profile for the soil at each abutment (see Appendix F).

It should be noted that several direct shear tests were performed on alluvial and glaciolacustrine soil samples obtained from test borings along the east and west approach embankments. Upon receipt of the results, we judged that the assigned laboratory test conditions resulted in unconservative strength parameter estimates that were not indicative of the in-situ density and moisture conditions. As a result, correlated values, as presented herein, were used as the basis for the embankment stability evaluations.

Based on the results, each soil profile was separated into multiple zones, designated Zone 1 through Zone 4, each with different thicknesses and strength parameters as summarized below. Please note that the zones summarized below were assumed to be consistent/uniform transverse and longitudinal to the project baseline in areas where subsurface information was not available.

Location	Soil Unit	Top Elevation	Bottom Elevation	Moist Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Abut. 1 - West Approach	Zone 1	618	606	115	0	26
	Zone 2	606	592	115	0	28
	Zone 3	592	576	115	0	30
	Zone 4	576	516	115	0	32
Abut. 2 - East Approach	Zone 1	618	606	115	0	26
	Zone 2	606	590	115	0	28
	Zone 3	590	560	115	0	30
	Zone 4	560	536	115	0	36

Please recall that test borings drilled for Abutment 2 (BB-RAR-119 and BB-RAR-120) were drilled within the limits of the river since the proposed Abutment 2 location could not be accessed by drilling equipment. The mudline elevation at the test boring locations (El. 600) is approximately 15 to 20 ft lower than the existing ground surface at the proposed abutment location (El. 615 to El. 620). Because of this we had to assume that the soil conditions at Abutment 2 between mudline and the ground surface at the proposed Abutment 2 location (i.e., between El. 600 and El. 620) were similar to the conditions encountered at Abutment 1 over the same elevation range.

As discussed in previous sections of this report, one groundwater observation well was installed in completed borehole BB-RAR-109 and water levels measured during the subsurface exploration program (13 June to 13 July 2012) were generally measured between El. 604 and El. 607. After considering that there was very little precipitation observed during the subsurface exploration program, which may have impacted the water levels measured in the observation well, we judged that the "seasonally average groundwater elevation" should be used in embankment stability evaluations. Further, we judged that the "seasonally average groundwater elevation" was indicative of the $Q_{1.1}$ water level (El. 613.1) in the river.

6.3.2.2 Residual Strength Parameters

As discussed above, the available data indicates continuous zones of in-situ soil are present along each approach embankment and within the limits of the proposed abutments that are likely to liquefy during the design earthquake event. When saturated, cohesionless soil liquefies, it experiences a temporary loss of shear strength due to a transient rise in excess pore pressure generated by strong ground motion. Empirical methods developed by Idriss and Boulanger (2008) and Olson and Stark (2003) were used to evaluate the post-liquefaction strength of each liquefied layer. These empirical methods were developed by back-calculating strengths of critical layers in flow slide slope failures after earthquakes. Using these methods, it is estimated that

the liquefied layers will have a residual friction angle equal to approximately 5 degrees (both methods resulted in similar values).

6.3.2.3 Seismic Coefficient

Evaluations of seismic effects on the embankments were accomplished using the seismic coefficient in the pseudo-static method of analysis. The pseudo-static method assumes that the earthquake causes additional horizontal forces in the direction of the potential failure.

The seismic coefficient is determined by multiplying the peak horizontal ground acceleration (0.180 g, determined from the design response spectrum developed in the SSRA) by a pseudo-static coefficient, which is based on the range in proposed approach embankment height above existing ground surface (up to approximately 25 ft). Based on the proposed embankment height we estimated the pseudo-static coefficient equal to 0.5. As a result, a seismic coefficient equal to 0.09 g was used in the pseudo-static embankment stability evaluations summarized herein.

6.3.2.4 Live Load Surcharge

A live load surcharge equivalent to 2 ft of normal weight earthfill (125 pcf) with the load factors presented in AASHTO LRFD Table 3.4.1-1 were used in our embankment stability evaluations. The surcharge loads presented below were modeled as uniformly distributed loads acting within the limits of the proposed roadway.

Case	Live Load Surcharge (psf)	Load Factor	Factored Live Load Surcharge (psf)
1	250	1.75	437.5
2	250	0.50	125
3	250	0.50	125

6.3.3 Results

A total of 5,000 to 10,000 failure surfaces were evaluated for each of the three load cases and a factor of safety was calculated for each surface. The surface with the lowest calculated factor of safety is reported for each loading condition evaluated. A summary of the results of the stability analyses is presented below, and output diagrams from Slide v6 showing the location of the critical surface and calculated factor of safety for each loading condition evaluated are presented in Appendix F.

Location	Minimum Calculated Factors of Safety		
	Case 1 Static	Case 2 Pseudo-Static	Case 3 Post-Event
Abutment 1, Longitudinal	1.4	1.1	0.4
Sta. 15+00, Transverse	1.5	1.2	0.4
Sta. 13+00, Transverse	1.6	1.3	0.4
Sta. 12+00, Transverse	1.7	1.4	1.6
Abutment 2, Longitudinal	1.4	1.1	0.8

As summarized above, calculated factors of safety for Case 1 and Case 2 met the minimum specified requirements with the exception the longitudinal sections through the proposed bridge abutment locations (FS slightly less than 1.5). It should be noted that the resistance effects of bridge abutment foundation piles were not considered at these locations. In addition, it is our opinion that the calculated factors of safety summarized above are slightly conservative. The slope stability software models the approach embankments as an infinitely long embankment; which we believe to be conservative based on the finite length of the embankments. Therefore, actual factors of safety for a three-dimensional model may be somewhat higher. Therefore, we consider the factors of safety for the longitudinal sections through the proposed bridge abutments to be acceptable.

In addition, calculated factors of safety for Case 3 (post-liquefaction analysis using residual strengths) are less than 1.0 in both the transverse and longitudinal directions along each approach embankment indicating that the embankments will fail if the foundation soils liquefy. As a result, embankment stability and liquefaction mitigation remedial measures, as discussed in the following section of this report, were evaluated to determine the most cost-effective option considering MaineDOT's risk tolerance.

6.4 Approach Embankment Stability and Liquefaction Mitigation Remedial Measures

Based on the results of the initial and site-specific liquefaction susceptibility evaluations as well as the approach embankment stability calculations, large portions of the approach embankments are likely to fail during/after the design seismic event, as indicated by the Case 3 calculated factors of safety summarized above. As a result of the unacceptable factors of safety, the following geotechnical design alternatives were presented to and discussed with MaineDOT and TranSystems:

- No Liquefaction Mitigation: allow embankments to fail if the design earthquake event occurs and causes the foundation soils to liquefy. This would require that the bridge be designed in accordance with SDC D and foundation piles be designed for an unsupported length equal to the thickness of the liquefiable soil layer as well as additional lateral forces caused by the failed embankment. This alternative would potentially require that MaineDOT temporarily close the road to traffic while reconstructing/rehabilitating the approach roadways.

- Partial Liquefaction Mitigation: employ ground improvement techniques to mitigate liquefaction from occurring in the immediate vicinity of each bridge abutment. Refer to Figures 2 and 3 for the plan limits of the partial liquefaction mitigation alternative. Since this alternative would prevent liquefaction from occurring within the immediate vicinity of the abutment substructures, the bridge could be designed in accordance with SDC A and would prevent the need to design the substructures for additional unsupported length and lateral loads from the failing embankment. Temporary road closure for post-event reconstruction/ rehabilitation of a limited length of the Abutment 1 approach embankment would be required.

- Full Liquefaction Mitigation: employ ground improvement techniques to mitigate liquefaction from occurring within the entire areas that are susceptible to liquefaction. Refer to Figures 2 and 3 for the plan limits of the full liquefaction mitigation alternative. Since this alternative would prevent liquefaction from occurring, the bridge could be designed in accordance with SDC A and would prevent the need to design the substructures for additional unsupported length and lateral loads from the failing embankment. This alternative would not require temporary road closure for post-event reconstruction/rehabilitation.

Table VIII provides a summary showing the comparison of geotechnical design requirements and approximate geotechnical quantities and costs that would be needed if the project was designed and constructed based on the results the simplified and site specific liquefaction evaluations. This table was provided to MaineDOT for their use in selecting the most appropriate design alternative for the project considering the Department's budget constraints and risk tolerances. Please note that Table VIII is intended to be used to compare the relative quantities and costs for each evaluation, and is not intended to be an engineer's estimate of costs.

It is our opinion that the partial liquefaction mitigation alternative is the most appropriate alternative for the project considering that by not implementing some form of ground improvement to mitigate liquefaction, the benefits of performing the SSRA would be lost and the total construction cost of the project would be significantly greater. We estimate that the results of the site specific evaluation, if used, will save the project an estimated $650,000 in hard construction costs (see Table VIII).

The required minimum limits of ground improvement for the partial liquefaction mitigation alternative are summarized in the table below.

Location[1]	Approximate Limits[1,2]		Elevation of Bottom of Ground Improvement[3] (ft, NAVD 88)
	Begin Sta.	End Sta.	
West Approach	14+50	15+00	El. 595
	15+00	15+25	El. 590
	15+25	15+55	El. 580
East Approach	19+80	20+40	El. 595

[1] – Refer to Figures 2 and 3. Limits measured along project centerline.
[2] – Ground improvement conducted within the full width of approach embankment toe of slope to toe of slope) within the station limits shown.
[3] – Determined from SSRA.

After discussions with the project team, we understand that MaineDOT management elected to move forward with the partial liquefaction mitigation alternative. Please recall that with this alternative, MaineDOT chose to accept the risk that portions of the west approach (between approximately Sta. 12+00 and Sta. 14+50), outside the limits of Abutment 1, could fail during the design earthquake event potentially resulting in road/bridge closure to rehabilitate/reconstruct the failed portion of the embankment.

Technically feasible liquefaction remediation alternatives to prevent post-liquefaction embankment failure are dependent on the desired level of embankment/bridge performance following a design earthquake. Based on discussions with MaineDOT, it is our understanding that a post-liquefaction static embankment stability factor of safety of 1.0 should be maintained to sufficiently reduce the potential for embankment failure. As discussed above, it is also our understanding that a post-earthquake stability scenario that includes embankment failure beyond the area within the immediate vicinity of the bridge abutments is acceptable to MaineDOT. We have evaluated multiple remedial alternatives based on this understanding. Potential liquefaction remediation measures include: 1) vibro-compaction, 2) vibro-replacement, 3) grouting and 4) deep dynamic compaction.

It is our opinion that due to the silty nature of the some zones of in-situ soil within the liquefaction mitigation areas that vibro-compaction may not yield the required post-remedial benefit needed density the in-situ soils to the minimum design requirements (see table below). Due to the relatively shallow depth to static groundwater levels at the site, it is our opinion that deep dynamic compaction is not a

technically feasible ground improvement alternative. It is our opinion that both grouting and vibro-replacement are technically feasible. Based on discussions with specialty geotechnical construction subcontractors and our recent project experiences, we believe that vibro-replacement is a more cost effective alternative than grouting.

Therefore, based on the nature/consistency of the liquefaction susceptible soils, technical feasibility, cost and post-construction performance, it is our opinion that the most practicable liquefaction remedial alternative is vibro-replacement.

6.4.1 Improved Strength Parameters and Slope Stability Evaluation Results

In order to prevent liquefaction from occurring within the immediate vicinity of the proposed bridge abutments, vibro-replacement ground improvement must increase the CRR sufficiently so that it is equal to or greater than the CSR (factor of safety equal to or greater than 1.0). CRR and SPT N_{60} values, corresponding to a factor of safety equal to 1.0, were back-calculated from the site-specific liquefaction susceptibility evaluations.

Estimated friction angle values were then calculated from the minimum required SPT N_{60} values using published correlations. Similar to the development of strength parameters summarized in Section 6.3.2.1 of this report, average and average plus/minus one standard deviation values were determined and were to develop a design strength profile for each soil profile (see Appendix F). The results are summarized below for each zone that is susceptible to liquefaction.

Location	Soil Unit	Top Elevation	Bottom Elevation	Moist Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Abutment 1/ West Approach	Zone 1	615	610	115	0	28
	Zone 2	610	605	115	0	32
	Zone 3	605	El. 580 to El. 595	115	0	33
Abutment 2/ East Approach	Zone 1	618	613	115	0	28
	Zone 2	613	608	115	0	32
	Zone 3	608	595	115	0	33

Case 3 was re-analyzed using the friction angles summarized above to model the post-liquefaction static conditions. This evaluation assumes that ground improvement, as recommended herein, is used to mitigate liquefaction in the immediate vicinity of the bridge abutments. The minimum calculated factors of safety for this condition were all above 1.0 and ranged from 1.2 to 1.5. Therefore, it is concluded that the portions of the approach embankments where ground improvement will be used to mitigate liquefaction potential will be stable in the post-liquefaction condition, and flow failure of the foundation soils is not likely.

6.4.2 Post Ground Improvement Requirements

We recommend that the following minimum SPT N_{60} values be achieved by the by the vibro-replacement liquefaction mitigation design:

Depth Below Existing Ground Surface	Minimum Required Post-Ground Improvement SPT N_{60} values
0 to 5 ft	3 bpf
5 to 10 ft	6 bpf
deeper than 10 ft	8 bpf

This requirement will be included in the vibro-replacement special provision that will be part of the Contract Document. The special provision will be set up as a performance specification which will require the Contractor's engineer to design a vibro-replacement program that will meet the minimum design requirements outlined above.

6.5 Bridge Abutment and Pier Foundation Recommendations

As shown on the interpretive geologic profile (Figure 4), the subsurface conditions along the centerline of the proposed bridge alignment are variable and consist of very loose to very dense alluvial, glaciofluvial, glaciolacustrine and/or glacial till soils overlying bedrock. Based on the magnitude of the design loads provided by TranSystems and the depth to the dense to very dense soils (suitable foundation bearing strata), we consider driven steel pile foundations as the most practicable foundation alternative. More specifically, we consider pipe piles, driven closed-ended and filled with concrete (displacement piles) as the most practicable driven pile alternative as summarized below.

- Concrete filled pipe piles are better suited for resisting lateral loads (bending) due to greater stiffness and larger moment of inertia relative to H-piles. This is especially important at the bridge pier locations where a significant amount of scour (unsupported pile length) is anticipated.

- Driving pipe piles closed-ended will aid in generating greater resistance at shallower depths (shorter pile) and the ability to more accurately predict pile lengths as compared to non-displacement (steel H-piles) driven into poor quality and/or severely sloping bedrock.

- If piles are driven to bedrock, the use of closed-ended pipe piles would limit penetration into the rock, allowing for a better prediction of actual pile length as compared to H-piles (non-displacement piles).

Based on the information summarized above, we recommend the following pile types and sizes be used to support the bridge abutments and piers. It is our opinion that these piles are the most technically feasible, practicable and cost effective driven pile foundation alternatives for the project:

- 14-in. OD steel pipe piles with a ½-in. thick wall, driven closed-ended with a conical steel tip, and filled with concrete to support Abutment 1 and Abutment 2.

- 24-in. OD steel pipe piles with a 5/8-in. thick wall, driven closed-ended with a conical steel tip, and filled with concrete to support Pier 1 and Pier 2.

Additional geotechnical engineering evaluations and design recommendations for the pipe piles are summarized in the following sections of this report.

6.5.1 Corrosion and Deterioration

The geotechnical engineering design of the proposed piles included consideration of corrosion in accordance with AASHTO LRFD Section 10.7.5. Based on our review of proposed bottom of pile cap/tremie seal elevations at each substructure location, as summarized below, abutment piles will likely be subject to periodic wetting and drying cycles as the water level in the river fluctuates.

<table>
<tr><th rowspan="2">Substructure Location</th><th rowspan="2">Bottom of Pile Cap/ Tremie Seal Elevation</th><th colspan="3">River Water Elevations</th></tr>
<tr><th>$Q_{1.1}$</th><th>Q_{50}</th><th>Record Flood (1936)</th></tr>
<tr><td>Abutment 1</td><td>El. 618.5</td><td rowspan="4">El. 613.1</td><td rowspan="4">El. 623.9</td><td rowspan="4">El. 630.7</td></tr>
<tr><td>Pier 1</td><td rowspan="2">El. 582.0</td></tr>
<tr><td>Pier 2</td></tr>
<tr><td>Abutment 2</td><td>El. 613.5</td></tr>
</table>

Since the piles will be embedded within undisturbed, naturally-deposited soil, will only be exposed to fresh water, and only those piles at the proposed abutment locations could be subject to periodic wetting/drying cycles, it is our opinion that the subsurface environment at the site has a low corrosive potential. Therefore, we recommend that abutment piles be designed considering a 1/16-in. reduction in cross-sectional area over the design life of the bridge to account for corrosion. We also recommend that the reduction only be considered on the exterior of pipe piles, assuming the inside is filled with Class A concrete as is recommended in subsequent sections of this report.

6.5.2 Liquefaction Induced Downdrag

The geotechnical engineering design of the proposed piles included consideration of downdrag loading in accordance with AASHTO LRFD Sections 3.11.8, 10.7.1.6.2, 10.7.2.5 and 10.7.3.7. Downdrag occurs when the soil adjacent to an installed pile moves downward relative to the pile. In this case, the downward movement (and resulting downdrag force) occurs after liquefaction of the in-situ soils occurs and excess pore water pressure has dissipated.

Downdrag loads were estimated considering the tremie seal dimensions and both the thickness of the liquefiable zone and non-liquefiable soil above the liquefiable zone using the static analysis methods presented in AASHTO LRFD Section 10.7.3.8.6 and the load factors presented in Tables 3.4.1-1 and 3.4.1-2. Please note that downdrag loads were not calculated at the proposed abutment locations since liquefaction of the soils directly adjacent to the piles will not occur as a result of the vibro-replacement ground improvement. The skin friction values used to estimate liquefaction induced downdrag loads at the pier locations were based on the non-liquefied soil strength. Based on our evaluations, we recommend that the downdrag allowances summarized below be used in pile design at the proposed pier locations to account for seismically-induced downdrag loading.

Substructure Location	Unfactored Downdrag Load (kips)	Factored Downdrag Load[1] (kips)		
		Service Limit State (γ_p=1.0)	Strength Limit State (γ_p=0.30,1.05)	Extreme Event Limit State (γ_p=0.30,1.05)
Pier 1	93	93	28, 98	28, 98
Pier 2	76	76	23, 80	23, 80

[1] – γ_p=0.30 used at Strength and Extreme Event Limit States when considering uplift loads. γ_p=1.05 used when considering compressive pile loads.

6.5.3 Axial Compression Pile Resistance

Compressive pile resistance will likely be developed through a combination skin friction within the very loose to very dense overburden soils and end bearing resistance within the dense to very dense alluvial, glaciofluvial, glacial till soils, and potentially rock. As a result, the resistance will be controlled by the available geotechnical resistance of the soil rather than the structural resistance of the pile. Therefore, axial compression pile resistance was estimated in accordance with the static analysis methods presented in AASHTO LRFD Section 10.7.3.8.6 with the resistance factors in Table 10.5.5.2.3-1.

The compression resistance estimates were used in the pile group evaluations to determine the most efficient pile layout (configuration and number of piles) required to resist the structural demand imparted on the individual piles as a result of the applied loads and moments as described in subsequent sections of this report.

Upon completion of the pile group evaluations, the factored pile compressive loads from FB-MultiPier were compared to the static pile compressive resistances to estimate pile length considering the effects of scour and the minimum required pile tip elevation to achieve fixity. Static pile compressive resistances for each substructure and pile type/size are summarized below based on the pile group evaluation results and the pile tip elevations recommended herein.

Substructure Location	Nominal Compressive Pile Resistance (kips)	Factored Compressive Pile Resistance (kips)		
		Service Limit State (ϕ=1.0)	Strength Limit State (ϕ=0.45)	Extreme Event Limit State (ϕ=1.0)
Abutment 1	522	522	235	522
Pier 1[1]	1,376	1,376	619	1,376
Pier 2[1]	2,793	2,793	1,257	2,793
Abutment 2	970	970	437	970

[1] – resistance values shown represent the average value calculated from both test borings drilled at each substructure.

6.5.4 Axial Uplift Pile Resistance

Uplift loads will be resisted by friction between the piles and the surrounding soil along the embedded pile length. The nominal uplift resistance of steel pipe piles was evaluated in accordance with the static analysis methods presented in AASHTO LRFD Section 10.7.3.8.6 with the strength limit state resistance factors specified in Table 10.5.5.2.3-1 and the extreme event limit state resistance factors specified in Section 10.5.5.3.3. The strength limit state resistance factor for driven piles subjected to uplift is 0.35. For uplift resistance during the extreme event limit state, the resistance factor is equal to 0.8.

As determined from pile group evaluations, piles supporting Pier 1 and Pier 2 experience uplift forces during extreme event limit state loading. The maximum factored pile uplift load at the extreme event limit state is equal to 47 kips (see Table VII). Please note that piles supporting Pier 1 and Pier 2 are not subjected to uplift forces during service or strength limit state loading. In addition, piles supporting Abutment 1 and Abutment 2 are not subjected to uplift forces during any of the limit state load combinations. In general, uplift in the piles is caused by overturning moments acting on the pile caps, at the base of the pier shafts.

As summarized above, the pile lengths (tip elevations) were estimated based on a combination of lateral loading and compressive pile demand. Upon completion of the pile group evaluations, the maximum factored uplift loads from FB-MultiPier were compared to the static pile uplift resistances to determine whether the piles had sufficient uplift resistance at the recommended pile tip elevation. Recommended static pile uplift resistances for pier substructures are summarized below based on the results of our pile group evaluations and the pile tip elevations recommended in Section 6.5.7.

Substructure Location	Nominal Uplift Pile Resistance (kip)	Extreme Event Limit State Resistance Factor	Factored Geotechnical Uplift Resistance (kip)
Pier 1	906	0.8	725
Pier 2	593		474

As reported above, factored axial uplift resistance well exceeds the maximum factored uplift demand of 47 kips.

6.5.5 Lateral Pile Group Evaluations

Haley & Aldrich completed lateral pile group evaluations for each proposed substructure. Substructure loading information was developed by TranSystems for the service, strength and extreme event limit states. In addition, TranSystems completed the structural design of all substructure pile caps. The substructure loads provided by TranSystems are summarized in Tables IV through VI.

Pile group analyses were performed using the computer program FB-MultiPier (FB-Pier Version 4). FB-MultiPier is a nonlinear finite element analysis program that is capable of analyzing multiple bridge pier structures interconnected by bridge spans. The program couples nonlinear structural finite element analysis with nonlinear static soil models for axial, lateral and torsional soil behavior to provide a system of analysis for coupled bridge pier structures and foundation systems.

FB-MultiPier files for each substructure were prepared by Haley & Aldrich, including substructure loading data and pile group geometry (pile cap dimensions, pile layout and spacing, etc.). The files included subsurface soil, rock and groundwater conditions based on the conditions encountered in the design phase test borings as well as the static compression resistance calculations summarized in previous sections of this report. Multiple iterations were completed at each substructure location to determine the most efficient pile type, pile size and pile layout (configuration and number of piles) required to resist the applied loads and moments. Based on our evaluations, the design of the pier pile groups is governed by the unsupported pile length (due to scour) during strength limit state loading. Because of this the design of the abutment pile groups is controlled by lateral loading at the strength limit state.

The program output was evaluated, summarized and discussed with TranSystems prior to finalizing. The results of our evaluations show the following optimum pile layout at each substructure location.

- Abutment 1: Two rows of plumb (vertical) 14-in. OD steel pipe piles with a ½-in. thick wall spaced 7 ft apart (on center) and individual piles within each row spaced at 5 ft on center. The piles are driven closed ended and filled with Class A concrete. Overall pile cap dimensions measure approximately 70 ft x 11 ft x 2.5 ft (L x W x H). The total number of piles required is 25.

- Abutment 2: Two rows of plumb (vertical) 14-in. OD steel pipe piles with a ½-in. thick wall spaced at 7 ft apart (on center, rows are staggered) and individual piles within each row spaced at 5 ft on-center. The piles are driven closed ended and filled with Class A concrete. Overall pile cap dimensions measure approximately 81 ft x 11 ft x 2.5 ft (L x W x H). The total number of piles required is 32.

- Pier 1 and Pier 2: Two rows of plumb (vertical) 24-in. OD steel pipe piles with a 5/8-in. thick wall spaced 10 ft apart (on center) and individual piles within each row spaced at 6 ft on-center. Two additional piles are located between the rows at the extreme ends of the pile group (one on each end). The piles are driven closed ended and filled with Class A concrete. Overall pile cap dimensions measure approximately 52 ft x 14 ft x 3 ft (L x W x H). The total number of piles required for each pier is 18.

A summary of the lateral pile group evaluation results for each substructure (abutment, bent, pier) including maximum factored compressive and uplift loads and maximum service limit state pile deflections in the transverse and longitudinal directions for all applicable limit states (service, strength, extreme event) is provided in the attached Table VII.

6.5.6 Nominal Pile Driving Resistance

We recommend that the piles be driven to the minimum required nominal driving resistances shown in the table below in accordance with AASHTO LRFD Section 10.7.3.7. The minimum required nominal driving resistances shown below are calculated using a resistance factor of 0.65 based on the assumption that dynamic testing will be performed to verify nominal axial compressive resistances during pile installations, as recommended herein.

Substructure Location	Max. Factored Strength Limit State Load[1] (kips)	Factored Downdrag Load (kips)	Total Factored Load (kips)	Nominal Resistance Required to Resist Factored Loads[2] (kips)	Side Resistance Through Downdrag Zone[3] (kips)	Min. Required Nominal Driving Resistance (kips)
Abutment 1	226	0	226	348	0	348
Pier 1	327	98	425	654	93	747
Pier 2	327	80	407	626	76	702
Abutment 2	248	0	248	382	0	382

[1] – Maximum factored strength limit state compressive loads from FB-MultiPier evaluations; see Table VII.
[2] – Based on a resistance factor equal to 0.65 applied to the total factored load (for dynamic field verification testing).
[3] – Based on a resistance factor equal to 1.05 applied to the factored downdrag load.

6.5.7 Pile Tip Elevations

As discussed previously, the piles are expected to develop the vast majority of their axial compressive resistance through a combination of skin frictional and end bearing resistance. Based on the results of the geotechnical engineering evaluations summarized herein, we do not anticipate that the piles will need to be driven to bedrock. Therefore, the recommended tip elevations for estimating pile lengths are based on the minimum depths required to provide sufficient compressive, uplift and lateral resistance during service, strength and extreme event limit state loading conditions. For estimating bid quantities, we recommend the following pile tip elevations at each substructure location:

Substructure	Pile Location Within Substructure	Estimated Pile Tip Elevation (ft, NAVD 88)	Representative Test Boring(s)	Anticipated Bearing Stratum at Pile Tip
Abutment 1	All piles (25 piles)	El. 505	BB-RAR-110, BB-RAR-111	Alluvial
Pier 1	Northern 1/3 (7 piles)	El. 485	BB-RAR-115	Till/Rock
	Central 1/3 (6 piles)	El. 495	-	unknown, likely Till
	Southern 1/3 (5 piles)	El. 505	BB-RAR-116	Till/Rock
Pier 2	Northern 1/3 (7 piles)	El. 510	BB-RAR-117	Glaciofluvial
	Central 1/3 (6 piles)	El. 520	-	unknown
	Southern 1/3 (5 piles)	El. 530	BB-RAR-118	Till
Abutment 2	All piles (32 piles)	El. 535	BB-RAR-119, BB-RAR-120, BB-RR-121	Till/Rock

6.5.8 Driveability Evaluation

The engineering design of the proposed piles included consideration of driveability in accordance with AASHTO LRFD Section 10.7.8. The driveability evaluations were conducted using the computer program GRL WEAP 2005 developed by GRL Engineers, Inc. The driveability analyses were conducted to verify that the piles could be driven to the recommended pile tip elevations using hammer sizes typical of local pile driving Contractors without damaging or overstressing the piles while keeping the penetration resistance below 15 blows per inch (bpi), which is the upper limit of penetration resistance typically allowed by MaineDOT.

The driveability evaluations were conducted using APE D19-42 (Abutments) and Delmag D46-32 (Piers) open-ended diesel hammers with maximum rated energy's equal to approximately 42,800 and 121,740 ft-lbs, respectively. Driveability evaluations were completed at each proposed substructure locations based on the subsurface conditions encountered in the design phase test borings and the resistances calculated using the static analysis procedures summarized previously. The driveability resistances for pipe piles at each substructure location are summarized below.

Substructure Location	Pile Section[1]	Pile Hammer	Penetration Resistance (blows/in)	Ram Stroke (ft)	Energy (kip-ft)	Max. Comp. Stress[2] (ksi)	Nominal Driveability Resistance[3] (kips)
Abutment 1	14in. OD x 1/2-in. wall	APE D19-42	6	8.5	23	25	560
Pier 1	24-in. OD x 5/8-in. wall	Delmag D46-32	11 to 12	6.5-9.5	34-56	26-34	1,021 to 1,141
Pier 2	24-in. OD x 5/8-in. wall	Delmag D46-32	9 to 15	9-9.5	58-60	32-33	1,079 to 1,111
Abutment 2	14in. OD x 1/2-in. wall	APE D19-42	12	6	14.5	20	446

[1] – All piles modeled as plumb piles.
[2] – Maximum permissible compressive stress equal to $0.9F_y$ (45 ksi).
[3] – Minimum required nominal resistances: Abutment 1 =348 kips; Pier 1 =747 kips; Pier 2 = 702 kips; Abutment 2 = 382 kips.

Based on the results summarized above, it is our opinion that the proposed foundation piles can be driven to the recommended pile tip elevations at reasonable penetration resistances without damage with typical pile hammer sizes used by local pile driving Contractors. It is likely that the design pile tip elevations will be revised in the field based on the results of the dynamic pile load testing program (see Section 7.3).

Prospective Contractors will be required to perform an independent driveability evaluation prior to construction, using the specific pile hammer that they select to install the piles during construction, to verify that the piles can be driven to the minimum required nominal resistance without damage.

6.5.9 Pile Settlement and Elastic Pile Compression

Pile settlement due to elastic shortening of the steel pipe piles as well as pile tip settlement was evaluated based on the maximum factored Service Limit State loads generated from pile group evaluations. Estimates of elastic pile compression for an individual pile at each substructure are summarized below.

Substructure Location	Maximum Factored Service Limit State Load[1] (kip)	Approximate Elastic Pile Compression (in.)
Abutment No. 1	168	0.2
Pier 1	278	0.1
Pier 2	278	0.1
Abutment No. 2	182	0.2

[1] – Based on pile group evaluations performed by Haley & Aldrich, see Table VII.

The values summarized above do not include pile tip settlement, which is considered to be negligible for two primary reasons: 1) the relatively small load transmitted to the pile tip during service limit state loading and 2) the piles will be driven into dense to very dense soil. The elastic shortening of the piles is anticipated to occur primarily during construction, soon after the superstructure loads are applied.

6.5.10 Pile Embedment, Spacing, Clearance and Pile Material

We recommend that minimum pile spacing, clearance and embedment (into the pile cap) meet the requirements of AASHTO LRFD Section 10.7.1.2. We also recommend that the piles be driven with a closed end; equipped with a pile tip in accordance with MaineDOT Standard Specification 501.10 meeting the minimum requirements of ASTM A148, Grade 90/60. Based on the results of the driveability evaluation (maximum compressive stress equal to 34 ksi) and potential for hard driving, we recommend piles conform to the requirements of ASTM A252, Grade 3 Modified and have a minimum yield strength of 50 ksi.

After installation and inspection for damage, we recommend that the pipe piles be filled with Class A concrete. We recommend that the concrete be placed from the bottom of pile to the top, using tremie methods.

7. CONSTRUCTION CONSIDERATIONS

7.1 Temporary Earth Support

Based on the proposed elevation of the bottom of the Pier 1, Pier 2 and Abutment 2 pile caps relative to water levels in the river and/or existing site grades, temporary earth support systems will be required to construct the substructures. Based on the subsurface soil, rock and groundwater conditions at the site, we anticipate that the most cost-effective excavation support system(s) for construction of the substructures will consist of either steel sheeting (Pier 1, Pier 2, and Abutment 2) or soldier piles and lagging (Abutment 2).

In general, design of temporary earth support system(s) are the responsibility of the Contractor and should be conducted by a Licensed Professional Engineer in the State of Maine. We recommend that temporary earth support system(s) be designed to support all appropriate combinations of earth, water and surcharge loads (from traffic, construction equipment, material stockpiles and other sources) imposed on the system(s) during all phases of the construction period. The Contractor is responsible for choosing an applicable factor of safety for the earth support system(s). The Contractor's design should also consider the means and methods and construction sequencing proposed by the Contractor. We recommend that design calculations and shop drawings be prepared by the Contractor, stamped by a Licensed Professional Engineer in the State of Maine and submitted to MaineDOT for review prior to construction.

Based on the nature and phasing of the proposed construction we anticipate that some portions of the support of excavation systems used to construct the Pier and Abutment 2 substructures may be cutoff and left in place.

7.2 Vibro-Replacement Ground Improvement

We recommend that the Contractor have a minimum of five continuous years of experience and a minimum of ten recent successful vibro-replacement liquefaction mitigation projects completed with soil and groundwater conditions similar to those at the project site. We also recommend that the Contractor performing the ground improvement work provide staff and/or consultants with technical expertise to design the ground improvement program to meet the minimum post-improvement requirements as summarized in Section 6.4.2. Minimum Contractor qualifications will be a requirement of the vibro-replacement special provision for the project and will be submitted to MaineDOT for review prior to construction.

Prior to production vibro-replacement ground improvement, we recommend that the Contractor conduct ground improvement within two test sections (in non-production locations), one at each abutment, with a minimum plan area of 400 square feet to confirm that the Contractor's design will can be constructed to meet the minimum requirements such that liquefaction potential is mitigated. We recommend that the Contractor conduct test borings and standard penetration testing at a minimum of two locations within each test section to verify that minimum level of improvement has been achieved. If the results of the post installation standard penetration testing do not meet the required minimum criteria (see Section 6.4.2), the Contractor will be required to modify their design, install another test section and conduct post installation testing. This cycle will be repeated until the improvement criteria are met. These requirements will be included in the vibro-replacement special provision.

Upon successful completion of the two test sections and production ground improvement, the Contractor shall provide all necessary equipment and labor for performing post-improvement testing. The Contractor shall provide drilling equipment to perform test borings using SPT procedures following the improvement processes. We recommend that between 8 and 10 test borings be required within the improved area at Abutment No. 1 (see Figure 2) and between 4 and 6 test borings be required within the improved area at Abutment No. 2 (see Figure 3; approximately one test boring per 1,500 square feet of improved area). The locations of the test borings within each improvement area should be established by MaineDOT prior to the start of production installation. We recommend that SPT testing be performed in accordance with ASTM D1586 and MaineDOT, "Appendix A, Specifications of Work to be Performed (Borings)," dated 4 June 2007. Additional recommended drilling requirements are summarized below.

- Drilling shall be conducted using cased-washed boring techniques.
- Drilling mud shall be used to advance the boreholes.
- Standard penetration tests shall be performed continuously from ground surface using a standard split-spoon sampler to a minimum 5 ft below the bottom of the improved zone. The split-spoon sampler shall be driven with a rope and cathead and safety hammer or a recently calibrated automatic hammer.
- A detailed visual description shall be made of each standard penetration test sample in accordance with ASTM D2487 and D2488, and the description shall be entered on a test boring log.
- Soil samples shall be collected, documented, labeled and delivered to the MaineDOT upon completion.

If quality control tests indicate that improvement in any area does not meet the minimum specified requirements, the area affected, as determined by MaineDOT, shall have the improvement procedure repeated at no additional cost to the MaineDOT (with the design/procedure revised when required). The quality control tests shall then also be repeated at no additional cost to the MaineDOT.

All quality control tests shall be accomplished, the results assessed by the MaineDOT, and MaineDOT's evaluation and recommendations approved prior to the Contractor's equipment leaving the project site.

7.3 Dynamic Pile Load Testing Program

The Contractor will be required to confirm the minimum required nominal pile resistances in the field using dynamic testing methods. The piles should be driven to a nominal resistance equal to the maximum factored axial compressive pile load divided by a resistance factor equal to 0.65 in accordance with AASHTO LRFD Table 10.5.5.2.3-1. We recommend that Contractor perform three dynamic pile load tests with 24-hour (minimum) restrike tests at each substructure location (12 total) to evaluate hammer system efficiencies, driving stresses in the pile, and the nominal resistance of the piles. We recommend that the three dynamic pile load tests at each substructure location be completed prior to production pile driving. We also recommend that CAPWAP analysis be performed on each indicator piles installed during the dynamic test program (12 total).

7.4 Reuse of Excavated On-Site Soils

Naturally-deposited soil will be excavated to facilitate the construction of the Pier 1 and Pier 2 substructures. Based on the $Q_{1.1}$ water elevation (El. 613.1) and the proposed bottom of pier pile cap elevation (El. 595.0), we anticipate that soil will need to be excavated from within the cofferdams down to approximately El. 582.0 to place the cofferdam concrete seal in-the-wet and to then construct the pier substructures in-the-dry.

Based on the design phase test borings drilled at Pier 1 and Pier 2 (BB-RAR-115 through BB-RAR-120) we anticipate that the excavated material will consist primarily of Alluvial soils. In addition, based on the results of grain size analyses conducted on samples of Alluvial Deposit soils and our discussions with MaineDOT, we understand that the material meets the minimum Beneficial Reuse requirements as the percentage of fine-grained soil particles passing the No. 200 (0.075 mm) sieve is less than 15 percent.

As a result, the excavated Alluvial soils could be reused to construct portions of the approach embankments, in areas adjacent to and draining into the river. Specifically, we recommend that the reuse area be limited to the portion of the west approach embankment that is downstation of Sta. 14+50 (outside the limits of vibro-replacement ground improvement area) and between 2H:1V and 1.5H:1V lines extending down from the edge of the roadway shoulder in accordance with MaineDOT Standard Detail 203(01) – Disposal of Waste Materials (Waste Storage Area).

Please note that Pier 1 and Pier 2 cofferdams may be excavated with a clamshell-type bucket and will likely take place in-the-wet. The excavated soil will be saturated and will likely require a lay down/stockpile area that can be used by the Contractor to moisture-condition (air dry) the excavated soil. Conditioning will be needed in order to achieve a moisture content suitable for placement and adequate compaction of the soils within the recommended portions of the west approach embankment.

7.5 Submittal Reviews

The contract drawings and specifications should be written so that the requirements of the documents are consistent with the design intent of the geotechnical recommendations outlined herein. The contract specifications require that the Contractor and the Contractor's engineer perform analyses and submit results to MaineDOT for review. We recommend that Haley & Aldrich be allowed to review the geotechnical-related submittals to ensure that the Contractor's analyses/submittals are in accordance with the intent of the design as summarized herein. This will enable us to observe compliance with the design concepts, assumptions and specifications, and to facilitate design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

7.6 Construction Monitoring

The geotechnical design and earthwork recommendations contained herein are based on the known and predictable behavior of a properly engineered and constructed foundation. Monitoring of the foundation and approach embankment construction is required to enable the geotechnical engineer to keep in contact with procedures and techniques used in construction. Therefore, it is recommended that an individual representing MaineDOT, qualified by geotechnical training and experience be present at the site to provide monitoring of dynamic testing of the indicator piles, review of the PDA results and development of production pile driving criteria, and monitoring of vibro-replacement ground improvement test sections and production installation.

8. LIMITATIONS OF RECOMMENDATIONS

This report is prepared for the exclusive use of MaineDOT relative to the Replacement of Martin Memorial Bridge over the Androscoggin River, in Rumford, Maine. There are no intended beneficiaries other than MaineDOT. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than MaineDOT for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from MaineDOT and from Haley & Aldrich indicating that the Report is adequate for such other use. Use of this report by such other person or entity without the written authorization of MaineDOT and Haley & Aldrich shall be at such other person's or entities sole risk, and shall be without legal exposure or liability to Haley & Aldrich.

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

9. REFERENCES

1. "Site-Specific Seismic Evaluation, Replacement of Martin Memorial Bridge, MaineDOT WIN 15105.00, Route 232 – Rumford, Maine," prepared by Haley & Aldrich, Inc., dated 10 May 2013.

G:\PROJECTS\38799 - martin memorial bridge\Deliverables\Geotechnical Design Report\2013_0524_HAI_15105 GT Report_f1.docx

TABLE I
Design Phase Exploration Location Data
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Test Boring No.[1]	Ground Surface/Mudline Elevation[3,4]	Station[5]	Offset Distance & Direction[5]	Coordinates[2]	
				Northing	Easting
BB-RAR-101	624.8	00+00	10.2' LT	606,494	906,345
BB-RAR-102	622.8	02+00	9.6' LT	606,692	906,323
BB-RAR-103	619.7	04+53	3.1' LT	606,934	906,265
BB-RAR-104	619.2	06+38	13.5' RT	607,103	906,186
BB-RAR-105	619.5	07+79	82.4' RT	607,259	906,173
BB-RAR-106	620.2	09+84	28.4' RT	607,406	906,023
BB-RAR-107	612.9	11+80	3.0' LT	607,583	905,960
BB-RAR-108	615.5	12+71	1.0' LT	607,672	905,984
BB-RAR-109	616.0	13+71	2.1' RT	607,756	906,036
BB-RAR-110	615.8	15+28	22.7' LT	607,876	906,142
BB-RAR-111	615.7	15+30	24.4' RT	607,838	906,170
BB-RAR-112	615.4	15+27	78.2' LT	607,922	906,111
BB-RAR-113	615.8	15+22	78.8' RT	607,788	906,193
BB-RAR-114	615.3	15+54	0.7' RT	607,871	906,177
BB-RAR-115	597.1	16+76	24.5' LT	607,959	906,265
BB-RAR-116	597.1	16+74	17.1' RT	607,923	906,286
BB-RAR-117	596.1	18+69	30.5' LT	608,070	906,423
BB-RAR-118	596.8	18+51	27.3' RT	608,012	906,440
BB-RAR-119	599.6	19+60	24.7' LT	608,115	906,502
BB-RAR-120	600.1	19+42	22.3' RT	608,066	906,513
BB-RAR-121	637.0	20+93	91.0' LT	608,245	906,585
BB-RAR-122	633.5	30+66	19.2' RT	607,891	906,839
BB-RAR-123	634.1	32+07	0.5' LT	607,755	906,804

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

	Individual	Date
Prepared By:	BCS	1/4/2013
Checked By:	EFW	4/3/2013
Reviewed By:	WAC	5/13/2013

TABLE II
Design Phase Exploration Subsurface Data
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Test Boring No.[1]	Ground Surface Elevation[3,4]	Approximate Strata Thickness[5] (ft)						Approximate Elevation of Top of Bedrock	Approximate Elevation of Bottom of Exploration
		Bituminous Concrete/ Topsoil	Man-Placed Fill	Alluvial	Glacio-lacustrine	Glaciofluvial	Glacial Till/Weathered Bedrock		
BB-RAR-101	624.8	0.7	1.3	> 8.0	--	--	--	--	614.8
BB-RAR-102	622.8	0.7	1.3	> 11.0	--	--	--	--	609.8
BB-RAR-103	619.7	2.0	NE	> 8.0	--	--	--	--	609.7
BB-RAR-104	619.2	3.0	NE	> 7.0	--	--	--	--	609.2
BB-RAR-105	619.5	4.0	NE	> 8.0	--	--	--	--	607.5
BB-RAR-106	620.2	4.0	NE	> 8.0	--	--	--	--	608.2
BB-RAR-107	612.9	4.0	NE	> 32.0	--	--	--	--	576.9
BB-RAR-108	615.5	6.0	NE	> 35.0	--	--	--	--	574.5
BB-RAR-109	616.0	2.0	NE	> 39.0	--	--	--	--	575.0
BB-RAR-110	615.8	3.5	NE	125.9	NE	NE	7.1	479.3	469.4
BB-RAR-111	615.7	3.5	NE	120.5	NE	NE	6.5	485.2	474.9
BB-RAR-112	615.4	3.5	NE	> 47.5	--	--	--	--	564.4
BB-RAR-113	615.8	2.0	NE	> 49.0	--	--	--	--	564.8
BB-RAR-114	615.3	4.0	NE	> 47.0	--	--	--	--	564.3
BB-RAR-115	597.1	NE	NE	31.0	79.8	NE	5.2	481.1	470.8
BB-RAR-116	597.1	NE	NE	25.0	66.5	NE	NE	505.6	485.2
BB-RAR-117	596.1	NE	NE	16.0	62.2	26.3	15.0	476.6	473.6
BB-RAR-118	596.8	NE	NE	15.0	50.7	NE	4.3	526.8	514.4
BB-RAR-119	599.6	NE	NE	36.5	NE	29.5	22.3	511.3	501.8
BB-RAR-120[7]	600.1	NE	NE	34.0	24.0	21.0	7.0	514.1	496.5
BB-RAR-121	637.0	0.5	1.5	42.0	5.0	NE	0.9	587.1	587.1
BB-RAR-122	633.5	0.4	2.1	> 9.0	--	--	--	--	622.0
BB-RAR-123	634.1	0.5	8.7	> 7.8	--	--	--	--	617.1

Notes:
[1] Test boring locations are shown on Figures 2 and 3, Site and Subsurface Exploration Location Plans.
[2] As-drilled coordinates of test borings were determined by MaineDOT using GPS survey equipment, are measured in feet and reference NAD83, Maine 2000 West Zone coordinate system.
[3] Ground surface elevations at test boring locations were determined in the field by MaineDOT using GPS survey equipment.
[4] Elevations are measured in feet and reference the North American Vertical Datum of 1988 (NAVD 88).
[5] "NE" indicates stratum was not encountered in test boring.
[6] "--" indicates test boring was not drilled deep enough to determine presence of stratum.
[7] Glaciofluvial deposit encountered both within and below the glaciolacustrine deposit in boring BB-RAR-120. Value represents cumulative thickness of deposit.

	Individual	Date
Prepared By:	MLS	1/17/2013
Checked By:	BCS	5/23/2013
Reviewed By:	WAC	5/23/2013

TABLE III
Cut/Fill Depths and Anticipated Subgrade Conditions
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Approximate Begin Station[1]	Approximate End Station[1]	Approximate Length[1] (ft)	Cut/Fill[1,2,3]	Approximate Cut/Fill Amount[1,2,3]	Reference Test Borings[4]	Anticipated Subgrade Material[4]	Subgrade Resilient Modulus[5] (psi)
0+00	4+33	433	Cut	0 to 6 ft	BB-RAR-101, BB-RAR-102	Exist. Fill, Alluvial	5,000
4+33	6+55	222	Fill	2.5 to 3 ft	BB-RAR-103, BB-RAR-104	Topsoil	2,000
6+55	10+25	370	Cut	0 to 1 ft	BB-RAR-105	Topsoil	2,000
10+25	15+15	490	Fill	2.5 to 23 ft	BB-RAR-106 through BB-RAR-114	Prop. Fill	6,000
20+20	20+57	37	Fill	2.5 to 20 ft	BB-RAR-121	Alluvial, Prop. Fill	6,000
20+57	20+89	32	Cut	0 to 4 ft	BB-RAR-121	Alluvial	5,000
**30+20	**32+30	210	Cut	1 ft	BB-RAR-122, BB-RAR-123	Exist. Fill	5,000

Notes:

[1] Station limits and cut/fill amounts are approximate and were determined by scaling distances from the centerline profile developed by TranSystems for the 50 percent design submission.

[2] Cut and fill amounts were measured along the proposed roadway centerline. Variations in cut/fill depths may exist transverse to the project baseline.

[3] Cut and fill depths are based on an assumed 30-in. thick pavement section as shown on the centerline profile developed by TranSystems for the 50 percent design submission.

[4] Anticipated subgrade material based on the subsurface conditions encountered in the design phase test borings drilled along the proposed roadway alignment.

[5] Subgrade resilient modulus values were determined based on correlations provided by MaineDOT.

** - Stationing references existing Route 232 baseline.

	Individual	Date
Prepared By:	BCS	10/10/2012
Checked By:	EFW	11/13/2012
Reviewed By:	WAC	5/13/2013

TABLE IV
Abutment 1 Factored Pile Cap Loads
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Load Case Description	Vertical (kip/ft)	Horizontal[3] (kip/ft)	Moment[3,4] (kip-ft/ft)
Service Limit State Loading[1,2]:			
Service I	45	16	133
Strength Limit State Loading[1,2]:			
Strength I (A)	61	21	201
Strength I (B)	38	20	79
Strength III	38	17	108
Strength IV	45	20	112
Extreme Event Limit State Loading[1,2]:			
Extreme Event I	36	14	55

Notes:
[1] - Loads provided to Haley & Aldrich by TranSystems on 13 February 2013.
[2] - Abutment loads were provided by TranSystems per unit width of abutment.
[3] - Horizontal loads and moments act perpendicular to the abutment.
[4] - Based on information provided by TranSystems, moments are taken about the toe of pile cap, restraining moments are positive and overturning moments are negative. Therefore, positive moments are not considered to be applied loads rather excess resistance against overturning.

	Individual	Date
Prepared By:	JLL	3/12/2013
Checked By:	BCS	5/7/2013
Reviewed By:	WAC	5/13/2013

TABLE V
Abutment 2 Factored Pile Cap Loads
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Load Case Description	Vertical (kip/ft)	Horizontal[3] (kip/ft)	Moment[3,4] (kip-ft/ft)
Service Limit State Loading[1,2]:			
Service I	53	23	98
Strength Limit State Loading[1,2]:			
Strength I (A)	71	29	159
Strength I (B)	46	29	26
Strength III	46	25	72
Strength IV	53	29	60
Extreme Event Limit State Loading[1,2]:			
Extreme Event I	44	20	-24

Notes:
[1] - Loads provided to Haley & Aldrich by TranSystems on 13 February 2013.
[2] - Abutment loads were provided by TranSystems per unit width of abutment.
[3] - Horizontal loads and moments act perpendicular to the abutment.
[4] - Based on information provided by TranSystems, moments are taken about the toe of pile cap, restraining moments are positive and overturning moments are negative. Therefore, positive moments are not considered to be applied loads rather excess resistance against overturning.

	Individual	Date
Prepared By:	JLL	3/12/2013
Checked By:	BCS	5/7/2013
Reviewed By:	EFW	5/13/2013

TABLE VI
Pier 1 and Pier 2 Factored Pile Cap Loads
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Load Case Description	Vertical (kip)	Horizontal[3] (kip)	Moment[3] (kip-ft)
Service Limit State Loading[1,2]:			
Service I	3,010	109	3,930
Strength Limit State Loading[1,2]:			
Strength I	4,165	58	1,936
Strength III	2,038	163	5,360
Strength V	2,692	104	3,374
Extreme Event Limit State Loading[1,2]:			
Extreme Event I	2,163	254	9,547
Extreme Event II	2,405	96	1,675

Notes:
[1] - Loads provided to Haley & Aldrich by TranSystems on 12 February 2013.
[2] - Loads do not include the bouyant effects of the tremie seal. Additional loads and moments due to the tremie seal were developed by Haley & Aldrich and were used in the pile group evaluations.
[3] - Horizontal loads and moments act perpendicular to the piers.

	Individual	Date
Prepared By:	JLL	3/12/2013
Checked By:	BCS	5/7/2013
Reviewed By:	EFW	5/13/2013

TABLE VII
FB-MultiPier Pile Group Evaluation Results
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

Substructure Location	Total Number of Piles	Pile Type / Pile Size	Maximum Lateral Pile Cap Deflections (in.)						Maximum Factored Pile Loads (kips)					
			Service I Limit State		Strength I Limit State		Extreme Event I Limit State		Service Limit State		Strength Limit State		Extreme Event Limit State	
			Transverse	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Compression	Uplift	Compression	Uplift	Compression	Uplift
Abutment 1	25	14"x1/2" Closed End Steel Pipe Pile	0.00	0.81	0.00	1.15	0.00	0.64	168	0	226	0	137	0
Pier 1	18	24"x5/8" Closed End Steel Pipe Pile	0.00	0.84	0.00	0.65	0.00	2.62	278	0	327	0	329	47
Pier 2	18	24"x5/8" Closed End Steel Pipe Pile	0.00	0.84	0.00	0.65	0.00	2.62	278	0	327	0	329	47
Abutment 2	32	14"x1/2" Closed End Steel PipePile	0.00	0.61	0.00	0.95	0.00	0.55	182	0	248	0	168	0

	Individual	Date
Prepared By:	JLL	3/12/2013
Checked By:	BCS	5/7/2013
Reviewed By:	WAC	5/13/2013

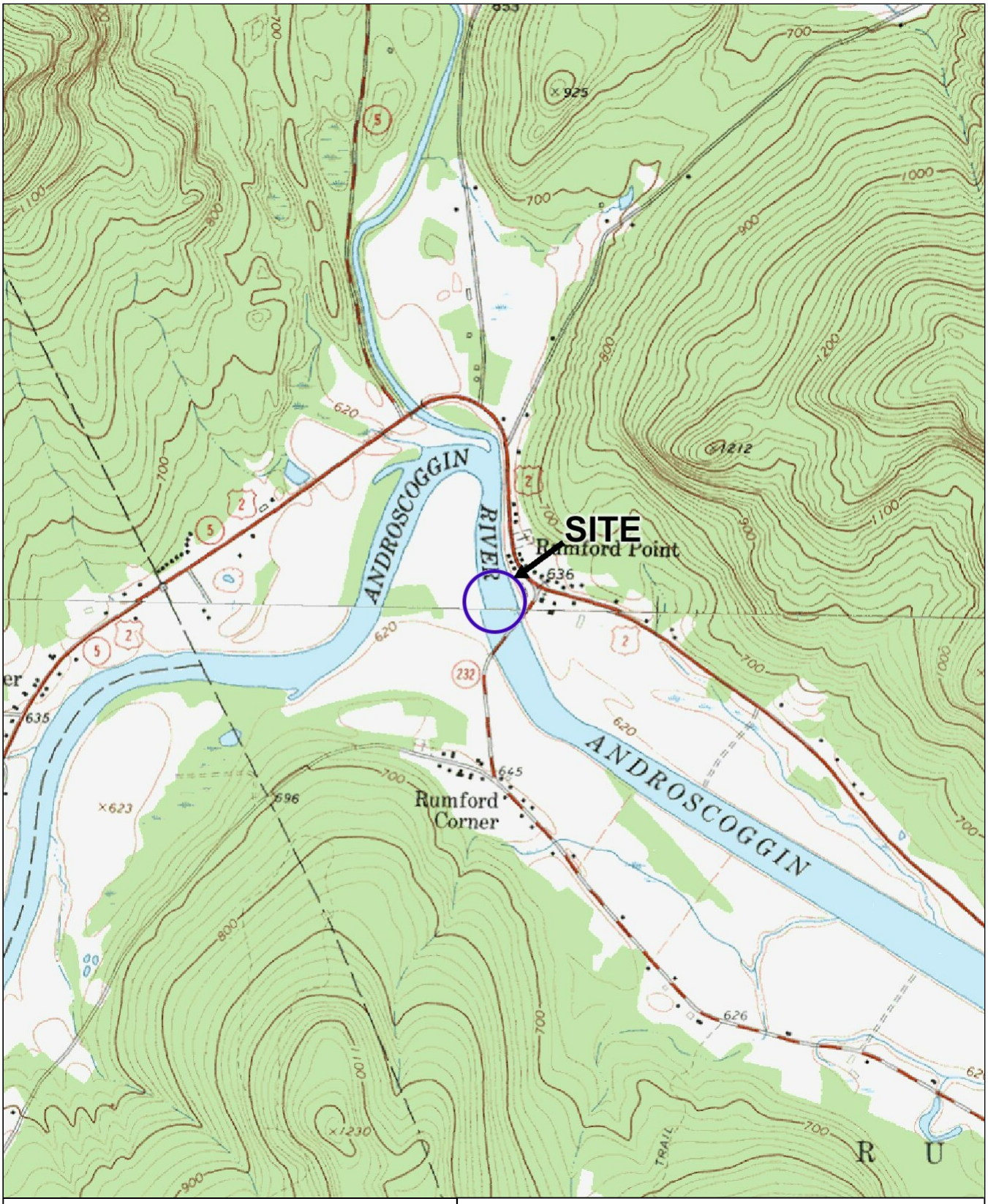
TABLE VIII
Preliminary Geotechnical Quantity and Cost Comparison - Simplified vs. Site Specific Liquefaction Evaluation Results
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Haley & Aldrich, Inc. File No.: 38799-000

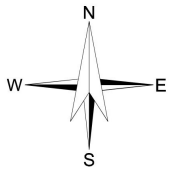
Design Element		Simplied Liquefaction Evaluation		Site-Specific Liquefaction Evaluation		Estimated Reduction in Cost Using the Results of the Site Specific Liquefaction Evaluation
		W/Mitigation[1]	W/O Mitigation[2]	W/Mitigation[3]	W/O Mitigation[4]	
Seismic Design Category (SDC)		B	D	A	D	NA
Response Spectrum		Site Class E	Site Class E	between Site Class E and 2/3 of Site Class E	between Site Class E and 2/3 of Site Class E	NA
Thickness of Liquefiable Zone		NA	45 ft (west), 60 ft (east)	NA	20 to 35 ft (23.5 ft average)	NA
Approiximate Plan Area of Liquefaction Mitigation Zone (Partial; see green and yellow shaded areas on Figures 2 and 3)		NA	West - 125 ft by 105 ft (13,100 sf) East - 50 ft by 130 ft (6,500 sf)	NA	West - 125 ft by 105 ft (13,100 sf) East - 50 ft by 130 ft (6,500 sf)	NA
Estimated number of Vibro-Replacement Elements (assuming an 8 ft center to center spacing)		NA	West - 205 elements East - 102 elements	NA	West - 205 elements East - 102 elements	NA
Vibro-Replacement Ground Improvement @ $35/lf installed (cost includes a $50,000 allowance for equipment mob/demob)[5]		$587,000	NA	$303,000	NA	$284,000
Abutment 1 Pile Design	Total No. of Piles @ 140 lf/ea.	35	Did Not Evaluate	26	Did Not Evaluate	$145,530
	Pile Length Delivered @ $85/lf	$416,500		$309,400		
	Pile Length Installed @ $25/lf	$122,500		$91,000		
	Splices @ $10/ea.	$700		$520		
	Pile Tips @ $750/ea.	$26,250		$19,500		
	Total =	$565,950		$420,420		
Pier 1 and Pier 2 Pile Design	Total No. of Piles @ 95 lf/ea.	NA; Scour zone deeper than liquefied zone	48	NA; Scour zone deeper than liquefied zone	36	$134,520
	Pile Length Delivered @ $85/lf		$387,600		$290,700	
	Pile Length Installed @ $25/lf		$114,000		$85,500	
	Splices @ $10/ea.		$480		$360	
	Pile Tips @ $750/ea.		$36,000		$27,000	
	Total =		$538,080		$403,560	
Abutment 2 Pile Design	Total No. of Piles @ 75 lf/ea.	40	Did Not Evaluate	31	Did Not Evaluate	$81,090
	Pile Length Delivered @ $85/lf	$255,000		$197,625		
	Pile Length Installed @ $25/lf	$75,000		$58,125		
	Splices @ $10/ea.	$400		$310		
	Pile Tips @ $750/ea.	$30,000		$23,250		
	Total =	$360,400		$279,310		
Totals		$2,051,430		$1,406,290		$645,140

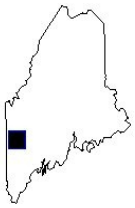
Notes:
1 - Assumption made that MaineDOT's risk tolerance to liquefaction and embankment stability is the same regardless of using simplified liquefaction or site-specific liquefaction results.
2 - Pile group evaluations used to develop the pile layout shown on the 80 percent drawings did not include additional active forces on the foundation piles caused by embankment failure.
3 - Evaluations completed based on results of our 7 Feb 2013 conference call. That is, liquefaction mitigation will be conducted in immendiate vicinity of both abutments but not beneath the approach embankments.
4 - Evaluations were not completed based on MaineDOT's risk tolerance, see Note 3.
5 - Preliminary unit pricing information was based on discussions with specialty geotechincal contractors who regularly install vibro-replacement elements.

	Individual	Date
Prepared By:	BCS	3/12/2013
Checked By:	WAC	5/13/2013
Reviewed By:	EFW	5/13/2013



SITE COORDINATES:44°30'1"N 70°40'24"W





U.S.G.S. QUADRANGLE: EAST ANDOVER, ME

HALEY & ALDRICH

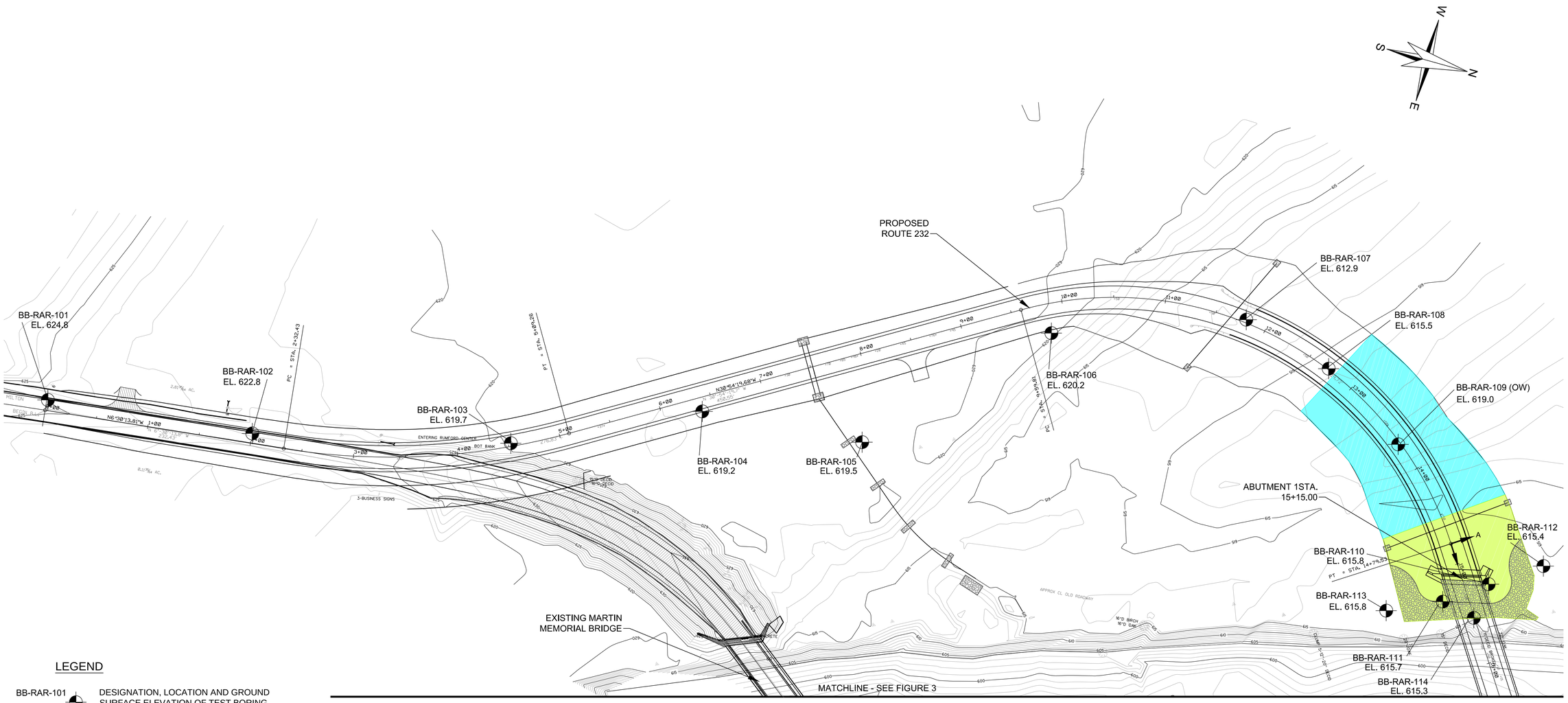
MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT WIN 15105.00
ROUTE 232 - RUMFORD, MAINE

PROJECT LOCUS

SCALE: 1:24,000
MAY 2013

FIGURE 1

38799-000 1.PDF



LEGEND

BB-RAR-101 EL. 624.8	DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORING DRILLED BY MAINE TEST BORINGS OF HERMAN, MAINE IN JUNE AND JULY 2012
(OW)	DENOTES OBSERVATION WELL INSTALLED IN COMPLETED BOREHOLE
1+00	STATIONING ALONG PROPOSED ROUTE 232 BASELINE
A A	DESIGNATION, LOCATION AND ORIENTATION OF SUBSURFACE PROFILE
595	ELEVATION CONTOUR OF EXISTING GROUND SURFACE
	APPROXIMATE LIMITS OF FULL LIQUEFACTION MITIGATION AREA
	APPROXIMATE LIMITS OF PARTIAL LIQUEFACTION MITIGATION AREA

NOTES:

1. BASE PLAN SHOWING EXISTING AND PROPOSED SITE CONDITIONS TAKEN FROM THE FOLLOWING ELECTRONIC MICROSTATION FILES: “Alignments.dgn,” “BDPLAN.dgn,” “Borings.dgn,” “Bridge.dgn,” “Contours.dgn,” “RWPLAN.dgn,” “Text.dgn” and “Topo.dgn.” MICROSTATION FILES PROVIDED TO HALEY & ALDRICH, INC. BY TRANSYSTEMS ON 11 MARCH 2013.
2. THE AS-DRILLED LOCATION AND GROUND SURFACE ELEVATION AT TEST BORING LOCATIONS WAS DETERMINED IN THE FILED BY MAINEDOT USING GPS SURVEY EQUIPMENT UPON THE COMPLETION OF DRILLING.
3. ELEVATIONS ARE IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
4. SUBSURFACE EXPLORATIONS WERE MONITORED IN THE FIELD BY HALEY & ALDRICH, INC. PERSONNEL.
5. REFER TO APPENDIX A AND APPENDIX B FOR TEST BORING LOGS AND OBSERVATION WELL INSTALLATION AND GROUNDWATER MONITORING REPORTS.
6. REFER TO FIGURE 4 FOR GEOLOGIC PROFILE A-A.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH

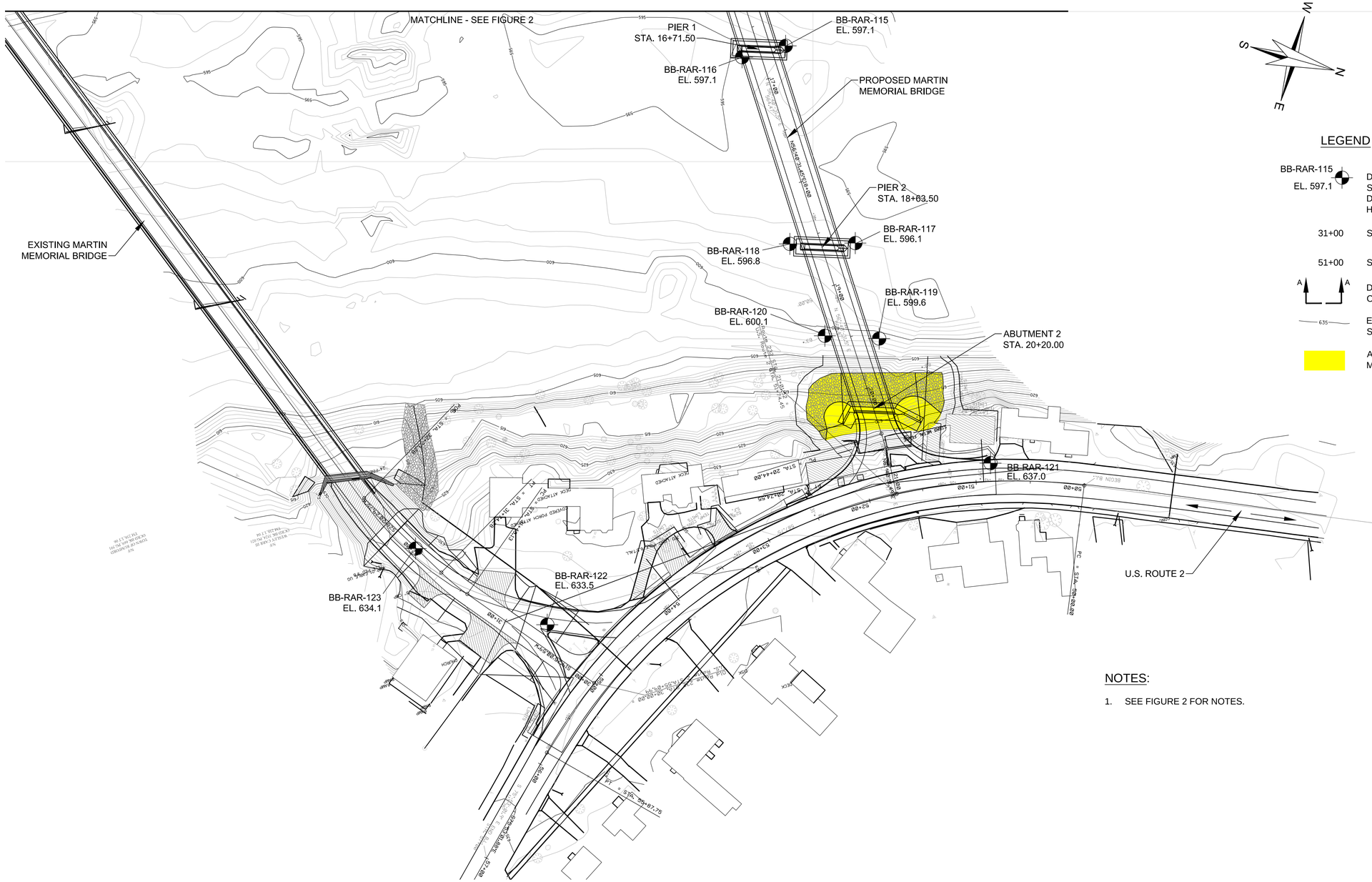
MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT WIN 15105.00
ROUTE 232 - RUMFORD, MAINE

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN (1 OF 2)

SCALE: AS SHOWN
MARCH 2013

FIGURE 2

G:\38799_MARTIN_BR\GLOBAL\CAD\DRAWING\38799_000 0003 BLP.DWG



LEGEND

BB-RAR-115 EL. 597.1	DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORING DRILLED BY MAINE TEST BORINGS OF HERMAN, MAINE IN JUNE AND JULY 2012.
31+00	STATIONING ALONG EXISTING ROUTE 232 BASELINE
51+00	STATIONING ALONG EXISTING ROUTE 2 BASELINE
A A	DESIGNATION, LOCATION AND ORIENTATION OF SUBSURFACE PROFILE
635	ELEVATION CONTOUR OF EXISTING GROUND SURFACE
	APPROXIMATE LIMITS OF PARTIAL LIQUEFACTION MITIGATION AREA

NOTES:

1. SEE FIGURE 2 FOR NOTES.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH

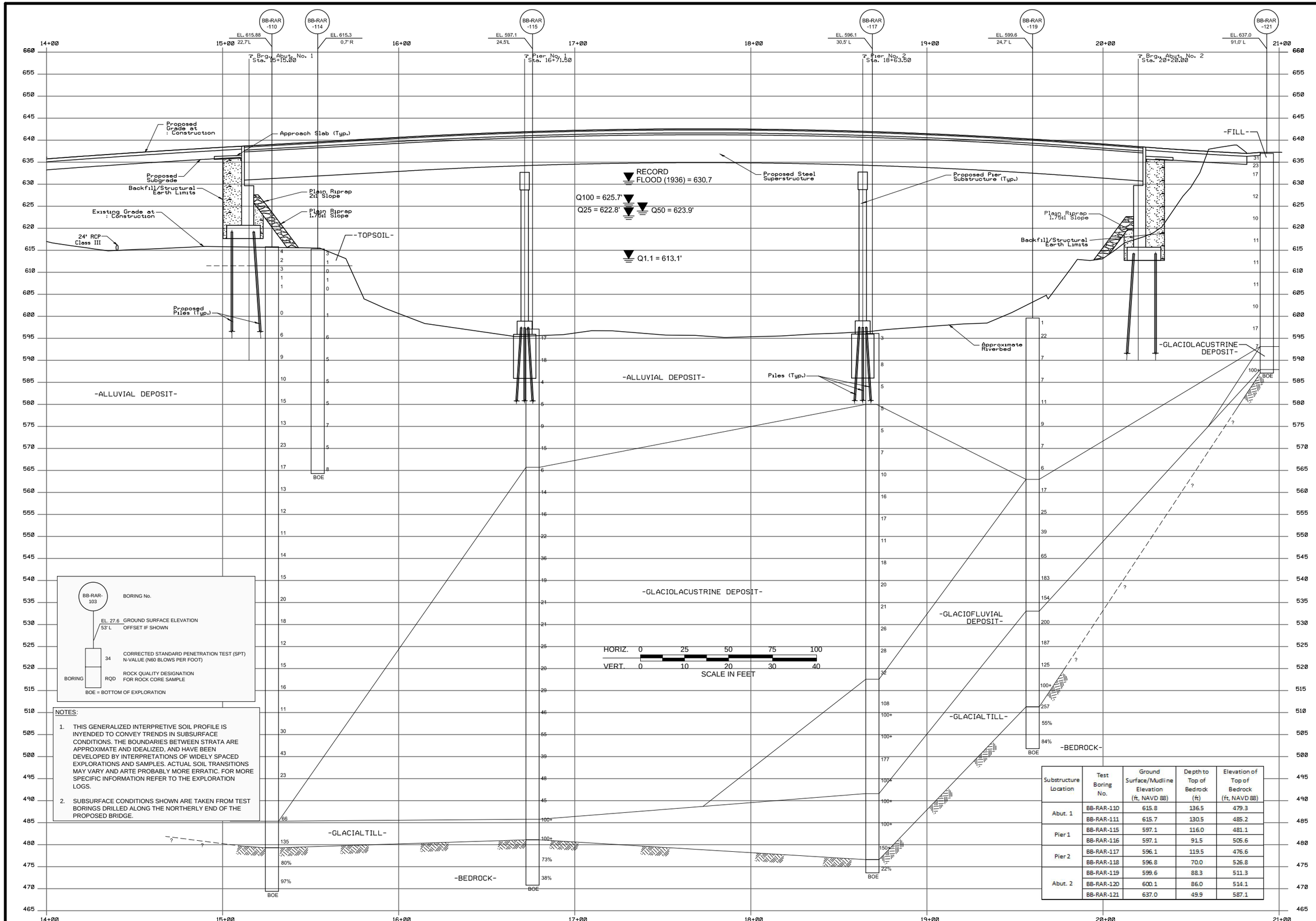
MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT WIN 15105.00
ROUTE 232 - RUMFORD, MAINE

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN (2 OF 2)

SCALE: AS SHOWN
MARCH 2013

FIGURE 3

G:\38799_MARTIN_BR\GLOBAL\CAD\DRAWING\38799_000 0003 BLP.DWG



Substructure Location	Test Boring No.	Ground Surface/Mudline Elevation (ft, NAVD 88)	Depth to Top of Bedrock (ft)	Elevation of Top of Bedrock (ft, NAVD 88)
Abut. 1	BB-RAR-110	615.8	136.5	479.3
	BB-RAR-111	615.7	130.5	485.2
Pier 1	BB-RAR-115	597.1	116.0	481.1
	BB-RAR-116	597.1	91.5	505.6
Pier 2	BB-RAR-117	596.1	119.5	476.6
	BB-RAR-118	596.8	70.0	526.8
Abut. 2	BB-RAR-119	599.6	88.3	511.3
	BB-RAR-120	600.1	86.0	514.1
	BB-RAR-121	637.0	49.9	587.1

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BH-1510(500)X

PIN 15105.00

BRIDGE PLANS

BRIDGE NO. 3248

PROJ. MANAGER $PROJMANAGER$	BY	DATE
DESIGN-DETAILED	KFP	5/2/13
CHECKED-REVIEWED	BCS	5/2/13
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

MARTIN MEMORIAL BRIDGE
ANDROSCOGGIN RIVER
RUMFORD OXFORD COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER

OF 1

FIGURE 4

Filename: $file$ Division: $wkgroup$ Username: $user$ Date:$date$

APPENDIX A

Test Boring Logs

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-101
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	624.8	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 00+00, 10.2' Lt.	**Casing ID/OD:**	--	**Water Level*:**	9.6
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	18/6	0.5 - 2.0	11/13/7	20	20	HSA	624.1	-BITUMINOUS CONCRETE- 0.7	
									Brown to light brown, dry, medium dense, fine to coarse SAND, trace silt, little fine gravel -FILL-(SW-SM)	G#248300 A-1-b, SW-SM WC=4.5%
	2D	24/12	2.0 - 4.0	11/6/3/2	9	9		622.8	2.0	
									Dark brown to brown, dry to moist, loose, fine to coarse SAND, little silt, little fine gravel, grading to silty SAND in tip of spoon -ALLUVIAL DEPOSIT-(SM)	G#248301 A-1-b, SM WC=7.4%
	3D	24/18	4.0 - 6.0	1/3/2/6	5	5			Brown to light brown, moist, loose, fine to medium SAND, little silt, trace coarse sand and fine gravel, stratified -ALLUVIAL DEPOSIT-(SM)	G#248302 A-1-b, SM WC=15.3%
5								618.8	6.0	
	4D	24/16	6.0 - 8.0	11/20/16/17	36	36			Light brown, moist, dense, fine to coarse SAND, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
	5D	24/14	8.0 - 10.0	25/20/16/15	36	36			Light brown, moist, dense, fine to coarse SAND, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
10								614.8	10.0	
									Bottom of Exploration at 10.0 feet below ground surface.	
15										
20										
25										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-102
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	622.8	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 02+00, 9.6' Lt.	**Casing ID/OD:**	--	**Water Level*:**	11.5
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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							HSA	622.1		-BITUMINOUS CONCRETE- 0.7	
	1D	24/15	1.0 - 3.0	13/4/3/4	7	7		620.8		Black to light brown, dry, loose, fine to medium SAND, trace coarse sand, little silt and fine gravel -FILL-(SM) 2.0	G#248303 A-1-b, SM WC=9.5%
	2D	24/14	3.0 - 5.0	4/3/3/5	6	6		619.8		Brown to red-brown, moist, loose, silty fine to medium SAND, trace coarse sand, some fine gravel -ALLUVIAL DEPOSIT-(SM) 3.0	G#248374 A-7-5, SM LL=55, PL=40 PI=15 WC=25.1%
5	3D	24/10	5.0 - 7.0	7/9/10/9	19	19				Light brown, moist, loose, fine to coarse SAND, little silt and fine gravel ALLUVIAL DEPOSIT-(SW-SM)	G#248304 A-1-b, SW-SM WC=10.8%
	4D	24/20	7.0 - 9.0	5/5/4/4	9	9				Light brown, moist, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
	5D	24/16	9.0 - 11.0	4/3/3/4	6	6				Light brown, moist, loose, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
10	6D	24/22	11.0 - 13.0	4/3/2/3	5	5				Light brown with occasional red-brown mottling, moist, loose, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
										Light brown, wet, loose, fine to medium SAND, trace coarse sand, trace silt, stratified -ALLUVIAL DEPOSIT-(SW)	
								609.8		13.0	
15										**Bottom of Exploration at 13.0 feet below ground surface.**	
20											
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-103
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	619.7	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 04+53, 3.1' Lt.	**Casing ID/OD:**	--	**Water Level*:**	9.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	24/14	0.0 - 2.0	1/1/2/3	3	3	HSA			Brown, moist, soft, elastic SILT, trace fine to medium sand, roots in top 6 in. of recovery -TOPSOIL-(MH)	G#248375 A-7-5, MH LL=53, PL=39 PI=14 WC=37.4%
								617.7		2.0	
	2D	24/12	2.0 - 4.0	5/10/10/10	20	20				Light brown, moist, medium dense, fine to coarse SAND, trace silt, some fine gravel, stratified -ALLUVIAL DEPOSIT-(SW)	G#248305 A-1-b, SW WC=4.4%
	3D	24/12	4.0 - 6.0	8/10/10/10	20	20				Light brown, moist, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
5	4D	24/20	6.0 - 8.0	9/8/8/7	16	16				Tan, moist, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
	5D	24/16	8.0 - 10.0	7/7/7/7	14	14				Tan with faint orange mottling, moist, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
10								609.7		10.0 **Bottom of Exploration at 10.0 feet below ground surface.**	
15											
20											
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-104
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	619.2	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 06+38, 13.5' Rt.	**Casing ID/OD:**	--	**Water Level*:**	9.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	24/14	0.0 - 2.0	1/2/3/4	5	5	HSA			Brown to red-brown, moist, medium stiff, elastic SILT, trace fine to medium sand, roots in top 6 in. -TOPSOIL-(MH)	G#248376 A-7-5, MH LL=50, PL=35 PI=15 WC=38.4%
	2D	24/14	2.0 - 4.0	2/5/8/14	13	13		616.2		3.0	
	3D	24/12	4.0 - 6.0	18/19/19/20	38	38		615.2		Brown to light brown, moist, medium dense, silty fine to medium SAND, trace coarse sand and fine gravel, stratified -ALLUVIAL DEPOSIT-(SM) 4.0	G#248377 A-4, SC-SM LL=23, PL=17 PI=6 WC=14.1%
5	4D	24/16	6.0 - 8.0	16/11/11/13	22	22				Tan, moist, dense, fine to coarse SAND, trace silt, little fine gravel, stratified -ALLUVIAL DEPOSIT-(SW-SM) Tan, moist, medium dense, fine to coarse SAND, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	G#248306 A-1-b, SW-SM WC=5.9%
	5D	24/16	8.0 - 10.0	10/8/7/9	15	15				Tan to gray-brown, moist to saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
10								609.2		10.0	
15										**Bottom of Exploration at 10.0 feet below ground surface.**	
20											
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-105
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	619.5	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 07+79, 82.4' Rt.	**Casing ID/OD:**	--	**Water Level*:**	8.5
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	24/20	0.0 - 2.0	1/3/2/3	5	5	HSA			Dark brown to brown, moist, medium stiff, SILT, little fine sand, trace clay, occasional stratification, roots in top 6 in. -TOPSOIL-(ML)	
	2D	24/14	2.0 - 4.0	1/2/3/3	5	5				Brown, moist to wet, medium stiff, SILT, little fine sand -TOPSOIL-(ML)	
	3D	24/16	4.0 - 6.0	2/5/6/8	11	11		615.5		4.0 Brown to light brown, moist to wet, medium dense, fine to coarse SAND, trace silt, stratified -ALLUVIAL DEPOSIT-(SW)	
5	4D	24/14	6.0 - 8.0	13/16/17/14	33	33				Tan, moist, dense, fine to coarse SAND, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
	5D	24/14	8.0 - 10.0	7/8/9/10	17	17				Tan to light brown, moist to wet, medium dense, fine to coarse SAND, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
10	6D	24/16	10.0 - 12.0	7/8/8/8	16	16		607.5		12.0 Light brown, wet, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
15										**Bottom of Exploration at 12.0 feet below ground surface.**	
20											
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-106
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	620.2	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 09+84, 28.4' Rt.	**Casing ID/OD:**	--	**Water Level*:**	9.2
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/20	0.0 - 2.0	1/2/3/3	5	5	HSA		Dark brown, moist, medium stiff, SILT, some fine sand, trace medium sand, occasional stratification, roots in top 6 in. -TOPSOIL-(ML)	G#248378 A-7-6, ML LL=41, PL=29 PI=12 WC=30.6%
	2D	24/14	2.0 - 4.0	2/1/1/2	2	2			Light brown, moist to wet, soft, SILT, some fine sand, trace clay, trace plant fibers, low plasticity to non-plastic -TOPSOIL-(ML)	
								616.2	4.0	
	3D	24/14	4.0 - 6.0	WOH/1/1/1	2	2			Light brown, moist, soft, SILT, some fine sand, trace plant fibers, occasional stratification -ALLUVIAL DEPOSIT-(ML)	
5	4D	24/18	6.0 - 8.0	2/2/3/2	5	5		613.7	Red-brown, moist, medium stiff, SILT, little fine sand -ALLUVIAL DEPOSIT-(ML)	
									6.5	
	5D	24/18	8.0 - 10.0	3/2/2/2	4	4			Mottled red-brown to gray-brown, wet, loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SM) Gray-brown with red-brown, wet, very loose, fine SAND, little silt, possible faint mottling visible -ALLUVIAL DEPOSIT-(SM)	
10	6D	24/24	10.0 - 12.0	2/2/3/7	5	5			Gray-brown with red-brown, saturated, loose, fine SAND, little medium to coarse sand, little silt, trace fine gravel in tip of spoon, stratified -ALLUVIAL DEPOSIT-(SM)	
								608.2	12.0	
									Bottom of Exploration at 12.0 feet below ground surface.	
15										
20										
25										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-107
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	612.9	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 11+80, 3.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	6.6
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	24/14	0.0 - 2.0	1/2/2/1	4	4	NW Push			Dark brown, moist, soft, SILT, little fine sand, roots -TOPSOIL-(ML)	
	2D	24/18	2.0 - 4.0	1/1/2/1	3	3				Dark brown, moist, soft, SILT, little fine sand, roots -TOPSOIL-(ML)	
	3D	24/20	4.0 - 6.0	1/1/2/1	3	3		608.9		4.0 Dark brown to brown, moist, soft, mottled fine sandy SILT -ALLUVIAL DEPOSIT-(ML)	
5							7				
	4D	24/20	6.0 - 8.0	1/2/2/2	4	4	6	606.9		6.0 Brown to gray-brown, wet, very loose, silty fine SAND, trace organics -ALLUVIAL DEPOSITS-(SM)	
							10				
	5D	24/24	8.0 - 10.0	3/3/4/4	7	7	12			Brown to gray-brown, wet, loose, fine SAND, little medium sand, trace silt, stratified, micaceous -ALLUVIAL DEPOSITS-(SP)	
							16				
10							20				
							18				
							16				
							17				
	6D	24/12	14.0 - 16.0	1/2/4/6	6	6	20	598.9		14.0 Gray, wet, loose, fine to medium SAND, trace coarse sand, trace gravel, wood pieces -ALLUVIAL DEPOSIT-(SP)	
15							16				
							13				
							27				
							21				
	7D	24/18	19.0 - 21.0	8/5/7/6	12	12	22			Gray, wet, medium dense, fine SAND, little medium sand, trace coarse sand, trace gravel, stratified -ALLUVIAL DEPOSIT-(SP)	
20							23				
							18				
							26				
							38				
25	8D	24/20	24.0 - 26.0	5/5/5/4	10	10	33			Brown to gray-brown, loose, fine SAND, some medium sand, little coarse sand, trace silt, trace gravel, stratified, rust-brown sand layer	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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-RAR-107

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-107
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	612.9	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 11+80, 3.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	6.6
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							23			and sandy silt seam -ALLUVIAL DEPOSIT-(SP)	
							29				
							38				
							38				
	9D	24/12	29.0 - 31.0	3/3/4/5	7	7	45			Gray-brown, loose, wet, fine to coarse SAND, trace gravel, well graded -ALLUVIAL DEPOSIT-(SW)	
30							40				
							34				
							43				
							30				
	10D	24/12	34.0 - 36.0	2/4/5/6	9	9	42			Gray-brown, wet, loose, fine to medium SAND, little coarse sand, trace gravel -ALLUVIAL DEPOSIT-(SP)	
35							44				
								576.9		36.0 **Bottom of Exploration at 36.0 feet below ground surface.**	
40											
45											
50											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-108
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.5	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-07-2012/06-08-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 12+71, 1.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.3
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/16	0.0 - 2.0	1/1/1/1	2	2	1			Dark brown to brown, moist, soft, fine sandy SILT, roots in top 6 in. -TOPSOIL-(ML)	
							1				
	2D	24/16	2.0 - 4.0	1/1/1/WOH	2	2	1			Brown to light brown, moist to wet, SILT, some fine sand, trace clay, low plasticity to non-plastic -TOPSOIL-(ML)	
							1				
	3D	24/20	4.0 - 6.0	1/WOH/1/2	1	1	2			Light brown, wet, very soft, SILT, some fine sand, trace clay, low plasticity to non-plastic -TOPSOIL-(ML)	
5							6				
								609.5		6.0	
	4D	24/22	6.0 - 8.0	2/2/1/2	3	3	8			Light brown to gray-brown, saturated, very loose, fine SAND, little medium to coarse sand, trace silt, stratified -ALLUVIAL DEPOSIT-(SP-SM)	
							10				
	5D	24/20	8.0 - 10.0	2/4/3/4	7	7	17			Gray-brown, saturated, loose, fine to medium SAND, trace coarse sand, stratified -ALLUVIAL DEPOSIT-(SW)	
							22				
10							20				
							17				
							18				
							22				
	6D	24/12	14.0 - 16.0	2/2/4/3	6	6	3			Light brown, saturated, loose, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
15							6				
							22				
							17				
							19				
	7D	24/12	19.0 - 21.0	2/2/4/4	6	6	3			Light brown, saturated, loose, medium to coarse SAND, little gravel, trace fine sand -ALLUVIAL DEPOSIT-(SW)	
20							4				
							17				
							17				
							18			Note: Driller notes gravel layer between approximately 22.5 and 23.5 ft.	
25	8D	24/14	24.0 - 26.0	3/3/3/4	6	6	9			Light brown, saturated, loose, fine to coarse SAND, trace gravel, stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-108
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.5	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-07-2012/06-08-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 12+71, 1.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.3
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							12			-ALLUVIAL DEPOSIT-(SW)	
							13				
							17				
							18				
	9D	24/10	29.0 - 31.0	1/2/3/11	5	5	11			Light brown, saturated, loose, fine to coarse SAND, trace gravel, trace silt, stratified	
30							22			-ALLUVIAL DEPOSIT-(SW)	
							47				
							34				
							35				
	10D	24/2	34.0 - 36.0	10/3/4/5	7	7	15			Light brown, saturated, loose, fine to coarse SAND, little coarse gravel, 1 in. piece of gravel in tip of spoon, attempted overdrive with no recovery	
35							27			-ALLUVIAL DEPOSIT-(SW)	
							35				
							37				
							39				
	11D	24/10	39.0 - 41.0	5/4/4/5	8	8				Light brown, saturated, loose, fine to coarse SAND, trace gravel, occasional stratification	
40										-ALLUVIAL DEPOSIT-(SW)	
								574.5		41.0	
										Bottom of Exploration at 41.0 feet below ground surface.	
45											
50											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-109
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	616.0	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-11-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 13+71, 2.1' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	12.5
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	24/16	0.0 - 2.0	1/1/2/1	3	3	NW Push			Dark brown, moist, soft, SILT, some fine sand, roots in top 6 in. -TOPSOIL-(ML)	
								614.0		2.0	
	2D	24/20	2.0 - 4.0	1/1/1/1	2	2				Brown, dry, very loose, silty fine SAND -ALLUVIAL DEPOSIT-(SM)	
	3D	24/20	4.0 - 6.0	1/WOH/1/1	1	1	4			Brown, moist, very loose, fine SAND, some silt -ALLUVIAL DEPOSIT-(SM)	
5							4				
	4D	24/16	6.0 - 8.0	1/1/1/WOH	2	2	4			Brown to gray-brown, moist, very loose, fine SAND, some silt -ALLUVIAL DEPOSIT-(SM)	
							6				
	5D	24/22	8.0 - 10.0	1/1/1/1	2	2	6			Brown with gray-brown, moist to wet, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SM)	
							6				
10							7				
							8				
							9				
							9				
	6D	24/12	14.0 - 16.0	3/4/3/4	7	7	5			Gray-brown with occasional red seams, saturated, loose, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
15							8				
							17				
							19				
							24				
	7D	24/12	19.0 - 21.0	3/2/3/3	5	5	3			Gray-brown, saturated, loose, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
20							4				
							4				
							17				
							41				
25	8D	24/15	24.0 - 26.0	4/5/6/8	11	11	17			Gray-brown, wet, medium dense, fine to medium SAND, little coarse sand, trace fine gravel, trace silt	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-109
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	616.0	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-11-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 13+71, 2.1' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	12.5
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							12			-ALLUVIAL DEPOSIT-(SP)	
							18				
							26				
							27				
	9D	24/18	29.0 - 31.0	4/5/5/5	10	10	14	587.0		29.0 Rust-brown, wet, loose, fine to medium SAND, little coarse sand, little silt, trace gravel -ALLUVIAL DEPOSIT-(SP-SM)	
30							19				
							26				
							30				
							35				
	10D	24/20	34.0 - 36.0	5/5/6/7	11	11	24			Rust-brown, wet, medium dense, fine to medium SAND, little coarse sand, little silt, trace gravel -ALLUVIAL DEPOSIT-(SP-SM)	
35							21				
							29				
							42				
							44				
	11D	24/20	39.0 - 41.0	4/5/5/6	10	10				Rust-brown, wet, loose, fine to medium SAND, little gravel, trace silt -ALLUVIAL DEPOSIT-(SW)	
40								575.0		41.0 **Bottom of Exploration at 41.0 feet below ground surface.**	
45											
50											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/20	0.0 - 2.0	2/2/2/1	4	4	NW Push			Dark brown, moist, soft, fine sandy SILT, rootlets -TOPSOIL-(ML)	
	2D	24/20	2.0 - 4.0	1/1/1/1	2	2				Dark brown, moist, soft, fine sandy SILT, rootlets -TOPSOIL-(ML)	
								612.3		3.5	
	3D	24/20	4.0 - 6.0	1/1/2/1	3	3	12			Brown, moist, very loose, fine SAND, some silt -ALLUVIAL DEPOSIT-(SM)	
5							5				
	4D	24/18	6.0 - 8.0	1/WOH/1/WOH	1	1	7			Brown, wet, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SP-SM)	
							4				
	5D	24/18	8.0 - 10.0	1/WOH/WOH/1	0	0	4			Brown, wet, very loose, fine SAND, some silt, contains organics -ALLUVIAL DEPOSIT-(SM)	
							7				
10							5				
							6				
							7				
	6D	24/20	14.0 - 16.0	1/WOH/WOH/1	1	1	4			Gray-brown to gray, saturated, very loose, fine SAND, trace medium sand, silt and fine gravel, trace fibrous organic soil, stratified, faint organic odor -ALLUVIAL DEPOSIT-(SP-SM)	G#248309 A-3, SP-SM WC=36.5% GTX#12194 DS-1 FA=36.9º c=92 psf
15							4				
							6				
							6				
							7				
	7D	24/16	19.0 - 21.0	3/3/3/5	6	6	12			Gray, saturated, loose, fine SAND, trace medium sand, silt and fine gravel, trace fibrous organic soil, stratified, faint organic odor -ALLUVIAL DEPOSIT-(SP-SM)	G#248309 A-3, SP-SM WC=36.5% GTX#12194 DS-1 FA=36.9º c=92 psf
20							12				
							17				
							24				
							32				
								591.8		24.0	
25	8D	24/16	24.0 - 26.0	5/5/4/4	9	9	14			Gray-brown, saturated, loose, fine to coarse SAND, trace gravel,	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							14			stratified -ALLUVIAL DEPOSIT-(SW) Note: Drilling mud used from 26.0 to 31.0 ft.	
							25				
							36				
							44				
	9D	24/14	29.0 - 31.0	3/4/6/9	10	10	21			Gray, saturated, loose, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
30							24				
							31				
							45				
							56				
	10D	24/12	34.0 - 36.0	5/6/9/11	15	15	21			Gray, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
35							27				
							41				
							52				
							60				
	11D	24/16	39.0 - 41.0	8/5/8/10	13	13	25			Light brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
40							26				
							33				
							51				
							66				
	12D	24/12	44.0 - 46.0	7/11/12/16	23	23	38			Light brown, saturated, medium dense, fine to medium SAND, trace coarse sand, stratified -ALLUVIAL DEPOSIT-(SW)	
45							43				
							63				
							84				
							87				
50	13D	24/10	49.0 - 51.0	5/7/10/12	17	17	54			Light brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50							45			-ALLUVIAL DEPOSIT-(SW)	
							65				
							91				
							83				
	14D	24/8	54.0 - 56.0	3/6/7/9	13	13	69			Light brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, stratified -ALLUVIAL DEPOSIT-(SP)	G#248310 A-1-b, SP
55							61				
							72				
							100				
							90				
	15D	24/14	59.0 - 61.0	5/6/6/7	12	12	71			Light brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, stratified -ALLUVIAL DEPOSIT-(SP)	G#248310 A-1-b, SP
60							65				
							86				
							100				
							110				
	16D	24/12	64.0 - 66.0	4/5/6/6	11	11	73			Light brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
65							92				
							78				
							88				
							84				
	17D	24/8	69.0 - 71.0	5/6/8/9	14	14	74			Light gray-brown, saturated, medium dense, fine to coarse SAND, trace gravel, weakly stratified -ALLUVIAL DEPOSIT-(SW)	
70							76				
							92				
							128				
							120				
75	18D	24/14	74.0 - 76.0	4/7/8/10	15	15	82			Light gray-brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
75							84			-ALLUVIAL DEPOSIT-(SW)	
							90				
							100				
							133				
	19D	24/16	79.0 - 81.0	5/9/11/14	20	20	90			Light gray-brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, stratified -ALLUVIAL DEPOSIT-(SP)	G#248311 A-3, SP
80							100				
							129				
							146				
							130				
	20D	24/8	84.0 - 86.0	5/7/11/12	18	18	90			Gray-brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, stratified -ALLUVIAL DEPOSIT-(SP)	G#248311 A-3, SP
85							80				
							96				
							136				
							140				
	21D	24/16	89.0 - 91.0	4/6/6/6	12	12	80			Gray-brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
90							84				
							87				
							101				
							110				
	22D	24/16	94.0 - 96.0	6/7/8/9	15	15	86			Gray-brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
95							80				
							113				
							116				
							124				
100	23D	24/8	99.0 - 101.0	6/7/9/10	16	16	89			Gray-brown, saturated, medium dense, fine to coarse SAND, trace silt, little fine gravel	G#248312 A-1-b, SP

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
100							85			-ALLUVIAL DEPOSIT-(SP)	
							120				
							112				
							120				
	24D	24/18	104.0 - 106.0	3/5/6/7	11	11	74			Light brown, saturated, medium dense, fine to coarse SAND, trace silt, little fine gravel -ALLUVIAL DEPOSIT-(SP)	G#248312 A-1-b, SP
105							80				
							113				
							140				
							169				
	MD		109.0 - 111.0	5/11/19/17	30	30	108			No recovery, residue in spoon similar to 24D. Probable pushed gravel.	
110							105				
							210				
							140				
							153				
								501.8		114.0	
	25D	24/14	114.0 - 116.0	11/18/25/23	43	43	129			Light brown with gray-brown, saturated, dense, fine to medium SAND, trace coarse sand, stratified -ALLUVIAL DEPOSIT-(SW)	
115							145				
							164				
							180				
							265				
	MD		119.0 - 121.0	6/11/12/12	23	23	96			No recovery, re-drove spoon without recovery. Residue in spoon similar to above.	
120							126				
							162				
							142				
							192				
125							131			Note: 18 in. blown sands in borehole prior to sampling at 124.0 ft. Drove spoon from 122.5 to 126 ft. Recovered 14 in. light brown,	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-110
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-18-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+28, 22.7' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	11.3 ft
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
125							154			saturated, fine to coarse SAND, little gravel, grading from fine to coarse material in bottom 6 in. of recovery (SW). Note: Drill action and cuttings indicate gravel between approximately 126.0 to 129.0 ft. Near total water loss while floating rods in/out of borehole prior to sampling.	
							146				
							145				
							180				
	26D	24/13	129.0 - 131.0	16/36/30/15	66	66	180	486.4		Light brown, saturated, very dense, medium to coarse SAND, little gravel, trace fine sand -ALLUVIAL DEPOSIT-(SW)	
130							238			129.4	
							195			Light brown with red-brown and gray, saturated, very dense, highly weathered BEDROCK interbedded with seams of fine to coarse SAND, trace gravel, mica specks throughout -GLACIAL TILL-(GW) Note: Advanced borehole to 134.0 ft and collected sample with NW casing at 132.0 ft.	
							190				
							157				
	27D	24/12	134.0 - 136.0	11/58/77/54	135	135	216			Olive-brown to red-brown to green-gray, wet, very dense, fine to coarse GRAVEL, some fine to coarse sand, trace silt, poorly sorted and well bonded in-situ with frequent pockets of slightly to highly weathered bedrock, mica fragments, pieces and specks throughout recovery	
135							387				
							334(8.0")	479.3		-GLACIAL TILL-(GW-GM)	
	R1	60/54	137.0 - 142.0	RQD = 80%						136.5 Top of Bedrock at El. 479.3 Light green-gray, coarse grained, micaceous quartz PEGMATITE, hard, very slight weathering. Joints dipping at low angles, moderately close, open, discolored. Rock Mass Quality=Good Recovery=90% R1 Core Times (min:sec): 137.0-138.0' (4:03); 138.0-139.0' (2:45); 139.0-140.0' (3:16); 140.0-141.0' (3:50); 141.0-142.0' (3:37) Note: Borehole open to 141.5 ft upon completion of core run. 6 in. of core left in borehole. Total water loss between 138.0 and 142.0 ft.	
140											
	R2	53/53	142.0 - 146.4	RQD = 97%						Light green-gray, coarse grained, micaceous quartz PEGMATITE, hard, very slight weathering. Joints dipping at low angles, moderately close, open, discolored. Rock Mass Quality=Excellent Recovery=97% R2 Core Times (min:sec): 142.0-143.0' (4:32); 143.0-144.0' (2:50); 144.0-145.0' (2:58); 145.0-146.0' (3:21); 146.0-146.4' (1:50)	
145											
								469.4		146.4 **Bottom of Exploration at 146.4 feet below ground surface.**	
150											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/18	0.0 - 2.0	2/2/2/1	4	4	7		Dark brown and tan, dry to moist, very loose, silty fine SAND with organics (rootlets) throughout -TOPSOIL-(SM)	
							7			
							9			
							8	612.2	3.5	
							10			
5	2D	24/16	5.0 - 7.0	2/1/1/1	2	2	6		Light brown, moist to wet, very loose, fine SAND, some silt, trace medium sand -ALLUVIAL DEPOSIT-(SM)	G#248313 A-2-4, SM WC=30.9% GTX#12194 DS-2 FA=32.5º c=264 psf
							6			
							10			
							11			
	3D	24/16	9.0 - 11.0	1/WOH/1/WOH	1	1	7		Light brown with orange, saturated, very loose, fine SAND, some silt, trace medium sand, occasional organics -ALLUVIAL DEPOSIT-(SM)	G#248313 A-2-4, SM WC=30.9% GTX#12194 DS-2 FA=32.5º c=264 psf
10							10			
							12			
							18		Note: Mix drilling mud prior washing ahead to 14 ft.	
							22			
	4D	24/18	14.0 - 16.0	1/1/1/1	2	2	11		Gray-brown and tan, saturated, very loose, fine to medium SAND, trace silt, frequent dark brown organics, bottom 3 in. of recovered sample predominantly dark brown organic material, organic odor -ALLUVIAL DEPOSIT-(SP)	
15							17			
							22			
							25	598.2	17.5	
							34			
	5D	24/12	19.0 - 21.0	2/2/3/3	5	5	26		Gray-brown, saturated, loose, fine to medium SAND, trace silt and coarse sand, frequent bands of dark brown organic material, numerous pieces of wood, organic odor -ALLUVIAL DEPOSIT-(SW)	
20							28			
							36			
							41			
							61			
25	MD	24/0	24.0 - 26.0	7/8/4/5	12	12	34		No Recovery, 1.5 in. cobble and wood fragments stuck in tip of spoon, wash suggests similar material to above with more coarse sand and	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							41			gravel, blow counts likely not representative of actual soil conditions	
							46				
							59			Note: Frequent gravel/cobble layers observed between approximately 24 and 29 ft based on drill action.	
							62				
	6D	24/10	29.0 - 31.0	7/6/5/7	11	11	45			Gray-brown, saturated, medium dense, medium to coarse SAND, trace silt, fine sand and gravel, occasional wood fibers -ALLUVIAL DEPOSIT-(SW)	
30							64				
							91	584.7		31.0	
							115				
							115				
	7D	24/12	34.0 - 36.0	6/6/5/7	11	11	OPEN			Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
35											
	8D	24/12	39.0 - 41.0	6/8/7/10	15	15				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
40											
	9D	24/11	44.0 - 46.0	9/11/8/9	19	19				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
45											
50	10D	24/10	49.0 - 51.0	5/7/7/7	14	14				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50							OPEN			-ALLUVIAL DEPOSIT-(SW)	
	11D	24/8	54.0 - 56.0	7/8/8/10	16	16				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
55											
	12D	24/10	59.0 - 61.0	5/8/9/9	17	17				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
60											
	13D	24/12	64.0 - 66.0	6/6/7/7	13	13				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
65											
	14D	24/10	69.0 - 71.0	6/7/7/7	14	14				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND with layers of fine sand, trace silt -ALLUVIAL DEPOSIT-(SW)	
70											
	15D	24/20	74.0 - 76.0	6/7/6/6	13	13				Gray-brown to red-brown, saturated, medium dense, fine to medium SAND, trace silt, coarse sand and fine gravel	G#248314 A-3, SP
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
75							OPEN			-ALLUVIAL DEPOSIT-(SP)	WC=20.6% GTX#12194 DS-3 FA=35.0º c=534 psf
	16D	24/12	79.0 - 81.0	5/3/4/5	7	7				Gray-brown to red-brown, saturated, loose, fine to medium SAND, trace silt, coarse sand and fine gravel -ALLUVIAL DEPOSIT-(SP)	G#248314 A-3, SP WC=20.6% GTX#12194 DS-3 FA=35.0º c=534 psf
80											
85	17D	24/15	85.0 - 87.0	9/7/9/11	16	16				Gray-brown to red-brown, saturated, medium dense, medium to coarse SAND, trace silt, fine sand and gravel, weakly stratified with alternating layers of medium and coarse sand -ALLUVIAL DEPOSIT-(SW)	
								527.2		88.5	
90	18D	24/16	90.0 - 92.0	11/11/10/12	21	21				Orange-brown, saturated, medium dense, gravelly medium to coarse SAND, trace fine sand -ALLUVIAL DEPOSIT-(SW)	
95	19D	24/13	95.0 - 97.0	8/7/9/9	16	16				Orange-brown to gray-brown, saturated, medium dense, fine to coarse SAND, trace silt, little fine gravel -ALLUVIAL DEPOSIT-(SP)	G#248315 A-1-b, SP WC=10.5% GTX#12194 DS-4 FA=38.1º c=211 psf
100											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
100	20D	24/12	100.0 - 102.0	8/10/11/14	21	21	OPEN			Orange-brown to gray-brown, saturated, medium dense, fine to coarse SAND, trace silt, little fine gravel -ALLUVIAL DEPOSIT-(SP)	G#248315 A-1-b, SP WC=10.5% GTX#12194 DS-4 FA=38.1º c=211 psf
105											
										Note: Increased drilling resistance at approximately 109 ft.	
110	21D	24/13	110.0 - 112.0	11/13/13/12	26	26	19			Orange-brown to gray-brown, saturated, medium dense, fine to coarse SAND, trace silt, trace gravel -ALLUVIAL DEPOSIT-(SW)	
							29				
							32			Note: Advance NW casing from 34 ft to approximately 119 ft after 22D.	
							35				
							44				
115							45				
							55				
							61				
							56				
	22D	24/14	119.0 - 121.0	7/9/13/20	22	22	36				
120								495.7		120.0	
							37			Gray-brown, saturated, medium dense, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SW)	
							111				
							108				
							112				
							155	491.7		124.0	
125											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-111
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.7	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Steinert	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-12-2012/07-13-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 15+30, 24.4' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	NE
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.
125							233			-PROBABLE GLACIAL TILL- Note: Geologic interpretation based on conditions encountered in testing boring BB-RAR-110 and observed casing blows.	
							200				
							205				
							192				
	23D		129.5 - 130.5	24/56	80	80	116 86(1.0")				
130	R1	60/49	130.8 - 135.8	RQD = 82%				485.2		130.5 Top of Bedrock at El. 485.2 Light to gray, medium grained SCHIST. Moderately hard, fresh to slightly weathered. Joints moderate to steeply dipping, close, open.	
								483.5		-LITTLETON FORMATION- 132.2 Light gray to greenish-gray, coarse grained quartz PEGMATITE. Hard, fresh to slightly weathered. Joints dipping at low to moderate angles, moderately close, open, discolored. Rock Mass Quality=Good Recovery=100% R1 Core Times (min:sec): 130.8-131.8' (3:09); 131.8-132.8' (2:47); 132.8-133.8' (2:32); 133.8-134.8' (2:41); 134.8-135.8' (2:57)	
135	R2	60/55	135.8 - 140.8	RQD = 92%						Light gray to green-gray, coarse grained quartz PEGMATITE. Hard, fresh to slightly weathered. Joints dipping at low to moderate angles, close to moderately close, open, discolored. Rock Mass Quality=Good Recovery=100% R2 Core Times (min:sec): 135.8-136.8' (2:20); 136.8-137.8' (1:47); 137.8-138.8' (2:18); 138.8-139.8' (2:26); 139.8-140.8' (2:36)	
140								474.9		140.8 **Bottom of Exploration at 140.8 feet below ground surface.**	
145											
150											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-112
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.4	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+27, 78.2' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/18	0.0 - 2.0	1/2/1/2	3	3	NW Push		Dark brown, moist, soft, fine sandy SILT, roots -TOPSOIL-(ML)	
								613.4	2.0	
	2D	24/18	2.0 - 4.0	1/WOH/2/1	2	2			Dark brown, moist, soft, silty fine SAND, rootlets -TOPSOIL-(SM)	
								611.9	3.5	
	3D	24/18	4.0 - 6.0	1/1/1/1	2	2	4		Brown, moist, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SP-SM)	
5							6			
	4D	24/18	6.0 - 8.0	1/WOH/WOH/1	0	0	4		Brown, wet, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SP-SM)	
							4			
	5D	24/22	8.0 - 10.0	2/1/1/WOH	2	2	5		Brown, wet, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SP-SM)	
							5			
10							10			
							10			
							9			
							8			
								601.4	14.0	
	6D	24/18	14.0 - 16.0	1/1/3/1	4	4	12		Gray, wet, very loose, fine SAND, trace silt, contains organics, organic odor -ALLUVIAL DEPOSIT-(SP-SM)	
15							12			
							9			
							14			
							16			
	7D	24/16	19.0 - 21.0	2/2/4/3	6	6	11		Gray, wet, loose, fine SAND, little medium sand, organic odor -ALLUVIAL DEPOSIT-(SP)	
20							11			
							15			
							26			
							28			
25	8D	24/20	24.0 - 26.0	2/2/5/7	7	7	13		Gray, wet, loose, fine to medium SAND, trace coarse sand and silt, little fine gravel, stratified	G#248316 A-1-b, SP

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-112
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.4	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+27, 78.2' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							16			-ALLUVIAL DEPOSIT-(SP)	WC=16.4% GTX#12194 DS-5 FA=41.5º c=188 psf
							22				
							33				
							38				
	9D	24/12	29.0 - 31.0	7/5/9/10	14	14	21			Gray-brown, wet, medium dense, fine to medium SAND, trace coarse sand and silt, little fine gravel -ALLUVIAL DEPOSIT-(SP)	G#248316 A-1-b, SP WC=16.4% GTX#12194 DS-5 FA=41.5º c=188 psf
30							20				
							37				
							41				
							41				
								581.4		34.0	
	10D	24/14	34.0 - 36.0	2/4/5/7	9	9	19			Brown, wet, loose, fine to medium SAND, little coarse sand, occasional stratification -ALLUVIAL DEPOSIT-(SP)	
35							16				
							32				
							36				
							41				
	11D	24/16	39.0 - 41.0	4/7/9/10	16	16	25			Brown, wet, medium dense, fine to medium SAND, trace coarse sand, trace silt -ALLUVIAL DEPOSIT-(SP)	
40							28				
							47				
							57				
							65				
	12D	24/20	44.0 - 46.0	5/11/11/13	22	22	47			Brown, wet, medium dense, fine to medium SAND, little coarse sand, stratified -ALLUVIAL DEPOSIT-(SW)	
45							43				
							57				
							69				
							68				
50	13D	24/12	49.0 - 51.0	3/3/5/8	8	8				Brown, wet, loose, fine to medium SAND, little coarse sand, occasional stratification	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-112
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.4	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	M. Snow	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-12-2012/06-12-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+27, 78.2' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50										-ALLUVIAL DEPOSIT-(SW)	
								564.4		51.0	
										Bottom of Exploration at 51.0 feet below ground surface.	
55											
60											
65											
70											
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-113
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-11-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+22, 78.8' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/20	0.0 - 2.0	1/2/2/2	4	4	NW Push			Dark brown to brown, moist to dry, very loose, fine SAND, some silt, roots in top 6 in. -TOPSOIL-(SM)	
								613.8		2.0	
	2D	24/14	2.0 - 4.0	1/1/WOH/1	1	1				Light brown, dry, very loose, fine SAND, little silt -ALLUVIAL DEPOSIT-(SM)	
	3D	24/16	4.0 - 6.0	1/1/WOH/1	1	1	3			Light brown, moist, very loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP-SM)	
5							3				
	4D	24/18	6.0 - 8.0	1/WOH/WOH/WOH	0	0	4			Light brown, wet, very loose, fine SAND, some silt, stratified -ALLUVIAL DEPOSIT-(SM)	
							3				
	5D	24/24	8.0 - 10.0	1/WOH/WOH/WOH	0	0	2			Light brown, saturated, very loose, fine SAND, trace silt, trace plant fibers -ALLUVIAL DEPOSIT-(SP-SM)	
							3				
10							9				
							8				
							10				
							11				
	6D	24/20	14.0 - 16.0	1/WOH/1/1	1	1	9			Gray-brown, saturated, very loose, fine SAND, trace silt, trace medium sand, trace gravel, stratified -ALLUVIAL DEPOSIT-(SP-SM)	
15							11				
							11				
							19				
							20				
	7D	24/20	19.0 - 21.0	1/2/2/2	4	4	14			Gray, saturated, very loose, fine to coarse SAND, trace silt, trace gravel, trace organic soil with plant fibers in very thin seams in top 6 in. of recovery, stratified -ALLUVIAL DEPOSIT-(SW)	
20							15				
							16				
							27				
							31				
25	8D	24/18	24.0 - 26.0	2/2/2/5	4	4	13			Gray, saturated, very loose, fine to coarse SAND, trace gravel, stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-113
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-11-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+22, 78.8' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							15			-ALLUVIAL DEPOSIT-(SW)	
							37				
							40				
							55				
	9D	24/6	29.0 - 31.0	6/6/6/6	12	12	26			Gray-brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, stratified -ALLUVIAL DEPOSIT-(SP)	G#248317 A-3, SP WC=21% GTX#12194 DS-6 FA=35.3º c=292 psf
30							26				
							42				
							45				
							59				
	10D	24/6	34.0 - 36.0	5/5/6/6	11	11	25			Gray-brown, saturated, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, weakly stratified -ALLUVIAL DEPOSIT-(SP)	G#248317 A-3, SP WC=21% GTX12194 DS-6 FA=35.3º c=292 psf
35							25				
							40				
							49				
							56				
	11D	24/10	39.0 - 41.0	4/4/6/5	10	10	31			Gray-brown, saturated, loose, fine to coarse SAND, trace gravel, weakly stratified -ALLUVIAL DEPOSIT-(SW)	
40							29				
							36				
							47				
							48				
	12D	24/4	44.0 - 46.0	3/4/5/7	9	9	31			Gray-brown, saturated, loose, fine to coarse SAND -ALLUVIAL DEPOSIT-(SW)	
45							34				
							45				
							51				
							83				
50	13D	24/14	49.0 - 51.0	1/5/7/7	12	12				Gray-brown, saturated, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-113
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-11-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+22, 78.8' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	8.0
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50								564.8		51.0 **Bottom of Exploration at 51.0 feet below ground surface.**	
55											
60											
65											
70											
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-114
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.3	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-08-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+54, 0.7' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.2
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/14	0.0 - 2.0	1/1/2/1	3	3	1		Dark brown to brown, moist, very loose, silty fine SAND, roots in top 6 in. of recovery -TOPSOIL-(SM)	
							1			
	2D	24/18	2.0 - 4.0	1/WOH/1/WOH	1	1	1		Brown to yellow-brown, moist, very soft, fine sandy SILT, occasional very thin seams of black organic soil -TOPSOIL-(ML)	
							3			
	3D	24/24	4.0 - 6.0	1/WOH/WOH/1	0	0	3	611.3	4.0 Yellow-brown with brown, wet, very loose, fine SAND, trace medium sand, some silt -ALLUVIAL DEPOSIT-(SM)	G#248318 A-2-4, SM WC=36%
5							4			
	4D	24/20	6.0 - 8.0	WOH/1/WOH/1	1	1	6		Light brown, saturated, very loose, fine SAND, trace medium sand, some silt, trace plant fibers, stratified -ALLUVIAL DEPOSIT-(SM)	GTX#12194 DS-7 FA=35.9º c=154 psf
							6			
	5D	24/20	8.0 - 10.0	1/WOH/WOH/WOH/1	0	0	7	607.3	8.0 Light brown, saturated, very loose, fine SAND, trace silt, trace medium sand, stratified -ALLUVIAL DEPOSIT-(SP-SM)	G#248318 A-2-4, SM WC=36% GTX#12194 DS-7 FA=35.9º c=154 psf
							9			
10							6			
							8			
							9			
							9			
	6D	24/24	14.0 - 16.0	1/WOH/1/WOH	1	1	8		Gray, saturated, very loose, fine SAND, little silt, trace wood, plant fibers throughout, frequent very thin seams of brown organic soil, faint organic odor, stratified -ALLUVIAL DEPOSIT-(SM)	
15							11			
							15			
							21			
							29			
	7D	24/18	19.0 - 21.0	2/2/4/5	6	6	13		Gray, saturated, loose, fine to medium SAND, trace gravel, trace coarse sand, stratified with occasional very thin seams of brown organic soil, very faint organic odor -ALLUVIAL DEPOSIT-(SW)	
20							14			
							15			
							37			
							44			
25	8D	24/8	24.0 - 26.0	4/2/3/4	5	5	12		Gray, saturated, loose, fine to medium SAND, trace coarse sand -ALLUVIAL DEPOSIT-(SW)	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-114
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.3	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-08-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+54, 0.7' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.2
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25							14				
							16				
							34				
							41				
	9D	24/2	29.0 - 31.0	1/2/3/3	5	5	13			Gray-brown, saturated, loose, fine to medium SAND, trace coarse sand -ALLUVIAL DEPOSIT-(SW)	
30							11				
							19				
							34				
							35				
	10D	24/18	34.0 - 36.0	2/2/3/3	5	5	24			Gray-brown, saturated, loose, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
35							15				
							29				
							37				
							50				
	11D	24/12	39.0 - 41.0	3/3/4/5	7	7	34			Gray-brown, saturated, loose, fine to coarse SAND, trace silt, little gravel, stratified -ALLUVIAL DEPOSIT-(SW)	G#248319 A-1-b, SW WC=16.8% GTX#12194 DS-8 FA=37.0º c=471 psf
40							27				
							42				
							60				
							74				
	12D	24/18	44.0 - 46.0	3/2/3/3	5	5	50			Gray-brown, saturated, loose, fine to coarse SAND, trace silt, little gravel, weakly stratified -ALLUVIAL DEPOSIT-(SW)	G#248319 A-1-b, SW WC=16.8% GTX#12194 DS-8 FA=37.0º c=471 psf
45							42				
							47				
							50				
							69				
50	13D	24/12	49.0 - 51.0	3/3/5/7	8	8				Gray-brown, saturated, loose, fine to coarse SAND, trace gravel, weakly stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-114
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	615.3	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/16; S-140/30
Date Start/Finish:	06-08-2012/06-11-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 15+54, 0.7' Rt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	4.2
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50								564.3		-ALLUVIAL DEPOSIT-(SW)	
										51.0	
										Bottom of Exploration at 51.0 feet below ground surface.	
55											
60											
65											
70											
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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*	24/14	0.0 - 2.0	1/5/12/12	17	17	PUSH			Gray-brown, saturated, medium dense, fine to coarse SAND, some fine to coarse gravel, grading from fine to coarse material, trace plant fibers in top 6 in. -ALLUVIAL DEPOSIT-(SW) Note: * indicates 3 in. diameter split spoon, 140 lb hammer used to collect sample.	
							32				
							31				
							36				
							29				
5							42				
	2D*	24/12	6.0 - 8.0	19/11/7/6	18	18	14			Light brown, saturated, medium dense, fine SAND, trace medium and coarse sand, trace silt, stratified -ALLUVIAL DEPOSIT-(SP)	G#248320 A-3, SP
							15				
							20				
							25				
10							41				
	3D	24/10	11.0 - 13.0	1/2/2/2	4	4	16			Light brown, saturated, very loose, fine SAND, trace medium and coarse sand, trace silt -ALLUVIAL DEPOSIT-(SP)	G#248320 A-3, SP
							15				
							19				
							38				
15							73				
	4D	24/1	16.0 - 18.0	1/2/3/4	5	5	25			Light brown, saturated, loose, fine SAND, trace silt, recovery lost while removing spoon from borehole -ALLUVIAL DEPOSIT-(SP)	
							21				
							47				
							90				
20							108				
	5D	24/10	21.0 - 23.0	3/4/5/6	9	9	45			Light brown with gray-brown, saturated, loose, fine SAND, trace coarse sand, little silt, stratified -ALLUVIAL DEPOSIT-(SP-SM)	G#248321 A-2-4, SP-SM
							45				
							OPEN			Note: Drilling mud introduced to borehole at 23.0 ft.	
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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							OPEN				
	6D	24/18	26.0 - 28.0	4/7/8/8	15	15				Gray-brown to light brown with red-brown, saturated, medium dense, fine SAND, little silt, stratified -ALLUVIAL DEPOSIT-(SM)	
30								566.1		31.0	
	7D	24/24	31.0 - 33.0	2/3/3/5	6	6				Light brown with red-brown, saturated, loose, silty fine SAND, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248322 A-4, SM WC=26.9% GTX#12194 DS-9 FA=35.7º c=153 psf
										Note: Drove HW casing to 31.0 ft through open hole following 7D.	
35	8D	24/20	36.0 - 38.0	4/6/8/11	14	14				Gray-brown with orange-brown, saturated, medium dense, silty fine SAND, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248322 A-4, SM WC=26.9% GTX#12194 DS-9 FA=35.7º c=153 psf
40	9D	24/18	41.0 - 43.0	5/6/10/15	16	16				Orange-brown with gray-brown, saturated, medium dense, fine SAND, little silt, stratified, grading to finer material in bottom 6 in. of recovery, very thin layering (<2 mm) -GLACIOLACUSTRINE DEPOSIT-(SM)	
										Note: Drove HW casing to 41.0 ft through open hole following 9D.	
45	10D	24/24	46.0 - 48.0	8/11/11/13	22	22				Light brown with gray-brown, saturated, medium dense, fine to medium SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
50											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50							OPEN				
	11D	24/20	51.0 - 53.0	16/18/18/16	36	36				Gray-brown with orange-brown, saturated, dense, fine to medium SAND, trace coarse sand and silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	G#248323 A-3, SP
										Note: Drove HW casing to 46.0 ft through open hole following 11D.	
55											
	12D	24/18	56.0 - 58.0	7/9/10/10	19	19				Light brown with gray-brown and red-brown, saturated, medium dense, fine to medium SAND, trace coarse sand and silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	G#248323 A-3, SP
										Note: Drove HW casing to 51.0 ft through open hole following 12D.	
60											
	13D	24/18	61.0 - 63.0	10/9/12/14	21	21				Gray-brown with orange-brown, saturated, medium dense, fine to medium SAND, trace silt -GLACIOLACUSTRINE DEPOSIT-(SP)	
										Note: Drove HW casing to 56.0 ft through open hole following 13D.	
65											
	14D	24/18	66.0 - 68.0	12/10/11/13	21	21				Light brown, saturated, medium dense, fine to medium SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
										Note: Drove HW casing to 66.0 ft through open hole following 14D.	
70											
	15D	24/18	71.0 - 73.0	12/11/14/17	25	25				Light brown, saturated, medium dense, fine to medium SAND, trace silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
75							OPEN				
	16D	24/16	76.0 - 78.0	8/8/12/15	20	20				Gray-brown with red-brown and orange-brown, saturated, medium dense, fine to medium SAND, little silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	G#248324 A-2-4, SP
80											
	17D	24/16	81.0 - 83.0	10/12/17/16	29	29				Light gray-brown with orange-brown, saturated, medium dense, fine to medium SAND, little silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	G#248324 A-2-4, SP
85											
	18D	24/18	86.0 - 88.0	18/24/22/21	46	46				Light brown, saturated, dense, fine SAND, little silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248325 A-2-4, SM
90											
	19D	24/14	91.0 - 93.0	19/26/29/33	55	55				Gray-brown, saturated, very dense, fine SAND, little silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248325 A-2-4, SM
95											
	20D	24/20	96.0 - 98.0	15/15/24/30	39	39				Gray-brown, saturated, dense, fine SAND, little silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248325 A-2-4, SM
100											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
100							OPEN			
	21D	24/24	101.0 - 103.0	20/24/24/33	48	48			Gray-brown with brown, saturated, dense, fine SAND, little silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248326 A-2-4, SM
105										
	22D	24/22	106.0 - 108.0	17/22/23/23	45	45			Gray-brown with orange-brown, saturated, dense, fine SAND, trace medium sand, little silt -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248326 A-2-4, SM
110									Note: Driller notes stratum change at approximately 110.8 ft.	
								486.3	110.8	
	23D	10/6	111.0 - 111.8	73/100(3.0")					Gray-brown with orange-brown, saturated, very dense, fine to medium SAND, trace silt, trace gravel, gravel fraction weathered, stratified -GLACIAL TILL-(SW-SM)	
							40			
							75			
115							100			
								481.1	116.0	
	24D R1	3/3 60/48	116.0 - 116.3 116.3 - 121.3	100(3") RQD = 73%			50(4.0")		Top of Bedrock at El. 481.1 Recovered 3 in. highly weathered GNEISS. Distinct rock fabric. Light purple-gray, fine to coarse grained micaceous GNEISS. Hard, very slightly weathered. Joints dipping at low to moderate angles parallel to foliation. Moderately close, rough, planar, discolored, open. Rock Mass Quality=Fair Recovery=80% -LITTLETON FORMATION- R1 Core Times (min:sec): 116.3-117.3' (4:18); 117.3-118.3'(2:55); 118.3-119.3' (2:28); 119.3-120.3' (2:22); 120.3-121.3' (1:31) Note: Drill action and recovery suggests severely weathered zone between 120.3 and 121.3 ft.	
120	R2	60/56	121.3 - 126.3	RQD = 38%					Light purple-gray, fine to coarse grained micaceous GNEISS. Hard to moderately hard, slightly weathered. Joints dipping at low to moderate angles, parallel to foliation, close, smooth, planar, discolored, open. Near total water loss throughout drilling. Frequent drill breaks throughout recovery. Rock Mass Quality=Poor Recovery=93%	
125										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-115
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-03-2012/07-04-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+76, 24.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
125										-LITTLETON FORMATION- R2 Core Times (min:sec): 121.3-122.3' (2:23); 122.3-123.3' (2:40); 123.3-124.3' (2:23); 124.3-125.3' (2:25); 125.3-126.3' (2:19)	
								470.8		126.3	
										Bottom of Exploration at 126.3 feet below ground surface.	
130											
135											
140											
145											
150											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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-RAR-115

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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*	24/6	0.0 - 2.0	1/2/3/2	5	5	0			Light gray-brown, saturated, loose, fine SAND, trace fine gravel, trace plant fiber -ALLUVIAL DEPOSIT-(SP) Note: * indicates 3 in. diameter split spoon, 140 lb. hammer used to collect sample.	
							3				
							3				
							5			Note: Wood in wash between approximately 3.0 and 4.5 ft.	
							30				
5	2D*	24/12	5.0 - 7.0	14/13/8/7	21	21	20			Light gray-brown, saturated, medium dense, fine to coarse SAND, some fine to coarse gravel, trace silt -ALLUVIAL DEPOSIT-(SW)	
							28				
							19				
							24				
							41				
10	3D	24/18	10.0 - 12.0	3/2/4/3	6	6	23			Light gray-brown, saturated, loose, fine SAND, trace medium sand, little silt, stratified -ALLUVIAL DEPOSIT-(SM)	G#248327 A-2-4, SM
							29				
							36				
							65			Note: Drilling mud introduced to borehole at 15.0 ft.	
							93				
15	4D	24/18	15.0 - 17.0	3/3/4/5	7	7	OPEN			Light gray-brown, saturated, loose, fine SAND, trace medium sand, little silt, stratified -ALLUVIAL DEPOSIT-(SM)	G#248327 A-2-4, SM
20	5D	24/14	20.0 - 22.0	5/6/6/6	12	12				Light brown with orange-brown, saturated, medium dense, fine SAND, trace medium sand, little silt, stratified -ALLUVIAL DEPOSIT-(SM)	G#248327 A-2-4, SM
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	6D	24/16	25.0 - 27.0	8/9/6/8	15	15	OPEN	572.1	Red-brown to gray-brown, saturated, medium dense, fine SAND, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM) (25.0) Note: Drove HW casing through open hole to 25.0 ft following 6D.	
30	7D	24/14	30.0 - 32.0	3/4/5/9	9	9			Light-brown, saturated, loose, fine SAND, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
35	8D	24/16	35.0 - 37.0	7/9/9/13	18	18			Light brown with red-brown and gray-brown,saturated, fine SAND, some silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
40	9D	24/14	40.0 - 42.0	12/12/11/13	23	23		557.1	(40.0) Light gray-brown with red-brown, saturated, medium dense, fine SAND, trace medium sand, some silt, stratified with very thin bedding in bottom 6 in. of recovery, grading to finer material -GLACIOLACUSTRINE DEPOSIT-(SM) Note: Drove HW casing through open hole to 40.0 ft following 9D.	G#248328 A-2-4, SM
45	10D	24/16	45.0 - 47.0	8/11/11/11	22	22			Light brown with red-brown, saturated, medium dense, fine SAND, trace medium sand, some silt, stratified with very thin bedding in top 8 in. of recovery, grading to coarser material -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248328 A-2-4, SM
50								548.6	(48.5) Note: Drive HW casing through open hole to 41.4 ft following 10D.	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50	11D	24/20	50.0 - 52.0	8/7/9/11	16	16	OPEN			Light-brown with red-brown, saturated, medium dense, fine to medium SAND, trace silt, stratified with thin bedding -GLACIOLACUSTRINE DEPOSIT-(SP)	
55	12D	24/18	55.0 - 57.0	6/7/5/6	12	12				Light-brown with red-brown, saturated, medium dense, fine to medium SAND, trace silt, stratified with thin bedding -GLACIOLACUSTRINE DEPOSIT-(SP)	
										Note: Drove HW casing through open hole to 50.4 ft following 12D.	
60	13D	24/20	60.0 - 62.0	11/13/13/14	26	26				Light-brown with red-brown, saturated, medium dense, fine to medium SAND, trace silt -GLACIOLACUSTRINE DEPOSIT-(SP)	
65	14D	24/18	65.0 - 67.0	9/10/11/12	21	21				Light-brown with red-brown, saturated, medium dense, fine to medium SAND, trace silt -GLACIOLACUSTRINE DEPOSIT-(SP)	
										Note: Drive HW casing through open hole to 60 ft following 14D. Mixed new batch of drilling mud.	
70	15D	24/14	70.0 - 72.0	6/9/12/15	21	21				Light brown, moist, medium dense, medium to fine SAND, trace silt, stratified in bottom 5 in. spoon with more fines -GLACIOLACUSTRINE DEPOSIT-(SP-SM)	
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75	16D	24/17	75.0 - 77.0	7/9/13/24	22	22	OPEN		Gray-brown and tan, moist, medium dense, fine SAND with thin silt laminae -GLACIOLACUSTRINE DEPOSIT-(SP-SM)	
80	17D	24/16	80.0 - 82.0	20/26/25/28	51	51			Gray-brown, moist, very dense, silty fine SAND, trace medium sand -GLACIOLACUSTRINE DEPOSIT-(SM)	
									Note: Gravel/cobble layer encountered between approximately 83.5 ft to 84.5 ft.	
85	18D	24/19	85.0 - 87.0	13/19/23/28	42	42			Gray-brown, saturated, dense, fine SAND, trace silt -GLACIOLACUSTRINE DEPOSIT-(SP)	
									Note: Drive casing through open hole to 80.7 ft after 18D.	
									Note: Gravel/cobble layer encountered from approximately 89.5 to 90.0 ft.	
90	19D	9/9	91.0 - 91.8	19/75(3.0")				505.6	Gray-brown, saturated, medium dense, fine SAND, trace silt to gray-brown to red-brown, saturated, medium dense to dense, clayey fine to medium SAND, decomposed rock fragments recovered in bottom 3 in. of spoon. -GLACIOLACUSTRINE DEPOSIT-(SP/SC)	
	R1	60/14	93.0 - 98.0	RQD = 12%					91.5 Top of Bedrock at El. 505.6 Gray, medium to fine grained SCHIST. Moderately hard, fresh to moderately weathered. Joints moderate to steeply dipping, very close to close, open, 6 in. granitic intrusion. Note: Variable erratic drilling, sand observed in wash water, frequent color changes in wash water. Probable weathered zones. Rock Mass Quality=Very Poor Recovery=23% -LITTLETON FORMATION- R1 Core Times (min:sec): 93.0-94.0' (1:41); 94.0-95.0' (2:02); 95.0-96.0' (1:18); 96.0-97.0' (1:40); 97.0-98.0' (1:00)	
95	R2	38/9	98.0 - 101.2	RQD = 0%					Gray, medium to fine grained SCHIST. Moderately hard, fresh to severely weathered. Few observed joints are moderately dipping,	
100										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
100										parallel to foliation, very close, open. Run is severely fractured (rubble-like pieces). Rock Mass Quality=Very Poor Recovery=26% -LITTLETON FORMATION- R2 Core Times (min:sec): 98.0-99.0' (0:27); 99.0-100.0' (0:37); 100.0-101.0' (3:16) Gray, medium to fine grained SCHIST. Moderately hard, fresh to severely weathered. Few observed joints are moderately dipping, parallel to foliation, very close, open. Run is severely fractured (rubble-like pieces). Rock Mass Quality=Very Poor Recovery=100% -LITTLETON FORMATION- R3 Core Times (min:sec): 101.2-102.2' (2:48); 102.2-103.2' (1:12); 103.2-104.2' (3:41) Gray, medium to fine grained SCHIST. Moderately hard, fresh to moderately weathered. Few observed joints are moderately dipping, parallel to foliation, very close, open. Run is severely fractured (rubble-like pieces). Rock Mass Quality=Very Poor Recovery=100% R4 Core Times (min:sec): 102.4-103.2' (2:24) Gray, medium to fine grained SCHIST. Moderately hard, fresh to severely weathered. Few observed joints are moderately dipping, parallel to foliation, very close, open. Run is severely fractured (rubble-like pieces). Rock Mass Quality=Poor Recovery=83% -LITTLETON FORMATION- R5 Core Times (min:sec): 103.2-104.2' (3:30) Gray, medium to fine grained SCHIST. Moderately hard, fresh to severely weathered. Few observed joints are moderately dipping, parallel to foliation, very close, open. Run is severely fractured (rubble-like pieces). Occasional 2 to 3 in. quartz intrusions and occasional quartz veins. Rock quality improves with depth becoming sound at approximately 105.0 ft. Rock Mass Quality=Very Poor Recovery=100% R6 Core Times (min:sec): 104.4-105.4' (2:15); 105.4-106.4' (3:22) Gray to dark gray, medium to fine grained SCHIST. Moderately hard, fresh to moderately weathered. Joints dipping at low to moderate angles, parallel to foliation, very close to moderately close, tight to open. Rock Mass Quality=Fair Recovery=83% R7 Core Times (min:sec): 106.9-107.9' (2:58); 107.9-108.9' (2:24); 108.9-109.9' (2:53); 109.9-110.9' (3:46) Gray to dark gray, medium to fine grained SCHIST. Moderately hard, fresh to moderately weathered. Joints dipping at low to moderate angles, parallel to foliation, very close to moderately close, tight to open. Discolored, rubble-like pieces approximately 4 in. at top of run, one quartz vein. Rock Mass Quality=Fair	
	R3	14/14	101.2 - 102.4	RQD = 0%							
	R4	11/11	102.4 - 103.3	RQD = 0%							
	R5	14/12	103.2 - 104.4	RQD = 29%							
	R6	30/30	104.4 - 106.9	RQD = 80%							
105											
	R7	48/41	106.9 - 110.9	RQD = 52%							
110											
	R8	12/12	110.9 - 111.9	RQD = 58%							
								485.2			
115											
120											
125											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-116
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	597.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	07-05-2012/07-11-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ-2.0 in. ID
Boring Location:	Sta. 16+74, 17.1' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
125										Recovery=100% R8 Core Times (min:sec) 110.9-111.9' (2:11)	
										111.9	
										Bottom of Exploration at 111.9 feet below ground surface.	
130											
135											
140											
145											
150											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-117
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-27-2012/06-29-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+69, 30.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/6	0.0 - 2.0	1/1/2/3	3	3	PUSH			Brown, saturated, very loose, medium to coarse SAND, some gravel, trace fine sand -ALLUVIAL DEPOSIT-(SW)	
							3			Note: * Indicates sample collected with 3 in. spoon and 140 lb. hammer.	
							8				
							16				
							14				
5							18				
	*2D	24/12	6.0 - 8.0	4/4/4/5	8	8	6			Light gray-brown, wet, loose, fine SAND, trace medium sand and silt, stratified -ALLUVIAL DEPOSIT-(SP)	G#248329 A-2-4, SP
							7				
							8				
							19				
10							38				
	3D	24/22	11.0 - 13.0	2/2/3/3	5	5	15			Light gray-brown, saturated, loose, fine SAND, trace medium sand and silt, stratified -ALLUVIAL DEPOSIT-(SP)	G#248329 A-2-4, SP
							18				
							30				
							72				
15							115				
								580.1		16.0	
	4D	24/18	16.0 - 18.0	1/2/3/3	5	5	43			Light gray-brown, saturated, loose, silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248330 A-4, SM
							68				
							63				
							146				
20							169				
	5D	24/22	21.0 - 23.0	2/2/3/3	5	5	70			Light gray-brown, saturated, loose, silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248330 A-4,SM
							49				
							40				
25							61				

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-117
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-27-2012/06-29-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+69, 30.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							67	570.1		
	6D	24/24	26.0 - 28.0	3/3/4/4	7	7	OPEN		Light gray-brown with light brown, saturated, loose, sandy SILT, stratified -GLACIOLACUSTRINE DEPOSIT-(ML) (26.0)	G#248331 A-4, ML
									Note: HW casing driven through open hole between 26.0 and 51.0 ft after washing ahead of casing with roller bit.	
30										
	7D	24/24	31.0 - 33.0	4/4/6/6	10	10		564.6	Light gray-brown with light brown, saturated, stiff, sandy SILT, stratified -GLACIOLACUSTRINE DEPOSIT-(ML) (31.5)	G#248331 A-4, ML
									Light brown, saturated, loose, fine SAND, trace silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
35										
	8D	24/16	36.0 - 38.0	5/7/9/11	16	16			Light brown, saturated, medium dense, silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248332 A-4, SM WC=28.6% GTX#12194 DS-10 FA=34.3º c=192 psf
40										
	9D	24/16	41.0 - 43.0	4/6/11/11	17	17			Light gray-brown, saturated, medium dense, silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248332 A-4, SM WC=28.6% GTX#12194 DS-10 FA=34.3º c=192 psf
45										
	10D	24/24	46.0 - 48.0	WOR/3/8/9	11	11			Light gray-brown with light brown, saturated, medium dense, fine SAND, trace medium sand, trace silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP-SM)	
50										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-117
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-27-2012/06-29-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+69, 30.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50							OPEN			Note: Drill mud introduced to borehole at 51.0 ft.	
	11D	24/10	51.0 - 53.0	2/8/10/16	18	18				Light brown, saturated, medium dense, fine to medium SAND, trace gravel -GLACIOLACUSTRINE DEPOSIT-(SW)	
55	12D	24/16	56.0 - 58.0	7/9/11/20	20	20				Light brown with gray-brown, saturated, medium dense, fine SAND, trace medium sand, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248333 A-2-4, SM WC=6.1% GTX12194 DS-11 FA=38.1º c=0 psf
60	13D	24/14	61.0 - 63.0	7/9/12/16	21	21				Light brown, saturated, medium dense, fine SAND, trace medium sand, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248333 A-2-4, SM WC=6.1% GTX#12194 DS-11 FA=38.1º c=0 psf
65										Note: Drill action indicates gravel/cobbles between approximately 64.0 and 66.0 ft.	
	14D	24/20	66.0 - 68.0	14/13/13/15	26	26				Gray, saturated, medium dense, fine SAND, trace medium sand, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248333 A-2-4, SM WC=6.1% GTX#12194 DS-11 FA=38.1º c=0 psf
70	15D	24/20	71.0 - 73.0	11/14/14/16	28	28				Gray, saturated, medium dense, fine SAND, trace silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SP-SM)	
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-117
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-27-2012/06-29-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+69, 30.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75							OPEN			
	16D	24/20	76.0 - 78.0	15/18/14/15	32	32			Gray, saturated, dense, fine SAND, little silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
								517.9	78.2	
							18		Note: Drill action indicates cobble from approximately 78.2 to 78.7 ft. Rig chatter from approximately 78.2 to 82.7 ft, telescope NW casing to 83.0 ft.	
80							41			
							33			
							45			
	17D	24/24	83.0 - 85.0	12/38/70/99	108	108	40		Gray, wet, very dense, fine to coarse SAND, trace silt, trace fine gravel, stratified -GLACIOFLUVIAL DEPOSIT-(SW-SM)	
							55			
85							103			
	18D	13/12	86.0 - 87.1	35/56/50(1")	106	106	41		Gray, saturated, very dense, fine to coarse SAND, trace gravel, stratified, occasional pockets of bonded material -GLACIOFLUVIAL DEPOSIT-(SW)	
							70	509.0	87.1	
							220	508.1	-GRAVEL/COBBLES- 88.0	
							346		Note: Attempted core run from approximately 87.5 to 91.0 ft with no recovery.	
90							475			
	19D	11/10	91.0 - 91.9	34/100(5.0")			68		Gray, saturated, very dense, fine to coarse SAND, trace gravel, trace silt, stratified, loosely bonded -GLACIOFLUVIAL DEPOSIT-(SW)	
							66			
							115		Note: Washed ahead of NW casing prior to driving.	
							210			
95							335			
	20D	17/16	96.0 - 97.4	71/77/100(5.0")			42		Gray, wet, very dense, fine to coarse SAND, little gravel, trace silt, stratified, occasional loose bonding -GLACIOFLUVIAL DEPOSIT-(SW)	
							33			
							36			
100							96		Note: Washed ahead of casing prior to driving. Drill action indicates gravel between approximately 99.0 and 101.0 ft.	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-117
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-27-2012/06-29-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+69, 30.5' Lt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
100							247			
	21D	11/10	101.0 - 101.9	35/100(5.0")			45		Gray, wet, very dense, fine to coarse SAND, trace gravel, trace silt, stratified, occasional loose bonding -GLACIOFLUVIAL DEPOSIT-(SW)	
							47			
							118		Note: Washed ahead of casing prior to driving from approximately 101.0 to 106.0 ft. Drill action indicates stratum change at approximately 104.5 ft.	
							330	491.6	104.5	
105							400			
	22D	5/4	106.0 - 106.4	100(5.0")			77		Gray, wet, very dense, fine to coarse SAND, some silt, little gravel, well bonded in-situ -GLACIAL TILL-(SM)	
							324			
							32			
							49		Note: Driller noted stratum change at approximately 110.0 ft.	
110							75	486.1	110.0	
	23D	8/6	111.0 - 111.7	74/100(3.0")			60		Recovered 6 in. completely weathered GNEISS consisting of dark green with gray, very dense, wet, SILT, some fine to coarse sand, little gravel, trace clay, distinct rock fabric	
	R1		111.7 - 116.5				120		R1:Recovered 16 in. severely weathered GNEISS, probable boulder. 3 in. dark olive-green, moist, very dense, SILT, some clay, little fine to coarse sand, little fine to coarse gravel, well bonded in-situ. Gravel fraction well rounded. Probable GLACIAL TILL.	
							183	483.0		
							198		113.1	
115							250(10.0")			
	24D	12/10	116.5 - 117.5	52/150					Dark olive-gray, moist, very dense, SILT, some gravel, little fine to coarse sand, trace clay, well bonded in-situ, gravel fraction angular to sub-rounded -GLACIAL TILL-(ML)	
									Note: Driller noted stratum change at approximately 119.5 ft.	
								476.6	119.5	
120									Top of Bedrock at El. 476.6	
	R2	18/6	121.0 - 122.5	RQD = 22%					Green with gray, coarse grained, GNEISS. Hard, very slightly weathered. Joints indiscernible due to poor recovery. Rock Mass Quality=Very Poor Recovery=33% -LITTLETON FORMATION- R2 Core Times (min:sec): 121.0-122.0' (1:57); 122.0-122.5' (2:00)	
								473.6	122.5	
125									**Bottom of Exploration at 122.5 feet below ground surface.**	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-118
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+51, 27.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/4	0.0 - 2.0	1/2/3/3	5	5	2			Light brown, saturated, loose, fine to coarse SAND, trace silt, little fine gravel -ALLUVIAL DEPOSIT-(SW)	G#248334 A-1-b, SW
							6			Note: * Indicates 3 in. diameter split spoon and 140 lb. hammer used to collect sample.	
							10				
							11				
							12				
5	*2D	24/8	5.0 - 7.0	5/4/4/5	8	8	6			Light brown, saturated, loose, fine to coarse SAND, trace silt, little fine gravel -ALLUVIAL DEPOSIT-(SW)	G#248334 A-1-b, SW
							10				
							12				
							13				
							41				
10	3D	24/20	10.0 - 12.0	2/2/3/3	5	5	15			Light gray-brown, saturated, loose, fine SAND, trace medium sand, trace silt, stratified -ALLUVIAL DEPOSIT-(SP)	
							19				
							27				
							58				
							81				
15	4D	24/18	15.0 - 17.0	2/2/2/3	4	4	22	581.8		15.0 Light gray-brown, saturated, very loose, fine SAND, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
							57				
							88				
							108				
							120				
20	5D	24/22	20.0 - 22.0	2/2/3/4	5	5	81			Light gray-brown, saturated, loose, fine SAND, some silt -GLACIOLACUSTRINE DEPOSIT-(SM)	
							75				
							93				
							149				
25							165				

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-118
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+51, 27.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
25	6D	24/24	25.0 - 27.0	3/2/3/3	5	5	50			Light brown with red-brown partings, saturated, loose, silty fine SAND, trace clay, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
							115				
							163				
							148				
							143				
30	7D	24/18	30.0 - 32.0	1/3/4/5	7	7	OPEN			Light gray-brown, saturated, loose, fine SAND, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
										Note: Mud introduced to borehole at 32.0 ft.	
35	8D	24/20	35.0 - 37.0	6/9/11/13	20	20				Light gray-brown with light brown and red-brown, saturated, medium dense, fine SAND, some silt, trace medium sand, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
40	9D	24/20	40.0 - 42.0	8/9/13/19	22	22				Light gray-brown with light brown, saturated, medium dense, fine SAND, some silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
45	10D	24/22	45.0 - 47.0	15/13/13/20	26	26				Light gray-brown, saturated, medium dense, fine SAND, trace silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
50											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-118
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+51, 27.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	11D	24/18	50.0 - 52.0	11/11/13/24	24	24	OPEN		Light gray-brown with light brown, saturated, medium dense, fine to medium SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SP)	
55	12D	24/20	55.0 - 57.0	11/14/16/13	30	30			Light brown, saturated, medium dense, fine SAND, little silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	
60	13D	24/16	60.0 - 62.0	9/10/12/17	22	22			Gray-brown to orange-brown, saturated, medium dense, fine SAND, trace silt, stratified -GLACIOLACUSTRINE DEPOSIT-(SP-SM)	
65	14D	8/6	65.0 - 65.7	12/100(2.0")				531.8	65.0	
							17	531.1	Brown with red-brown, saturated, very dense, fine to medium SAND, trace silt, trace gravel in tip of spoon, stratified -GLACIOLACUSTRINE DEPOSIT-(SW) Note: HW casing advanced through open borehole to 64.0 ft.	
							14	529.8	Advanced borehole to 70.0 ft through boulder (65.7-67.0 ft), cobbles/ gravel (67.0-70.0 ft).	
							14		65.7 -BOULDER- 67.0	
							42		Gravel/cobbles -PROBABLE GLACIAL TILL-	
70	MD	0/0	70.0 - 70.0	50(0.0")			120(6.0")	526.8	70.0 No recovery. Approximately 2.0 ft blow-in in borehole prior to sampling attempt at 70.0 ft. Gray gravel in tip of spoon. Note: Telescope NW casing to 66.1 ft following failed sample attempt at 70.0 ft. End of drilling mud use.	
	R1	60/60	72.4 - 77.4	RQD = 65%					Note: Advanced borehole to 72.4 ft with rollerbit. Drill action suggests bedrock. Top of Bedrock at El. 526.8 Light purple-gray with light green, fine to coarse grained, micaceous GNEISS. Hard to moderately hard, very slightly weathered. Joints dipping at low angles, close, rough, stepped, discolored to very slightly	
75										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-118
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	596.8	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 18+51, 27.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
75										weathered, open. Quartzose veins from approximately 75.3 to 76.0 ft and 77.0 to 77.4 ft. Foliation dipping at low to moderate angles. Rock Mass Quality=Fair Recovery=100% -LITTLETON FORMATION- R1 Core Times (min:sec): 72.4-73.4' (3:52); 73.4-74.4' (2:33); 74.4-75.4' (2:45); 75.4-76.4' (1:55); 76.4-77.4' (2:05)	
	R2	60/60	77.4 - 82.4	RQD = 40%						Light green with light purple-gray, coarse grained, micaceous GNEISS. Hard, very slightly weathered. Joints dipping at low angles, close to moderately close, rough, stepped, discolored, open. Foliation dipping at low to moderate angles where discernible. Approximately 75% of fractures due to drill breaks, mineralogy. Rock Mass Quality=Poor Recovery=100% -LITTLETON FORMATION- R2 Core Times (min:sec): 77.4-78.4' (2:13); 78.4-79.4' (1:37); 79.4-80.4' (1:43); 80.4-81.4' (1:38); 81.4-82.4' (2:11)	
80								514.4		82.4 **Bottom of Exploration at 82.4 feet below ground surface.**	
85											
90											
95											
100											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-119
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	599.6	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	06-18-2012/06-20-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+60, 24.7' Lt.	**Casing ID/OD:**	HW/NW - 1.333 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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*	24/6	0.0 - 2.0	WOH/WOH/1/2	1	1	1			Gray-brown, saturated, very loose, fine to medium SAND, trace leaves, plant fibers, sticks -ALLUVIAL DEPOSIT-(SP)	
							3				
							6			Note: * indicates 3 in. spoon and 140 lb. hammer used to collect sample.	
	2D*	24/10	3.0 - 5.0	14/12/10/11	22	22	32			Gray-brown, saturated, medium dense, fine SAND, some silt -ALLUVIAL DEPOSIT-(SM)	
							30				
5							31				
							54			Note: Gravel layer encountered from approximately 6 to 8 ft based on drill action.	
							81				
	3D	24/20	8.0 - 10.0	2/3/4/5	7	7	20			Gray-brown, moist, loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
							28				
10							54			Note: Mix drilling mud prior to washing out from 8 to 13 ft.	
							89				
							107				
	4D	24/18	13.0 - 15.0	3/3/4/5	7	7	OPEN			Gray-brown, moist, loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
15											
	5D	24/18	18.0 - 20.0	3/5/6/6	11	11				Gray-brown, moist, medium dense, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
20											
	6D	24/18	23.0 - 25.0	3/4/5/5	9	9				Gray-brown, moist, loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-119
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	599.6	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	06-18-2012/06-20-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+60, 24.7' Lt.	**Casing ID/OD:**	HW/NW - 1.333 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							OPEN			
	7D	24/20	28.0 - 30.0	4/3/4/5	7	7			Gray-brown, saturated, loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
30										
	8D	24/20	33.0 - 35.0	5/3/3/2	6	6			Gray-brown, saturated, loose, fine SAND, trace silt -ALLUVIAL DEPOSIT-(SP)	
35								563.1	36.5	
	9D	24/24	38.0 - 40.0	6/5/12/9	17	17		560.6	Red-brown to red, saturated, medium dense, fine to medium SAND, little gravel, trace silt -GLACIOFLUVIAL DEPOSIT-(SW) 39.0	
40									Gray-brown to red-brown, saturated, medium dense, fine SAND, some gravel, some silt, trace medium to coarse sand -GLACIOFLUVIAL DEPOSIT-(SM)	
	10D	24/10	43.0 - 45.0	6/7/18/23	25	25			Gray-brown with red-brown, saturated, medium dense, fine to medium SAND, little silt, trace coarse sand, trace gravel, stratified -GLACIOFLUVIAL DEPOSIT-(SM)	
45									Note: Frequent zones of gravel between approximately 45 and 48 ft.	
	11D	24/12	47.5 - 49.5	15/16/23/22	39	39			Gray-brown with red-brown, saturated, dense, fine to medium SAND, trace coarse sand, little silt, trace gravel, stratified -GLACIOFLUVIAL DEPOSIT-(SM)	
							83			
50							85			

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-119
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	599.6	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	06-18-2012/06-20-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+60, 24.7' Lt.	**Casing ID/OD:**	HW/NW - 1.333 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50							46			Note: Approximately 2.5 ft of soil in casing after washout. Wash out again and float rods.	
							60				
							65				
	12D	12/12	53.0 - 54.0	9/65			11			Gray-brown to red-brown, moist, very dense, medium SAND, trace fine sand -GLACIOFLUVIAL DEPOSIT-(SP)	
							166				
55							27			Note: Split spoon refusal at approximately 54.0 ft. Casing refusal at approximately 55.0 ft. Washed ahead and drive to 58.0 ft.	
							41				
							106(7.0")				
	13D	24/15	58.0 - 60.0	7/132/51(3.0")			25			Gray-brown to red-brown, moist, loose to very dense, medium SAND, trace fine sand -GLACIOFLUVIAL DEPOSIT-(SP)	
							125				
60							325				
							128(2.0")	538.6		61.0	
	14D	24/19	62.5 - 64.5	32/61/93/38(1.0")	154	154	DRIVE			Gray-brown to gray, moist, very dense, fine SAND, trace silt to medium sand, trace fine sand and silt, alternating layers -GLACIOFLUVIAL DEPOSIT-(SP)	
65								533.6		66.0	
	15D	24/16	68.0 - 70.0	80/104/96(5.0")			OPEN			Gray, moist, very dense, fine SAND, trace silt and gravel, well bonded -GLACIAL TILL-(SW)	
70											
	16D	16/16	73.0 - 74.3	60/87/100(4.0")						Gray, moist, very dense, fine to medium SAND, trace silt, coarse sand and gravel, well bonded -GLACIAL TILL-(SW)	
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-119
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	599.6	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	06-18-2012/06-20-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+60, 24.7' Lt.	**Casing ID/OD:**	HW/NW - 1.333 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75							OPEN		Note: Encountered frequent gravel layers from approximately 75.0 to 78.0 ft.	
	17D	16/16	78.0 - 79.3	34/50/75(4.0")			13		Gray, wet, dense to very dense, medium to coarse SAND, trace silt, fine sand and gravel -GLACIAL TILL-(SW)	
							17			
80							25		Note: Driller washing ahead before driving casing from approximately 79.3 to 88.6 ft.	
							52			
							250			
	18D	10/8	83.0 - 83.8	56/100(3.0")			24		Gray, moist, very dense, fine to medium SAND, little silt, trace gravel, trace coarse sand, trace clay, well bonded in-situ -GLACIAL TILL-(SM)	
							28			
85							40		Note: Drill action indicates gravel between approximately 83.0 and 87.0 ft.	
							75			
							150			
	19D	3/3	88.0 - 88.3	257(3.0")			300(7")	511.3	Green-gray, wet, very dense, fine to coarse SAND, little fine to coarse gravel, little silt, approximately 50% weathered bedrock, well bonded in-situ -GLACIAL TILL-(SM)	
	R1	58/32	88.9 - 93.7	RQD = 55%					88.3	
90									Top of Bedrock at El. 511.3 Light green, coarse grained, quartz, mica, PEGMATITE. Very hard, very slightly weathered. Joints dipping at low to moderate angles, close, rough, stepped, open, discolored. Note: Wash color changes from milky white to dark gray at approximately 93.0 ft.	
								506.6	93.0	
	R2	50/42	93.7 - 97.9	RQD = 84%					Dark purple-gray, fine to coarse grained, micaceous GNEISS. Very hard, slightly weathered. Joints dipping at moderate angles, close, rough, stepped, open, discolored to slightly weathered. Foliation dipping at moderate angles. Rock Mass Quality=Fair Recovery=100% -LITTLETON FORMATION- R1 Core Times (min:sec): 88.9-90.9' (3:40); 90.9-91.9 (2:38); 91.9-92.9' (2:43); 92.9-93.9' (2:56); 93.9-94.9' (3:11)	
95										
								501.8	Note: Bottom 10 in. of recovery captured during R2. Dark purple-gray, fine to coarse grained, micaceous GNEISS. Very hard, very slightly weathered. Joints dipping at moderate angles, close to moderately close, rough, stepped to planar, open, discolored to slightly weathered with minimal silt infilling. Foliation dipping at	
100										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-119
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	599.6	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock/B. Steinert	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/16; S-140/30
Date Start/Finish:	06-18-2012/06-20-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+60, 24.7' Lt.	**Casing ID/OD:**	HW/NW - 1.333 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
100										moderate angles Rock Mass Quality=Fair Recovery=100% -LITTLETON FORMATION- R2 Core Times (min:sec): 93.7-94.7' (1:56); 94.7-95.7 (1:51); 95.7-96.7' (1:52); 96.7-97.7' (2:05); 97.7-97.8' (1:00/0.1')	
										97.8 **Bottom of Exploration at 97.8 feet below ground surface.**	
105											
110											
115											
120											
125											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-120
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	600.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+42, 22.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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	24/4	0.0 - 2.0	WOR/WOH/WOH/1	0	0	PUSH			Gray-brown, saturated, very loose, fine SAND, trace medium to coarse sand, some silt, trace fine gravel, trace plant fibers, faint organic odor -ALLUVIAL DEPOSIT-(SM)	G#248335 A-2-4, SM
							1				
							2			Note: * Indicates 3 in. spoon, 140 lb. hammer used to collect sample.	
							1				
	*2D	24/14	4.0 - 6.0	15/13/8/15	21	21	25			Light brown, saturated, medium dense, fine SAND, trace medium to coarse sand, trace fine gravel grading to fine sand, some silt -ALLUVIAL DEPOSIT-(SM)	G#248335 A-2-4, SM
5							26				
							26				
							28				
							30				
	3D	24/18	9.0 - 11.0	4/3/4/4	7	7	12			Light brown, saturated, loose, fine SAND, trace silt, trace medium sand -ALLUVIAL DEPOSIT-(SP-SM)	
10							18				
							35				
							53				
							100				
	4D	24/16	14.0 - 16.0	5/3/5/5	8	8	26			Light brown, saturated, loose, fine SAND, trace silt, trace medium sand -ALLUVIAL DEPOSIT-(SP)	G#248336 A-3, SP WC=24.8% GTX#12194 DS-12 FA=32.5º c=264 psf
15							43				
							26				
							66				
							80			Note: Drilling mud introduced to borehole at 19.0 ft.	
	5D	24/18	19.0 - 21.0	4/3/4/4	7	7	OPEN			Light brown, saturated, loose, fine SAND, trace silt, trace medium sand -ALLUVIAL DEPOSIT-(SP)	G#248336 A-3, SP WC=24.8% GTX#12194 DS-12 FA=32.5º c=264 psf
20											
	6D	24/14	24.0 - 26.0	5/5/7/9	12	12				Light gray-brown, saturated, medium dense, fine SAND, trace medium sand, little silt	G#248337 A-2-4, SM
25											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-120
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	600.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+42, 22.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							OPEN		-ALLUVIAL DEPOSIT-(SM)	
	7D	24/14	29.0 - 31.0	5/8/8/8	16	16			Light gray-brown, saturated, medium dense, fine SAND, trace medium sand, little silt -ALLUVIAL DEPOSIT-(SM)	G#248337 A-2-4, SM
30										
								566.1	34.0	
	8D	24/20	34.0 - 36.0	5/5/5/7	10	10			Light brown, saturated, silty fine SAND -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248338 A-4, SM WC=28.8% GTX#12194 DS-13 FA=34.7º c=156 psf
35										
	9D	24/16	39.0 - 41.0	9/10/10/12	20	20			Light brown with partings and pockets of red- brown, saturated, medium dense, silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248338 A-4, SM WC=28.8% GTX#12194 DS-13 FA=34.7º c=156 psf
40										
	10D	24/14	44.0 - 46.0	4/2/3/9	5	5			Light brown with red-brown, saturated, loose, sandy SILT, frequent partings of silt and fine sand, frequent silt laminae, stratified -GLACIOLACUSTRINE DEPOSIT-(ML)	G#248339 A-4, ML
45										
								551.1	49.0	
	11D	24/24	49.0 - 51.0	11/12/17/20	29	29			Light brown to red-brown, saturated, medium dense, sandy SILT to	G#248339 A-4, ML
50										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-120
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	600.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+42, 22.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50							OPEN	550.1	silty fine SAND, stratified -GLACIOLACUSTRINE DEPOSIT-(ML)	
									50.0 -GLACIOFLUVIAL DEPOSIT- Note: Drill action indicates gravel between approximately 51.0 and 54.0 ft.	
								546.1	54.0	
	12D	24/20	54.0 - 56.0	8/11/12/16	23	23			Light brown with red-brown, saturated, medium dense, silty fine to medium SAND, trace coarse sand and fine gravel, stratified -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248340 A-4, SM WC=17.4% GTX#12194 DS-14 FA=28.9º c=431 psf
55									Note: HW casing driven through open hole to 54.0 ft on 6/21/12.	
	13D	24/20	59.0 - 61.0	4/5/9/20	14	14			Light-brown with red-brown, saturated, medium dense, silty fine to medium SAND, trace coarse sand and gravel, stratified, with pockets of slightly plastic silt and clay -GLACIOLACUSTRINE DEPOSIT-(SM)	G#248340 A-4, SM WC=17.4% GTX#12194 DS-14 FA=28.9º c=431 psf
60								538.1	62.0	
									Note: Drill action indicates gravel between approximately 62.0 and 64.0 ft. Probable stratum change.	
	14D	24/16	64.0 - 66.0	9/17/21/26	38	38			Gray-brown with red and gray, saturated, dense, fine to coarse SAND, trace gravel, stratified -GLACIOFLUVIAL DEPOSIT-(SW)	
65										
									Note: Driller overshot sample depth at 69.0 ft.	
70										
									Note: Drill wash changes from brown to gray at approximately 72.5 ft. Gravel/cobbles encountered from approximately 72.5 to 74.0 ft.	
	15D	11/6	74.0 - 74.9	52/100(5.0")					Gray, wet, very dense, fine SAND, little silt, trace medium sand -GLACIOFLUVIAL DEPOSIT-(SM)	
75										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-120
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	600.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+42, 22.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.
75							OPEN			Note: Drill action indicates gravel/cobbles between approximately 74.9 and 79.0 ft.	
	16D	12/6	79.0 - 80.0	78/100				521.1		79.0 — Gray, wet, very dense, fine to coarse SAND, trace silt, trace gravel, bonded -GLACIAL TILL-(SW-SM)	
80											
	MD	6/0	84.0 - 84.5	100			60			No recovery. Residue in spoon similar to above, possible pushed gravel. Note: Drill action indicates stratum change at approximately 86.0 ft.	
85							80				
							24	514.1		86.0 — Note: Drill action and cuttings indicate light green-gray GRANULITE from 86.0-88.0 ft. Drill action and casing advancement indicate - WEATHERED BEDROCK-	
							28				
							30	512.1		88.0 — Top of Bedrock at EL. 512.1	
	R1	36/36	89.0 - 92.0	RQD = 12%						Dark purple-gray, fine to coarse grained, micaceous GNEISS. Soft to hard, severely to moderately weathered. Joints dipping at low angles, close, rough to smooth, planar, slightly to severely weathered with decomposed rock infilling, open. Foliation dipping at low angles. Rock Mass Quality=Very Poor Recovery=100% -LITTLETON FORMATION- R1 Core Times (min:sec): 89.0-90.0' (6:10); 90.0-91.0' (3:11); 91.0-92.0' (3:09)	
90											
	R2	56/30	92.0 - 96.7	RQD = 0%						Dark green-gray, fine to coarse grained, micaceous GNEISS. Soft, moderately severe to severely weathered. Joints dipping at low angles where discernible, very close, rough, planar, moderately weathered to decomposed. Probable zone of lost recovery is 94.0 to 96.7 ft based on drill action. Borehole open to 96.7 ft at completion of run. Rock Mass Quality=Very Poor Recovery=54% -LITTLETON FORMATION- R2 Core Times (min:sec): 92.0-93.0' (3:28); 93.0-94.0' (2:37); 94.0-95.0' (1:35); 95.0-96.0' (1:55); 96.0-96.7' (1:36)	
95											
	R3	48/24	96.7 - 100.7	RQD = 0%						Dark green-gray to light green-gray, fine to coarse grained, micaceous GNEISS, very soft, severely weathered. Joints indiscernible due to fractured/decomposed nature of recovery. Foliation dipping at low angles where discernible.	
100											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-120
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	600.1	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Spud Barge	**Hammer Wt./Fall:**	HW/NW-300/24; S-140/30
Date Start/Finish:	06-25-2012/06-27-2012	**Drilling Method:**	HW/NW Drive	**Core Barrel:**	NQ - 2.0 in. ID
Boring Location:	Sta. 19+42, 22.3' Rt.	**Casing ID/OD:**	HW-4.0 in. ID/NW-3.0 in. ID	**Water Level*:**	Not Measured
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
100	R4	35/18	100.7 - 103.6	RQD = 0%				496.5		Rock Mass Quality=Very Poor Recovery=50% -LITTLETON FORMATION- R3 Core Times (min:sec): 96.7-97.7' (3:00); 97.7-98.7' (3:08); 98.7-99.7' (4:47); 99.7-100.7' (4:33) Dark green-gray to light green-gray, fine to coarse grained, micaceous GNEISS. Very soft, severely weathered. Joints indiscernible due to fractured/decomposed nature of recovery. Foliation dipping at low angles where discernible. Rock Mass Quality=Very Poor Recovery=51% -LITTLETON FORMATION- R4 Core Times (min:sec): 100.7-101.7' (6:46); 101.7-102.2' (6:00); 102.2-103.2' (4:15); 103.2-103.6' (5:23) 103.6 **Bottom of Exploration at 103.6 feet below ground surface.**	
105											
110											
115											
120											
125											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. DS-1 = direct shear test no.; FA = friction angle; c = cohesion; psf = pounds per square foot.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-121
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	637.0	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-06-2012/06-06-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 20+93, 91.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	22.4
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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	18/8	0.5 - 2.0	7/17/14	31	31	NW Push	636.5		-BITUMINOUS CONCRETE- 0.5	
										Brown, dry, dense, fine to medium SAND, trace coarse sand and silt, little fine gravel	G#248307 A-1-b, SP WC=2.6%
	2D	24/12	2.0 - 4.0	8/11/12/12	23	23		635.0		-FILL-(SP) 2.0	
										Brown, dry, medium dense, fine to medium SAND, trace coarse sand, silt and fine gravel, weakly stratified -ALLUVIAL DEPOSIT-(SP)	G#248308 A-1-b, SP WC=4.4%
	3D	24/20	4.0 - 6.0	10/9/8/9	17	17	14			Tan, dry, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
5							12				
							10				
							10				
							16				
	4D	24/8	9.0 - 11.0	5/6/6/6	12	12	16			Tan, wet, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
10							16				
							15				
							15				
							15				
	5D	24/6	14.0 - 16.0	4/4/6/7	10	10	20			Gray-brown, wet, loose, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
15							19				
							18				
							16				
							18				
	6D	24/8	19.0 - 21.0	5/5/6/6	11	11	18			Gray-brown, saturated, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
20							20				
							26				
							29				
							30				
25	7D	24/10	24.0 - 26.0	6/5/6/6	11	11	19			Gray-brown to brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-121
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	637.0	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-06-2012/06-06-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 20+93, 91.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	22.4
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							20			-ALLUVIAL DEPOSIT-(SW)	
							24				
							25				
							24				
	8D	24/10	29.0 - 31.0	4/5/6/8	11	11	14			Gray-brown, saturated, medium dense, fine to coarse SAND, trace gravel, stratified -ALLUVIAL DEPOSIT-(SW)	
30							18				
							26				
							37				
							44				
								603.0		34.0	
	9D	24/12	34.0 - 36.0	4/4/6/7	10	10	26			Gray-brown, saturated, loose, fine SAND, trace silt, trace medium sand, weakly stratified -ALLUVIAL DEPOSIT-(SP)	
35							48				
							58				
							64				
							69				
								598.0		39.0	
	10D	24/8	39.0 - 41.0	8/10/7/6	17	17	24			Brown with gray-brown, saturated, medium dense, fine to coarse SAND, little gravel, trace silt, occasional very loose bonding -ALLUVIAL DEPOSIT-(SW)	
40							39				
							57				
							43				
							49				
								593.0		44.0	
	11D	24/16	44.0 - 46.0	3/2/5/7	7	7	OPEN			Gray-brown, saturated, loose, silty fine SAND, trace clay, trace medium to coarse sand in bottom 2 in. of recovery, stratified with occasional clay laminae -GLACIOLACUSTRINE DEPOSIT-(SM)	
45											
								588.0		49.0	
50	12D	11/6	49.0 - 49.9	11/100(5.0")						Brown, wet, very dense, fine to coarse SAND, little silt, trace gravel,	

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-121
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	637.0	**Auger ID/OD:**	--
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	NW-300/24; S-140/30
Date Start/Finish:	06-06-2012/06-06-2012	**Drilling Method:**	NW Drive	**Core Barrel:**	--
Boring Location:	Sta. 20+93, 91.0' Lt.	**Casing ID/OD:**	NW-3.0 in. ID	**Water Level*:**	22.4
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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.
50								587.1		weakly bonded -GLACIAL TILL-(SM) 49.9	
										Bottom of Exploration at 49.9 feet below ground surface.	
										Note: Split spoon refusal on top of probable bedrock at 49.9 ft.	
55											
60											
65											
70											
75											

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-122
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	633.5	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 30+66, 19.2' Rt.	**Casing ID/OD:**	--	**Water Level*:**	None Encountered
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/16	0.5 - 2.5	10/18/13/31	31	31	HSA	633.1	-BITUMINOUS CONCRETE- 0.4	
									Brown, dry, dense, fine to coarse SAND, trace gravel, trace silt -FILL-(SW)	
	2D	24/14	2.5 - 4.5	19/14/10/10	24	24		631.0	2.5	
									Red-brown to tan, dry, medium dense, fine SAND, little medium to coarse sand, trace gravel in top 2 in. of recovery, stratified -ALLUVIAL DEPOSIT-(SP)	
5	3D	24/18	5.5 - 7.5	6/6/8/8	14	14		628.0	5.5	
									Tan, dry, medium dense, fine to coarse SAND, trace silt, stratified with frequent silt partings -ALLUVIAL DEPOSIT-(SW-SM)	
	4D	24/12	7.5 - 9.5	6/6/7/9	13	13			Tan, dry, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
	5D	24/20	9.5 - 11.5	7/5/7/7	12	12			Tan, dry, medium dense, fine to coarse SAND, stratified -ALLUVIAL DEPOSIT-(SW)	
10								622.0	11.5	
									Bottom of Exploration at 11.5 feet below ground surface.	
15										
20										
25										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. Station and offset information reference the existing Route 232 baseline.

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: Martin Memorial Bridge Replacement
Location: Route 232 - Rumford, Maine

Boring No.: BB-RAR-123
PIN: 15105.00

Driller:	Maine Test Borings	**Elevation (ft.)**	634.1	**Auger ID/OD:**	HSA-2.25 in. ID
Operator:	B. Enos	**Datum:**	NAVD 88	**Sampler:**	Split Spoon-1.375 in. ID
Logged By:	B. Babcock	**Rig Type:**	CME 45 Skid on Trailer	**Hammer Wt./Fall:**	S-140/30
Date Start/Finish:	06-07-2012/06-07-2012	**Drilling Method:**	HSA	**Core Barrel:**	--
Boring Location:	Sta. 32+07, 0.5' Lt.	**Casing ID/OD:**	--	**Water Level*:**	16.9
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
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

Sample Information

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.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	18/10	0.5 - 2.0	22/25/24	49	49	HSA	633.6	-BITUMINOUS CONCRETE- 0.5	
									Brown, dry, dense, fine to coarse SAND, little gravel -FILL-(SW) Note: Drill action and cuttings indicated 10-20% fine to coarse gravel between approximately 0.5 and 4.0 ft.	
	2D	24/10	2.0 - 4.0	10/9/10/9	19	19			Light brown, dry, medium dense, fine to coarse SAND, little gravel -FILL-(SW)	
	3D	24/12	4.0 - 6.0	4/4/2/2	6	6			Light brown to tan, dry, loose, fine to coarse SAND, trace gravel, occasional weak layering -FILL-(SW)	
5	4D	24/4	6.0 - 8.0	2/1/1/5	2	2			Light brown, dry, very loose, fine to coarse SAND, trace fine to coarse gravel -FILL-(SW)	
	5D	24/17	8.0 - 10.0	4/3/4/11	7	7			Light brown, dry, loose, fine to coarse SAND -FILL-(SW)	
								624.9	9.2	
10	6D	24/8	10.0 - 12.0	10/9/8/7	17	17			Dark gray-brown, moist, loose, fine to coarse SAND, trace silt, trace plant fibers, stratified -ALLUVIAL DEPOSIT-(SW-SM) Dark gray-brown to mottled gray with red, moist, medium dense, fine to medium SAND, little silt, trace coarse sand, stratified -ALLUVIAL DEPOSIT-(SW)	
15	7D	24/10	15.0 - 17.0	1/1/1/3	2	2		619.1	15.0	
									Light brown to red-brown, moist, soft, SILT, little fine to medium sand, trace clay, trace plant fibers, low plasticity -ALLUVIAL DEPOSIT-(ML)	
								617.1	17.0	
									Bottom of Exploration at 17.0 feet below ground surface.	
20										
25										

Remarks:

1. As-drilled coordinates of test borings determined by MaineDOT and provided to Haley & Aldrich in NAD 83 Maine 2000 West Zone Coordinate System. As-drilled coordinates related to station and offset information by TranSystems.
2. Station and offset information reference the existing Route 232 baseline.

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

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

APPENDIX B

Observation Well Installation and Groundwater Monitoring Reports

HALEY & ALDRICH

OBSERVATION WELL INSTALLATION REPORT

Well No. BB-RAR-109(OW)

Boring No. BB-RAR-109

PROJECT	Martin Memorial Bridge Replacement	**H&A FILE NO.**	38799-000
LOCATION	Route 232 - Rumford, Maine	**PROJECT MGR.**	B. Steinert
CLIENT	Maine Department of Transportation	**FIELD REP.**	B. Babcock
CONTRACTOR	Maine Test Borings	**DATE INSTALLED**	6/12/2012
DRILLER	B. Enos	**WATER LEVEL**	12.4 ft

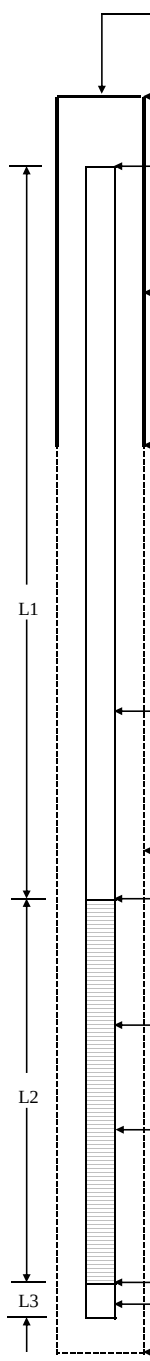
Ground El. 616.0 ft
El. Datum NAVD 88

Location See Plan

☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL
Gray-brown to rust-brown, fine to coarse SAND, little to trace silt and gravel -ALLUVIAL DEPOSIT-	Filter Sand

41.0 **41.0**
(Bottom of Exploration)
(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock	Steel Cover with Padlock	
Height of top of guard pipe above ground surface	3.0	ft
Height of top of riser pipe above ground surface	2.9	ft
Type of protective casing:	Steel Guardpipe	
Length	5.0	ft
Inside Diameter	3.0	in
Depth of bottom of guard pipe	2.0	ft

Type of Seals	Top of Seal (ft)	Thickness (ft)

Type of riser pipe:	Schedule 40 PVC	
Inside diameter of riser pipe	2.0	in
Type of backfill around riser	Filter Sand	
Diameter of borehole	3.0	in
Depth to top of well screen	5.0	ft
Type of screen	Machine Slotted Sch. 40 PVC	
Screen gauge or size of openings	0.010/10 slot	in
Diameter of screen	2.0	in
Type of backfill around screen	Filter Sand	
Depth of bottom of well screen	20.0	ft
Bottom of Silt trap	--	ft
Depth of bottom of borehole	41.0	ft

Riser Pay Length (L1)	+	Length of screen (L2)	+	Length of silt trap (L3)	=	Pay length
7.9 ft	+	15.0 ft	+	-- ft	=	22.9 ft

COMMENTS:

Form 2007

GROUNDWATER MONITORING REPORT

HALEY & ALDRICH

OW/PZ NUMBER

BB-RAR-109

PROJECT	Martin Memorial Bridge Replacement	**H&A FILE NO.**	38799-000
LOCATION	Route 232 - Rumford, Maine	**PROJECT MGR.**	B. Steinert
CLIENT	Maine Department of Transportation	**FIELD REP.**	B. Babcock
CONTRACTOR	Maine Test Borings	**DATE**	6/12/2012

ELEVATION OF REFERENCE POINT 619.0 (NAVD 88) **REFERENCE POINT:** **Ground Surface** ☐ **PVC** ☑ **Other** ☐

Date	Time	Elapsed Time (days)	Depth of Water from Reference Point	Elevation of Water	Remarks	Read By
6/13/2012	750	1	12.8	606.3		BB
6/14/2012	645	2	12.7	606.3		BB
6/14/2012	1854	2	12.7	606.3		BB
6/15/2012	721	3	12.9	606.1		BB
6/18/2012	943	6	14.7	604.3		BB
6/21/2012	1733	9	14.2	604.8		BB
6/26/2012	1503	14	14.8	604.3		BB
6/27/2012	1840	15	12.7	606.3		BB
6/28/2012	1314	16	12.2	606.8		BB
6/28/2012	1751	16	12.2	606.9		BB
6/29/2012	555	17	12.1	606.9		BB
7/3/2012	606	21	14.1	604.9		BB
7/3/2012	1826	21	14.3	604.8		BB
7/4/2012	601	22	14.3	604.7		BB
7/5/2012	1406	23	14.3	604.7		BB
7/9/2012	815	27	14.3	604.7		BCS
7/12/2012	712	30	14.8	604.2		BCS
7/13/2012	750	31	14.9	604.1		BCS

APPENDIX C

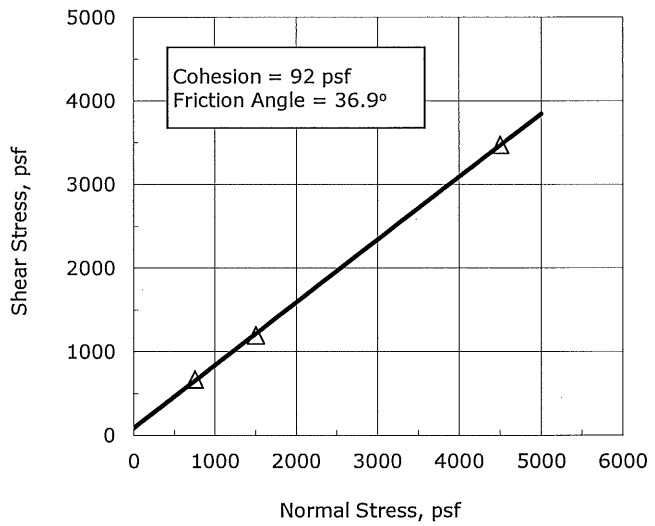
Laboratory Test Results

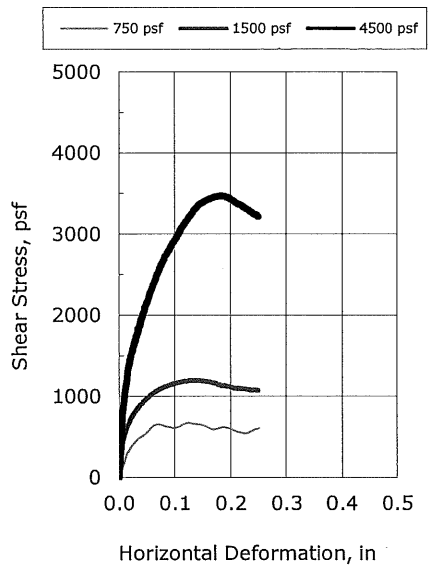
TEST NO. DS-1

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/06/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-110
Sample ID:	6D, 7D
Depth, ft:	14-21
Visual Description:	Moist, brownish gray sand with silt

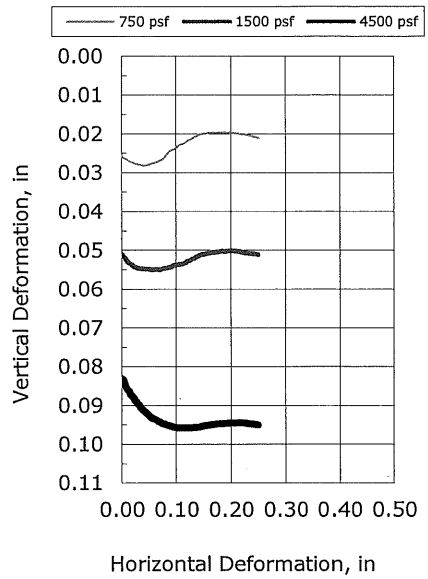
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-1	DS-2	DS-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	117	117	117
Initial Moisture Content, %:	2.8	2.8	2.8
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	18.3	18.3	18.3
Initial Void Ratio:	0.41	0.41	0.41
Final Dry Density, pcf:	120	124	130
Final Moisture Content, %:	27.5	28.7	28.8
Final Bulk Density, pcf:	153	159	167
Normal Stress, psf:	750	1499	4499
Maximum Shear Stress, psf:	671	1197	3474
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	9.1
Soil Classification:	---
Group Symbol:	---



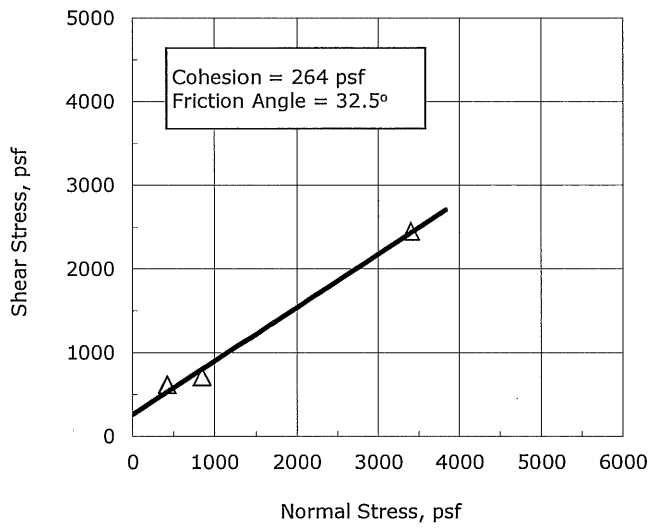
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

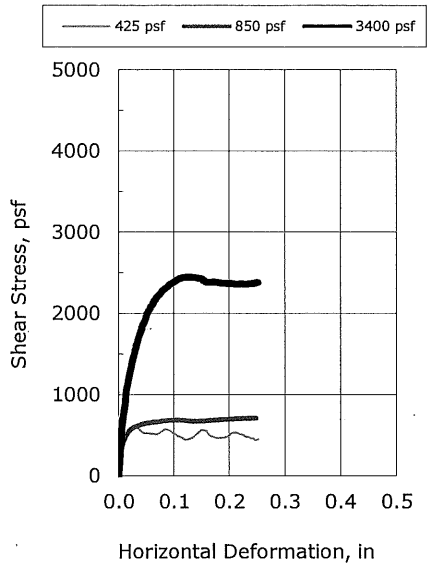
TEST NO. DS-2

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/12/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-111
Sample ID:	2D, 3D
Depth, ft:	5-11
Visual Description:	Moist, brown silty sand

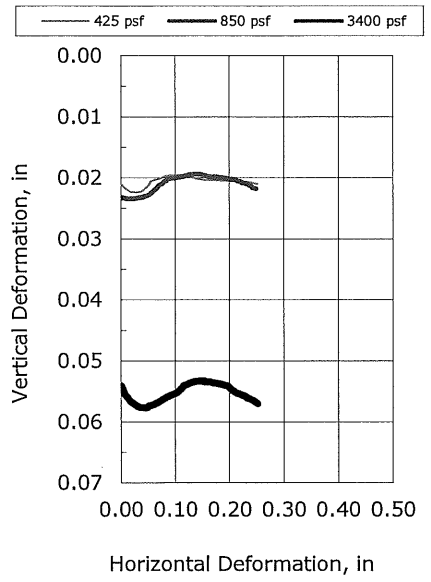
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-16	DS-17	DS-18
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	6.0	6.0	6.0
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	35.2	35.2	35.2
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	116	116	121
Final Moisture Content, %:	25.4	25.5	24.7
Final Bulk Density, pcf:	146	146	151
Normal Stress, psf:	425	849	3399
Maximum Shear Stress, psf:	616	711	2447
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	26.4
Soil Classification:	---
Group Symbol:	---



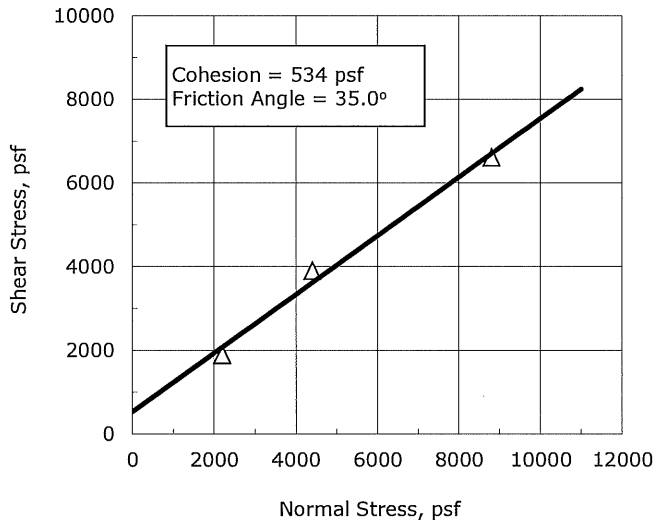
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

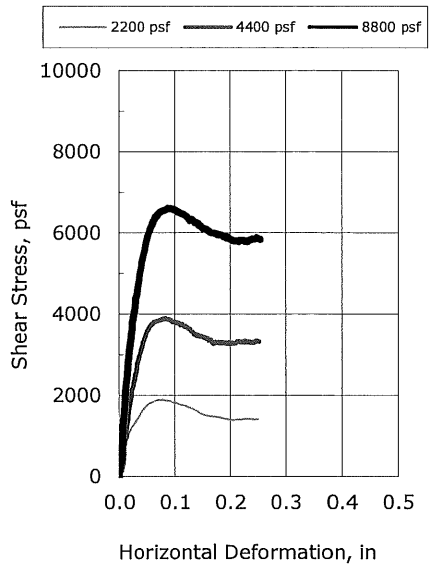
TEST NO. DS-3

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/17/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-111
Sample ID:	15D, 16D
Depth, ft:	69-76
Visual Description:	Moist, yellowish brown sand

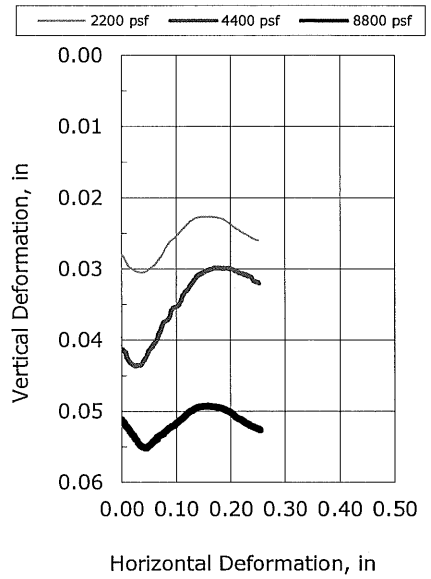
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-25	DS-26	DS-27
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	113	113	113
Initial Moisture Content, %:	6.5	6.5	6.5
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	37.6	37.6	37.6
Initial Void Ratio:	0.46	0.46	0.46
Final Dry Density, pcf:	116	117	120
Final Moisture Content, %:	20.0	19.3	20.0
Final Bulk Density, pcf:	140	140	144
Normal Stress, psf:	2199	4400	8800
Maximum Shear Stress, psf:	1890	3897	6610
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	2.4
Soil Classification:	---
Group Symbol:	---



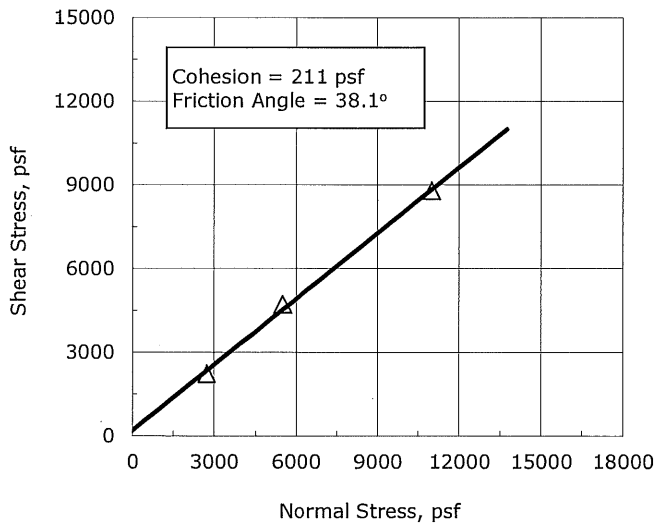
Notes:
- Moisture content obtained before shear from sample trimmings
- Moisture Content determined by ASTM D 2216
- Percent passing #200 sieve determined by ASTM D 422
- Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
- Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
- "---" indicates testing required to determine these values was not requested.

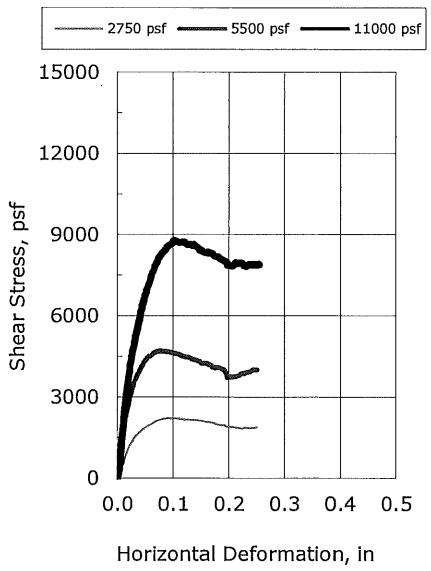
TEST NO. DS-4

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/08/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-111
Sample ID:	19D, 20D
Depth, ft:	90-97
Visual Description:	Moist, yellowish brown sand

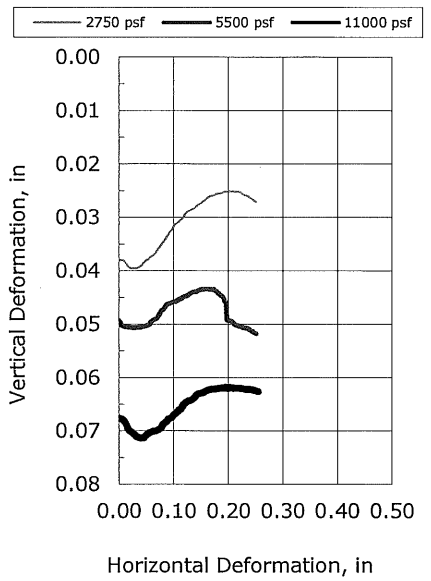
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-4	DS-5	DS-6
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	115	115	115
Initial Moisture Content, %:	5.3	5.3	5.3
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	31.6	31.6	31.6
Initial Void Ratio:	0.44	0.44	0.44
Final Dry Density, pcf:	118	121	122
Final Moisture Content, %:	18.0	17.3	17.3
Final Bulk Density, pcf:	139	142	144
Normal Stress, psf:	2724	5499	11000
Maximum Shear Stress, psf:	2226	4712	8783
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	2.9
Soil Classification:	---
Group Symbol:	---



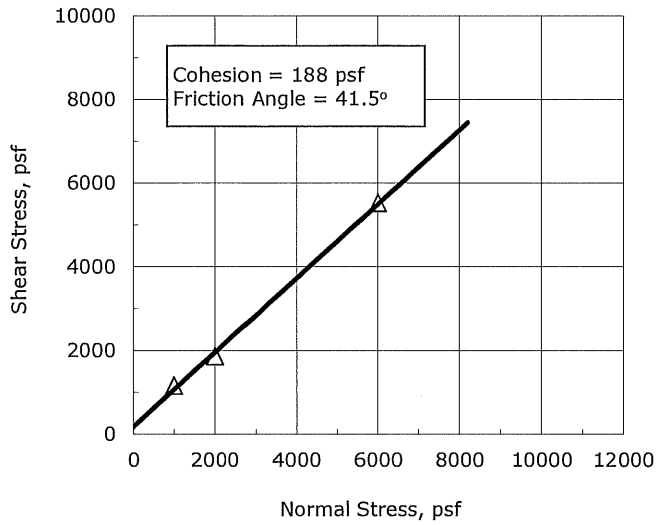
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

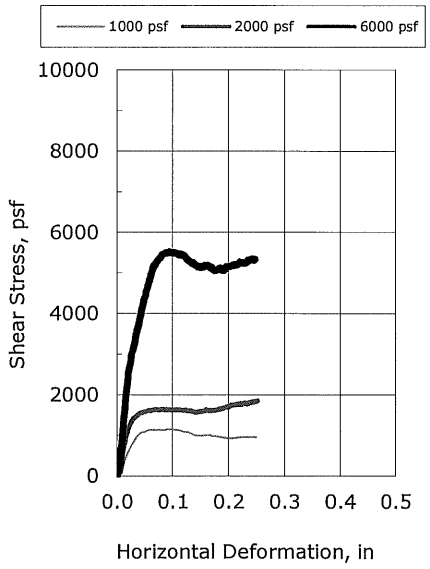
TEST NO. DS-5

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/19/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-112
Sample ID:	8D, 9D
Depth, ft:	24-31
Visual Description:	Moist, yellowish brown sand with gravel

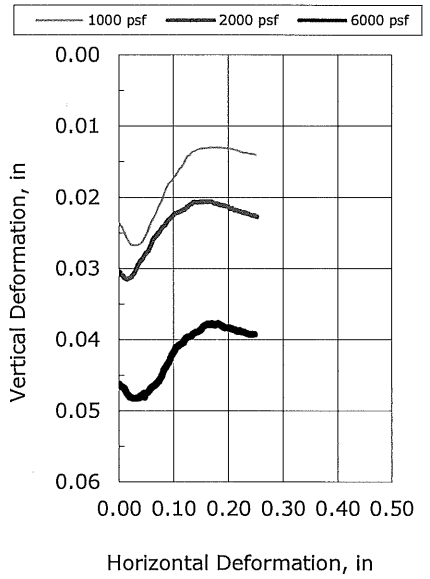
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-34	DS-35	DS-36
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	112	112	112
Initial Moisture Content, %:	8.0	8.0	8.0
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	44.2	44.2	44.2
Initial Void Ratio:	0.48	0.48	0.48
Final Dry Density, pcf:	113	114	116
Final Moisture Content, %:	19.6	19.6	18.4
Final Bulk Density, pcf:	136	137	138
Normal Stress, psf:	1000	2000	6000
Maximum Shear Stress, psf:	1154	1858	5523
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	2.1
Soil Classification:	---
Group Symbol:	---



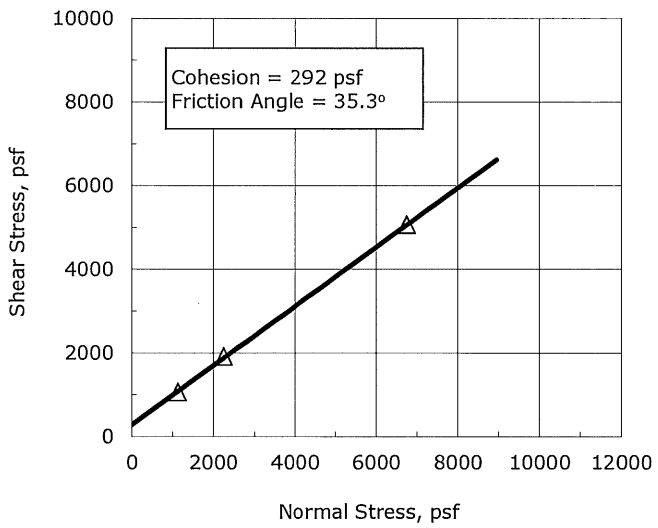
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

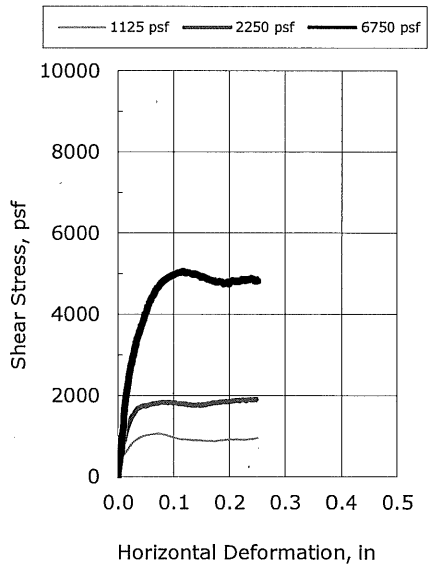
TEST NO. DS-6

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/18/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-113
Sample ID:	9D, 10D
Depth, ft:	29-36
Visual Description:	Moist, yellowish brown sand

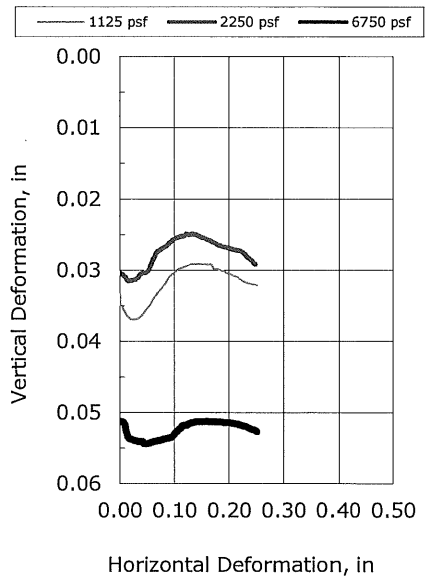
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-31	DS-32	DS-33
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	113	113	113
Initial Moisture Content, %:	7.1	7.1	7.1
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	40.1	40.1	40.1
Initial Void Ratio:	0.47	0.47	0.47
Final Dry Density, pcf:	117	116	119
Final Moisture Content, %:	20.9	21.9	21.3
Final Bulk Density, pcf:	141	142	144
Normal Stress, psf:	1124	2250	6750
Maximum Shear Stress, psf:	1063	1914	5061
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	1.6
Soil Classification:	---
Group Symbol:	---



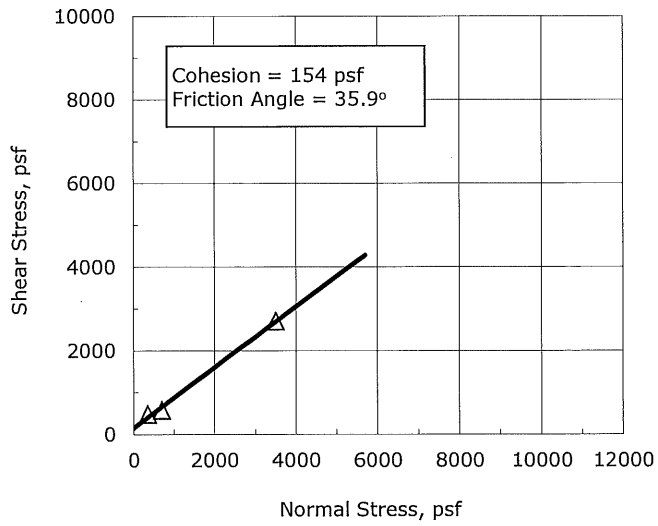
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

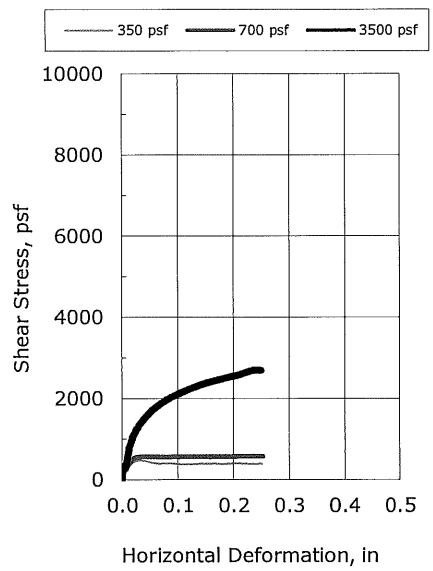
TEST NO. DS-7

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/18/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-114
Sample ID:	3D, 4D
Depth, ft:	4-8
Visual Description:	Moist, yellowish brown silty sand

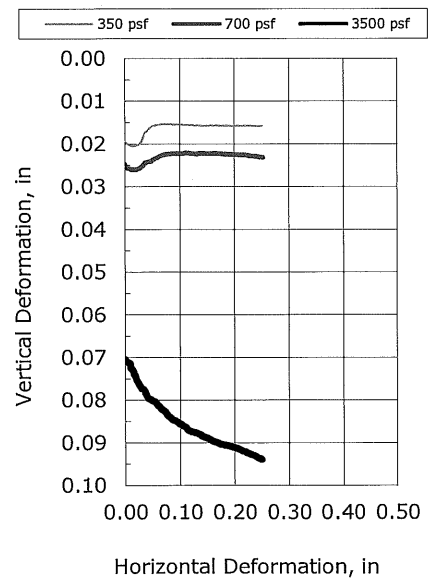
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-28	DS-29	DS-30
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	5.9	5.9	5.9
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	34.5	34.5	34.5
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	116	117	126
Final Moisture Content, %:	26.5	28.1	26.8
Final Bulk Density, pcf:	147	150	160
Normal Stress, psf:	350	700	3498
Maximum Shear Stress, psf:	481	580	2700
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	33.3
Soil Classification:	---
Group Symbol:	---



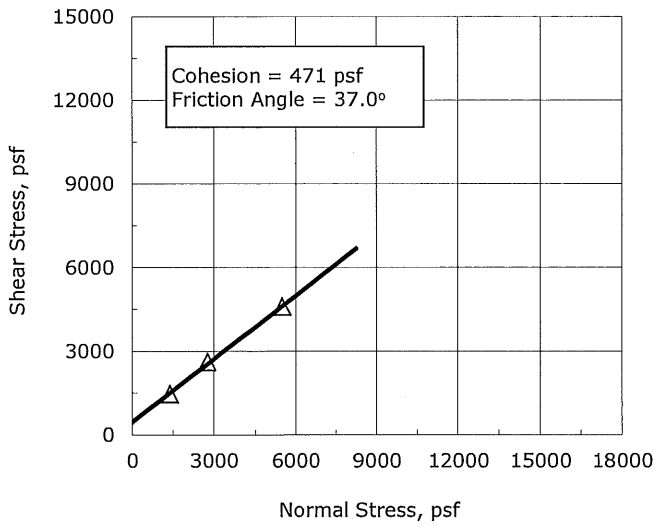
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

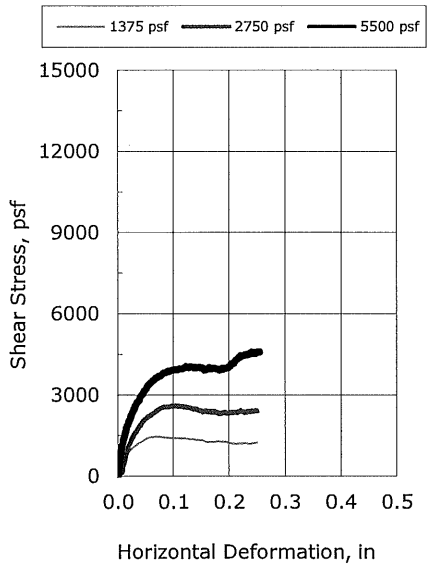
TEST NO. DS-8

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/09/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-114
Sample ID:	11D, 12D
Depth, ft:	39-46
Visual Description:	Moist, yellowish brown sand

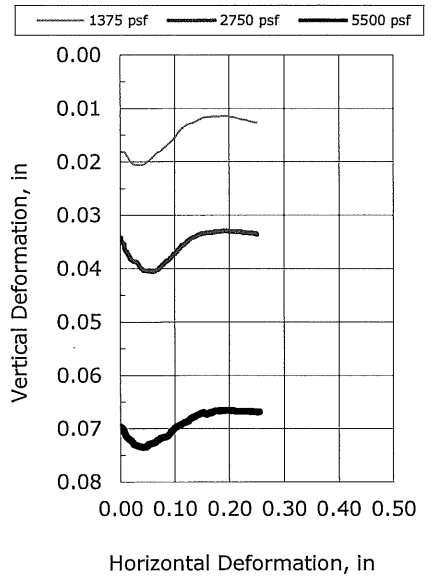
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-7	DS-8	DS-9
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	5.8	5.8	5.8
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	34.2	34.3	34.3
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	116	118	122
Final Moisture Content, %:	18.5	18.5	18.1
Final Bulk Density, pcf:	137	140	144
Normal Stress, psf:	1375	2749	5499
Maximum Shear Stress, psf:	1463	2608	4592
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	1.6
Soil Classification:	---
Group Symbol:	---



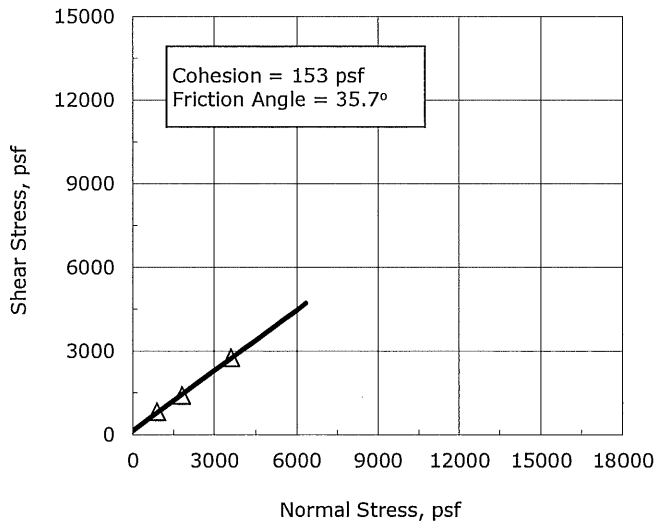
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

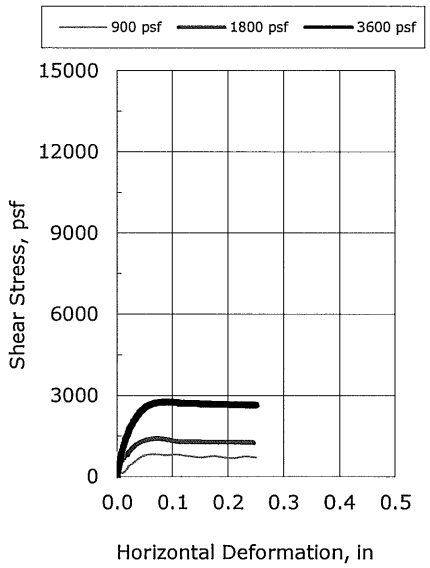
TEST NO. DS-9

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/11/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-115
Sample ID:	7D, 8D
Depth, ft:	31-38
Visual Description:	Moist, yellowish brown silty sand

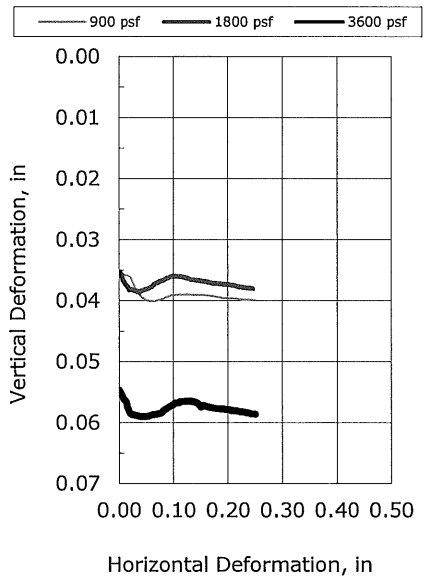
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-13	DS-14	DS-15
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	115	115	115
Initial Moisture Content, %:	5.0	5.0	5.0
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	30.0	30.0	30.0
Initial Void Ratio:	0.44	0.44	0.44
Final Dry Density, pcf:	120	120	122
Final Moisture Content, %:	25.7	25.8	24.8
Final Bulk Density, pcf:	151	150	153
Normal Stress, psf:	899	1800	3599
Maximum Shear Stress, psf:	827	1409	2756
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	42.2
Soil Classification:	---
Group Symbol:	---



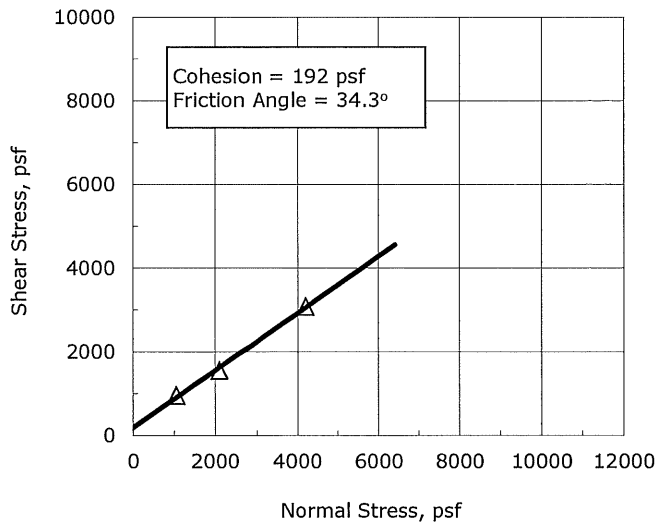
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

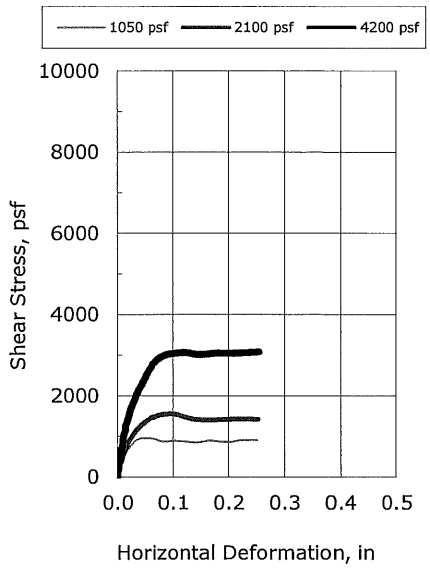
TEST NO. DS-10

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/19/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-117
Sample ID:	8D, 9D
Depth, ft:	36-43
Visual Description:	Moist, yellowish brown silty sand

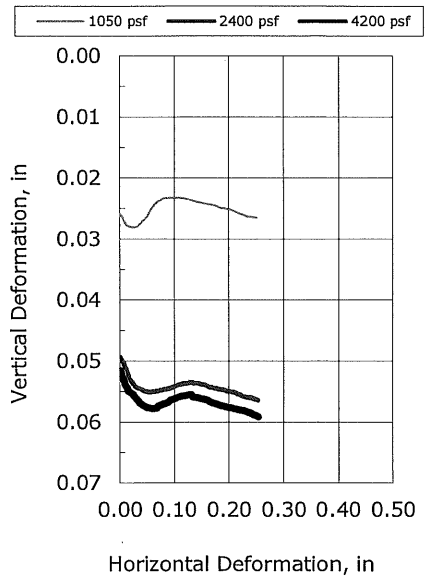
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-37	DS-38	DS-39
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	116	116	116
Initial Moisture Content, %:	4.1	4.1	4.1
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	25.3	25.3	25.3
Initial Void Ratio:	0.43	0.43	0.43
Final Dry Density, pcf:	119	123	123
Final Moisture Content, %:	27.9	27.9	27.7
Final Bulk Density, pcf:	153	157	157
Normal Stress, psf:	1050	2099	4199
Maximum Shear Stress, psf:	956	1552	3081
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	40.5
Soil Classification:	---
Group Symbol:	---



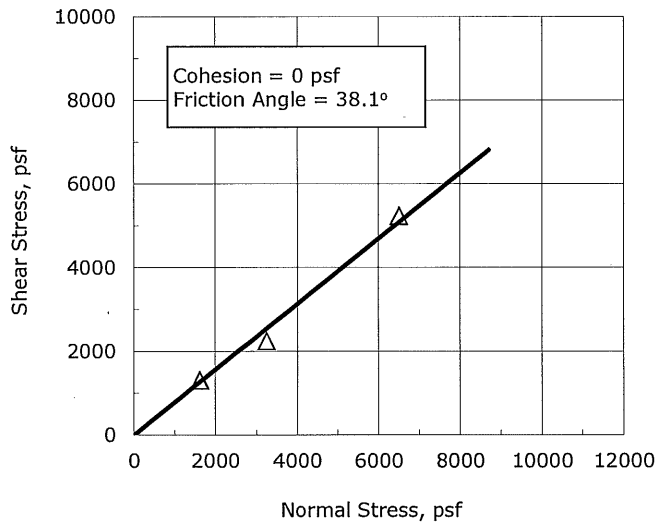
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

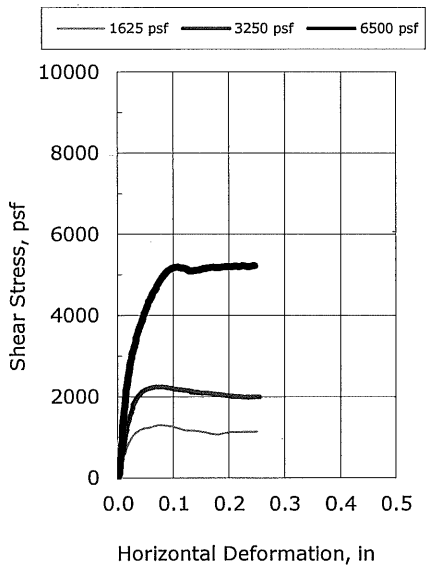
TEST NO. DS-11

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/20/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-117
Sample ID:	12D, 13D, 14D
Depth, ft:	56-68
Visual Description:	Moist, yellowish brown silty sand

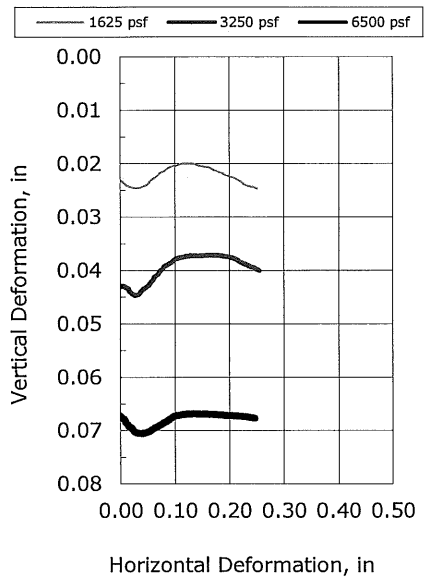
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-40	DS-41	DS-42
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	113	113	113
Initial Moisture Content, %:	6.4	6.4	6.4
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	37.2	37.2	37.2
Initial Void Ratio:	0.46	0.46	0.46
Final Dry Density, pcf:	116	118	122
Final Moisture Content, %:	26.4	26.8	26.2
Final Bulk Density, pcf:	147	150	154
Normal Stress, psf:	1624	3250	6500
Maximum Shear Stress, psf:	1303	2244	5231
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	21.1
Soil Classification:	---
Group Symbol:	---



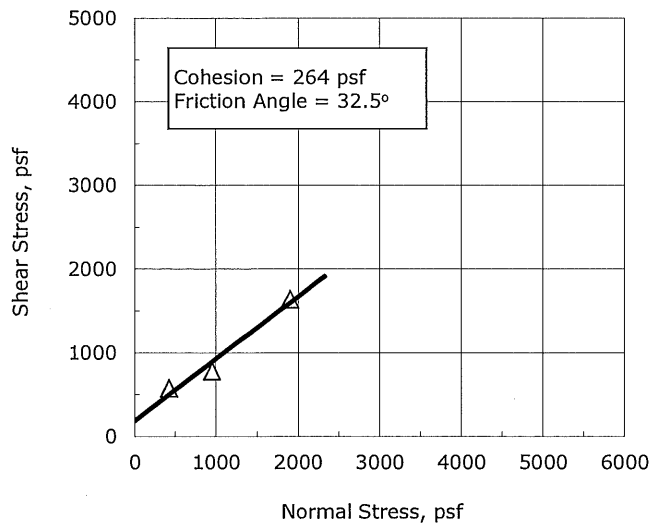
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

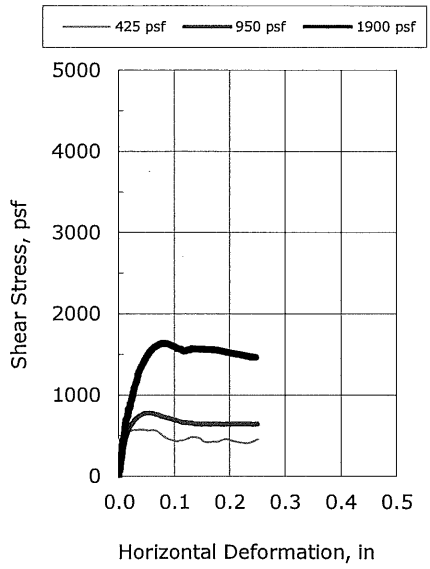
TEST NO. DS-12

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/13/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-120
Sample ID:	4D, 5D
Depth, ft:	14-21
Visual Description:	Moist, yellowish brown sand with silt

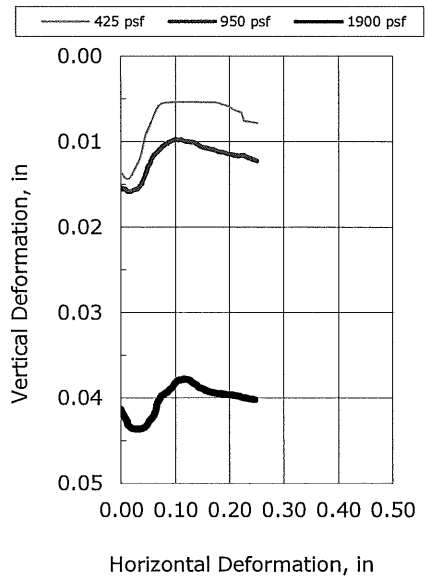
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-19	DS-20	DS-21
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	5.5	5.5	5.5
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	32.9	32.9	32.9
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	115	116	119
Final Moisture Content, %:	25.3	25.9	25.9
Final Bulk Density, pcf:	144	146	150
Normal Stress, psf:	425	950	1900
Maximum Shear Stress, psf:	576	779	1637
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	7.5
Soil Classification:	---
Group Symbol:	---



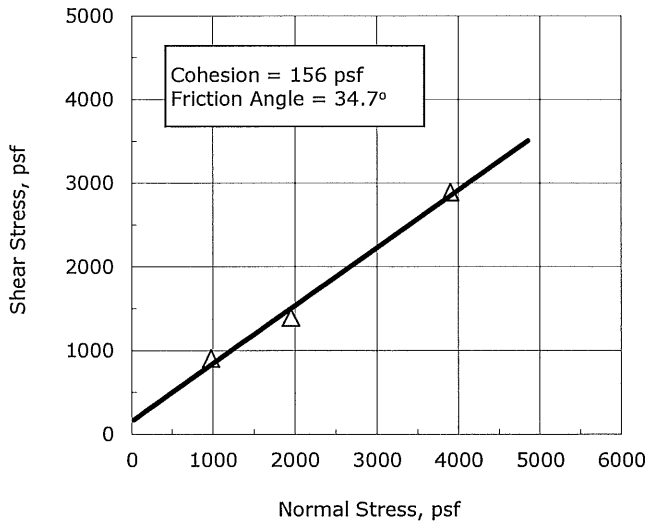
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

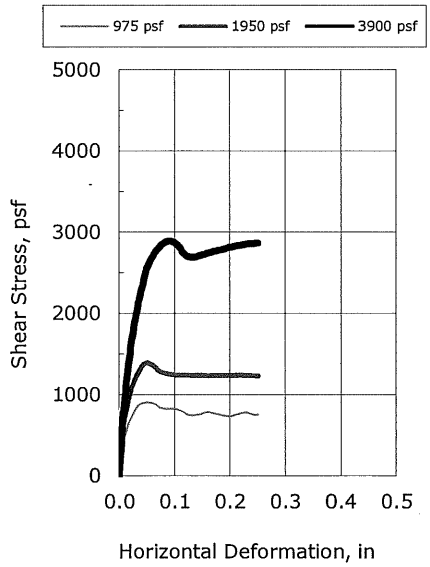
TEST NO. DS-13

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/14/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-120
Sample ID:	8D, 9D
Depth, ft:	34-40
Visual Description:	Moist, yellowish brown silty sand

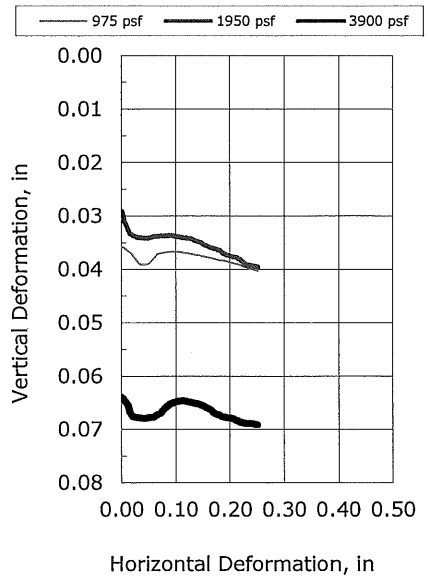
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-22	DS-23	DS-24
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	5.9	5.9	5.9
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	34.7	34.7	34.7
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	119	119	122
Final Moisture Content, %:	26.7	27.2	25.8
Final Bulk Density, pcf:	151	151	154
Normal Stress, psf:	975	1949	3899
Maximum Shear Stress, psf:	904	1392	2889
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	45.6
Soil Classification:	---
Group Symbol:	---



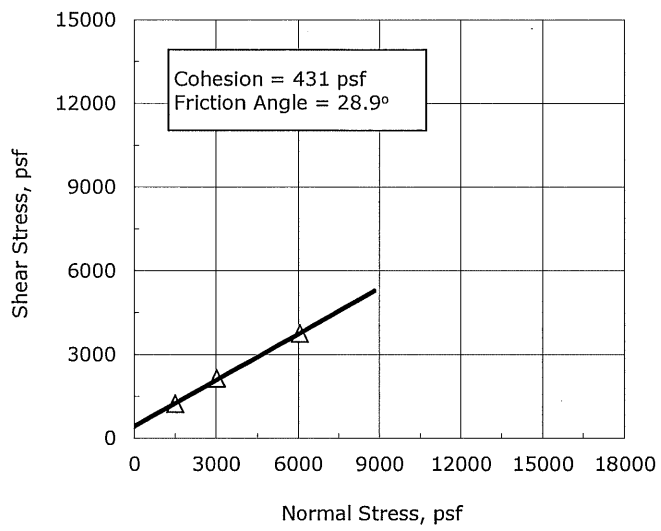
Notes: Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

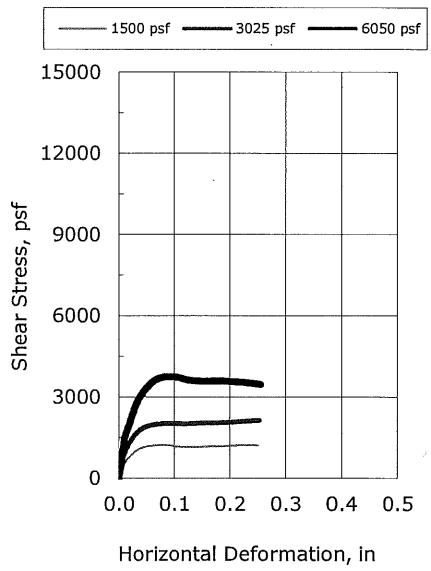
TEST NO. DS-14

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.
Project Name:	Martin Memorial Bridge Replacement
Project Location:	Rumford, ME
GTX #:	12194
Test Date:	09/10/12
Tested By:	md
Checked By:	jdt
Boring ID:	BB-RAR-120
Sample ID:	12D, 13D
Depth, ft:	54-61
Visual Description:	Moist, yellowish brown silty sand

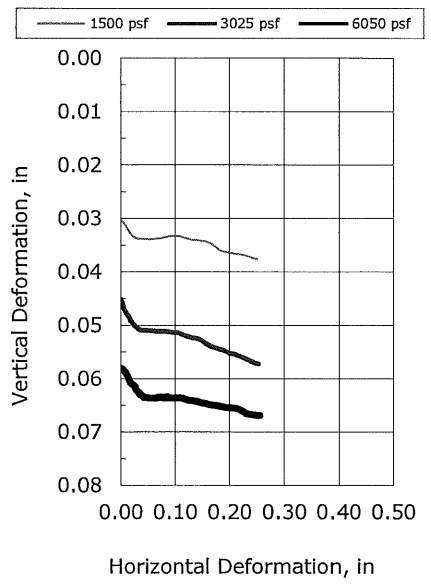
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D 3080





Test No.:	DS-10	DS-11	DS-12
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	156	156	156
Initial Dry Density, pcf:	114	114	114
Initial Moisture Content, %:	6.0	6.0	6.0
Initial Bulk Density, pcf:	121	121	121
Initial Degree of Saturation:	34.9	35.0	34.9
Initial Void Ratio:	0.45	0.45	0.45
Final Dry Density, pcf:	118	121	122
Final Moisture Content, %:	16.0	16.4	15.5
Final Bulk Density, pcf:	137	141	141
Normal Stress, psf:	1500	3024	6049
Maximum Shear Stress, psf:	1230	2139	3751
Shear Rate, in/min:	0.002	0.002	0.002

Sample Type:	remolded
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	45.3
Soil Classification:	---
Group Symbol:	---



Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D 2216
Percent passing #200 sieve determined by ASTM D 422
Target Compaction: 95% of 115.0 pcf at 5% moisture content (values provided by client).
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.
"---" indicates testing required to determine these values was not requested.

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: ---	Sample Type: ---	Tested By:	jek
Sample ID:---	Test Date: 09/13/12	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
BB-RAR-101	1D	0.5-2.5 ft.	Moist, grayish brown sand with silt	4.5
BB-RAR-101	2D	2.0-4.0 ft.	Moist, dark yellowish brown silty sand with gravel	7.4
BB-RAR-101	3D	4.0-6.0 ft.	Moist, yellowish brown silty sand	15.3
BB-RAR-102	1D	1.0-2.0 ft.	Moist, dark yellowish brown silty sand with gravel	9.5
BB-RAR-102	1DA	2.0-3.0 ft.	Moist, reddish brown silty sand with gravel	25.1
BB-RAR-102	2D	3.0-5.0 ft.	Moist, yellowish brown silty sand with gravel	10.8
BB-RAR-103	1D	0.0-2.0 ft.	Moist, dark yellowish brown silt	37.4
BB-RAR-103	2D	2.0-4.0 ft.	Moist, yellowish brown sand with silt and gravel	4.4

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: ---	Sample Type: ---	Tested By:	jek
Sample ID:---	Test Date: 09/13/12	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
BB-RAR-104	1D	0.0-2.0 ft.	Moist, grayish brown silt	38.4
BB-RAR-104	2D	2.0-4.0 ft.	Moist, olive brown silty, clayey sand	14.1
BB-RAR-104	3D	4.0-6.0 ft.	Moist, olive brown sand with silt	5.9
BB-RAR-106	1D	0.0-2.0 ft.	Moist, grayish brown silt with sand	30.6
BB-RAR-110	6D, 7D	14.0-21.0 ft.	Moist, brownish gray sand with silt	36.5
BB-RAR-111	2D, 3D	5.0-11.0 ft.	Moist, brown silty sand	30.9
BB-RAR-111	15D, 16D	69.0-76.0 ft.	Moist, yellowish brown sand	20.6
BB-RAR-111	19D, 20D	90.0-97.0 ft.	Moist, yellowish brown sand	10.5
BB-RAR-112	8D, 9D	24.0-31.0 ft.	Moist, yellowish brown sand with gravel	16.4
BB-RAR-113	9D, 10D	29.0-36.0 ft.	Moist, yellowish brown sand	21

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: ---	Sample Type: ---	Tested By:	jek
Sample ID:---	Test Date: 09/13/12	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

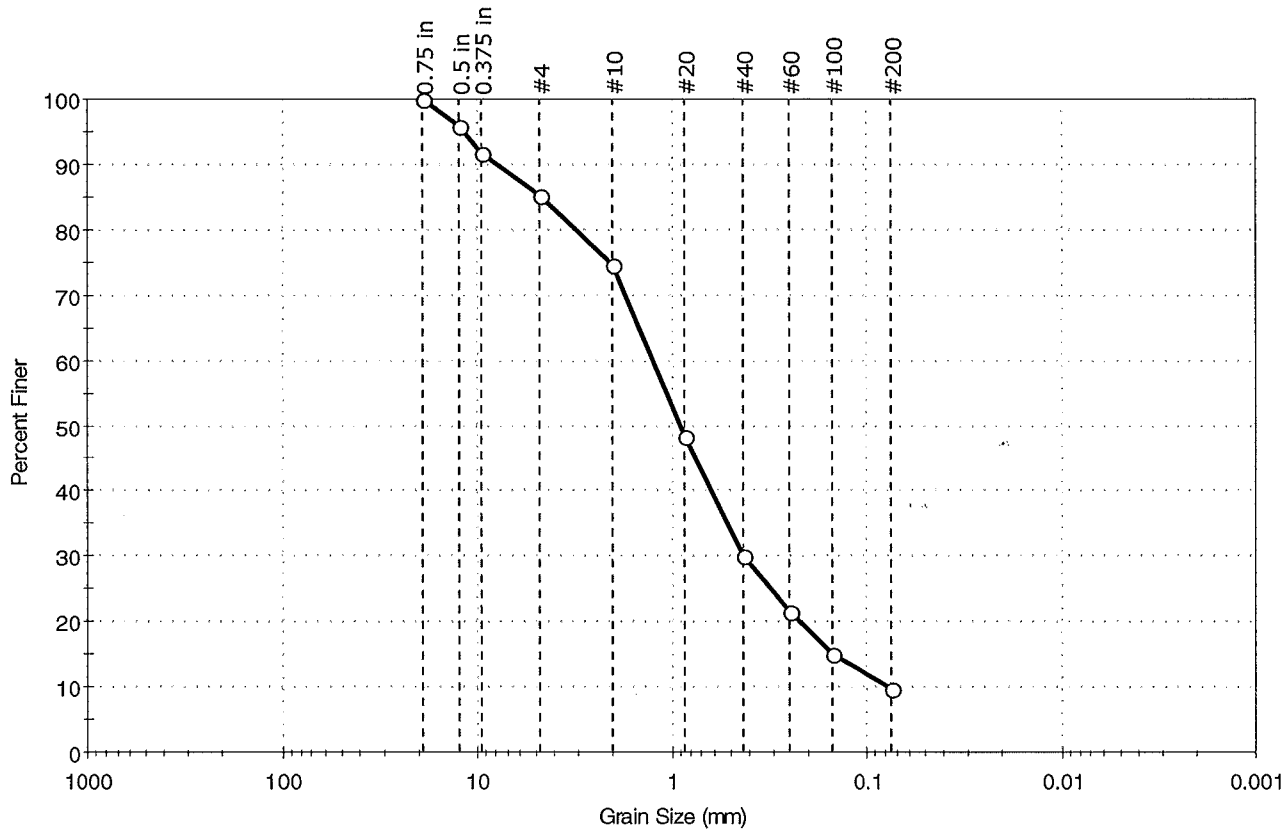
Boring ID	Sample ID	Depth	Description	Moisture Content,%
BB-RAR-114	3D, 4D	4.0-8.0 ft.	Moist, yellowish brown silty sand	36
BB-RAR-114	11D, 12D	39.0-46.0 ft.	Moist, yellowish brown sand	16.8
BB-RAR-115	7D, 8D	31.0-38.0 ft.	Moist, yellowish brown silty sand	26.9
BB-RAR-117	8D, 9D	36.0-43.0 ft.	Moist, yellowish brown silty sand	28.6
BB-RAR-117	12D, 13D, 14D	56.0-68.0 ft.	Moist, yellowish brown silty sand	6.1
BB-RAR-120	4D, 5D	14.0-21.0 ft.	Moist, yellowish brown sand with silt	24.8
BB-RAR-120	8D, 9D	34.0-40.0 ft.	Moist, yellowish brown silty sand	28.8
BB-RAR-120	12D, 13D	54.0-61.0 ft.	Moist, yellowish brown silty sand	17.4
BB-RAR-121	1D	0.5-2.0 ft.	Moist, grayish brown sand with silt and gravel	2.6
BB-RAR-121	2D	2.0-4.0 ft.	Moist, olive brown sand with silt	4.4

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-101	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 08/31/12	Checked By:	jdt
Depth : 0.5-2.5 ft.	Test Id: 248300		
Test Comment:	---		
Sample Description:	Moist, grayish brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	14.6	75.5	9.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	96		
0.375 in	9.50	92		
#4	4.75	85		
#10	2.00	75		
#20	0.85	48		
#40	0.42	30		
#60	0.25	21		
#100	0.15	15		
#200	0.075	10		

Coefficients

D_{85} = 4.6170 mm D_{30} = 0.4225 mm

D_{60} = 1.2426 mm D_{15} = 0.1485 mm

D_{50} = 0.8995 mm D_{10} = 0.0764 mm

C_u = 16.264 C_c = 1.880

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

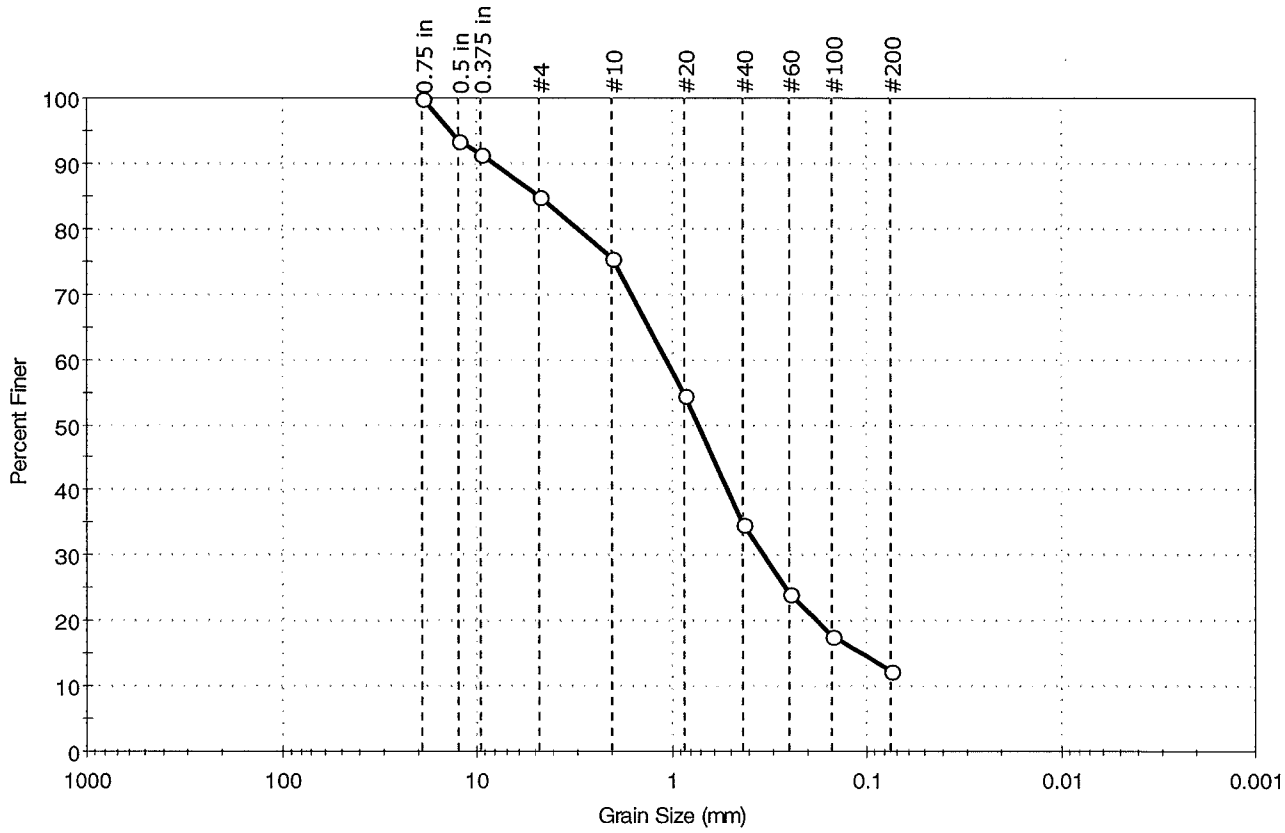
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-101	Sample Type: jar	Tested By:	jbr
Sample ID:2D	Test Date: 08/29/12	Checked By:	jdt
Depth : 2.0-4.0 ft.	Test Id: 248301		
Test Comment:	---		
Sample Description:	Moist, dark yellowish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.0	72.5	12.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	93		
0.375 in	9.50	92		
#4	4.75	85		
#10	2.00	75		
#20	0.85	55		
#40	0.42	35		
#60	0.25	24		
#100	0.15	18		
#200	0.075	12		

Coefficients

D_{85} =4.7734 mm D_{30} =0.3331 mm

D_{60} =1.0623 mm D_{15} =0.1049 mm

D_{50} =0.7238 mm D_{10} =0.0541 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

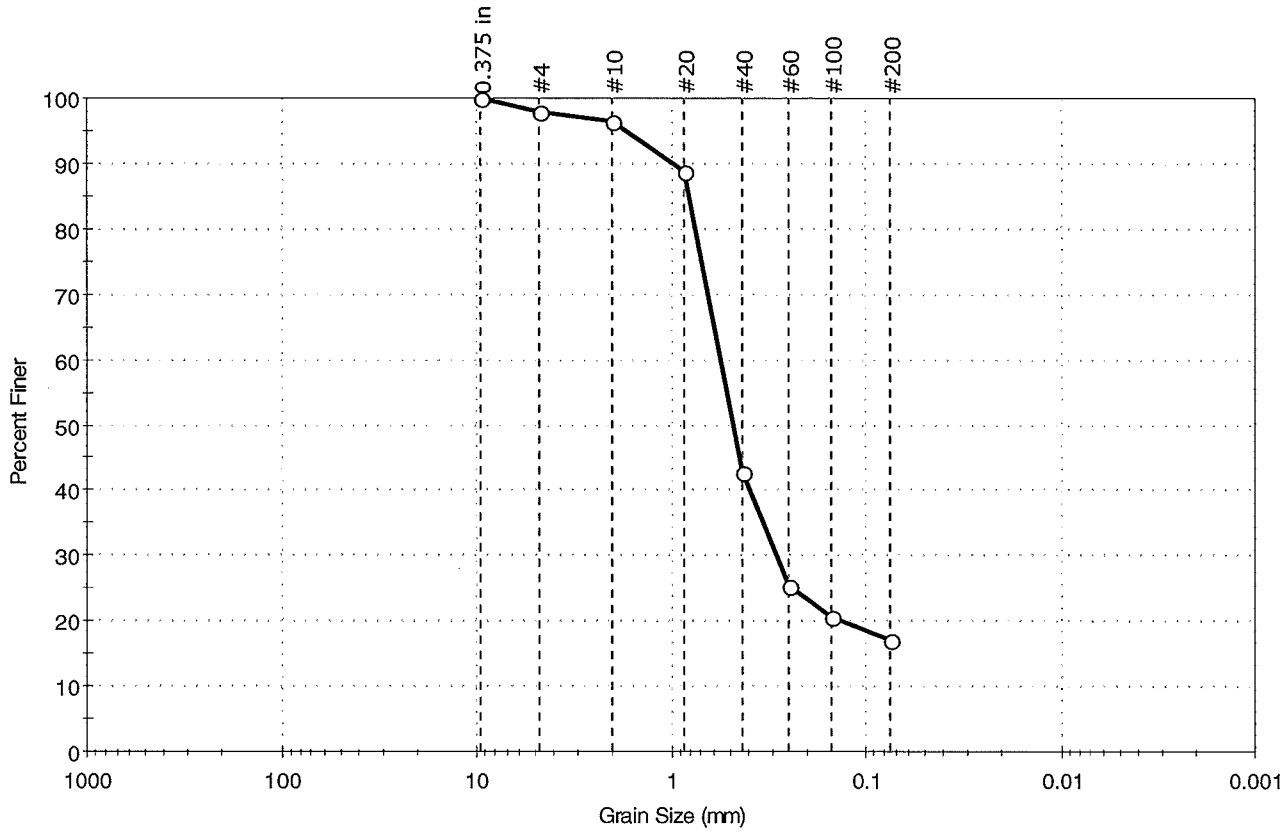
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-101	Sample Type: jar	Tested By:	jbr
Sample ID:3D	Test Date: 09/04/12	Checked By:	jdt
Depth : 4.0-6.0 ft.	Test Id: 248302		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.1	80.8	17.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	96		
#20	0.85	89		
#40	0.42	43		
#60	0.25	25		
#100	0.15	21		
#200	0.075	17		

Coefficients

D_{85} = 0.8034 mm D_{30} = 0.2884 mm
D_{60} = 0.5506 mm D_{15} = N/A
D_{50} = 0.4733 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

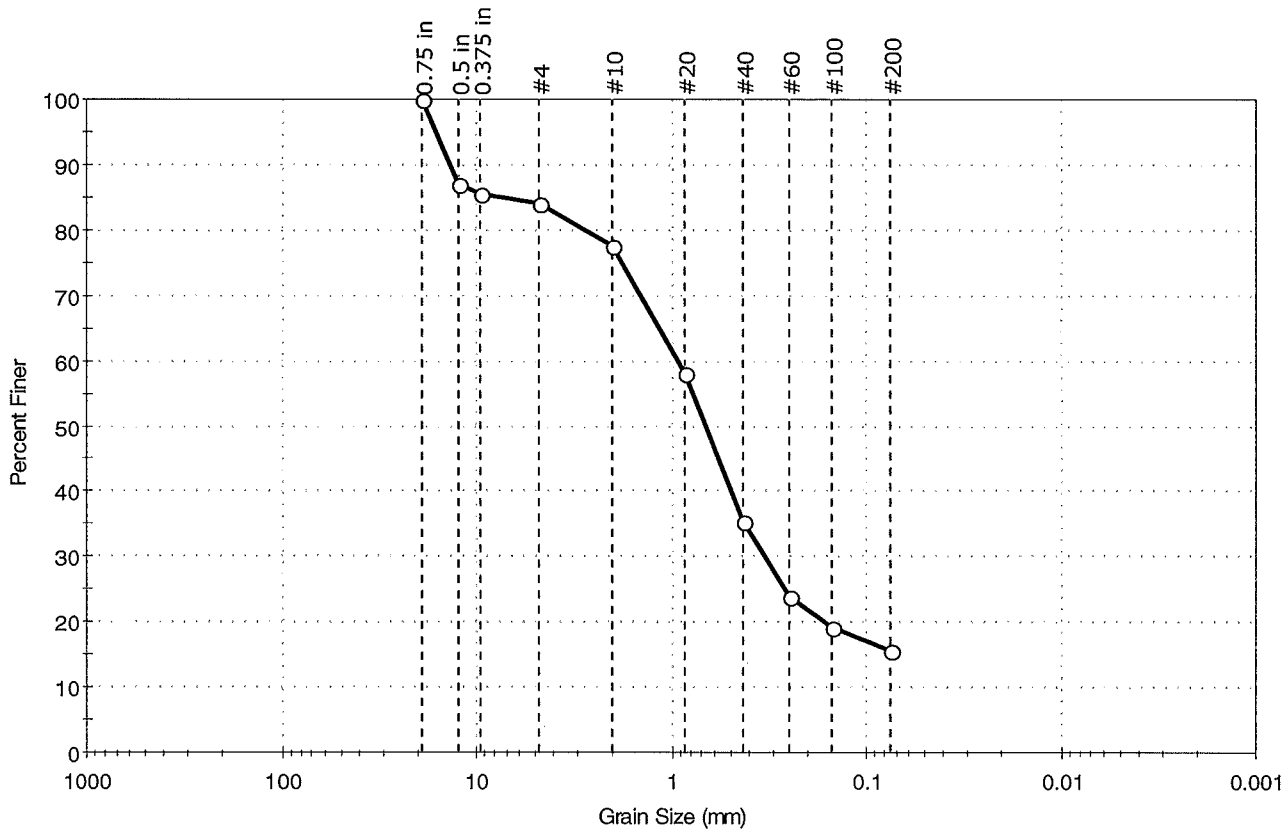
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-102	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 08/29/12	Checked By:	jdt
Depth : 1.0-2.0 ft.	Test Id: 248303		
Test Comment:	---		
Sample Description:	Moist, dark yellowish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.0	68.5	15.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	87		
0.375 in	9.50	86		
#4	4.75	84		
#10	2.00	78		
#20	0.85	58		
#40	0.42	35		
#60	0.25	24		
#100	0.15	19		
#200	0.075	16		

Coefficients

D_{85} = 7.4015 mm D_{30} = 0.3329 mm
D_{60} = 0.9255 mm D_{15} = N/A
D_{50} = 0.6648 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

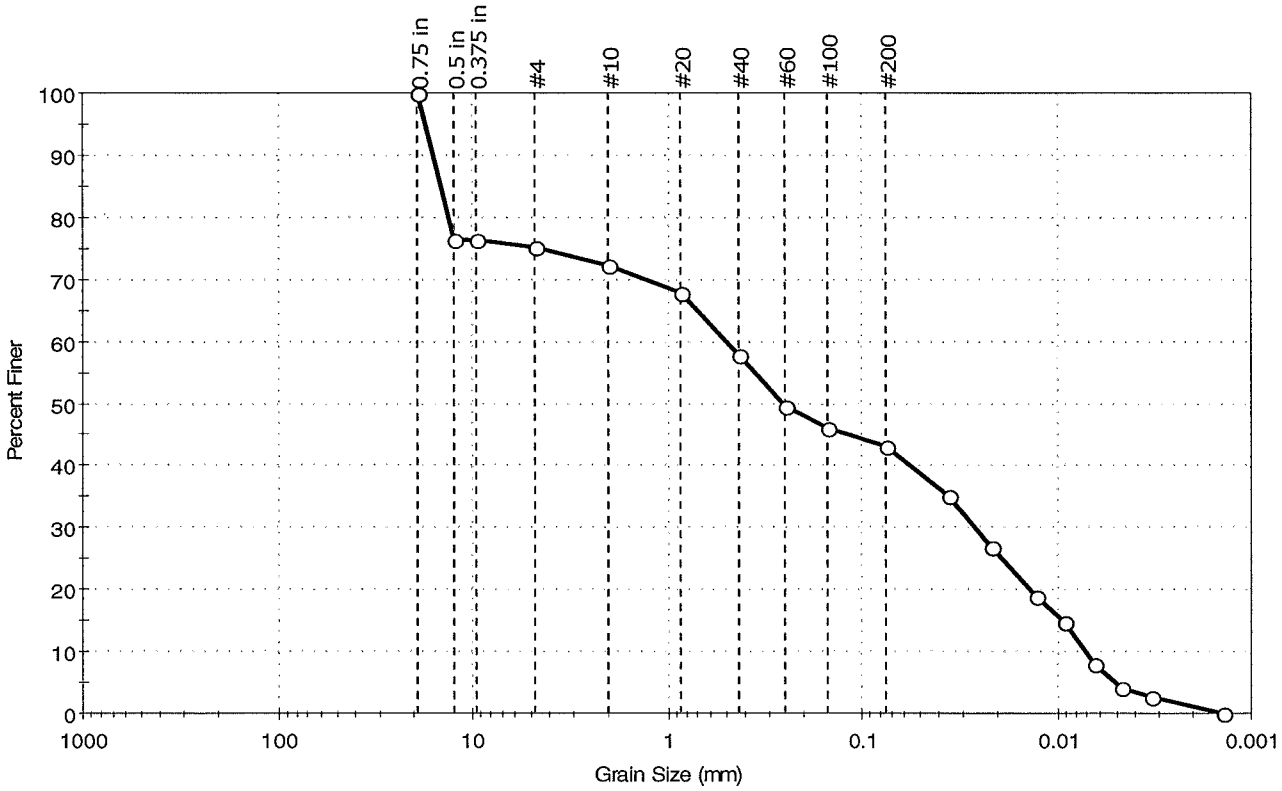
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-102	Sample Type: jar	Tested By:	jbr
Sample ID:1DA	Test Date: 08/29/12	Checked By:	jdt
Depth : 2.0-3.0 ft.	Test Id: 248374		
Test Comment:	---		
Sample Description:	Moist, reddish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	24.9	32.2	42.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	76		
0.375 in	9.50	76		
#4	4.75	75		
#10	2.00	72		
#20	0.85	68		
#40	0.42	58		
#60	0.25	50		
#100	0.15	46		
#200	0.075	43		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0355	35		
---	0.0216	27		
---	0.0129	19		
---	0.0092	15		
---	0.0065	8		
---	0.0047	4		
---	0.0033	3		
---	0.0014	0		

Coefficients

D_{85} = 14.5688 mm D_{30} = 0.0261 mm
D_{60} = 0.4941 mm D_{15} = 0.0093 mm
D_{50} = 0.2573 mm D_{10} = 0.0071 mm
C_u = N/A C_c = N/A

Classification

ASTM Silty sand with gravel (SM)

AASHTO Clayey Soils (A-7-5 (5))

Sample/Test Description

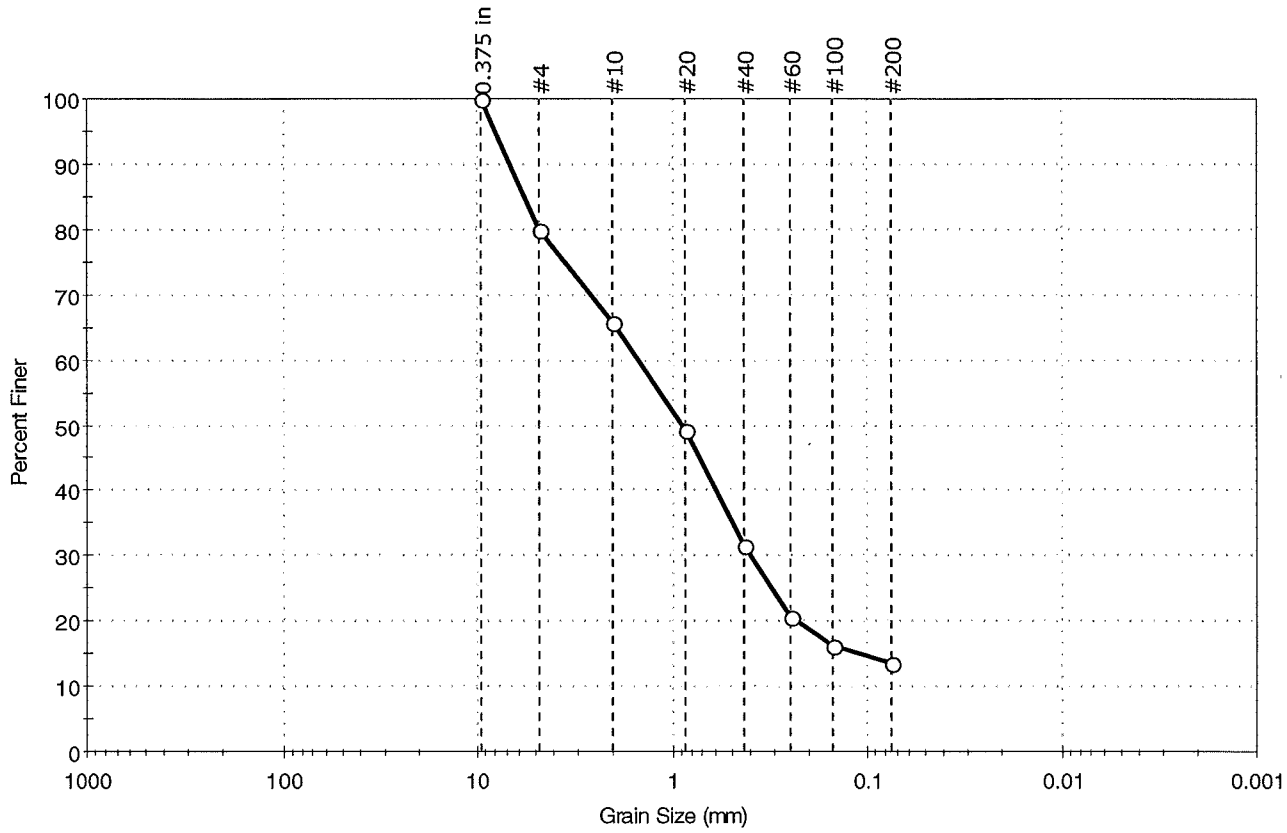
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-102	Sample Type: jar	Tested By:	jbr
Sample ID:2D	Test Date: 08/29/12	Checked By:	jdt
Depth : 3.0-5.0 ft.	Test Id: 248304		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	20.1	66.3	13.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	80		
#10	2.00	66		
#20	0.85	49		
#40	0.42	31		
#60	0.25	21		
#100	0.15	16		
#200	0.075	14		

Coefficients

D_{85} = 5.6635 mm D_{30} = 0.3949 mm

D_{60} = 1.4883 mm D_{15} = 0.1077 mm

D_{50} = 0.8870 mm D_{10} = 0.0308 mm

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

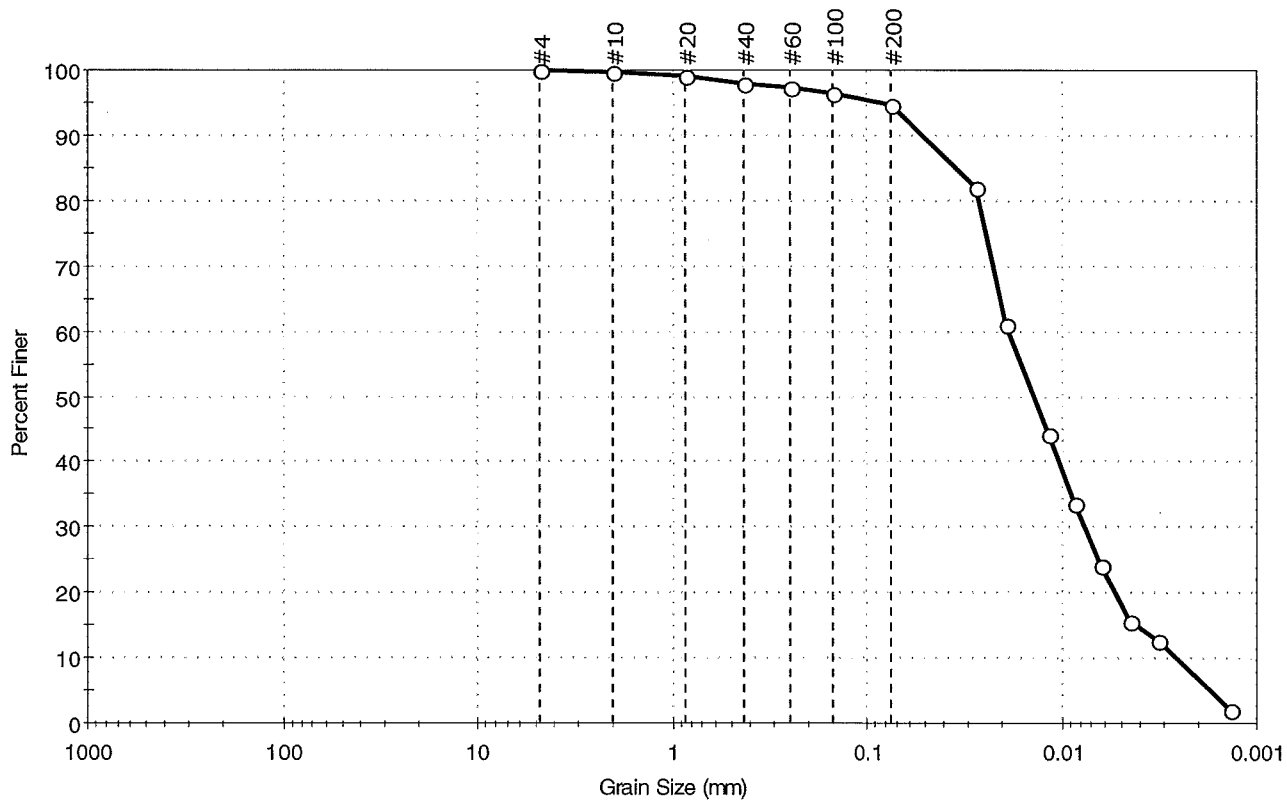
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-103	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 08/29/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248375		
Test Comment:	---		
Sample Description:	Moist, dark yellowish brown silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	5.3	94.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	96		
#200	0.075	95		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0279	82		
---	0.0192	61		
---	0.0118	44		
---	0.0086	34		
---	0.0063	24		
---	0.0045	16		
---	0.0032	13		
---	0.0014	2		

Coefficients

D_{85} = 0.0351 mm D_{30} = 0.0076 mm
D_{60} = 0.0187 mm D_{15} = 0.0042 mm
D_{50} = 0.0139 mm D_{10} = 0.0026 mm
C_u = N/A C_c = N/A

Classification

ASTM elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (19))

Sample/Test Description

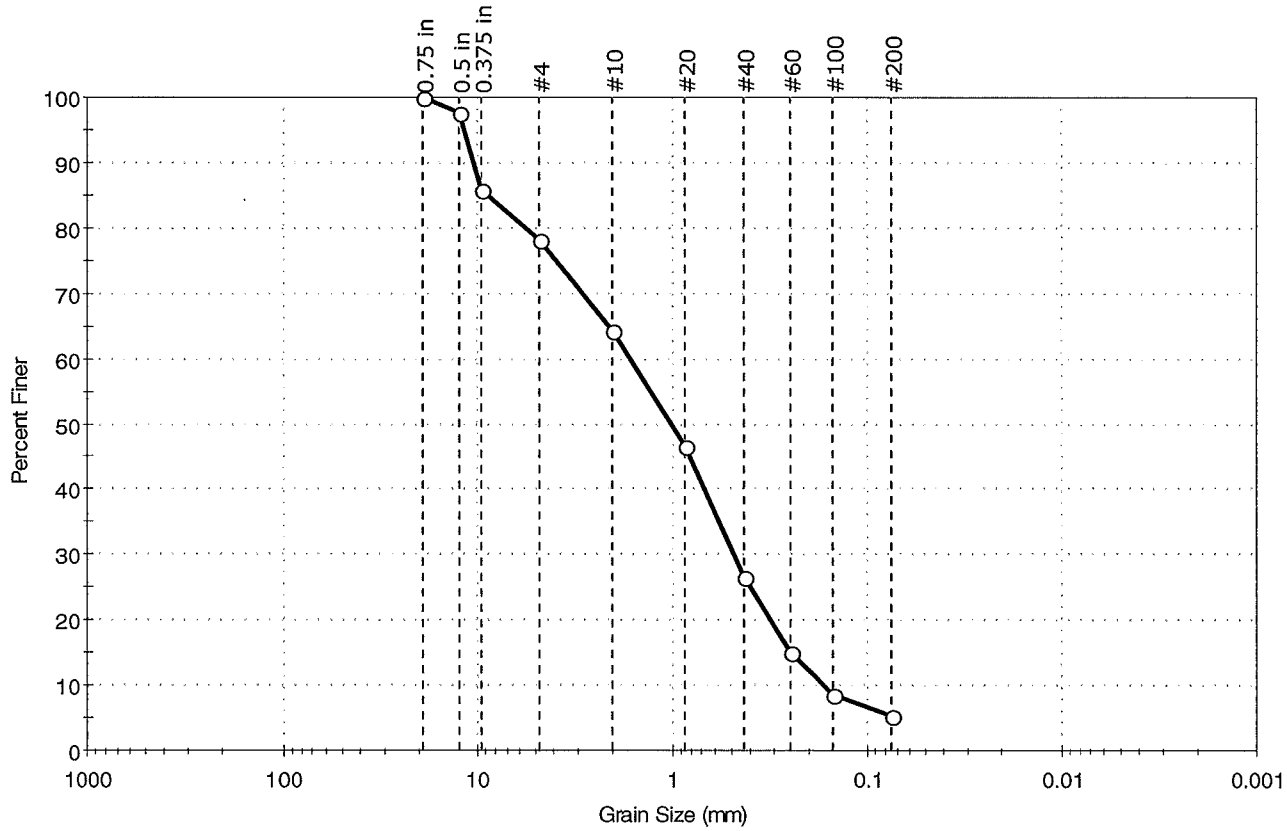
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-103	Sample Type: jar	Tested By:	jbr
Sample ID:2D	Test Date: 09/04/12	Checked By:	jdt
Depth : 2.0-4.0 ft.	Test Id: 248305		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand with silt and gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	21.9	72.7	5.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	98		
0.375 in	9.50	86		
#4	4.75	78		
#10	2.00	64		
#20	0.85	47		
#40	0.42	27		
#60	0.25	15		
#100	0.15	8		
#200	0.075	5		

Coefficients

D_{85} = 8.7265 mm D_{30} = 0.4787 mm
D_{60} = 1.6250 mm D_{15} = 0.2502 mm
D_{50} = 1.0031 mm D_{10} = 0.1692 mm
C_u = 9.604 C_c = 0.833

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

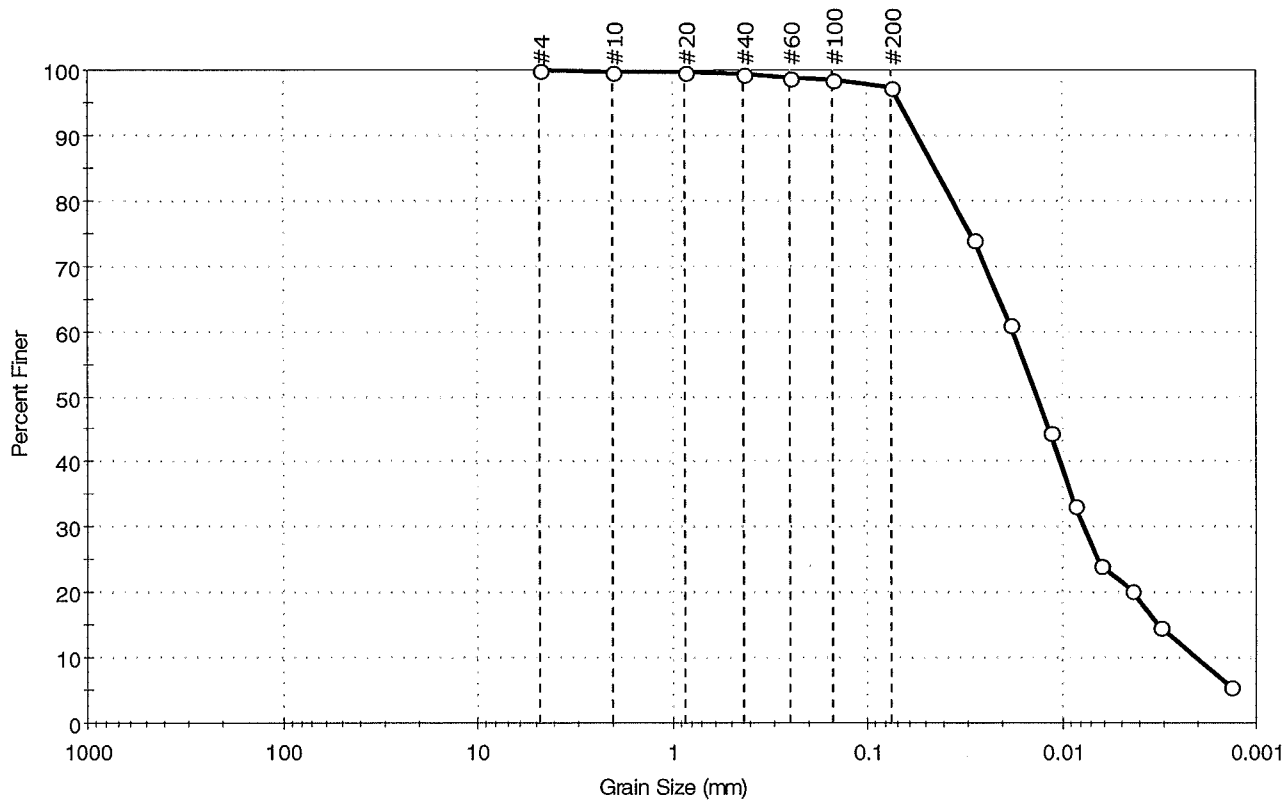
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-104	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 08/30/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248376		
Test Comment:	---		
Sample Description:	Moist, grayish brown silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	2.7	97.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#200	0.075	97		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0282	74		
---	0.0185	61		
---	0.0115	45		
---	0.0085	33		
---	0.0062	24		
---	0.0044	20		
---	0.0032	15		
---	0.0014	6		

Coefficients

D_{85} = 0.0446 mm D_{30} = 0.0076 mm
D_{60} = 0.0179 mm D_{15} = 0.0032 mm
D_{50} = 0.0134 mm D_{10} = 0.0021 mm
C_u = N/A C_c = N/A

Classification

ASTM elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (20))

Sample/Test Description

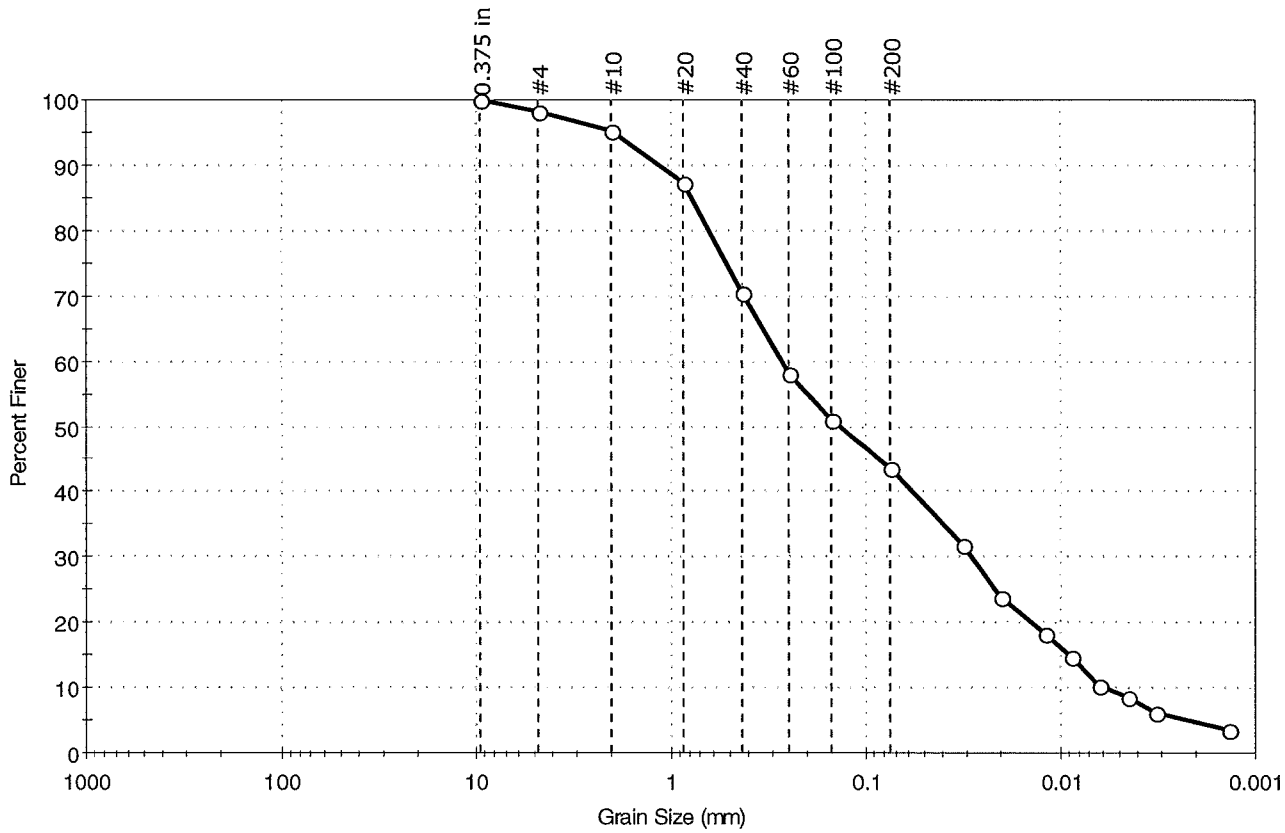
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-104	Sample Type: jar	Tested By:	jbr
Sample ID:2D	Test Date: 08/29/12	Checked By:	jdt
Depth : 2.0-4.0 ft.	Test Id: 248377		
Test Comment:	---		
Sample Description:	Moist, olive brown silty, clayey sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.8	54.7	43.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	95		
#20	0.85	87		
#40	0.42	70		
#60	0.25	58		
#100	0.15	51		
#200	0.075	44		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0317	32		
---	0.0203	24		
---	0.0120	18		
---	0.0088	15		
---	0.0063	10		
---	0.0045	9		
---	0.0032	6		
---	0.0014	3		

Coefficients

D_{85} = 0.7755 mm	D_{30} = 0.0285 mm
D_{60} = 0.2719 mm	D_{15} = 0.0089 mm
D_{50} = 0.1370 mm	D_{10} = 0.0060 mm
C_u = N/A	C_c = N/A

Classification

ASTM Silty, clayey sand (SC-SM)

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

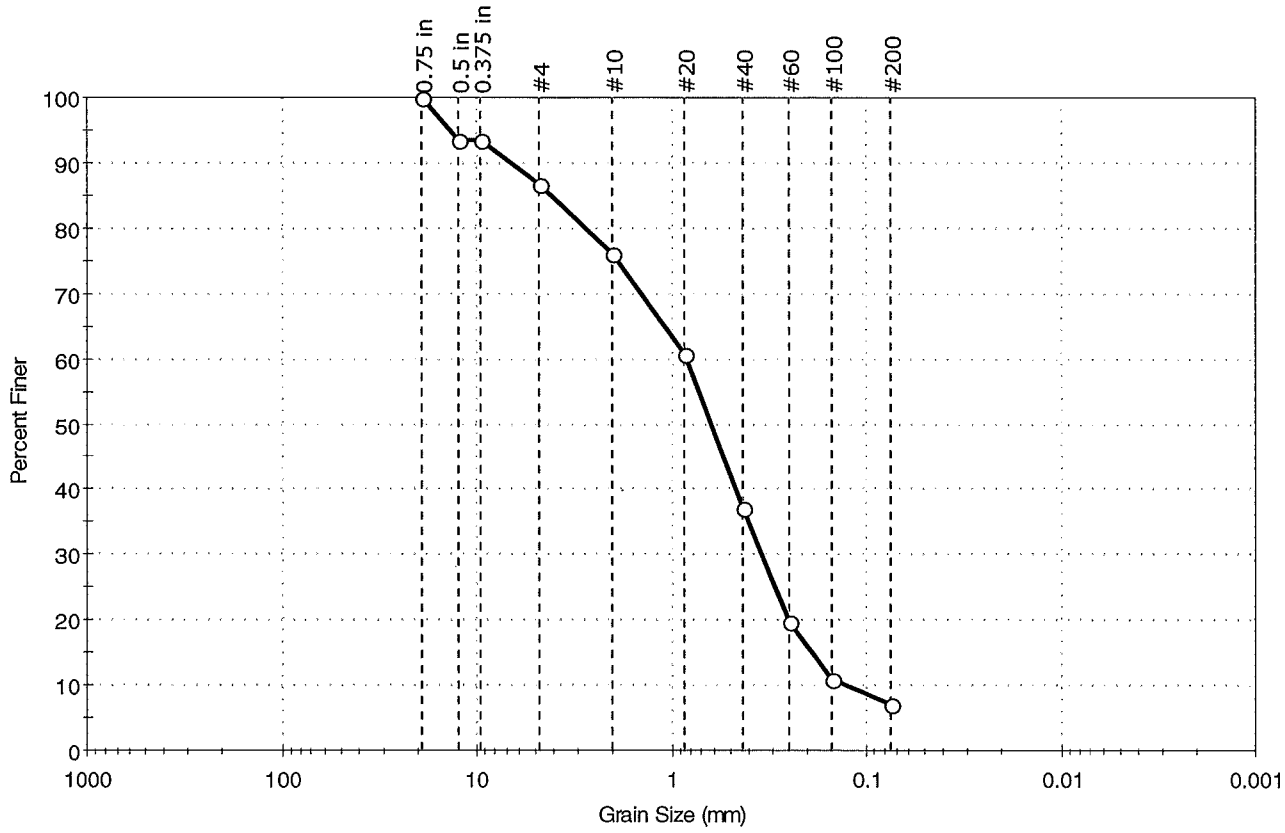
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-104	Sample Type: jar	Tested By:	jbr
Sample ID:3D	Test Date: 09/04/12	Checked By:	jdt
Depth : 4.0-6.0 ft.	Test Id: 248306		
Test Comment:	---		
Sample Description:	Moist, olive brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	13.3	79.5	7.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	93		
0.375 in	9.50	93		
#4	4.75	87		
#10	2.00	76		
#20	0.85	61		
#40	0.42	37		
#60	0.25	20		
#100	0.15	11		
#200	0.075	7		

Coefficients

D_{85} =4.1292 mm D_{30} =0.3417 mm

D_{60} =0.8332 mm D_{15} =0.1900 mm

D_{50} =0.6214 mm D_{10} =0.1290 mm

C_u =6.459 C_c =1.086

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

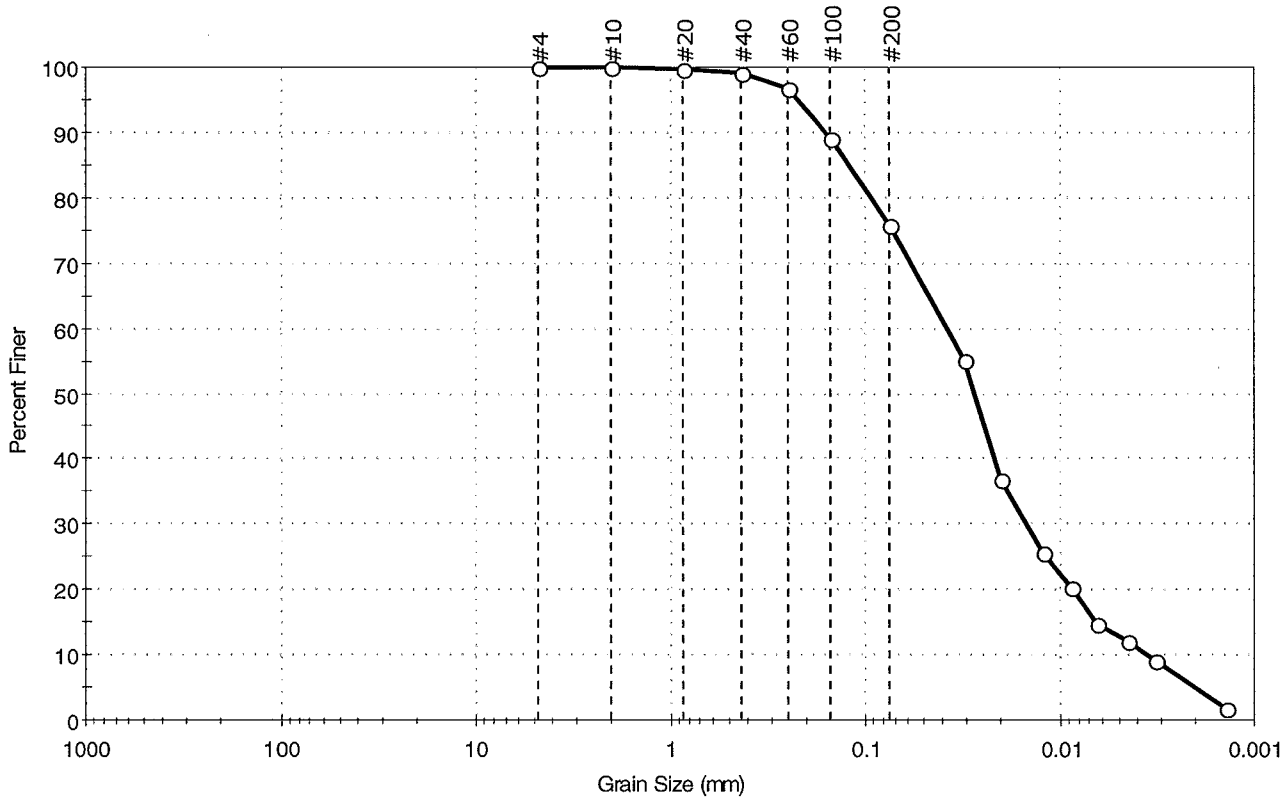
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-106	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 08/30/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248378		
Test Comment:	---		
Sample Description:	Moist, grayish brown silt with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	24.2	75.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	97		
#100	0.15	89		
#200	0.075	76		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0313	55		
---	0.0204	37		
---	0.0122	26		
---	0.0089	20		
---	0.0064	15		
---	0.0045	12		
---	0.0032	9		
---	0.0014	2		

Coefficients

D_{85} = 0.1207 mm D_{30} = 0.0149 mm
D_{60} = 0.0384 mm D_{15} = 0.0065 mm
D_{50} = 0.0277 mm D_{10} = 0.0035 mm
C_u = N/A C_c = N/A

Classification

ASTM silt with sand (ML)

AASHTO Clayey Soils (A-7-6 (9))

Sample/Test Description

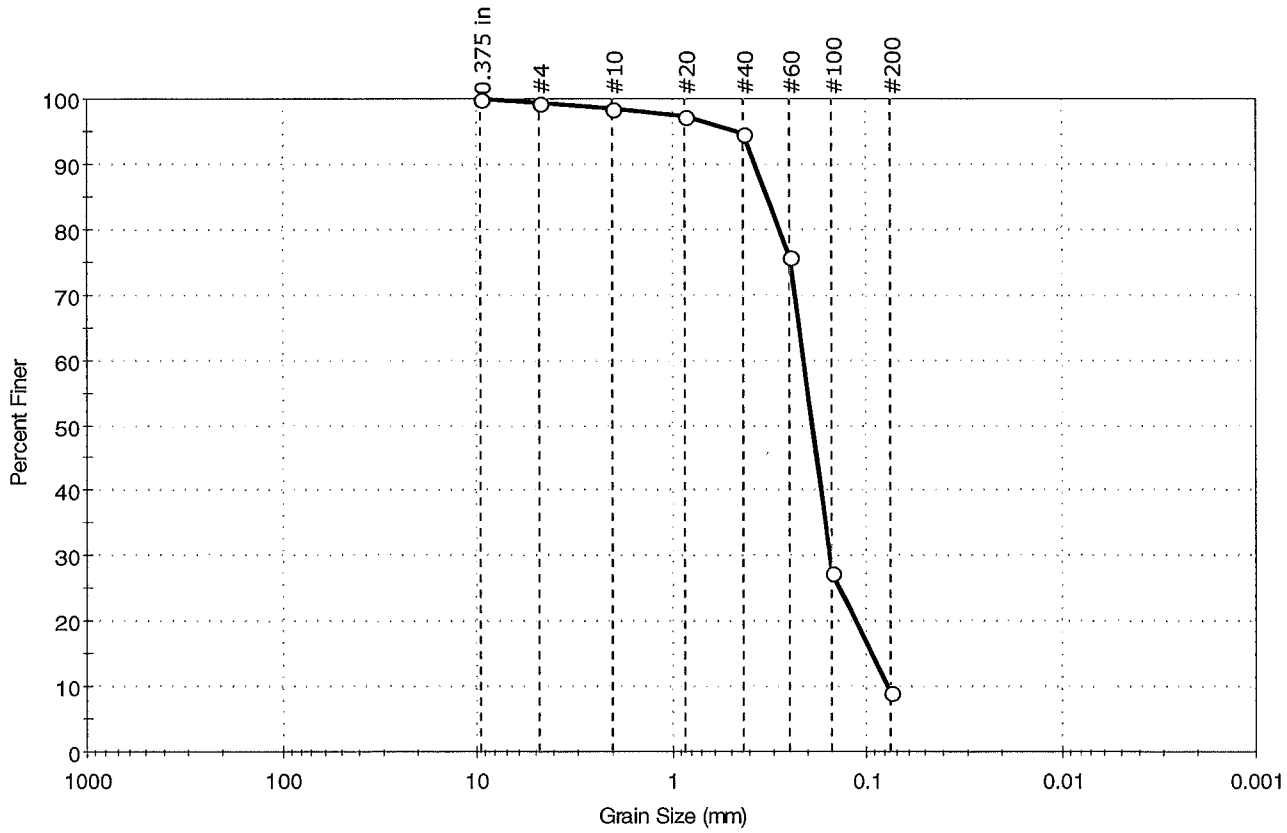
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-110	Sample Type: jar	Tested By:	jbr
Sample ID:6D, 7D	Test Date: 09/05/12	Checked By:	jdt
Depth : 14.0-21.0 ft.	Test Id: 248309		
Test Comment:	---		
Sample Description:	Moist, brownish gray sand with silt		
Sample Comment:	Sample contains organics		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	90.3	9.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	99		
#20	0.85	97		
#40	0.42	95		
#60	0.25	76		
#100	0.15	27		
#200	0.075	9		

Coefficients

D_{85} = 0.3231 mm D_{30} = 0.1542 mm

D_{60} = 0.2115 mm D_{15} = 0.0939 mm

D_{50} = 0.1903 mm D_{10} = 0.0777 mm

C_u = 2.722 C_c = 1.447

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

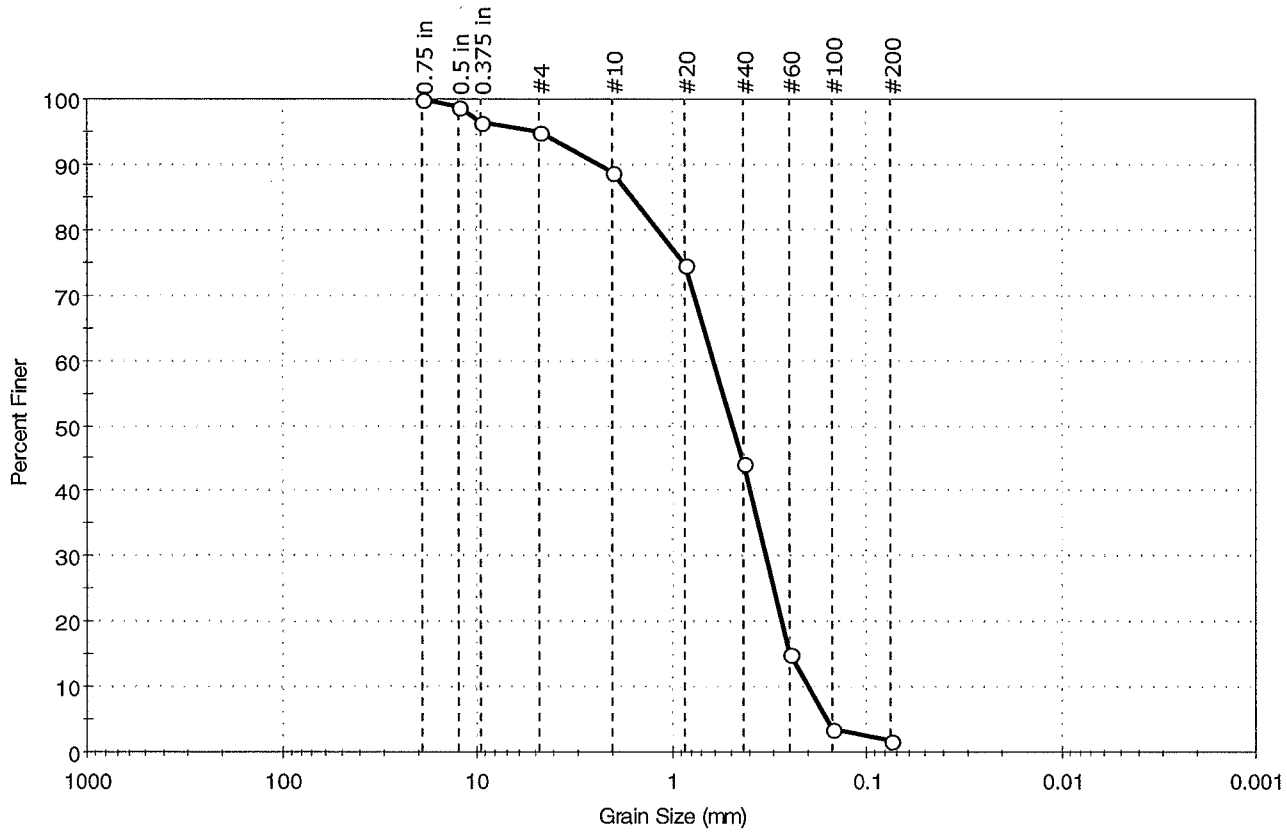
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-110	Sample Type: jar	Tested By:	jbr
Sample ID:14D, 15D	Test Date: 08/31/12	Checked By:	jdt
Depth : 54.0-61.0 ft.	Test Id: 248310		
Test Comment:	---		
Sample Description:	Moist, grayish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.1	93.2	1.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	97		
#4	4.75	95		
#10	2.00	89		
#20	0.85	75		
#40	0.42	44		
#60	0.25	15		
#100	0.15	4		
#200	0.075	2		

Coefficients

D_{85} = 1.5976 mm D_{30} = 0.3277 mm

D_{60} = 0.6090 mm D_{15} = 0.2486 mm

D_{50} = 0.4843 mm D_{10} = 0.1990 mm

C_u = 3.060 C_c = 0.886

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

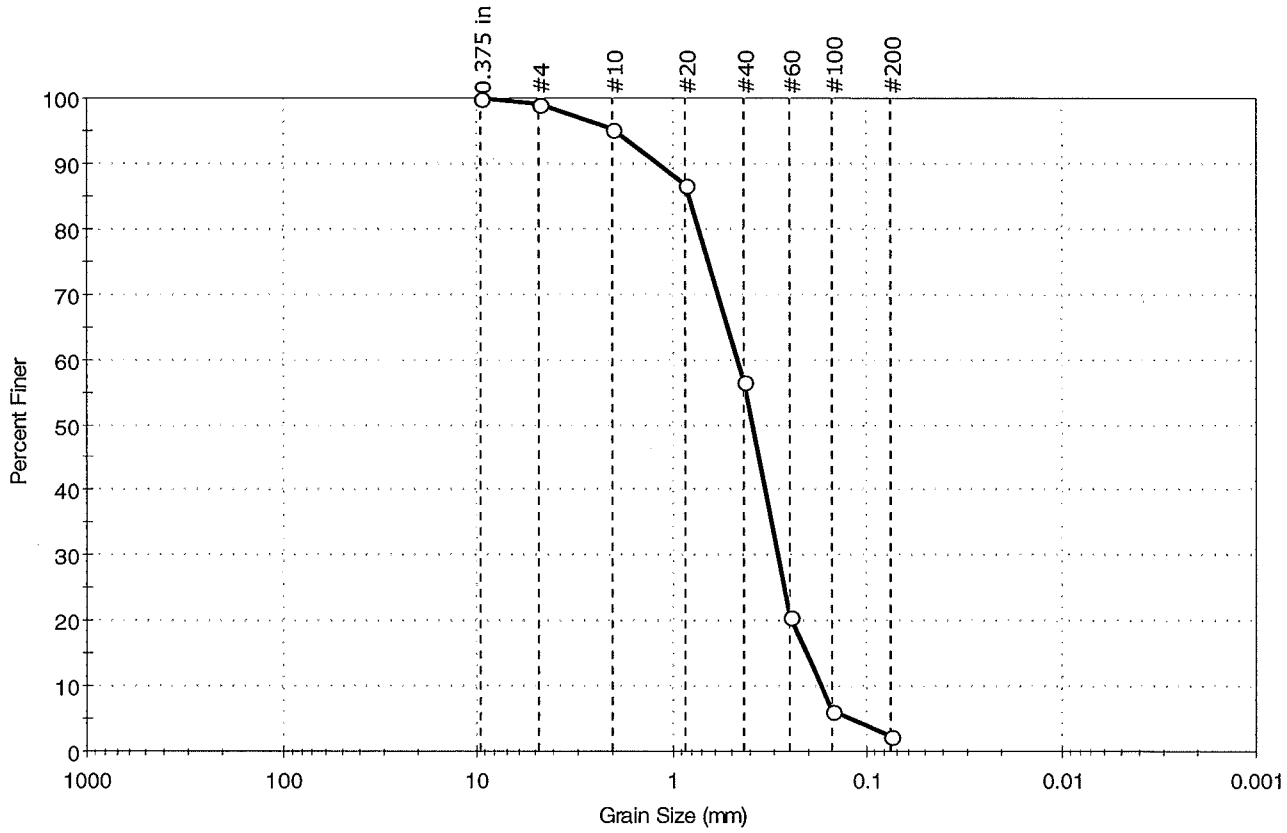
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-110	Sample Type: jar	Tested By:	jbr
Sample ID:19D, 20D	Test Date: 09/04/12	Checked By:	jdt
Depth : 79.0-86.0 ft.	Test Id: 248311		
Test Comment:	---		
Sample Description:	Moist, grayish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.8	96.7	2.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	95		
#20	0.85	87		
#40	0.42	57		
#60	0.25	21		
#100	0.15	6		
#200	0.075	2		

Coefficients

D_{85} = 0.8166 mm D_{30} = 0.2864 mm

D_{60} = 0.4579 mm D_{15} = 0.2042 mm

D_{50} = 0.3846 mm D_{10} = 0.1714 mm

C_u = 2.672 C_c = 1.045

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

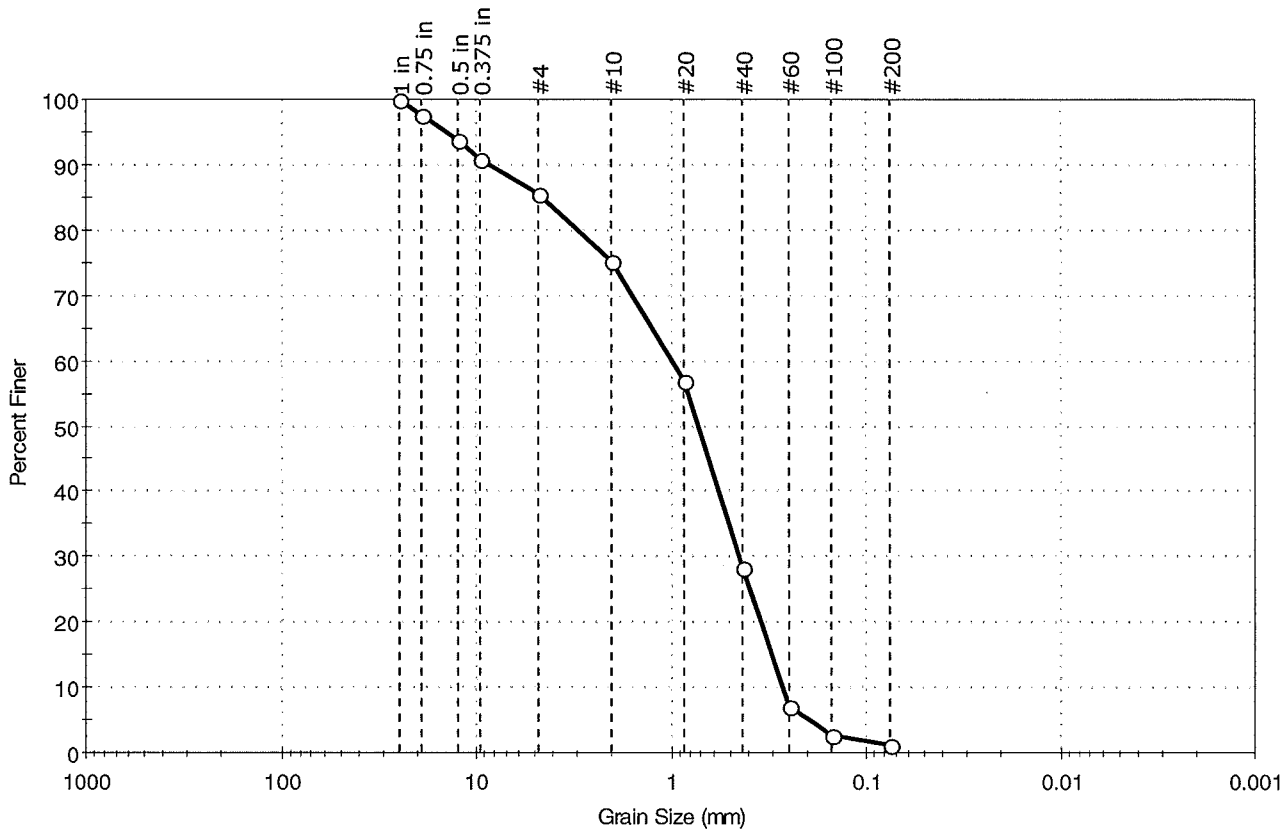
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-110	Sample Type: jar	Tested By:	jbr
Sample ID:23D, 24D	Test Date: 08/29/12	Checked By:	jdt
Depth : 99.0-106.0 ft.	Test Id: 248312		
Test Comment: ---			
Sample Description: Moist, grayish brown sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	14.3	84.4	1.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	98		
0.5 in	12.50	94		
0.375 in	9.50	91		
#4	4.75	86		
#10	2.00	75		
#20	0.85	57		
#40	0.42	28		
#60	0.25	7		
#100	0.15	3		
#200	0.075	1		

Coefficients

D_{85} = 4.5073 mm D_{30} = 0.4427 mm

D_{60} = 0.9753 mm D_{15} = 0.3046 mm

D_{50} = 0.7168 mm D_{10} = 0.2688 mm

C_u = 3.628 C_c = 0.748

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

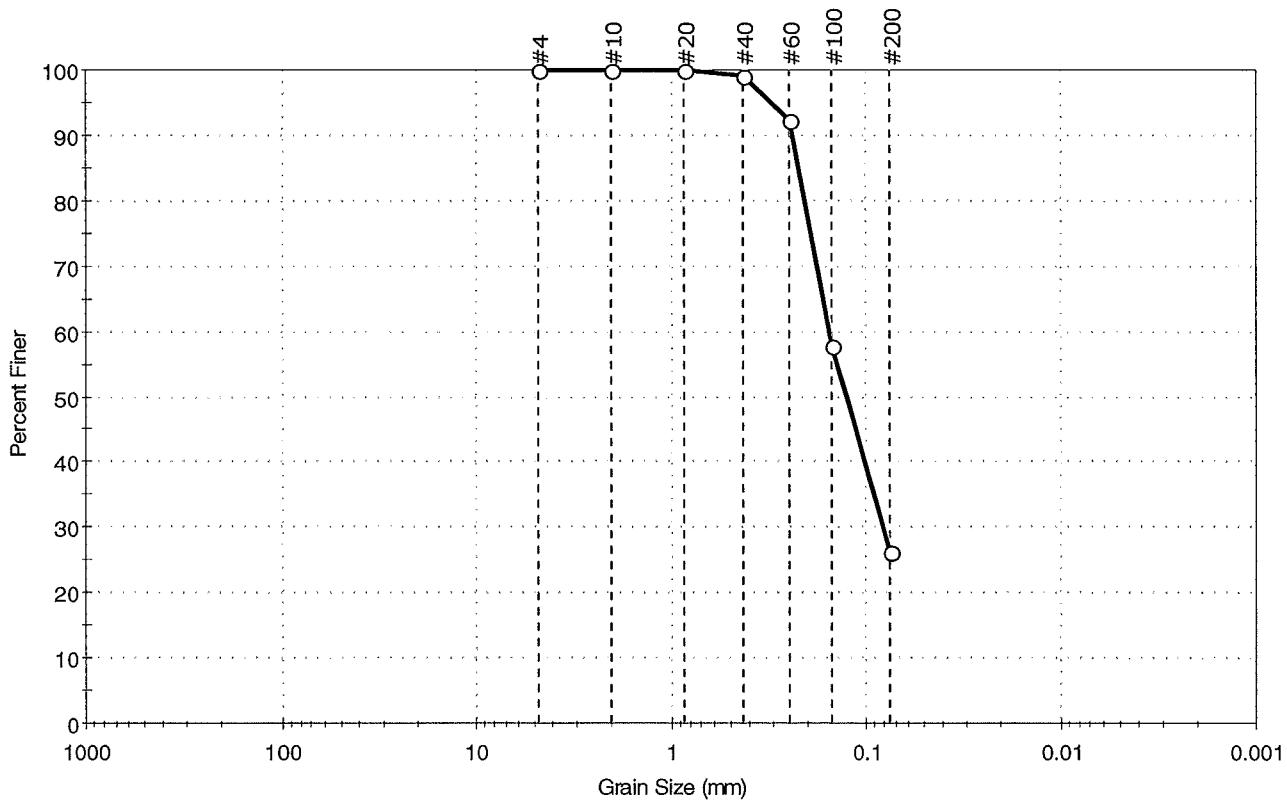
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-111	Sample Type: jar	Tested By:	jbr
Sample ID:2D, 3D	Test Date: 09/04/12	Checked By:	jdt
Depth : 5.0-11.0 ft.	Test Id: 248313		
Test Comment:	---		
Sample Description:	Moist, brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	73.6	26.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	92		
#100	0.15	58		
#200	0.075	26		

Coefficients

D_{85} = 0.2243 mm D_{30} = 0.0812 mm
D_{60} = 0.1549 mm D_{15} = N/A
D_{50} = 0.1262 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

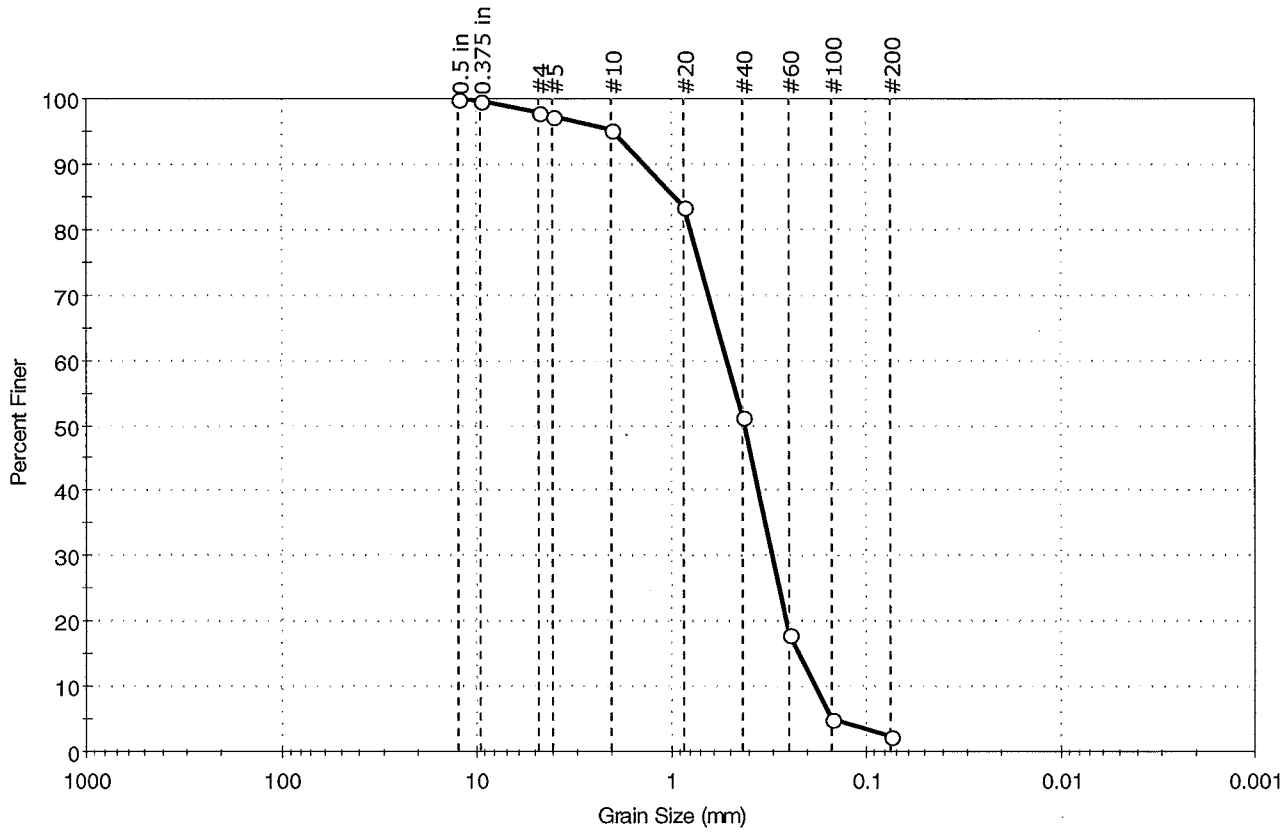
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-111	Sample Type: jar	Tested By:	jbr
Sample ID:15D, 16D	Test Date: 08/31/12	Checked By:	jdt
Depth : 69.0-76.0 ft.	Test Id: 248314		
Test Comment: ---			
Sample Description: Moist, yellowish brown sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	2.0	95.6	2.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	100		
#4	4.75	98		
#5	4.00	97		
#10	2.00	95		
#20	0.85	83		
#40	0.42	51		
#60	0.25	18		
#100	0.15	5		
#200	0.075	2		

Coefficients

D_{85} = 0.9482 mm D_{30} = 0.3029 mm
D_{60} = 0.5118 mm D_{15} = 0.2229 mm
D_{50} = 0.4157 mm D_{10} = 0.1826 mm
C_u = 2.803 C_c = 0.982

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

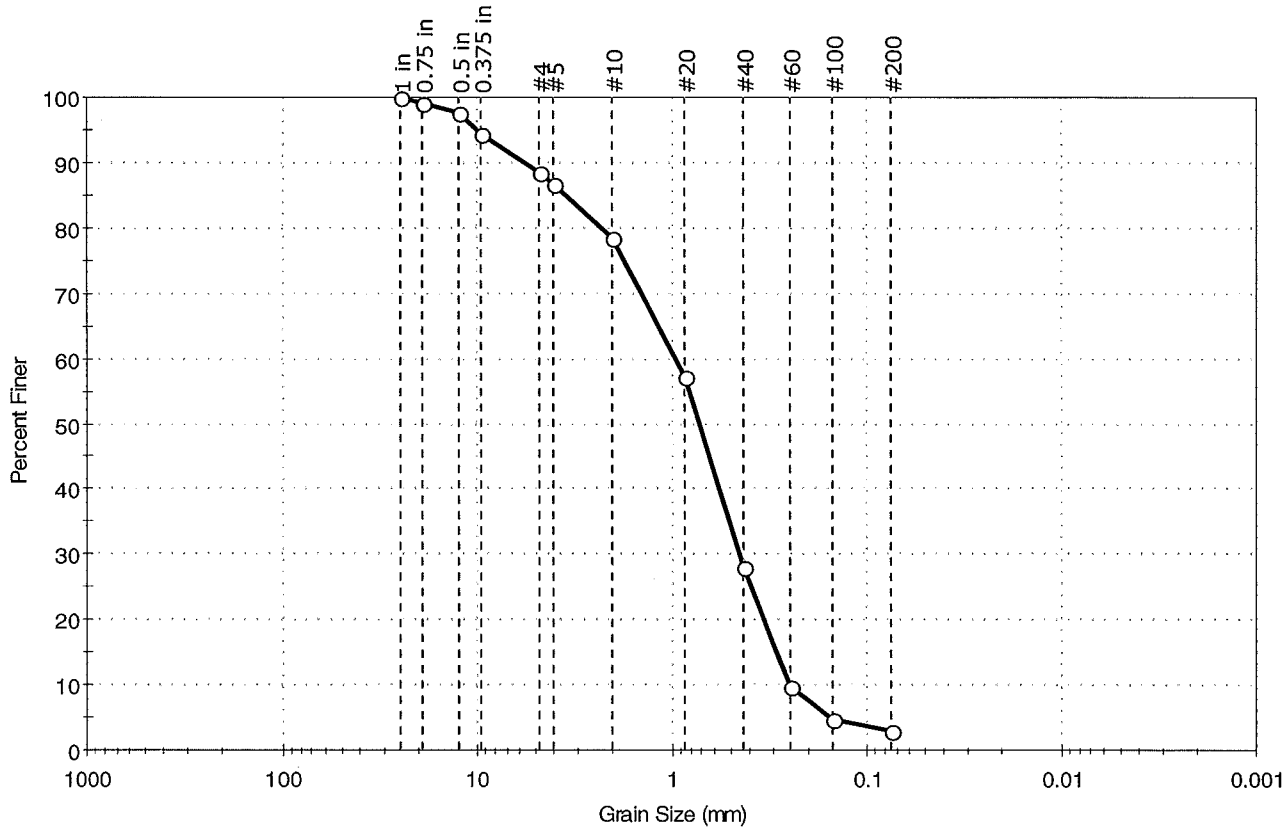
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-111	Sample Type: jar	Tested By:	jbr
Sample ID:19D, 20D	Test Date: 09/04/12	Checked By:	jdt
Depth : 90.0-97.0 ft.	Test Id: 248315		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	11.7	85.4	2.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	99		
0.5 in	12.50	98		
0.375 in	9.50	94		
#4	4.75	88		
#5	4.00	87		
#10	2.00	78		
#20	0.85	57		
#40	0.42	28		
#60	0.25	10		
#100	0.15	5		
#200	0.075	3		

Coefficients

D_{85} = 3.4767 mm D_{30} = 0.4450 mm
D_{60} = 0.9463 mm D_{15} = 0.2920 mm
D_{50} = 0.7141 mm D_{10} = 0.2529 mm
C_u = 3.742 C_c = 0.827

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

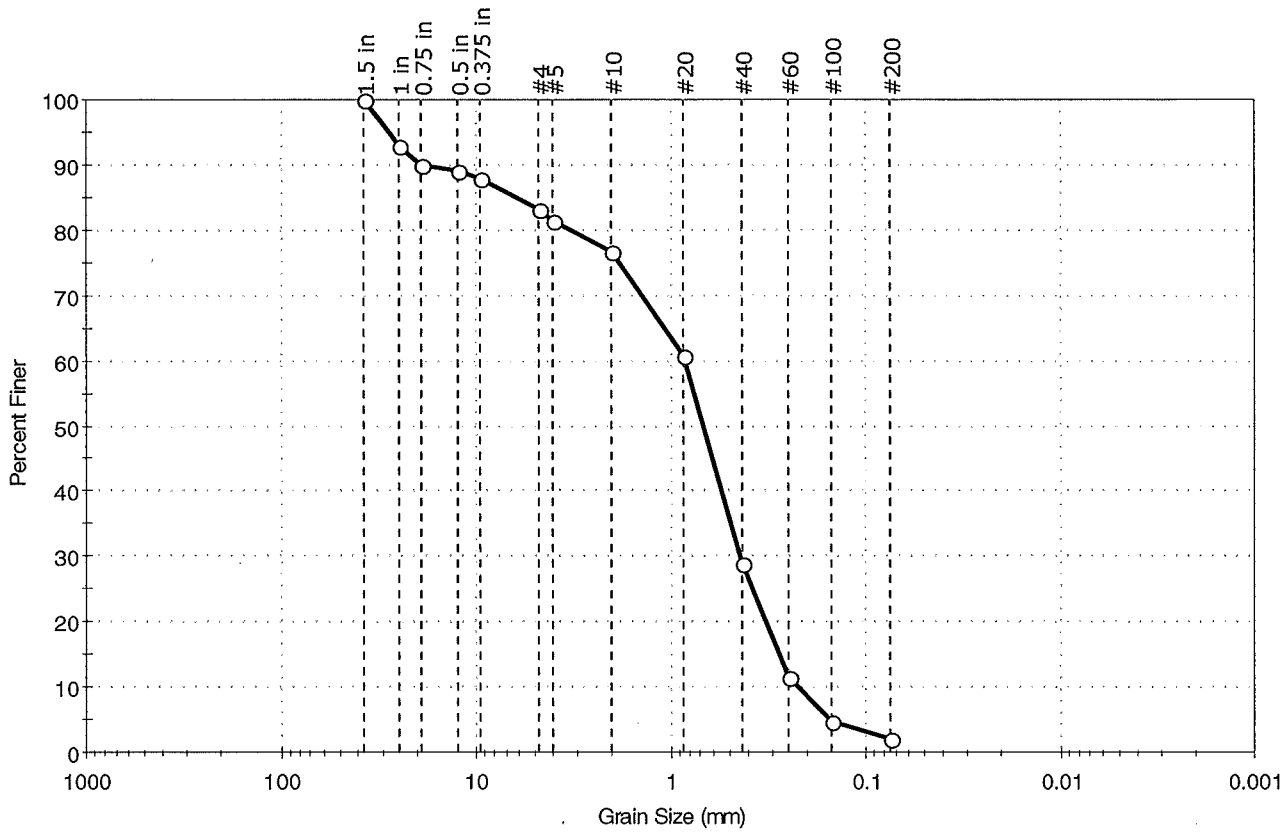
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-112	Sample Type: jar	Tested By:	jbr
Sample ID:8D, 9D	Test Date: 09/05/12	Checked By:	jdt
Depth : 24.0-31.0 ft.	Test Id: 248316		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.9	81.0	2.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	93		
0.75 in	19.00	90		
0.5 in	12.50	89		
0.375 in	9.50	88		
#4	4.75	83		
#5	4.00	82		
#10	2.00	77		
#20	0.85	61		
#40	0.42	29		
#60	0.25	12		
#100	0.15	5		
#200	0.075	2		

Coefficients

D_{85} = 6.2423 mm D_{30} = 0.4341 mm
D_{60} = 0.8378 mm D_{15} = 0.2778 mm
D_{50} = 0.6729 mm D_{10} = 0.2230 mm
C_u = 3.757 C_c = 1.009

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

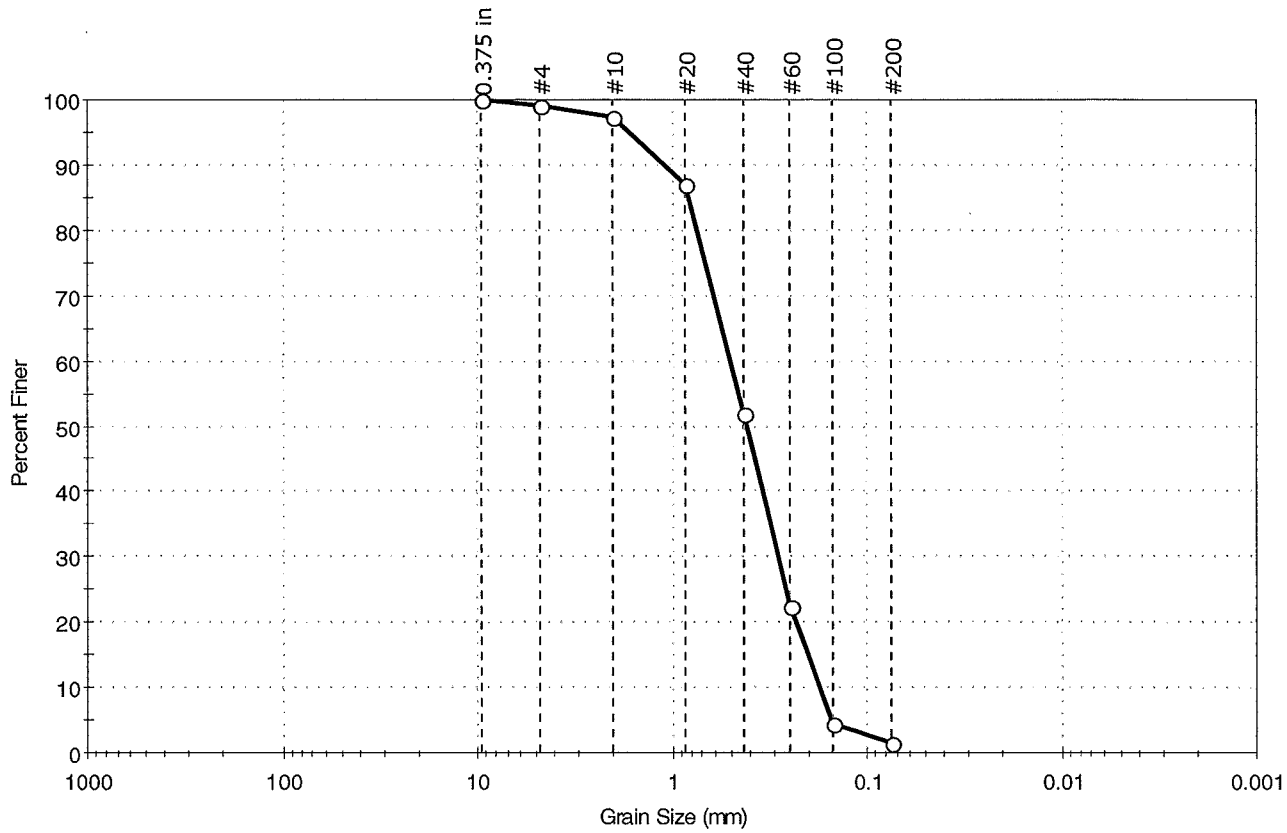
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-113	Sample Type: jar	Tested By:	jbr
Sample ID:9D, 10D	Test Date: 09/05/12	Checked By:	jdt
Depth : 29.0-36.0 ft.	Test Id: 248317		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.9	97.5	1.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	87		
#40	0.42	52		
#60	0.25	22		
#100	0.15	4		
#200	0.075	2		

Coefficients

D_{85} =0.8167 mm D_{30} =0.2866 mm

D_{60} =0.4984 mm D_{15} =0.2028 mm

D_{50} =0.4105 mm D_{10} =0.1761 mm

C_u =2.830 C_c =0.936

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

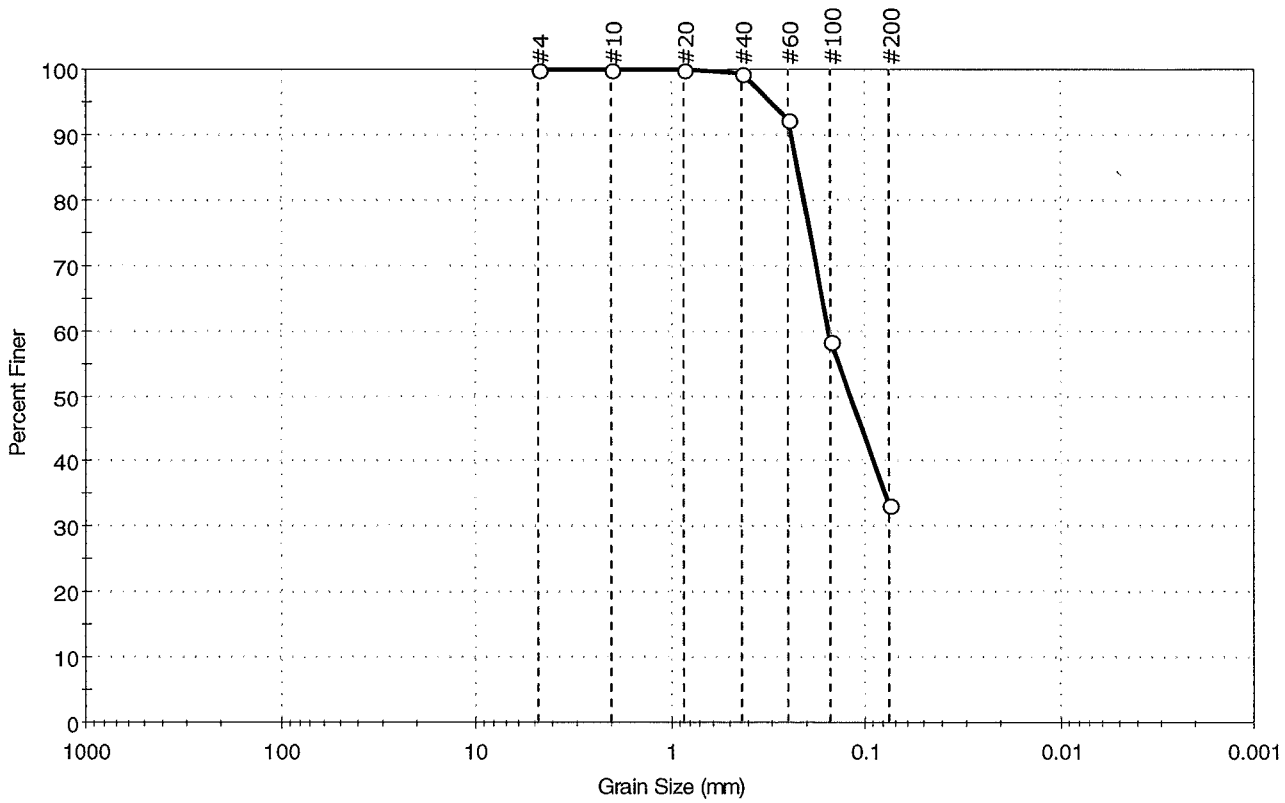
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-114	Sample Type: jar	Tested By:	jbr
Sample ID:3D, 4D	Test Date: 09/04/12	Checked By:	jdt
Depth : 4.0-8.0 ft.	Test Id: 248318		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	66.7	33.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	92		
#100	0.15	58		
#200	0.075	33		

Coefficients

D_{85} =0.2237 mm D_{30} =N/A

D_{60} =0.1537 mm D_{15} =N/A

D_{50} =0.1190 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

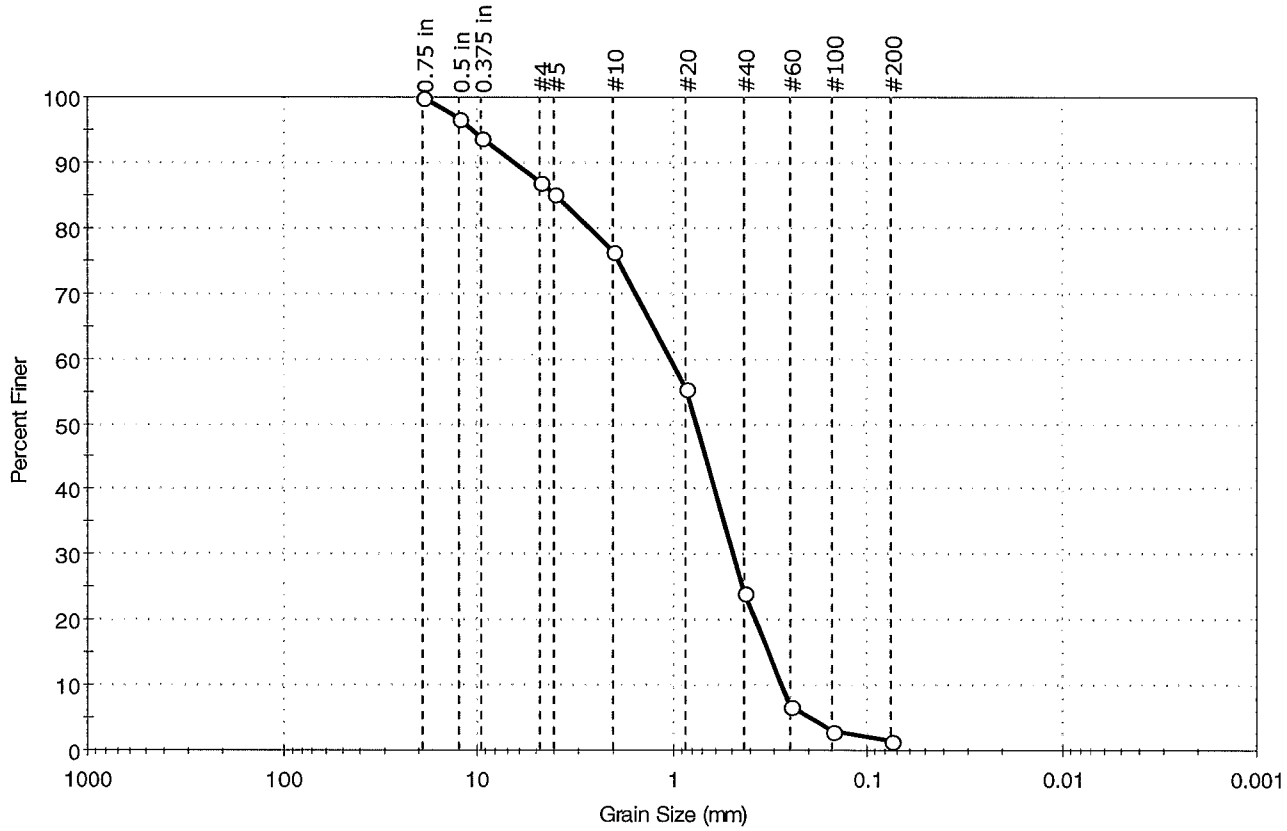
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-114	Sample Type: jar	Tested By:	jbr
Sample ID:11D, 12D	Test Date: 08/31/12	Checked By:	jdt
Depth : 39.0-46.0 ft.	Test Id: 248319		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	12.9	85.5	1.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	97		
0.375 in	9.50	94		
#4	4.75	87		
#5	4.00	85		
#10	2.00	77		
#20	0.85	56		
#40	0.42	24		
#60	0.25	7		
#100	0.15	3		
#200	0.075	2		

Coefficients

D_{85} = 3.9536 mm D_{30} = 0.4843 mm

D_{60} = 1.0185 mm D_{15} = 0.3216 mm

D_{50} = 0.7519 mm D_{10} = 0.2758 mm

C_u = 3.693 C_c = 0.835

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

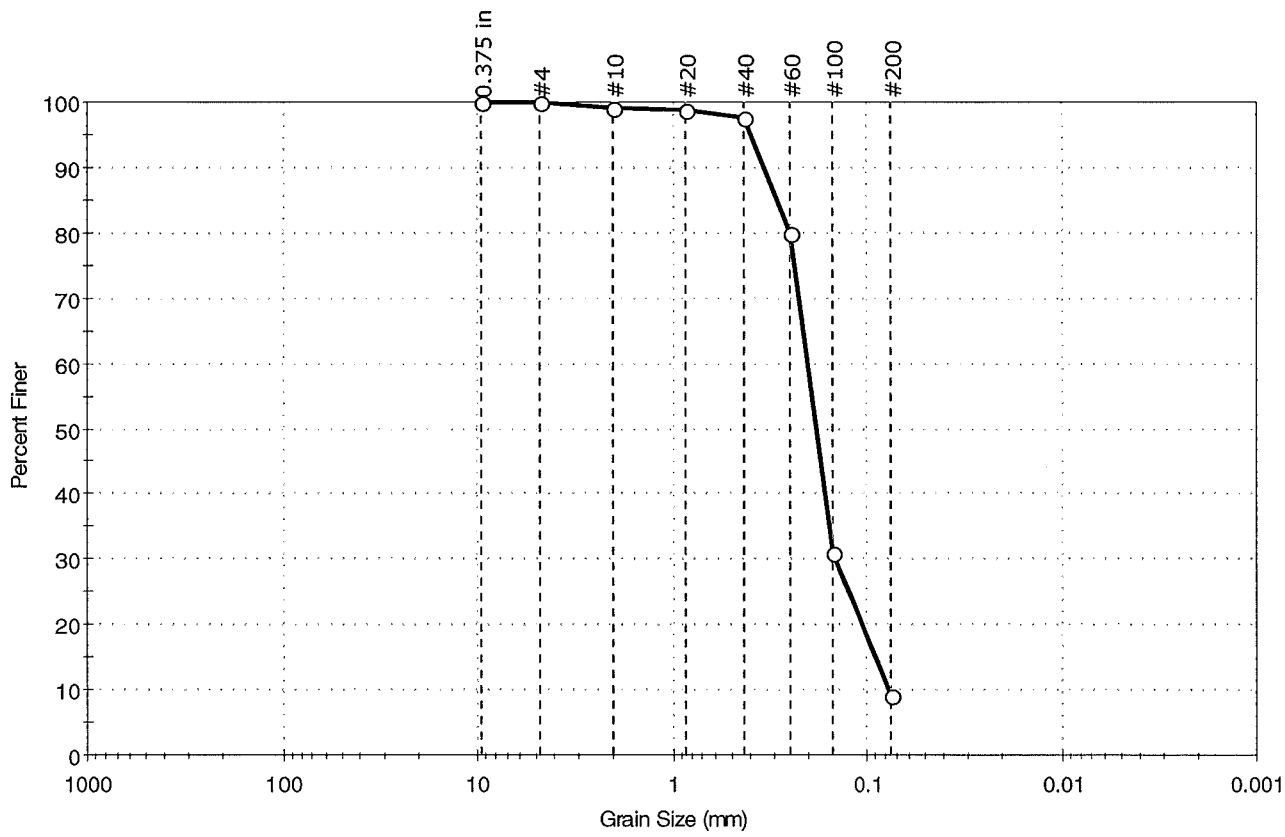
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:2D, 3D	Test Date: 09/04/12	Checked By:	jdt
Depth : 6.0-13.0 ft.	Test Id: 248320		
Test Comment:	---		
Sample Description:	Moist, grayish brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.1	90.7	9.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	80		
#100	0.15	31		
#200	0.075	9		

Coefficients

D_{85} =0.2903 mm D_{30} =0.1452 mm

D_{60} =0.2029 mm D_{15} =0.0903 mm

D_{50} =0.1828 mm D_{10} =0.0770 mm

C_u =2.635 C_c =1.349

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

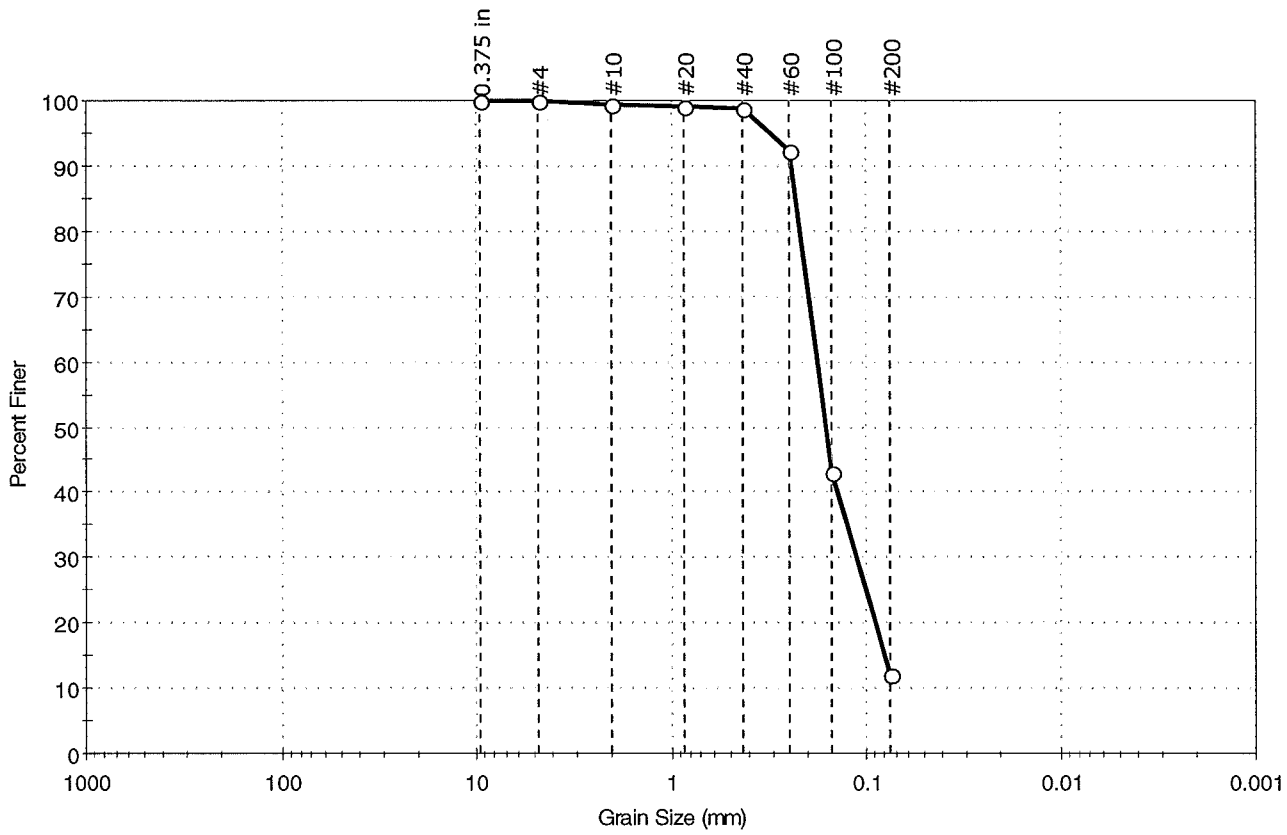
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:5D	Test Date: 09/05/12	Checked By:	jdt
Depth : 21.0-23.0 ft.	Test Id: 248321		
Test Comment:	---		
Sample Description:	Moist, olive brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.1	87.7	12.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	99		
#60	0.25	92		
#100	0.15	43		
#200	0.075	12		

Coefficients

D_{85} = 0.2318 mm D_{30} = 0.1120 mm

D_{60} = 0.1789 mm D_{15} = 0.0799 mm

D_{50} = 0.1613 mm D_{10} = 0.0714 mm

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

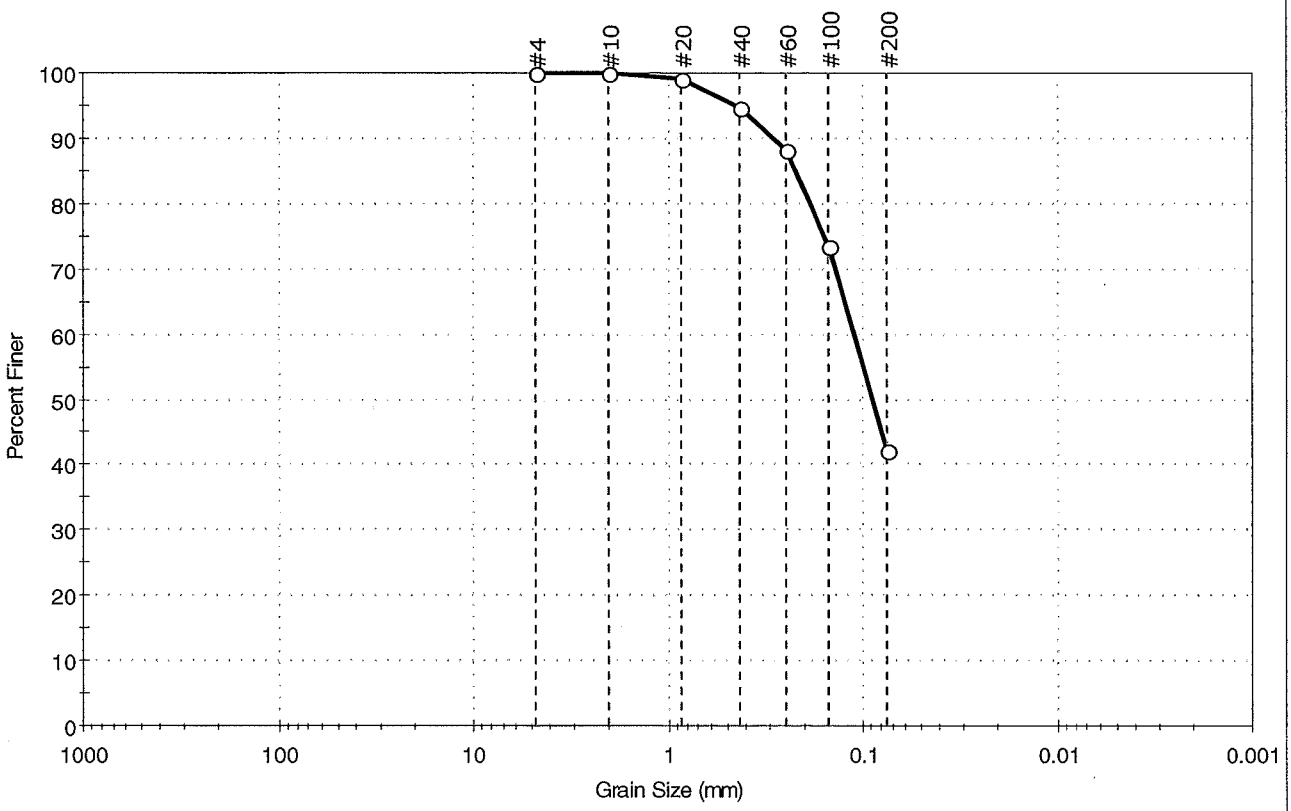
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:7D, 8D	Test Date: 09/05/12	Checked By:	jdt
Depth : 31.0-38.0 ft.	Test Id: 248322		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	57.8	42.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
#60	0.25	88		
#100	0.15	73		
#200	0.075	42		

Coefficients

D_{85} = 0.2237 mm D_{30} = N/A
D_{60} = 0.1115 mm D_{15} = N/A
D_{50} = 0.0893 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

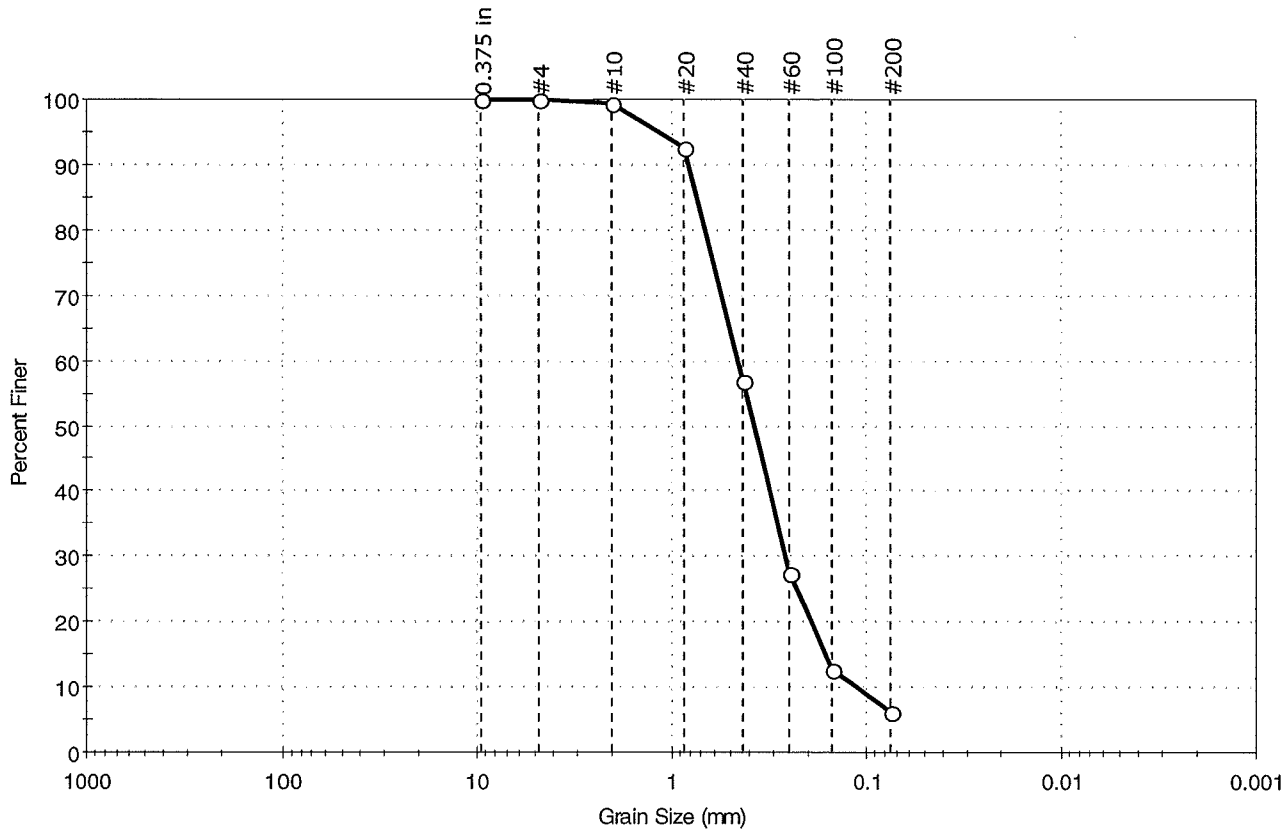
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:11D, 12D	Test Date: 08/31/12	Checked By:	jdt
Depth : 51.0-58.0 ft.	Test Id: 248323		
Test Comment: ---			
Sample Description:	Moist, olive brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	93.8	6.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	92		
#40	0.42	57		
#60	0.25	27		
#100	0.15	13		
#200	0.075	6		

Coefficients

D_{85} = 0.7350 mm D_{30} = 0.2618 mm

D_{60} = 0.4524 mm D_{15} = 0.1618 mm

D_{50} = 0.3759 mm D_{10} = 0.1118 mm

C_u = 4.047 C_c = 1.355

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

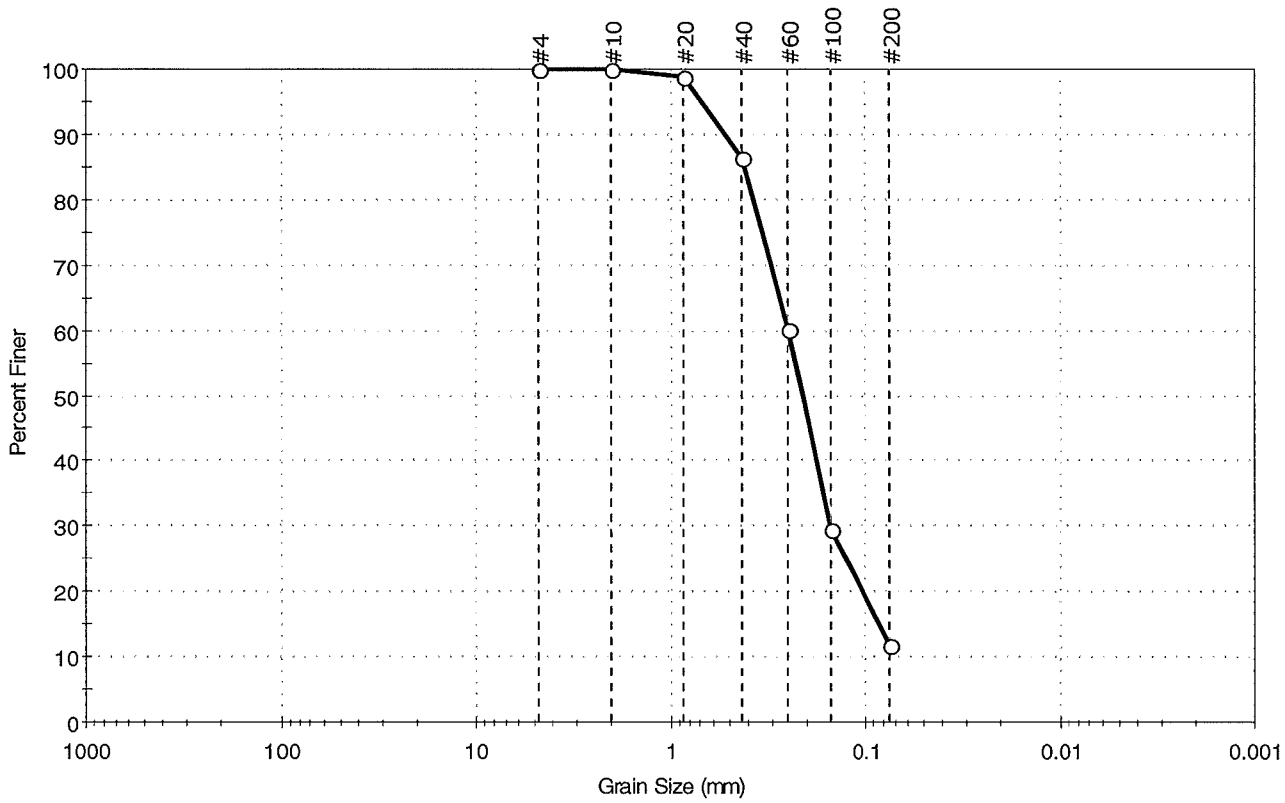
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:16D, 17D	Test Date: 08/31/12	Checked By:	jdt
Depth : 76.0-83.0 ft.	Test Id: 248324		
Test Comment: ---			
Sample Description: Moist, yellowish brown sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	88.1	11.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	86		
#60	0.25	60		
#100	0.15	29		
#200	0.075	12		

Coefficients

D_{85} =0.4140 mm	D_{30} =0.1515 mm
D_{60} =0.2488 mm	D_{15} =0.0847 mm
D_{50} =0.2108 mm	D_{10} =0.0695 mm
C_u =3.580	C_c =1.327

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

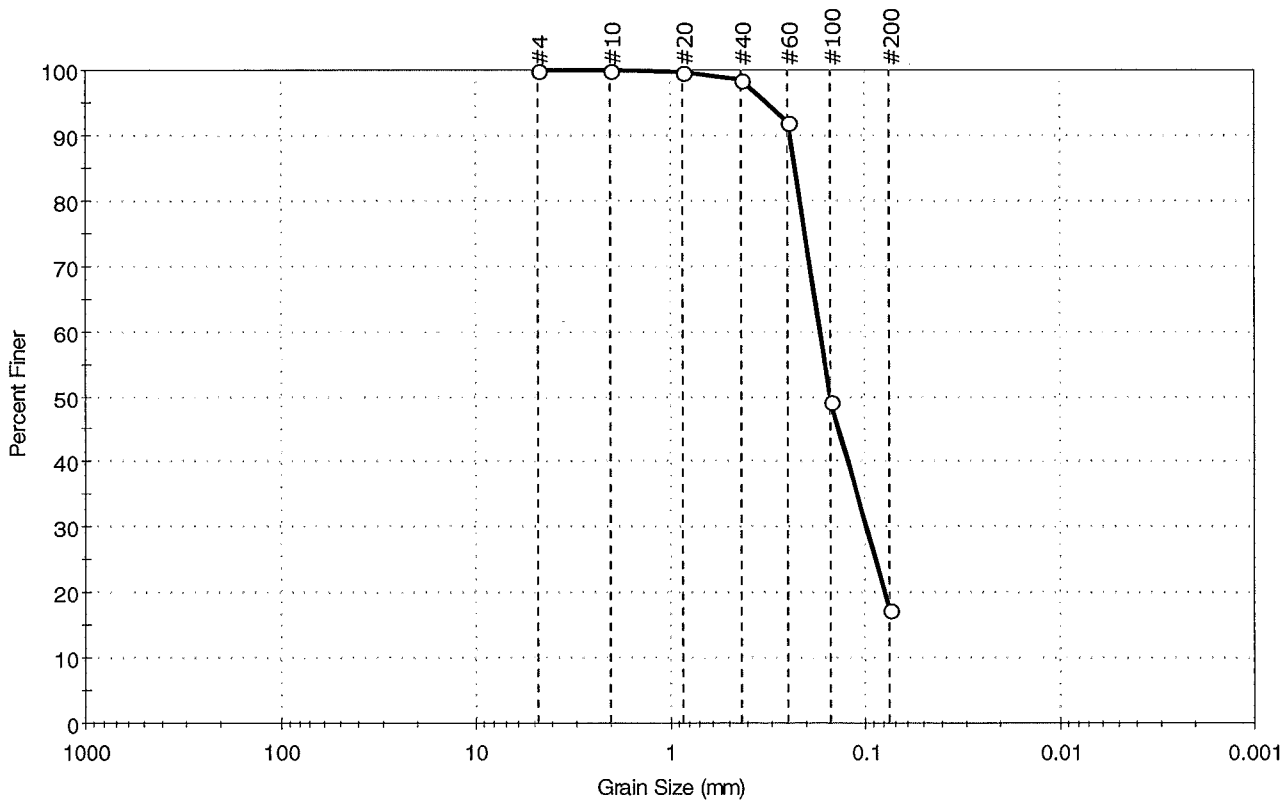
Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:18D, 19D, 20D	Test Date: 09/04/12	Checked By:	jdt
Depth : 86.0-98.0 ft.	Test Id: 248325		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	82.6	17.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	98		
#60	0.25	92		
#100	0.15	49		
#200	0.075	17		

Coefficients

D_{85} = 0.2301 mm D_{30} = 0.0987 mm
D_{60} = 0.1706 mm D_{15} = N/A
D_{50} = 0.1514 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

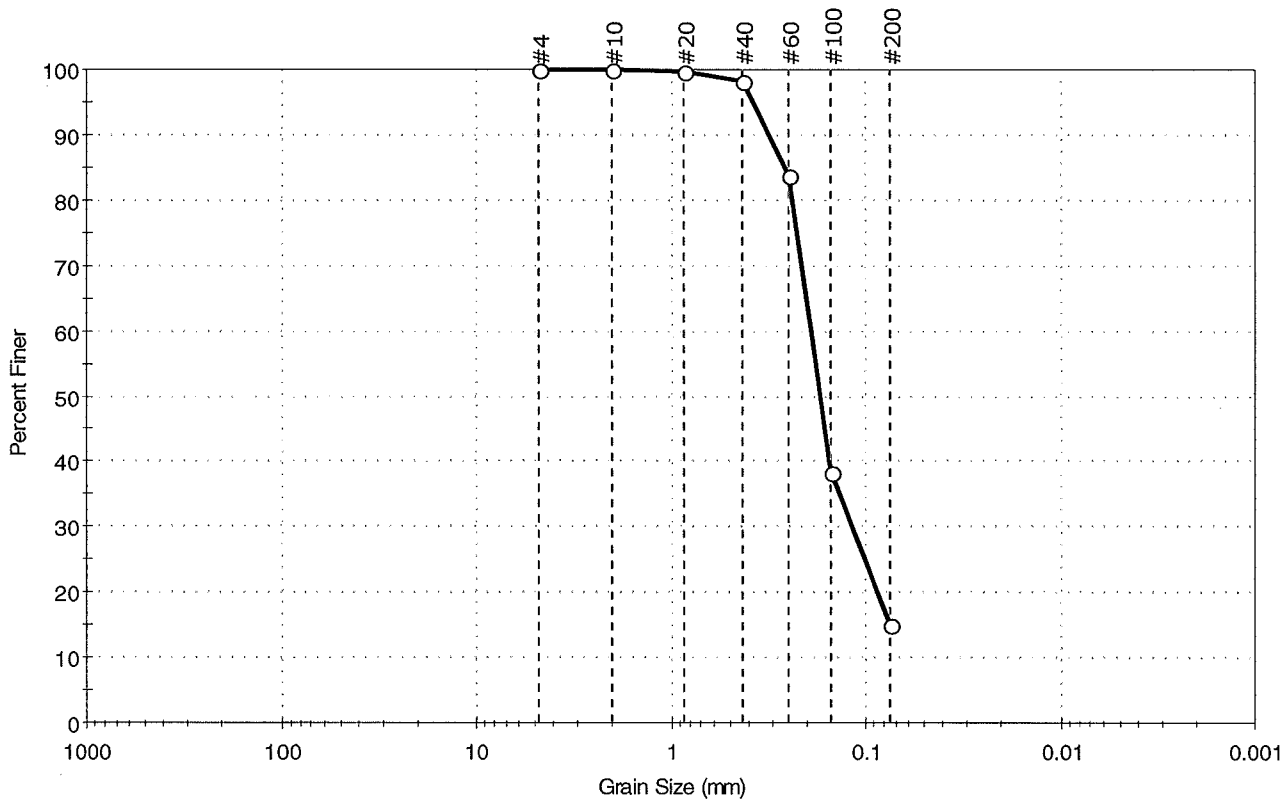
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-115	Sample Type: jar	Tested By:	jbr
Sample ID:21D, 22D	Test Date: 09/04/12	Checked By:	jdt
Depth : 101.0-108.0 ft.	Test Id: 248326		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	84.9	15.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	98		
#60	0.25	84		
#100	0.15	38		
#200	0.075	15		

Coefficients

D_{85} = 0.2623 mm D_{30} = 0.1172 mm
D_{60} = 0.1916 mm D_{15} = N/A
D_{50} = 0.1712 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

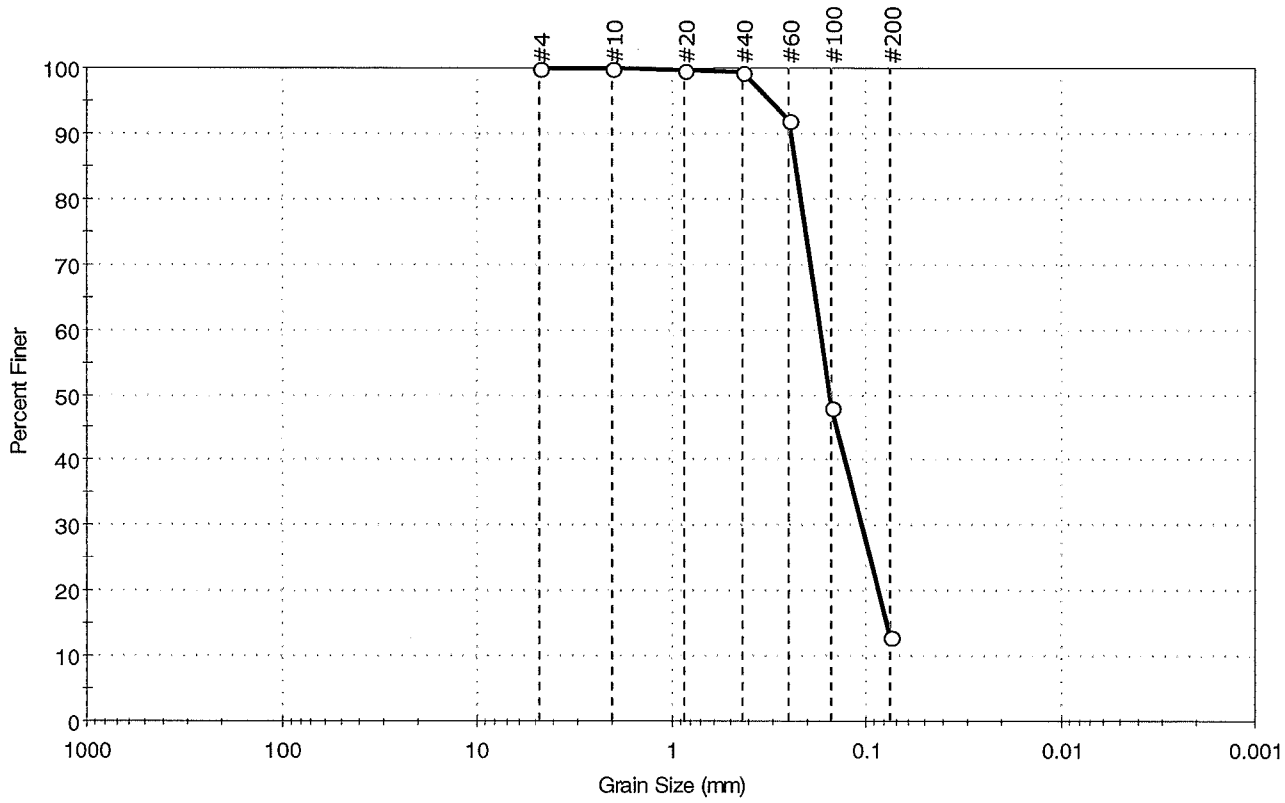
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-116	Sample Type: jar	Tested By:	jbr
Sample ID:3D, 4D, 5D	Test Date: 08/29/12	Checked By:	jdt
Depth : 10.0-22.0 ft.	Test Id: 248327		
Test Comment: ---			
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	87.0	13.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	92		
#100	0.15	48		
#200	0.075	13		

Coefficients

D_{85} = 0.2307 mm D_{30} = 0.1048 mm

D_{60} = 0.1722 mm D_{15} = 0.0780 mm

D_{50} = 0.1532 mm D_{10} = 0.0707 mm

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

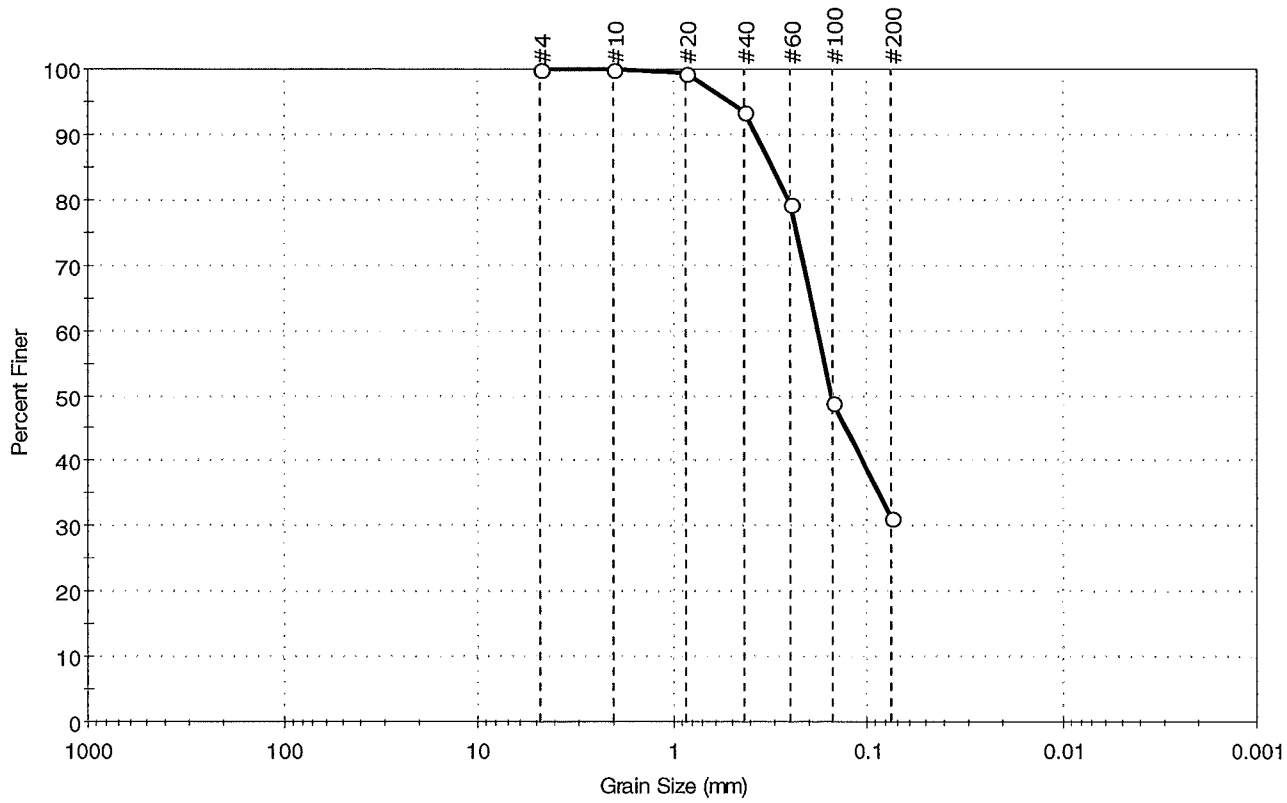
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-116	Sample Type: jar	Tested By:	jbr
Sample ID:9D, 10D	Test Date: 08/29/12	Checked By:	jdt
Depth : 40.0-47.0 ft.	Test Id: 248328		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	68.8	31.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	93		
#60	0.25	79		
#100	0.15	49		
#200	0.075	31		

Coefficients

D_{85} = 0.3086 mm D_{30} = N/A
D_{60} = 0.1804 mm D_{15} = N/A
D_{50} = 0.1526 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

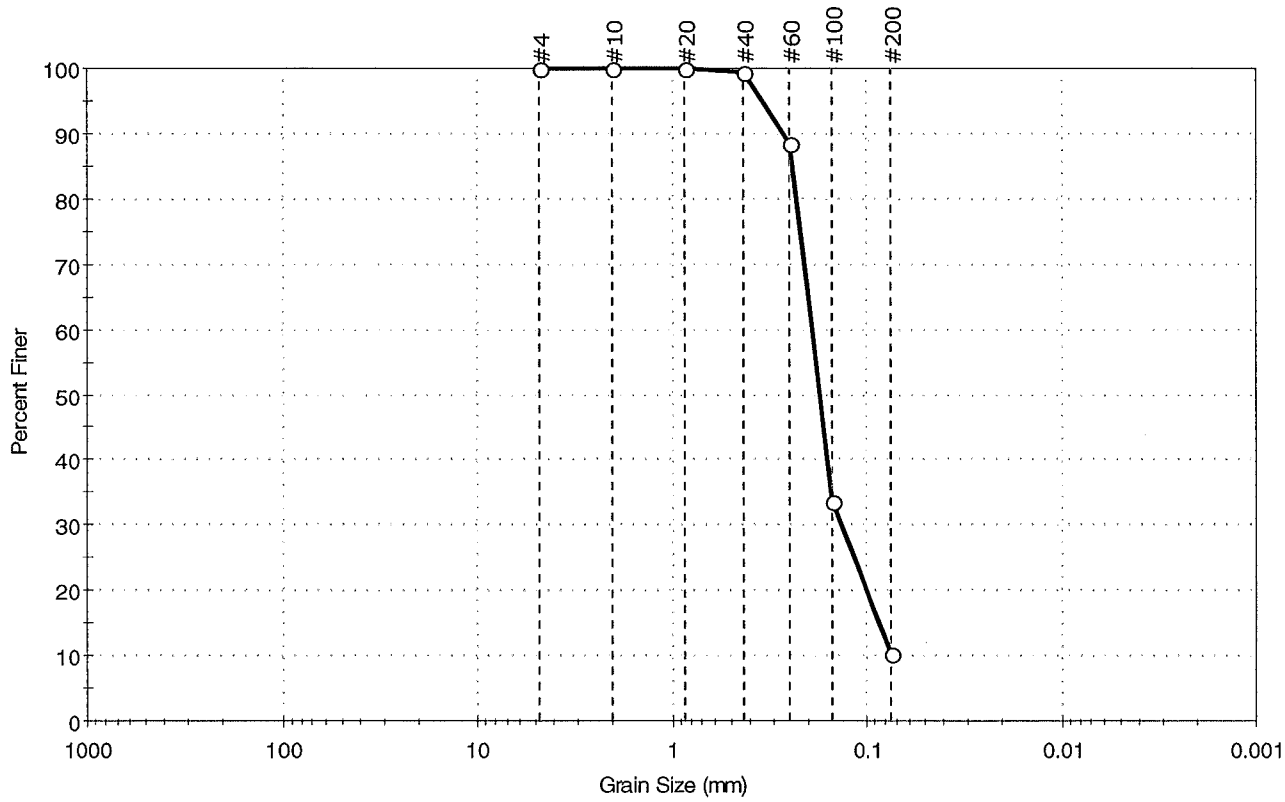
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-117	Sample Type: jar	Tested By:	jbr
Sample ID:2D, 3D	Test Date: 09/04/12	Checked By:	jdt
Depth : 6.0-13.0 ft.	Test Id: 248329		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	89.7	10.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	88		
#100	0.15	34		
#200	0.075	10		

Coefficients

D_{85} =0.2420 mm D_{30} =0.1343 mm

D_{60} =0.1917 mm D_{15} =0.0862 mm

D_{50} =0.1746 mm D_{10} =0.0744 mm

C_u =2.577 C_c =1.265

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

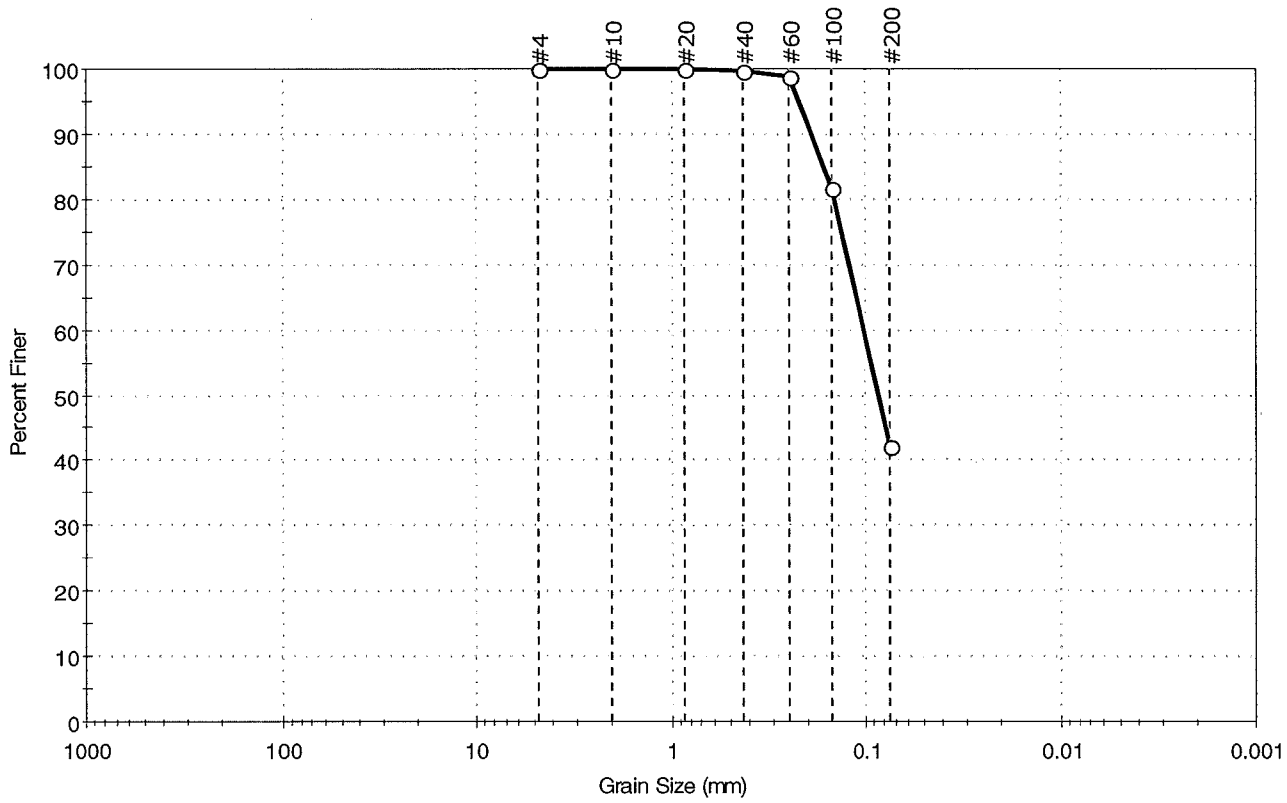
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-117	Sample Type: jar	Tested By:	jbr
Sample ID:4D, 5D	Test Date: 09/04/12	Checked By:	jdt
Depth : 16.0-23.0 ft.	Test Id: 248330		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	57.9	42.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	82		
#200	0.075	42		

Coefficients

D_{85} = 0.1659 mm D_{30} = N/A
D_{60} = 0.1027 mm D_{15} = N/A
D_{50} = 0.0862 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

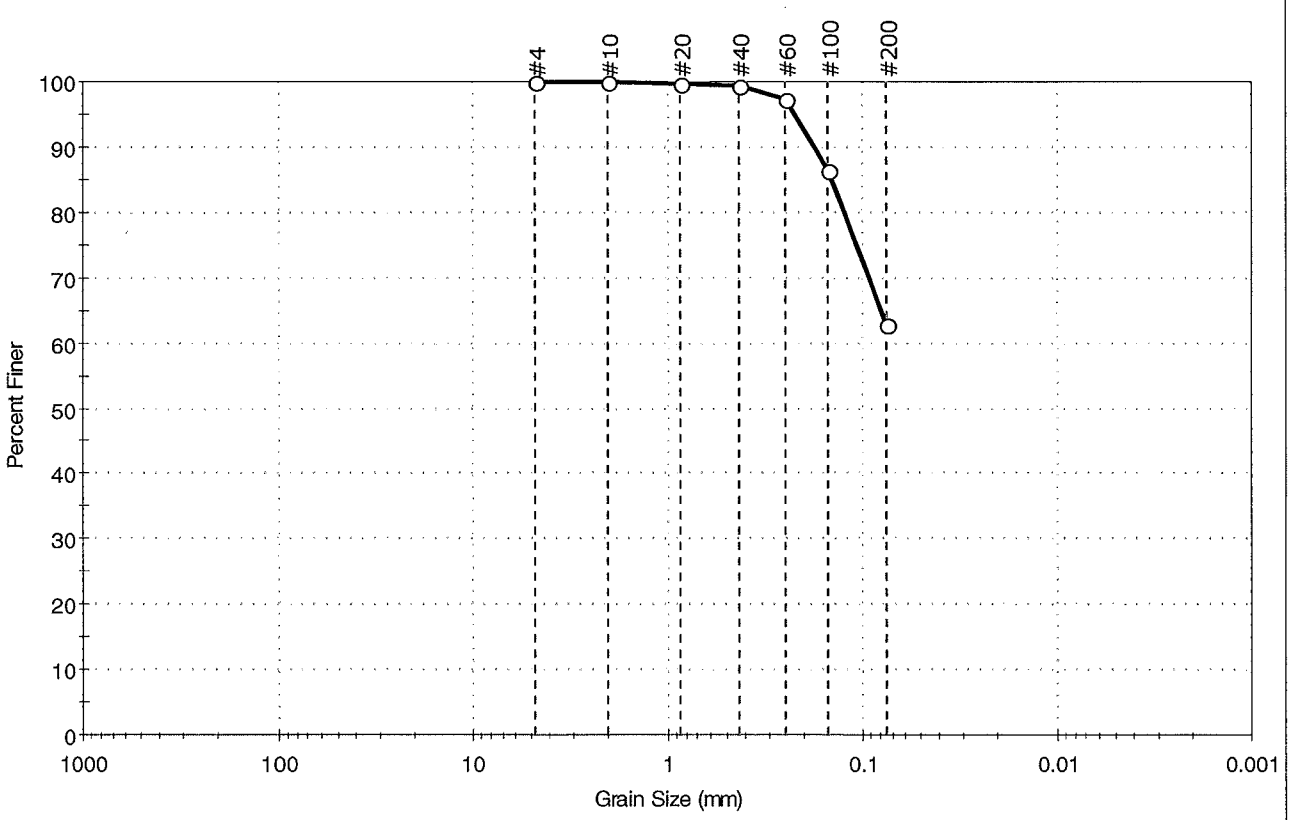
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-117	Sample Type: jar	Tested By:	jbr
Sample ID:6D, 7D	Test Date: 08/29/12	Checked By:	jdt
Depth : 26.0-31.5 ft.	Test Id: 248331		
Test Comment:	---		
Sample Description:	Moist, olive sandy silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	37.2	62.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	97		
#100	0.15	86		
#200	0.075	63		

Coefficients

D_{85} = 0.1437 mm D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

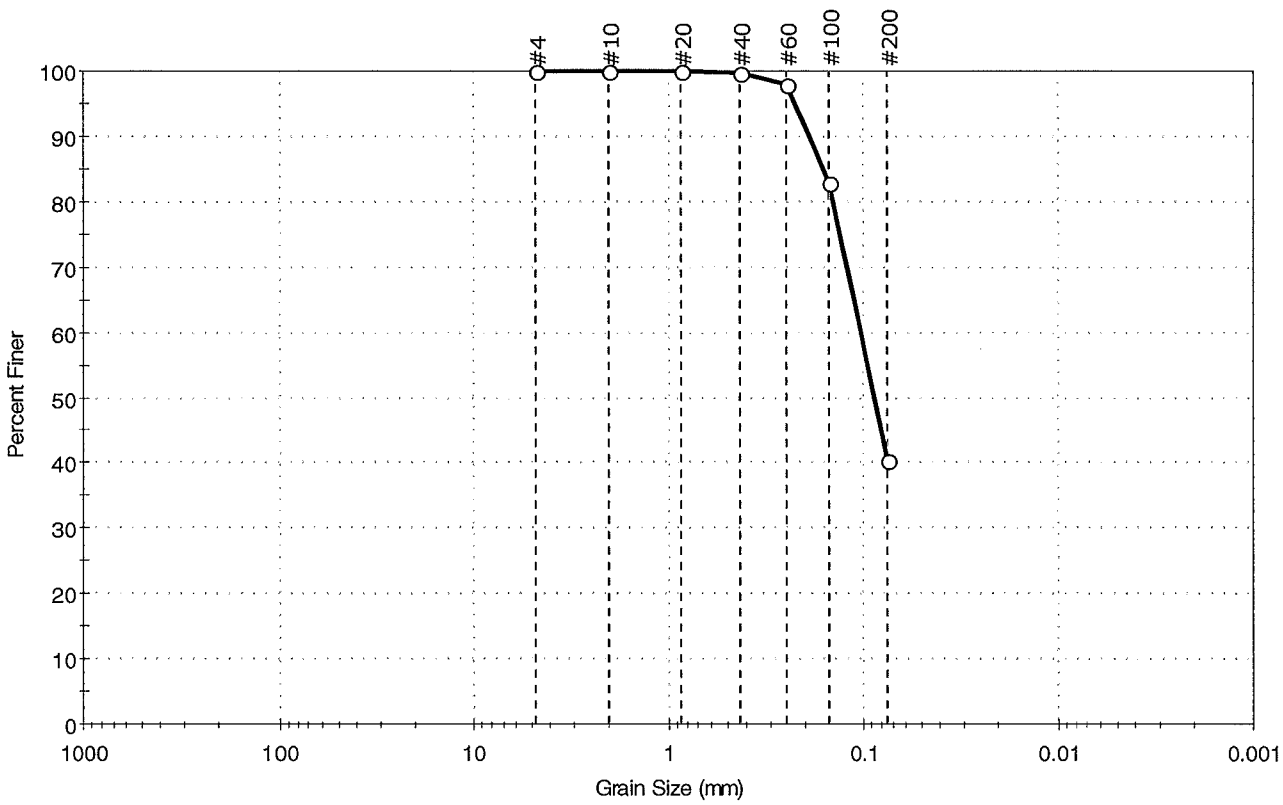
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-117	Sample Type: jar	Tested By:	jbr
Sample ID:8D, 9D	Test Date: 09/05/12	Checked By:	jdt
Depth : 36.0-43.0 ft.	Test Id: 248332		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	59.5	40.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	98		
#100	0.15	83		
#200	0.075	40		

Coefficients

D_{85} = 0.1616 mm D_{30} = N/A

D_{60} = 0.1033 mm D_{15} = N/A

D_{50} = 0.0877 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

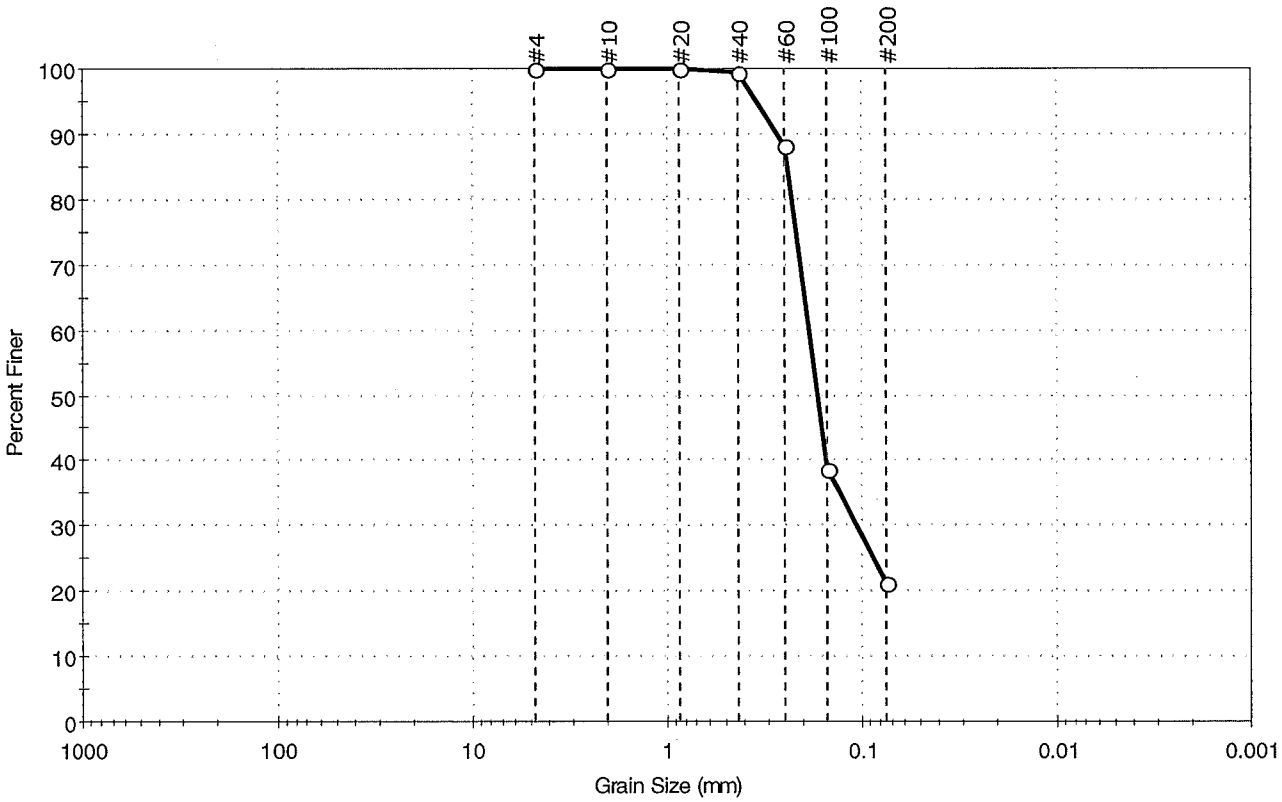
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-117	Sample Type: jar	Tested By:	jbr
Sample ID:12D, 13D, 14D	Test Date: 08/31/12	Checked By:	jdt
Depth : 56.0-68.0 ft.	Test Id: 248333		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	78.9	21.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	88		
#100	0.15	39		
#200	0.075	21		

Coefficients

D_{85} = 0.2422 mm D_{30} = 0.1066 mm
D_{60} = 0.1871 mm D_{15} = N/A
D_{50} = 0.1687 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

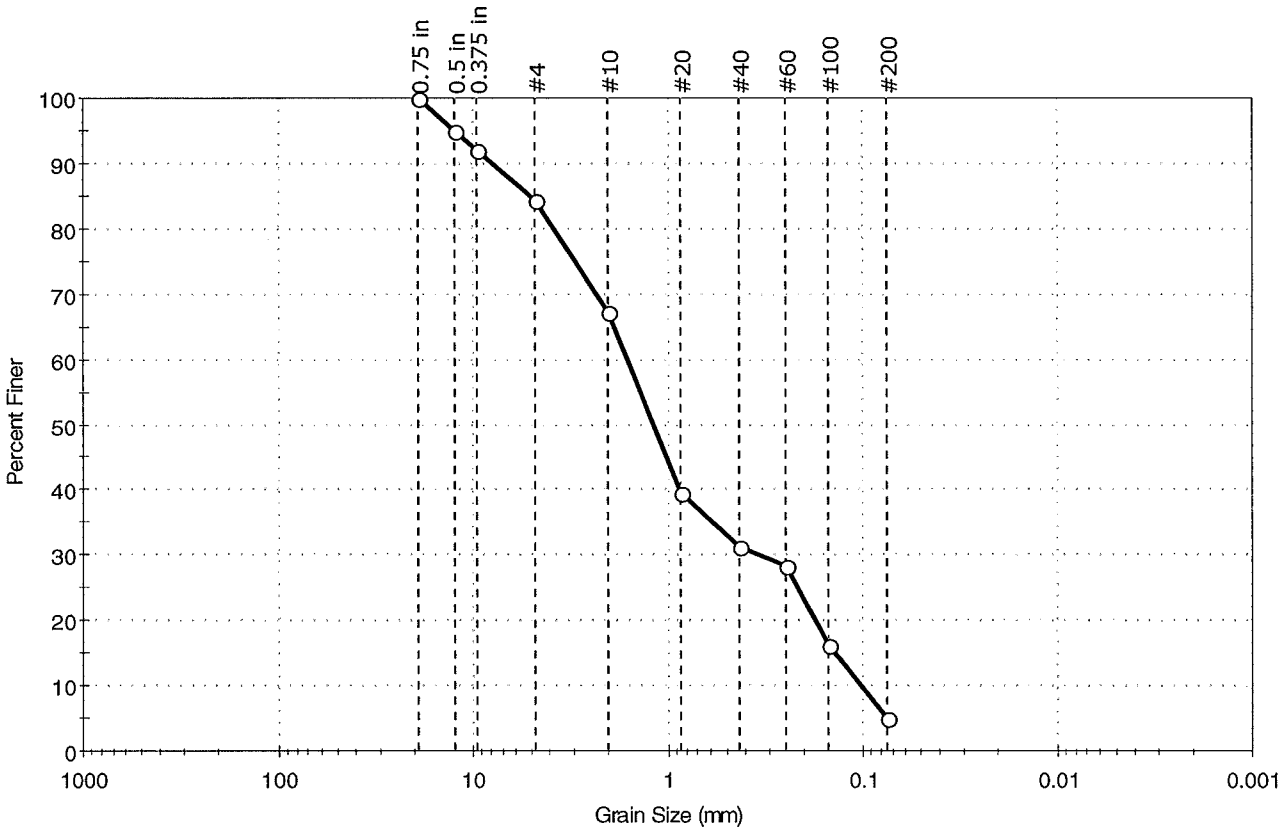
Sand/Gravel Hardness : ---

printed 9/13/2012 8:44:42 AM

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-118	Sample Type: jar	Tested By:	jbr
Sample ID:1D, 2D	Test Date: 09/04/12	Checked By:	jdt
Depth : 0.0-7.0 ft.	Test Id: 248334		
Test Comment:	---		
Sample Description:	Moist, light olive brown sand with silt with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.8	79.2	5.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	95		
0.375 in	9.50	92		
#4	4.75	84		
#10	2.00	67		
#20	0.85	40		
#40	0.42	31		
#60	0.25	28		
#100	0.15	16		
#200	0.075	5		

Coefficients

D_{85} = 5.0719 mm D_{30} = 0.3339 mm
D_{60} = 1.5969 mm D_{15} = 0.1385 mm
D_{50} = 1.1719 mm D_{10} = 0.1018 mm
C_u = 15.687 C_c = 0.686

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

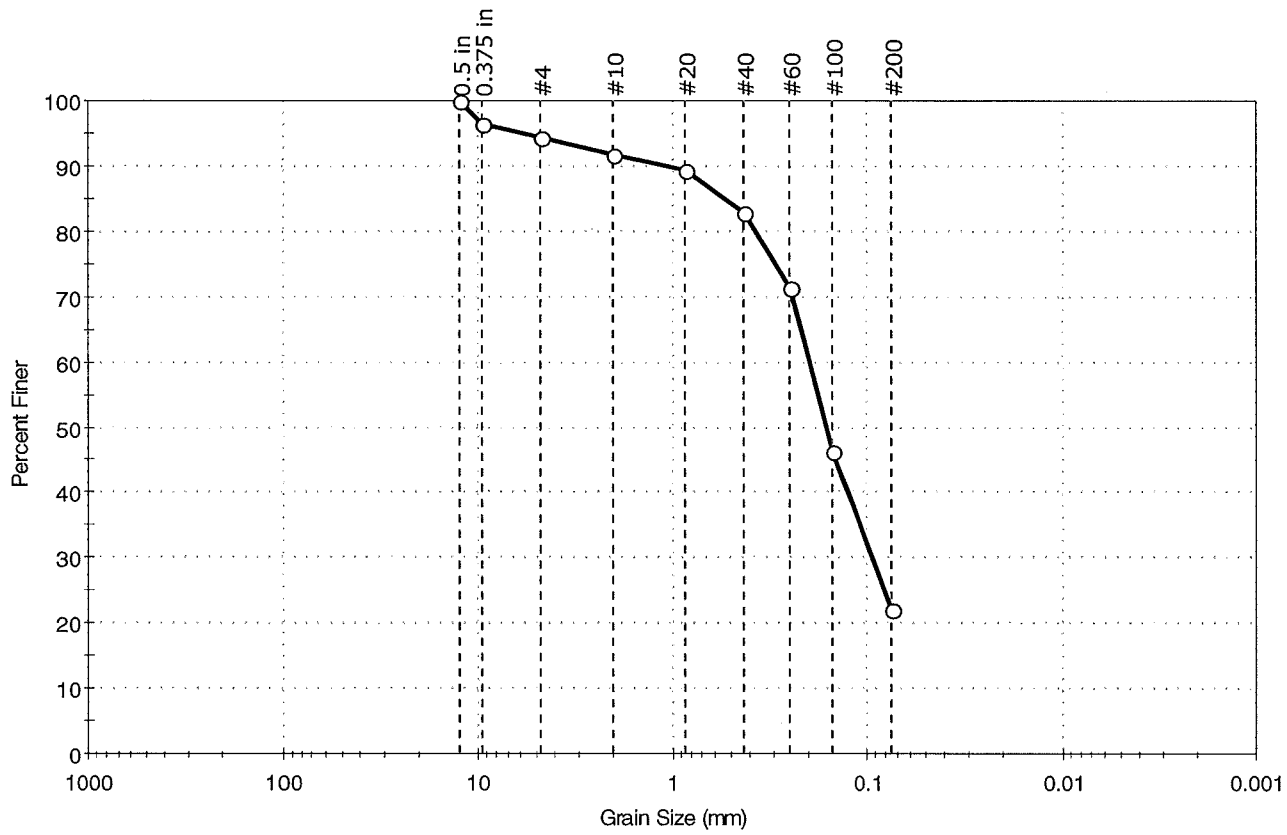
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:1D, 2D	Test Date: 08/31/12	Checked By:	jdt
Depth : 0.0-6.0 ft.	Test Id: 248335		
Test Comment:	---		
Sample Description:	Moist, olive brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.7	72.1	22.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	94		
#10	2.00	92		
#20	0.85	89		
#40	0.42	83		
#60	0.25	71		
#100	0.15	46		
#200	0.075	22		

Coefficients

D_{85} = 0.5356 mm D_{30} = 0.0937 mm
D_{60} = 0.1981 mm D_{15} = N/A
D_{50} = 0.1614 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

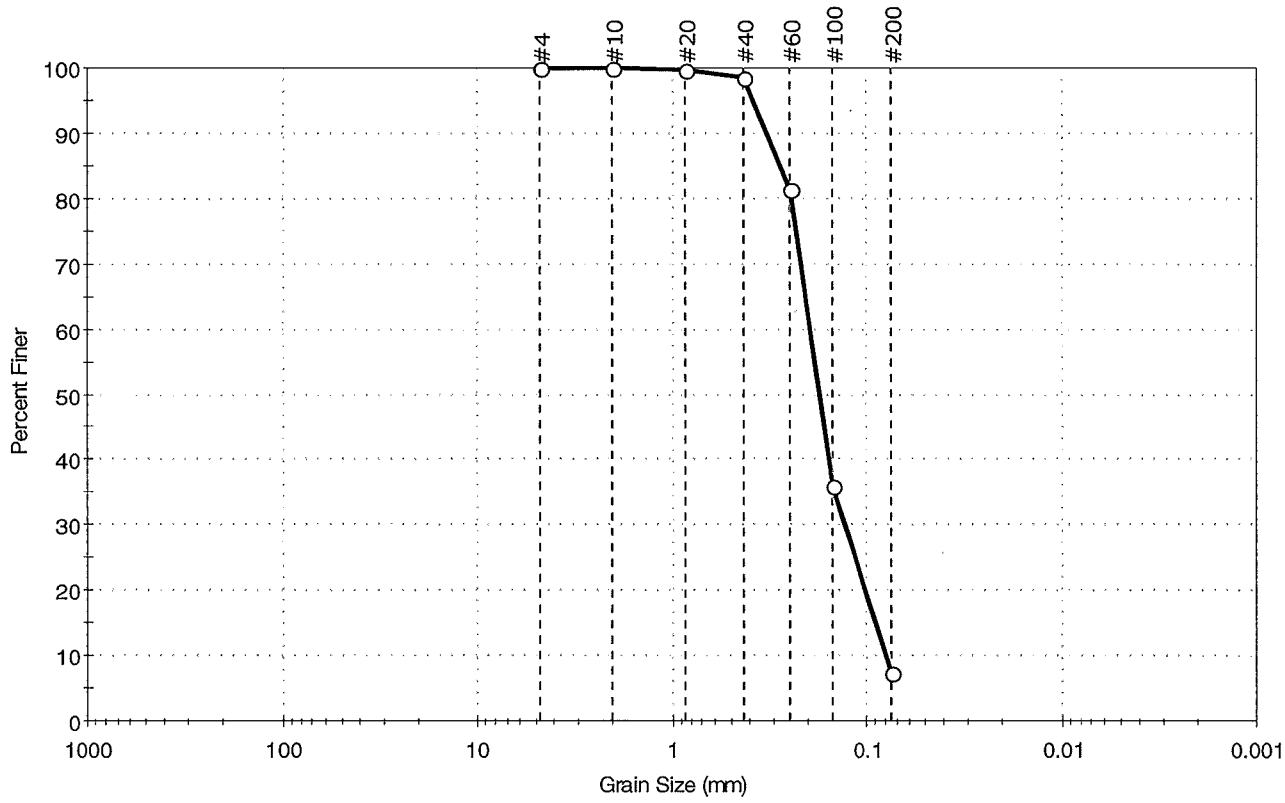
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:4D, 5D	Test Date: 09/05/12	Checked By:	jdt
Depth : 14.0-21.0 ft.	Test Id: 248336		
Test Comment:	---		
Sample Description:	Moist, yellowish brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	92.5	7.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	81		
#100	0.15	36		
#200	0.075	7		

Coefficients

D_{85} = 0.2790 mm D_{30} = 0.1299 mm

D_{60} = 0.1965 mm D_{15} = 0.0901 mm

D_{50} = 0.1757 mm D_{10} = 0.0797 mm

C_u = 2.465 C_c = 1.077

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

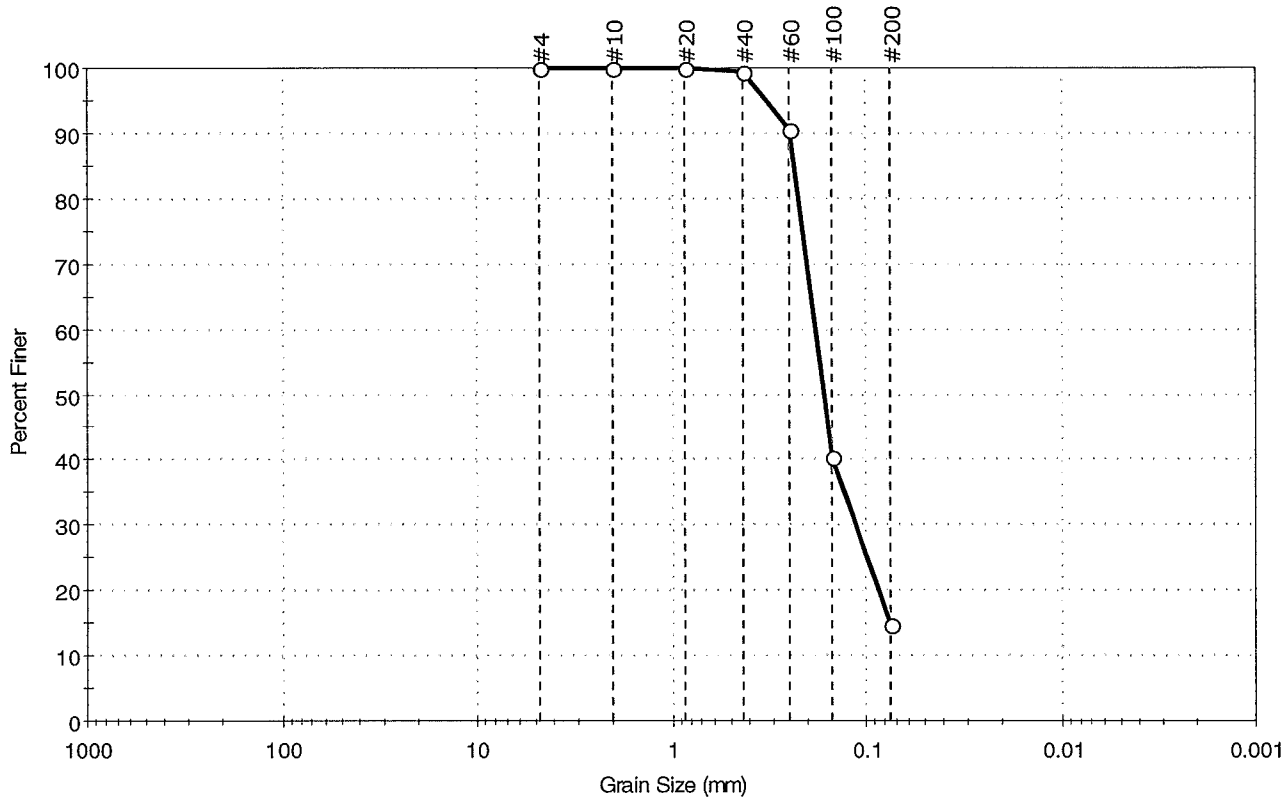
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:6D, 7D	Test Date: 09/05/12	Checked By:	jdt
Depth : 24.0-31.0 ft.	Test Id: 248337		
Test Comment:	---		
Sample Description:	Moist, light olive brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	85.4	14.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	91		
#100	0.15	40		
#200	0.075	15		

Coefficients

D_{85} = 0.2360 mm D_{30} = 0.1134 mm
D_{60} = 0.1830 mm D_{15} = 0.0758 mm
D_{50} = 0.1653 mm D_{10} = 0.0662 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

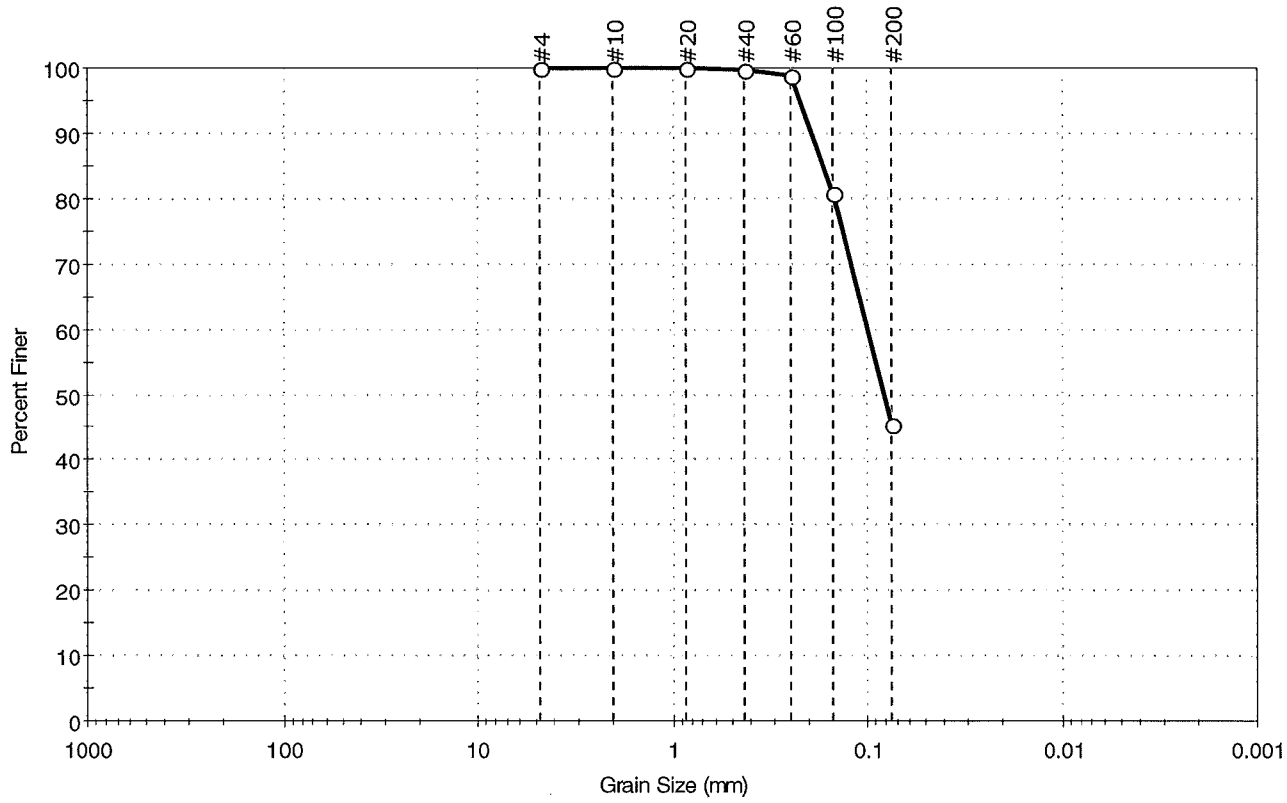
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:8D, 9D	Test Date: 09/05/12	Checked By:	jdt
Depth : 34.0-40.0 ft.	Test Id: 248338		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	54.4	45.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	81		
#200	0.075	46		

Coefficients

D_{85} = 0.1693 mm D_{30} = N/A
D_{60} = 0.0997 mm D_{15} = N/A
D_{50} = 0.0818 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

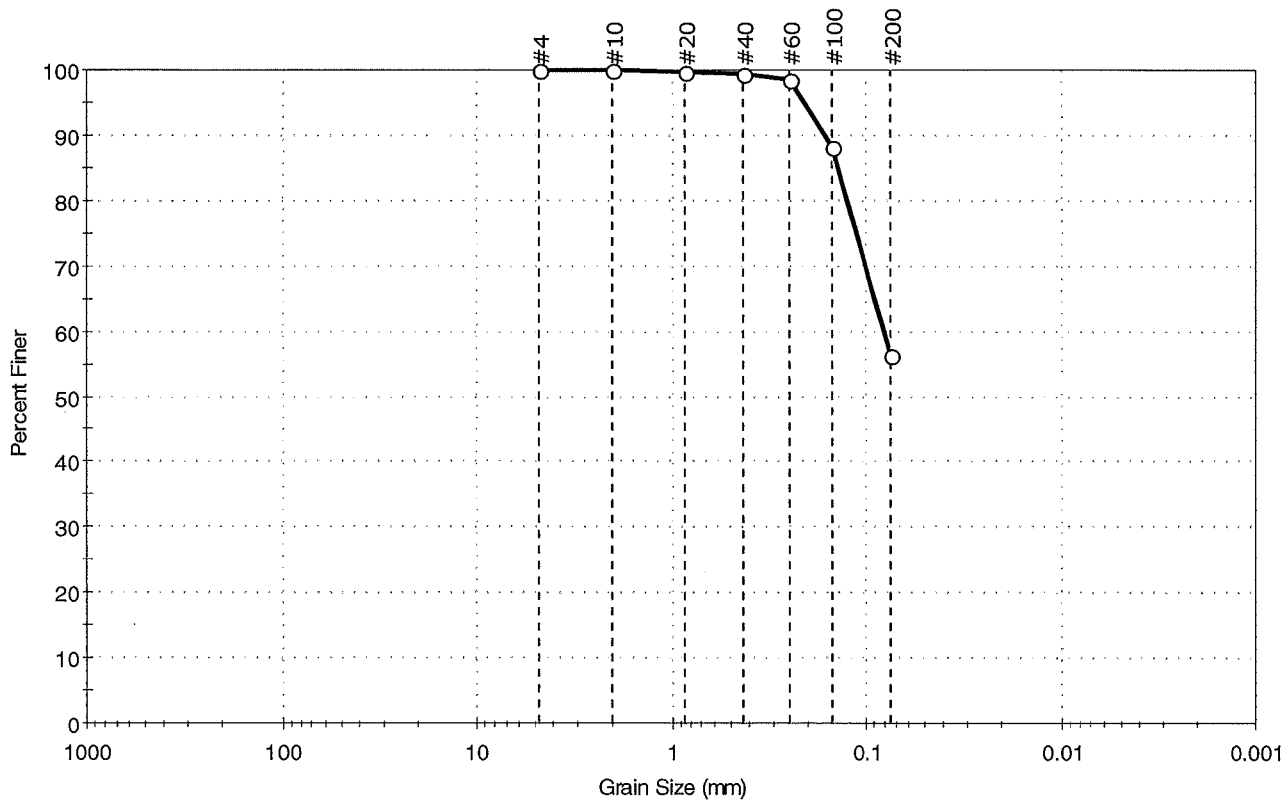
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:10D, 11D	Test Date: 08/29/12	Checked By:	jdt
Depth : 44.0-51.0 ft.	Test Id: 248339		
Test Comment:	---		
Sample Description:	Moist, light olive brown sandy silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	43.7	56.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	88		
#200	0.075	56		

Coefficients

D_{85} = 0.1400 mm D_{30} = N/A
D_{60} = 0.0813 mm D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

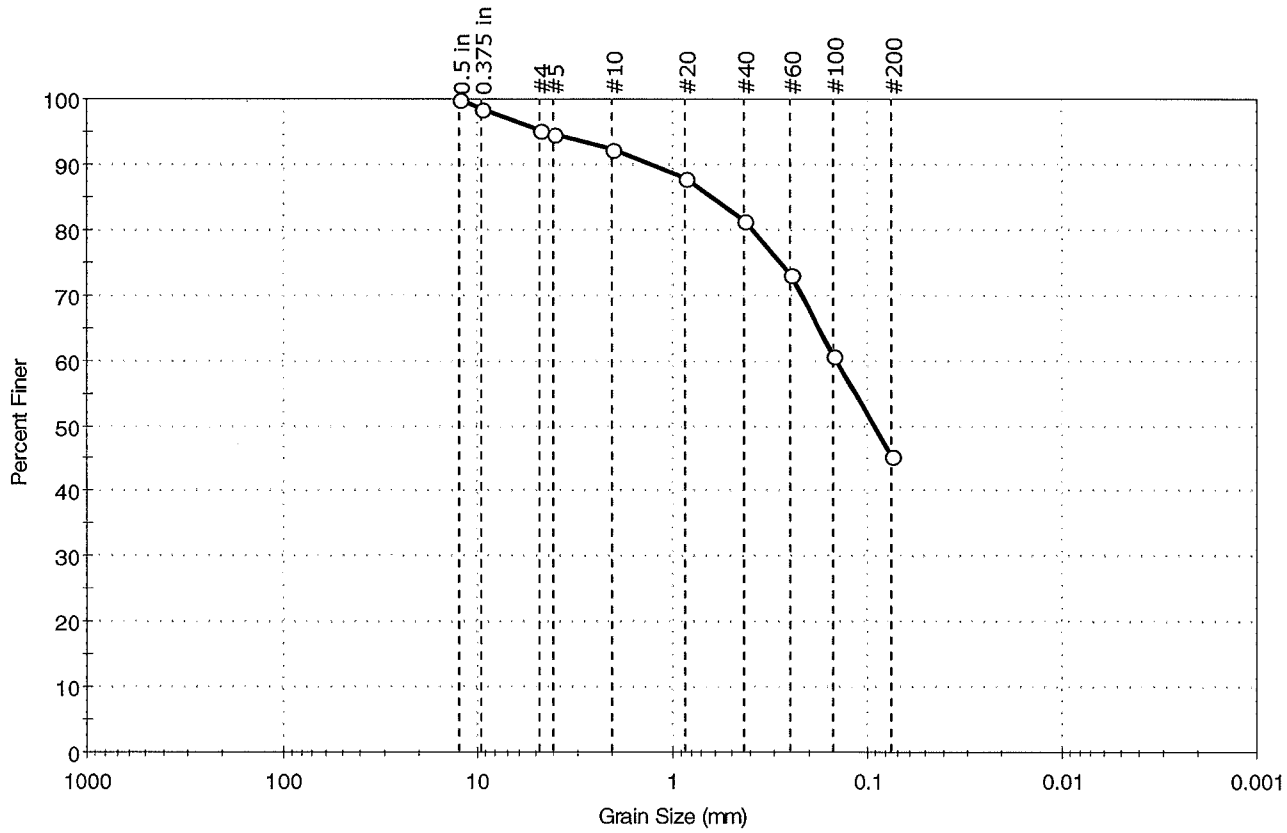
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-120	Sample Type: jar	Tested By:	jbr
Sample ID:12D, 13D	Test Date: 08/31/12	Checked By:	jdt
Depth : 54.0-61.0 ft.	Test Id: 248340		
Test Comment: ---			
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.7	50.0	45.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	95		
#5	4.00	95		
#10	2.00	92		
#20	0.85	88		
#40	0.42	81		
#60	0.25	73		
#100	0.15	61		
#200	0.075	45		

Coefficients

D_{85} = 0.6215 mm D_{30} = N/A
D_{60} = 0.1456 mm D_{15} = N/A
D_{50} = 0.0927 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

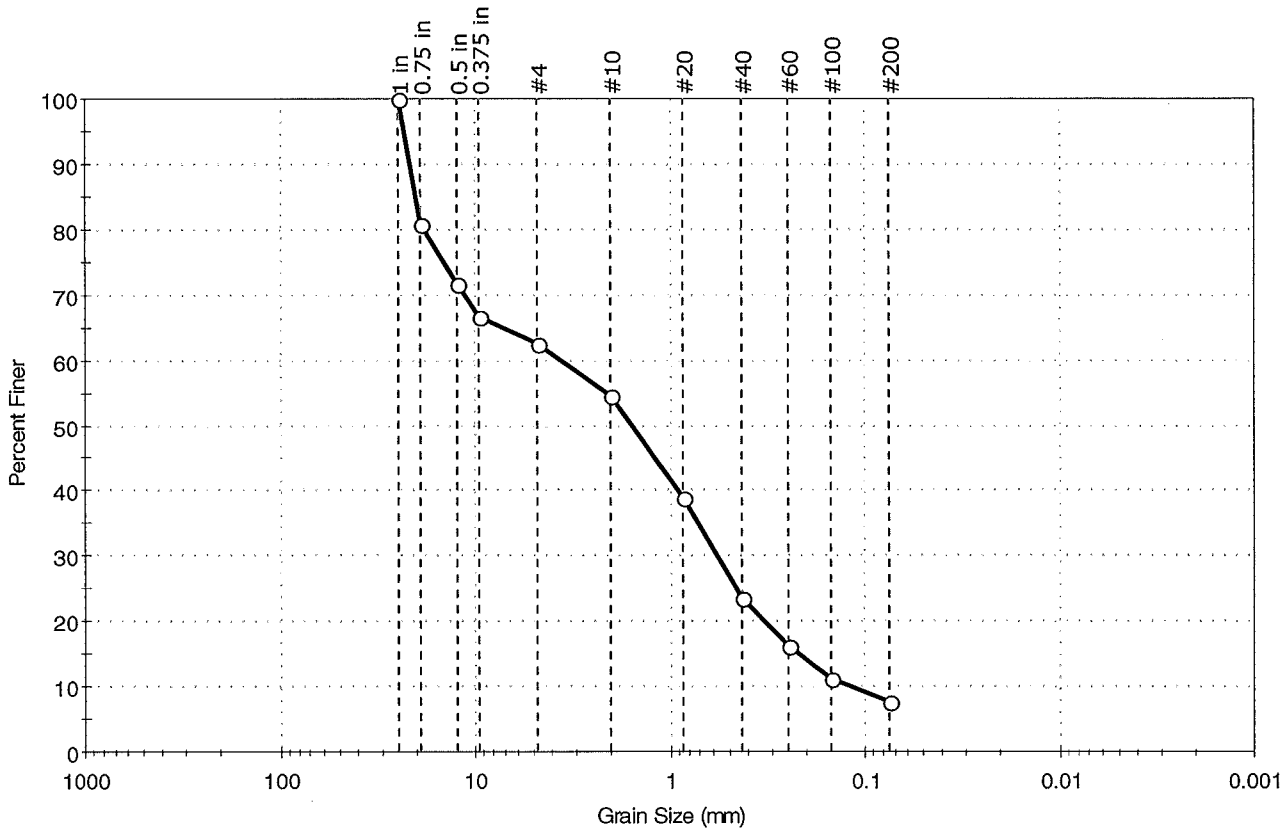
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-121	Sample Type: jar	Tested By:	jbr
Sample ID:1D	Test Date: 09/04/12	Checked By:	jdt
Depth : 0.5-2.0 ft.	Test Id: 248307		
Test Comment:	---		
Sample Description:	Moist, grayish brown sand with silt and gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	37.5	54.8	7.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	81		
0.5 in	12.50	72		
0.375 in	9.50	67		
#4	4.75	63		
#10	2.00	55		
#20	0.85	39		
#40	0.42	24		
#60	0.25	16		
#100	0.15	11		
#200	0.075	8		

Coefficients

D_{85} = 20.1783 mm D_{30} = 0.5661 mm

D_{60} = 3.6084 mm D_{15} = 0.2221 mm

D_{50} = 1.5607 mm D_{10} = 0.1170 mm

C_u = 30.841 C_c = 0.759

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

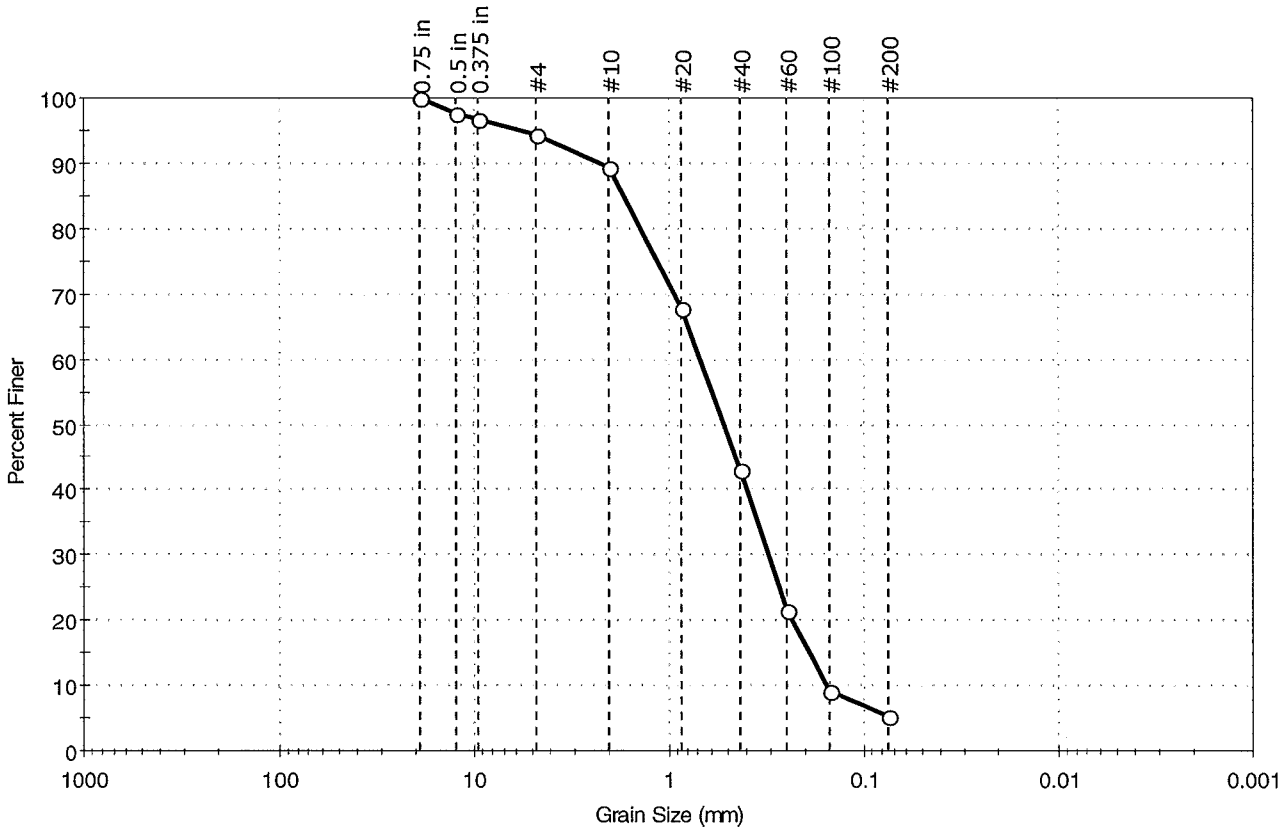
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-121	Sample Type: jar	Tested By:	jbr
Sample ID:2D	Test Date: 08/29/12	Checked By:	jdt
Depth : 2.0-4.0 ft.	Test Id: 248308		
Test Comment:	---		
Sample Description:	Moist, olive brown sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.6	89.2	5.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	98		
0.375 in	9.50	97		
#4	4.75	94		
#10	2.00	89		
#20	0.85	68		
#40	0.42	43		
#60	0.25	21		
#100	0.15	9		
#200	0.075	5		

Coefficients

D_{85} = 1.6836 mm D_{30} = 0.3080 mm

D_{60} = 0.6839 mm D_{15} = 0.1914 mm

D_{50} = 0.5159 mm D_{10} = 0.1558 mm

C_u = 4.390 C_c = 0.890

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

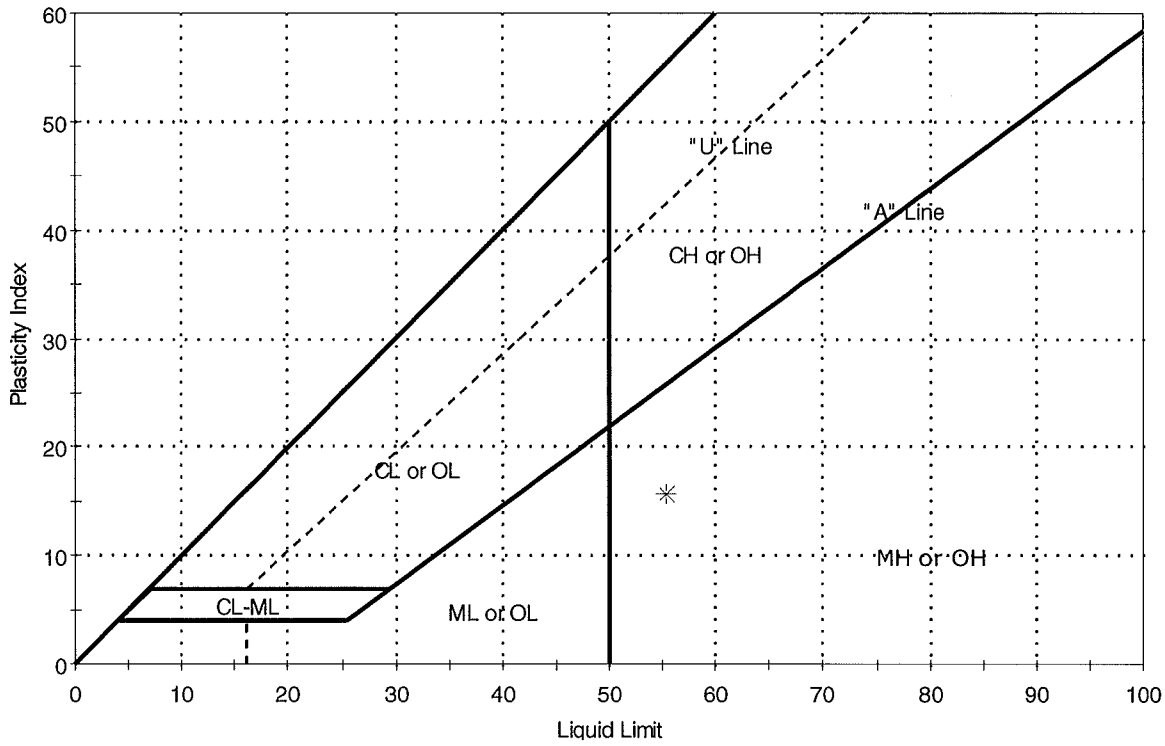
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-102	Sample Type: jar	Tested By:	cam
Sample ID:1DA	Test Date: 08/30/12	Checked By:	jdt
Depth : 2.0-3.0 ft.	Test Id: 248369		
Test Comment:	---		
Sample Description:	Moist, reddish brown silty sand with gravel		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	1DA	B-RAR-10	2.0-3.0 ft.	25	55	40	15	-1	Silty sand with gravel (SM)

Sample Prepared using the WET method

42% Retained on #40 Sieve

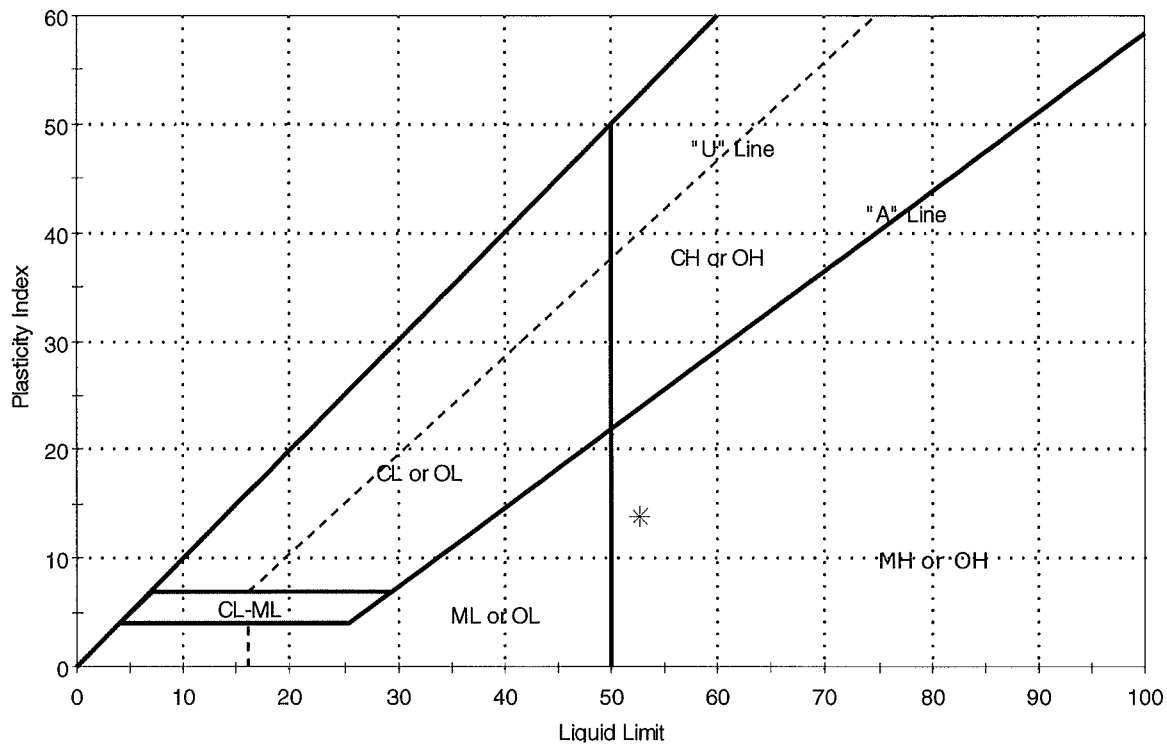
Dry Strength: HIGH

Dilentancy: SLOW

Toughness: LOW

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-103	Sample Type: jar	Tested By:	cam
Sample ID:1D	Test Date: 08/30/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248370		
Test Comment:	---		
Sample Description:	Moist, dark yellowish brown silt		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	1D	B-RAR-10	0.0-2.0 ft.	37	53	39	14	0	elastic silt (MH)

Sample Prepared using the WET method

2% Retained on #40 Sieve

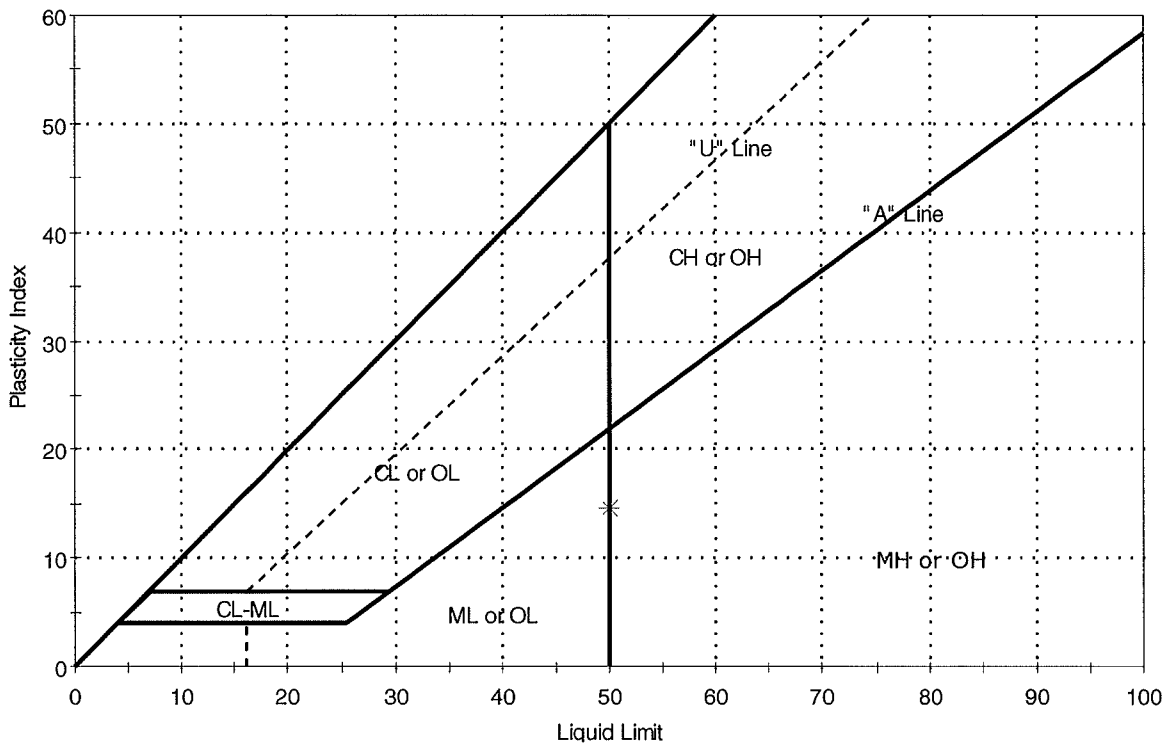
Dry Strength: HIGH

Dilentancy: SLOW

Toughness: LOW

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-104	Sample Type: jar	Tested By:	cam
Sample ID:1D	Test Date: 08/31/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248371		
Test Comment:	---		
Sample Description:	Moist, grayish brown silt		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	1D	B-RAR-10	0.0-2.0 ft.	38	50	35	15	0	elastic silt (MH)

Sample Prepared using the WET method

1% Retained on #40 Sieve

Dry Strength: HIGH

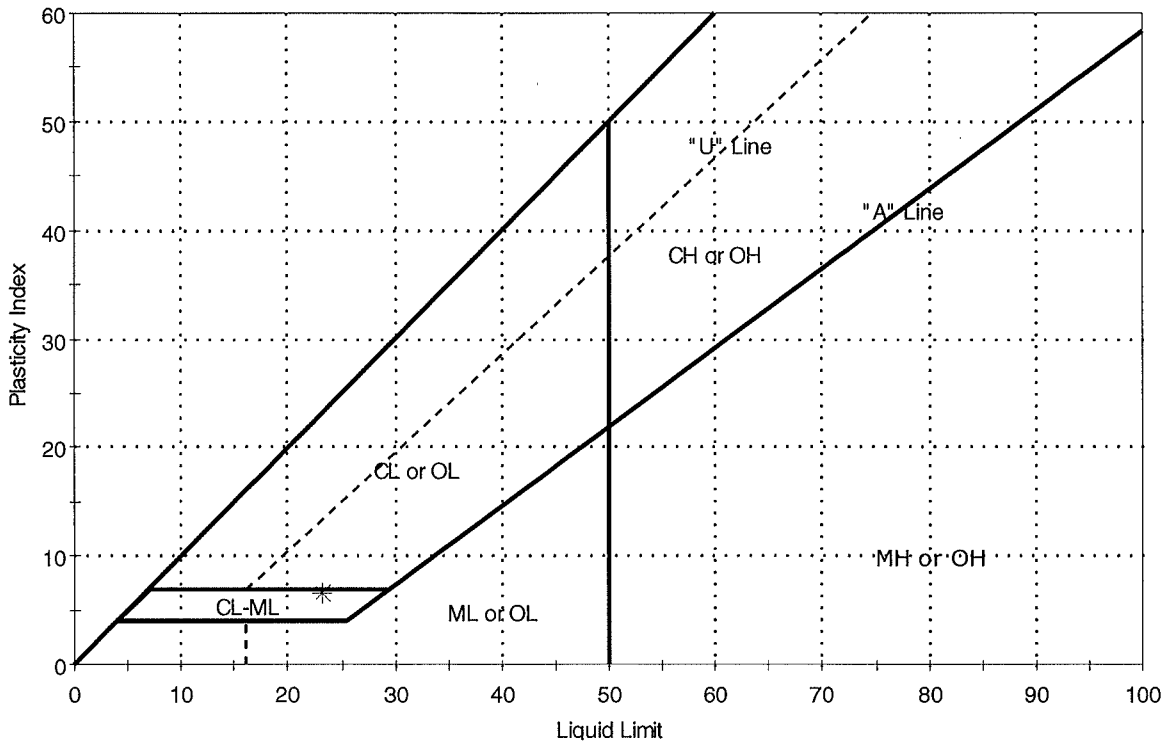
Dilentancy: SLOW

Toughness: LOW

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-104	Sample Type: jar	Tested By:	cam
Sample ID:2D	Test Date: 08/30/12	Checked By:	jdt
Depth : 2.0-4.0 ft.	Test Id: 248372		
Test Comment: ---			
Sample Description: Moist, olive brown silty, clayey sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

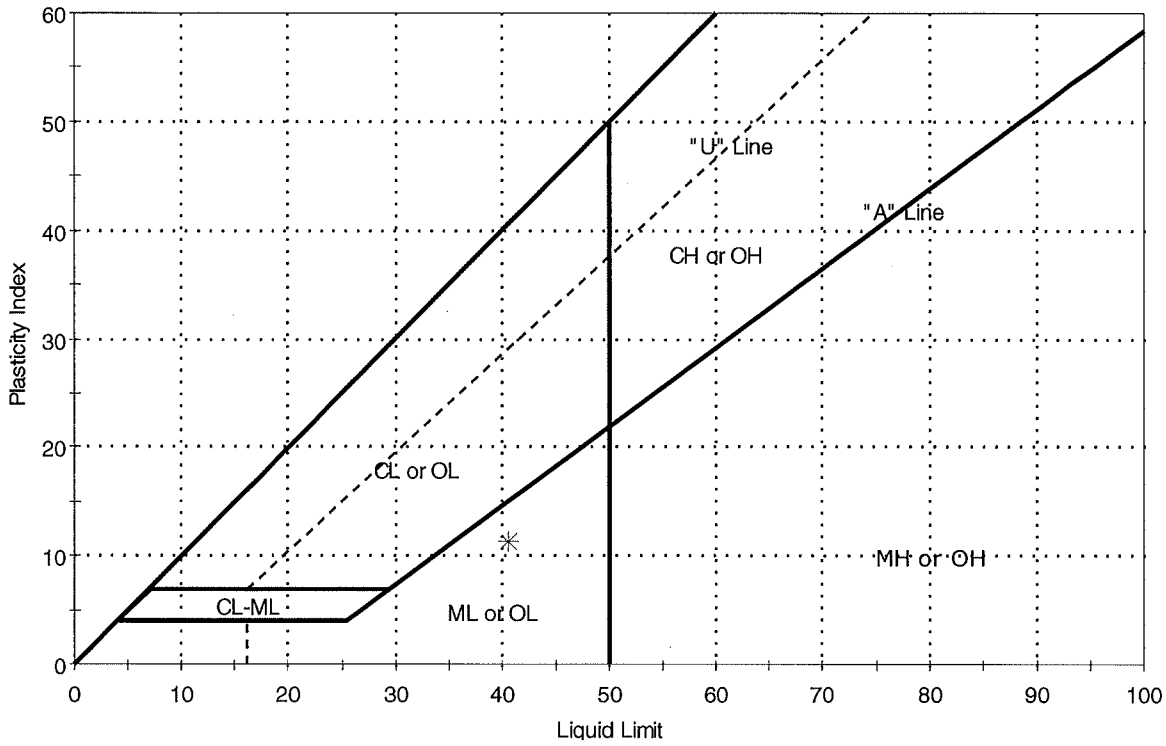


Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	2D	B-RAR-10	2.0-4.0 ft.	14	23	17	6	0	Silty, clayey sand (SC-SM)

Sample Prepared using the WET method
30% Retained on #40 Sieve
Dry Strength: HIGH
Dilentancy: SLOW
Toughness: LOW

Client:	Haley & Aldrich, Inc.		
Project:	Martin Memorial Bridge Replacement		
Location:	Rumford, ME	Project No:	GTX-12194
Boring ID: BB-RAR-106	Sample Type: jar	Tested By:	cam
Sample ID:1D	Test Date: 08/30/12	Checked By:	jdt
Depth : 0.0-2.0 ft.	Test Id: 248373		
Test Comment:	---		
Sample Description:	Moist, grayish brown silt with sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	1D	B-RAR-10	0.0-2.0 ft.	31	41	29	12	0	silt with sand (ML)

Sample Prepared using the WET method

1% Retained on #40 Sieve

Dry Strength: HIGH

Dilentancy: RAPID

Toughness: LOW

APPENDIX D

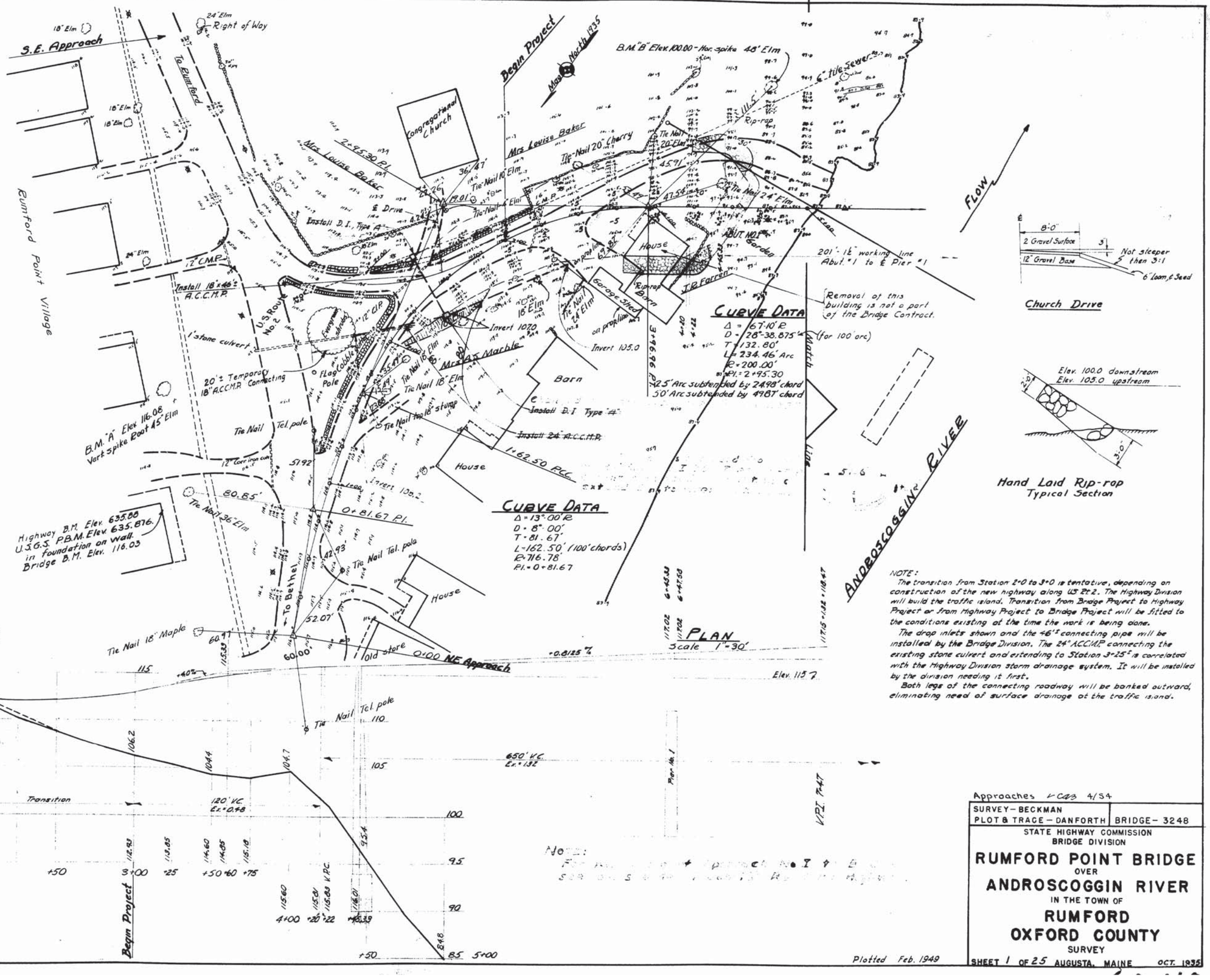
Existing Bridge Drawings

SOUNDINGS

ROD PENETRATIONS AND AUGER BORINGS

Ave. depth of sounding - 45. Ave. penetration - 4" per blow.
At this depth, quicksand near surface. Banks on both locations, generally run to fine river silt. High water Elev. 112.38

Sta.	Depth below str. bed or ground	Materials	Penetration Inches	Blows
4+38	0.0' (93.4)	V.F. Sandy Silt		
	8.0'	Moist V.F. Sandy Silt		
	15.0'	Acts like quick sand		
	28.0'		34	10
	31.0'		24	10
5+00	0.0' (84.8)	Silt		
	6.0'	Gravel layer		
	6.5'	Quicksand		
	12.0'		4	6
	16.0'		4	10
	20.0'		4	12
	24.0'		4	11
	28.0'		4	14
	32.0'		4	18
	36.0'		4	24
	40.0'	Stopped at this depth	4	35
6+62	0.0' (80.6)	Quick sand - Crust at bank		
	30.0'	4' below str. bed - drove	4	16
	45.0'	rods thru easily	4	30
8+26	0.0' (78.6)	At one end		
	18.0'	Did not drive further because could not pull from boat	4	8
10+85	0.0' (83.8)	Fine silt		
	7.5'	Quicksand - Water level		
	15.5'	Sand - slightly coarse		
	28.0'		4	6
	32.0'		4	10
	36.0'		4	12
	40.0'		4	17
	44.0'		4	16
	48.0'		4	19
	50.0'	Stopped	4	10
10+46	0.0' (96.8)	Loam and silt		
	8.0'	Gravel - auger stopped		
	12.0'	Sand and Gravel	4	10
10+66	0.0' (99.7)	Loam and silt		
	30'	Coarse sand		
	35	Coarse sand and water		
10+79	0.0' (100.6)	Loam and silt		
	14.0'	Gravel		



CURVE DATA

Δ = 67°10' Rt.
D = 28°38.875' (for 100' arc)
T = 132.80'
L = 234.46' Arc
R = 200.00'
P.I. = 2+95.30
125' Arc subtended by 24.98' chord
50' Arc subtended by 49.87' chord

CURVE DATA

Δ = 13°00' Rt.
D = 8°00'
T = 81.67'
L = 162.50' (100' chords)
R = 716.78'
P.I. = 0+81.67

PLAN

Scale 1" = 30'

PROFILE ALONG SURVEY LINE

Scale: Vert. 1" = 5'
Horiz. 1" = 30'

NOTE:

The transition from Station 2+0 to 3+0 is tentative, depending on construction of the new highway along US Rt 2. The Highway Division will build the traffic island. Transition from Bridge Project to Highway Project or from Highway Project to Bridge Project will be fitted to the conditions existing at the time the work is being done.

The drop inlets shown and the 46'± connecting pipe will be installed by the Bridge Division. The 24" ACCMP connecting the existing stone culvert and extending to Station 3+25± is correlated with the Highway Division storm drainage system. It will be installed by the division needing it first.

Both legs of the connecting roadway will be banked outward, eliminating need of surface drainage at the traffic island.

Approaches - CAB 4/54

SURVEY - BECKMAN
PLOT & TRACE - DANFORTH | BRIDGE - 3248

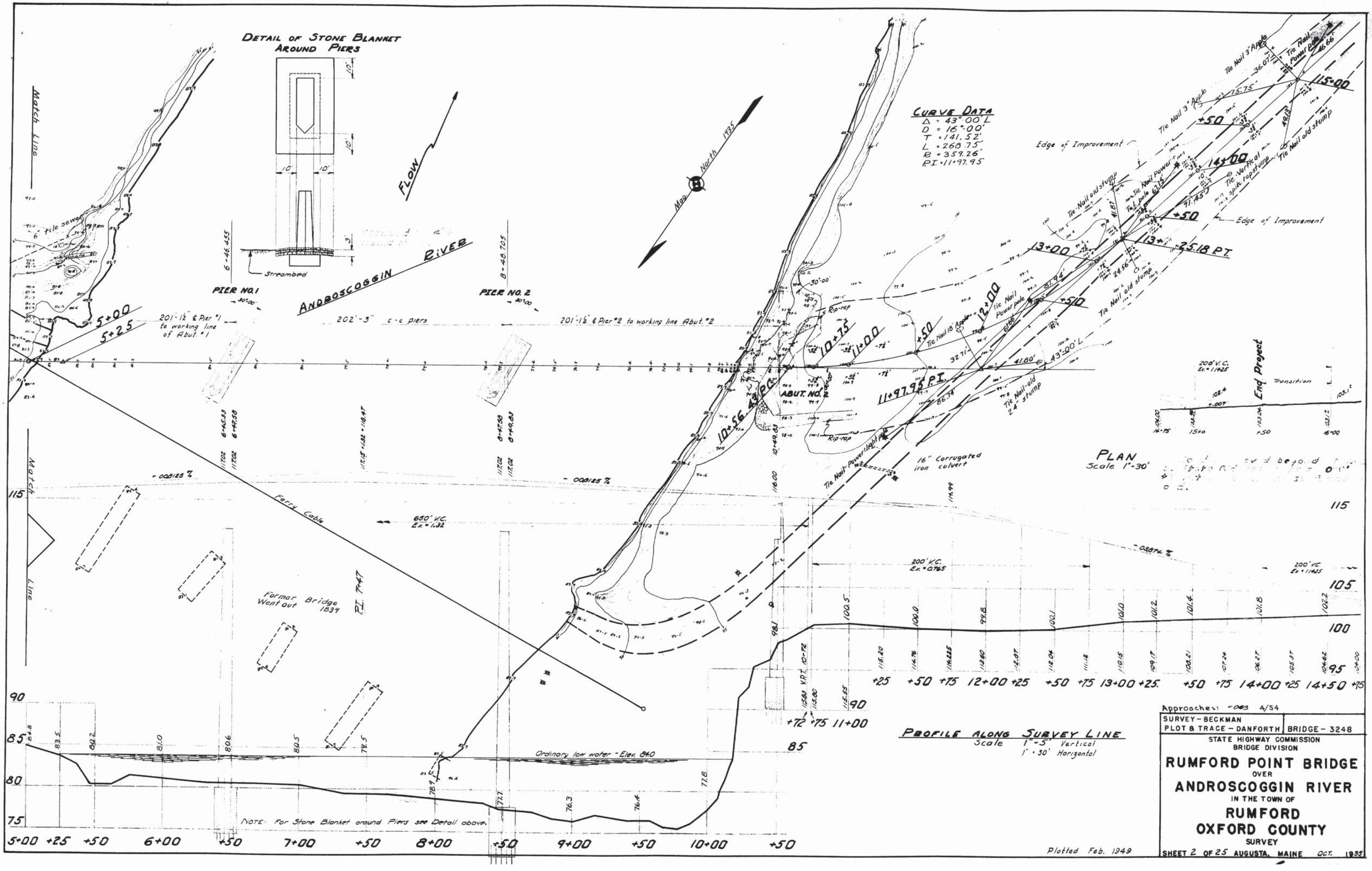
STATE HIGHWAY COMMISSION
BRIDGE DIVISION

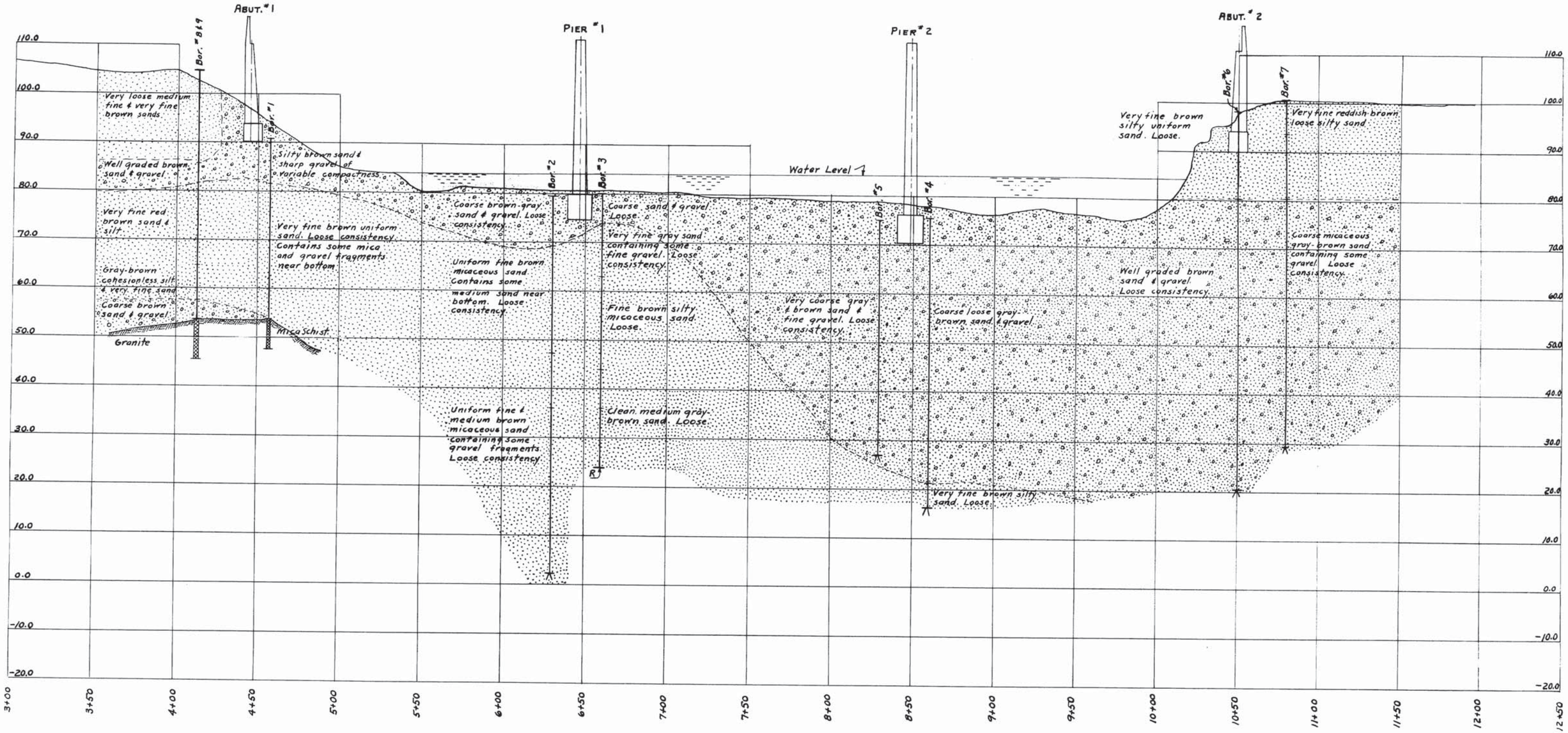
RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY

SURVEY

SHEET 1 OF 25 AUGUSTA, MAINE OCT. 1935

Plotted Feb. 1949


DETAIL OF STONE BLANKET AROUND PIERS
Streambed
PIER NO. 1
PIER NO. 2
ANDROSCOGGIN RIVER
Flow
Mag. North 1935
Match Line
6" tile sewer
201'-1½" ℄ Pier #1 to working line of Abut. #1
202'-3" c-c piers
201'-1½" ℄ Pier #2 to working line Abut. #2
CURVE DATA
Δ = 43°-00' L
D = 16°-00'
T = 141.52'
L = 268.75'
R = 359.26'
P.I. = 11+97.95
Edge of Improvement
Tie Nail 3" Apple
Tie Nail Power Pole
Tie Nail old stump
Tie Vertical spike rop stump
Tie Nail 18" Apple
Tie Nail Power pole
Tie Nail old stump 24" stump
Tie Nail Power Light Pole
16" Corrugated iron culvert
Rip-rap
ABUT. NO. 2
10+56.43 P.C.
11+97.95 P.T.
13+25.18 P.T.
10+75
11+00
12+00
13+00
14+00
115+00
End Project
Transition
200' V.C. Ex. = 1.1925
PLAN
Scale 1"=30'
-.008125 %
650' V.C. Ex. = 1.32
200' V.C. Ex. = 0.7765
-.0874 %
Former Bridge Went out 1839
P.T. 7+47
Ferry Cable
Ordinary low water - Elev. 84.0
NOTE: For Stone Blanket around Piers see Detail above.
PROFILE ALONG SURVEY LINE
Scale 1" = 5' Vertical
1" = 30' Horizontal
Plotted Feb. 1949
Approaches: -.043 A/S4
SURVEY - BECKMAN
PLOT & TRACE - DANFORTH
BRIDGE - 3248
STATE HIGHWAY COMMISSION
BRIDGE DIVISION
RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY
SURVEY
SHEET 2 OF 25 AUGUSTA, MAINE OCT. 1935



PROFILE

HOR. SCALE 1" = 30 FT.
VERT. " 1" = 10 FT.

SOILS ENGINEER – H. GRAY
TRACE-WELCH

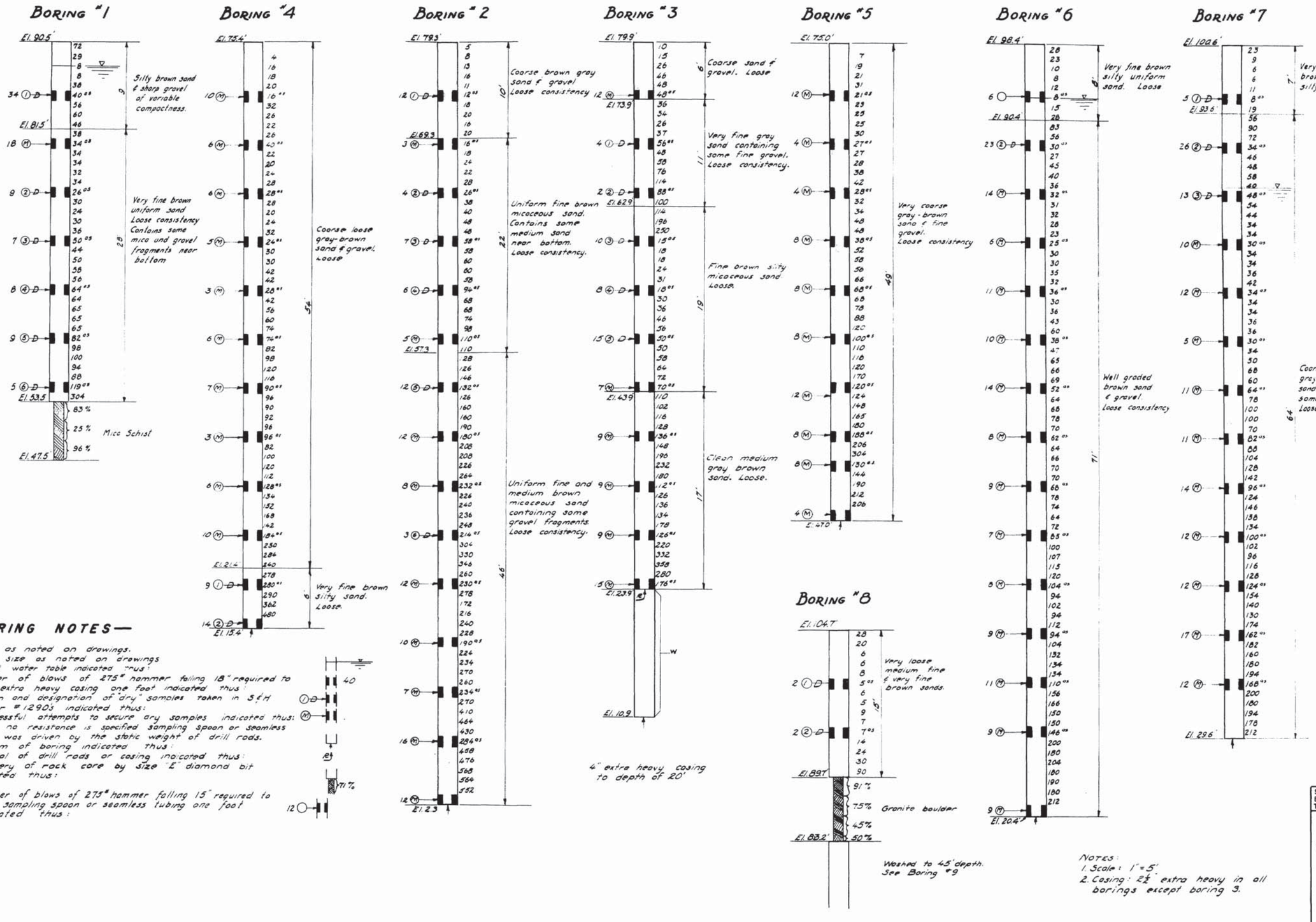
BRIDGE – 3248

STATE HIGHWAY COMMISSION
BRIDGE DIVISION

RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY

GENERAL PROFILE & BORINGS

SHEET 3 OF 25 AUGUSTA, MAINE APRIL 1954



—BORING NOTES—

1. Scales as noted on drawings.
2. Casing size as noted on drawings
3. Ground water table indicated thus:
4. Number of blows of 275# hammer falling 18" required to drive extra heavy casing one foot indicated thus:
5. Location and designation of "dry" samples taken in S&H sampler #1290S indicated thus:
6. Ursuccessful attempts to secure dry samples indicated thus:
7. Where no resistance is specified sampling spoon or seamless tubing was driven by the static weight of drill rods.
8. Bottom of boring indicated thus:
9. Refusal of drill rods or casing indicated thus:
10. Recovery of rock core by size "E" diamond bit indicated thus:
11. Number of blows of 275# hammer falling 15" required to drive sampling spoon or seamless tubing one foot indicated thus:

NOTES:
1. Scale: 1" = 5'
2. Casing: 2½" extra heavy in all borings except boring 3.

SOILS ENGINEER – H. GRAY
BORING SUPERVISOR – L. CLARK
TRACE – BAILEY, FORTIER

BRIDGE - 3248

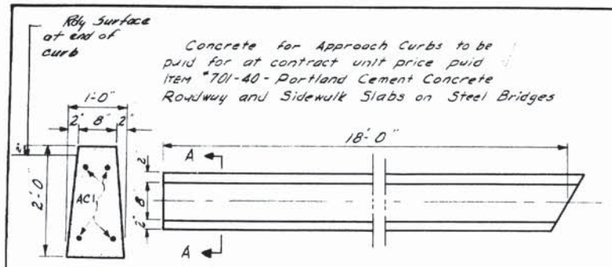
STATE HIGHWAY COMMISSION
BRIDGE DIVISION

RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY

— WASH BORING LOGS —

SHEET 4 OF 25 AUGUSTA, MAINE APRIL 1954

Concrete for Approach Curbs to be paid for at contract unit price paid Item "701-40 - Portland Cement Concrete Roadway and Sidewalk Slabs on Steel Bridges

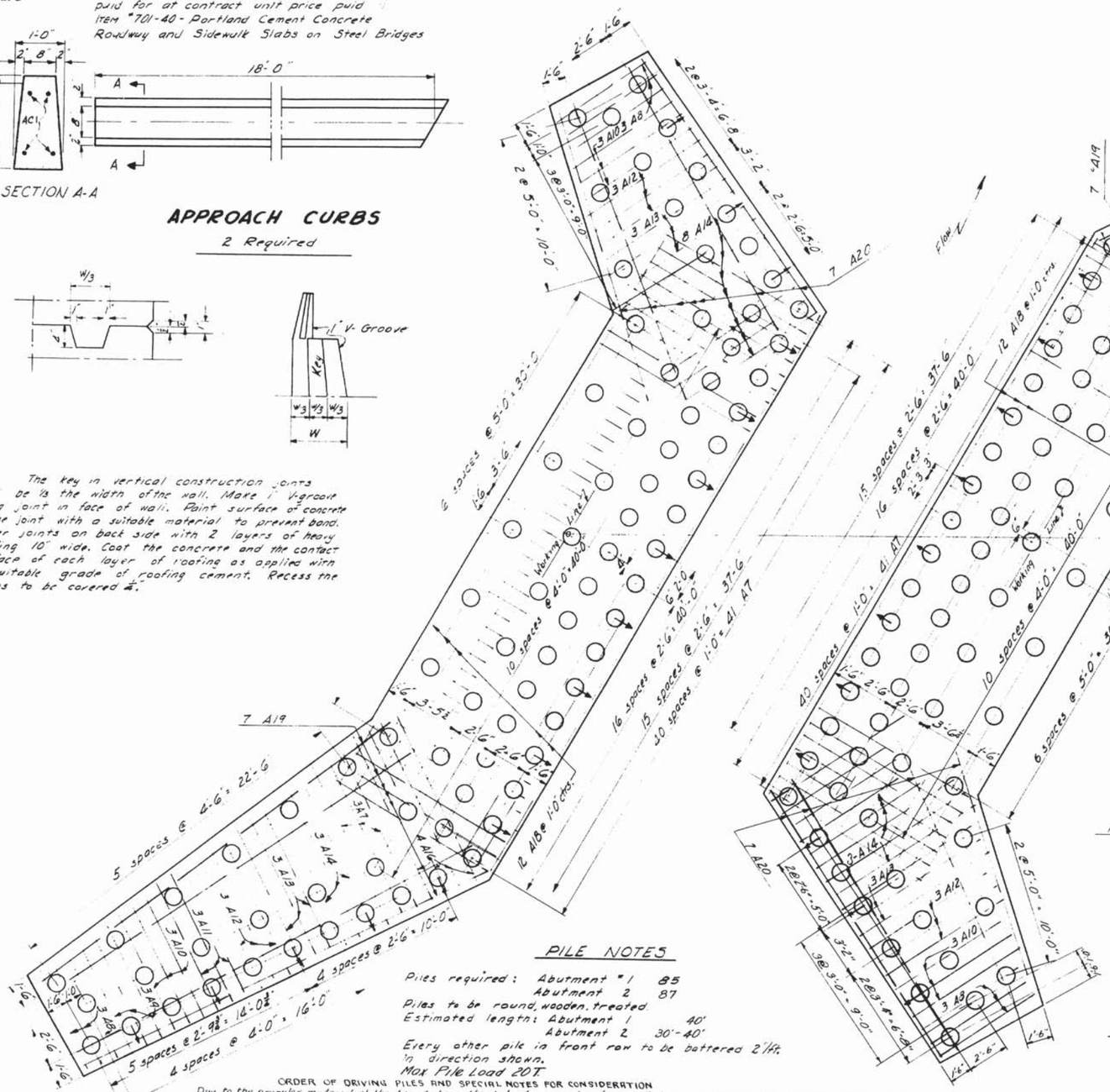


SECTION A-A

APPROACH CURBS

2 Required

The key in vertical construction joints shall be 1/3 the width of the wall. Make 1" V-groove along joint in face of wall. Paint surface of concrete in the joint with a suitable material to prevent bond. Cover joints on back side with 2 layers of heavy roofing 10" wide. Coat the concrete and the contact surface of each layer of roofing as applied with a suitable grade of roofing cement. Recess the areas to be covered ¼".



ABUT. 1

ABUT. 2

PILE PLAN AND FOOTING STEEL - ABUTMENTS

PILE NOTES

Piles required: Abutment #1 85
Abutment 2 87

Piles to be round, wooden, treated.
Estimated length: Abutment 1 40'
Abutment 2 30'-40'

Every other pile in front row to be battered 2"/ft. in direction shown.

Max Pile Load 20T.

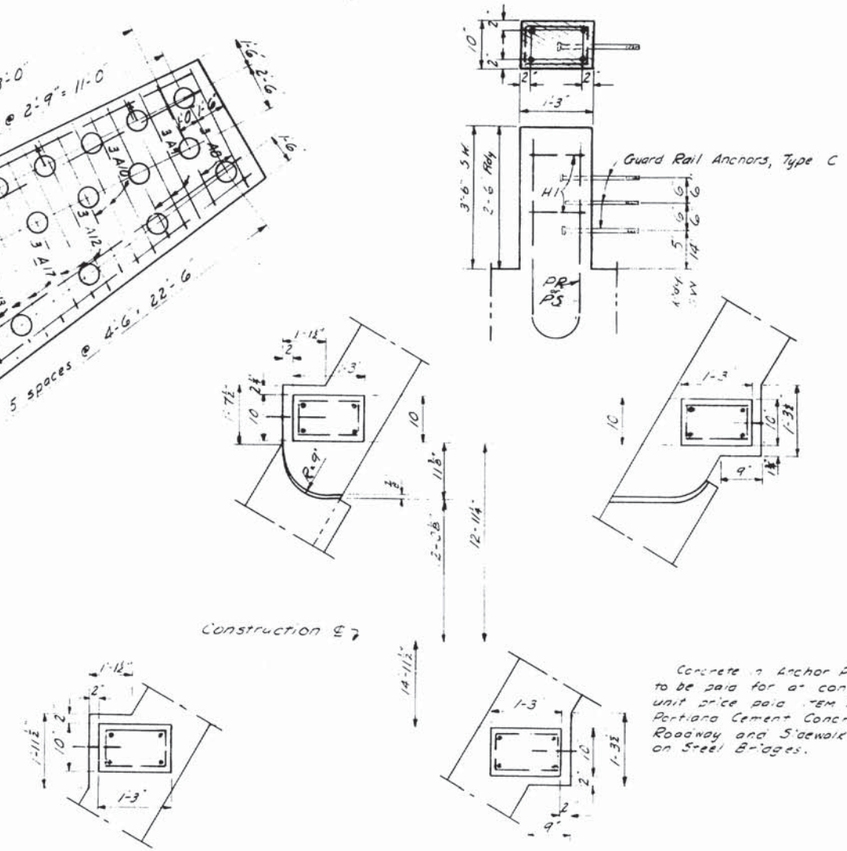
ORDER OF DRIVING PILES AND SPECIAL NOTES FOR CONSIDERATION

Due to the granular material of the foundation the pile driving operation will have a tendency to compact the ground so that the first piles driven may be expected to penetrate to somewhat greater depths than those driven later.

The order of driving piles in each foundation shall be:

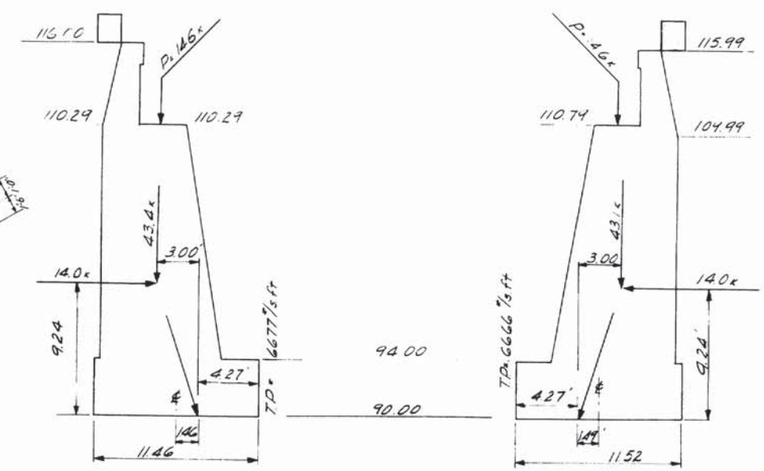
1. Alternate piles of various locations of the unit until about one-half the piles for the unit are driven.
2. The remaining piles.

In each of the above steps piles in the front row shall be driven first.



Concrete in Anchor Posts to be paid for at contract unit price paid Item 701-60 Portland Cement Concrete Roadway and Sidewalk Slabs on Steel Bridges.

ANCHOR POST DETAIL



ABUT. 1

ABUT. 2

ABUTMENT ANALYSIS

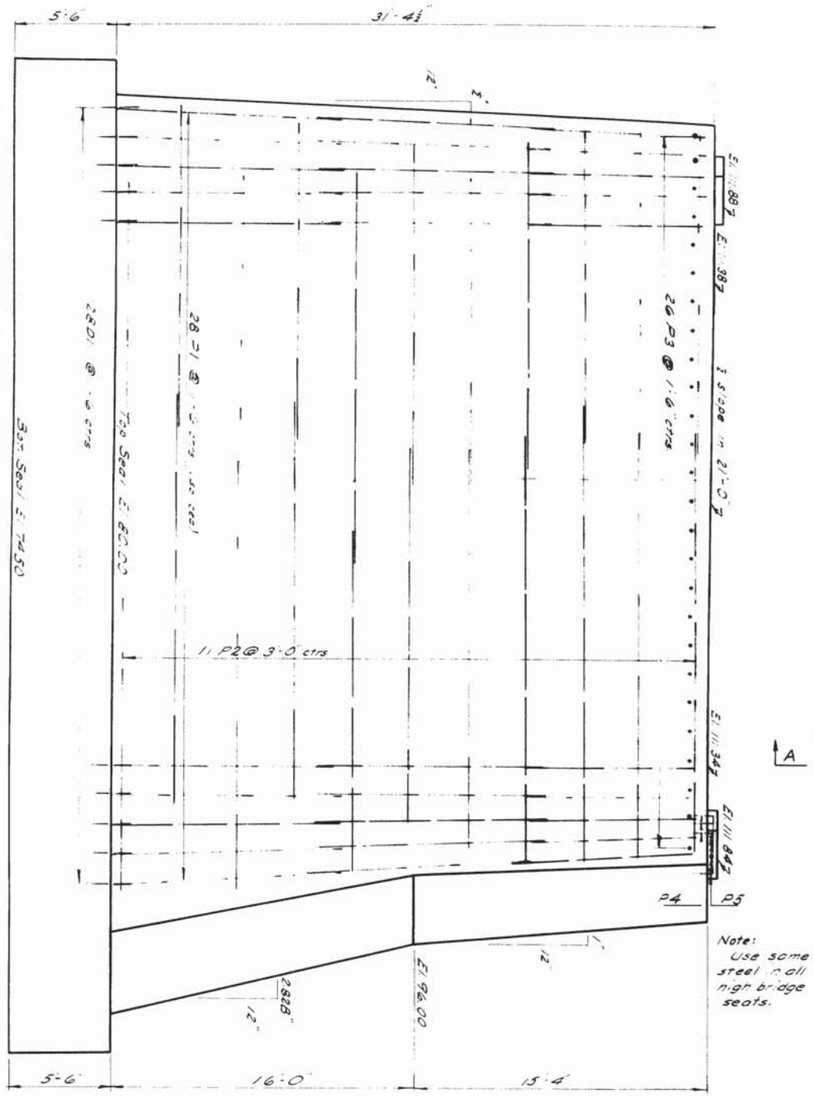
DESIGN - MAZEIKO, SHAILER DETAIL & TRACE - MAZEIKO CHECK -	BRIDGE 3248

STATE HIGHWAY COMMISSION
BRIDGE DIVISION

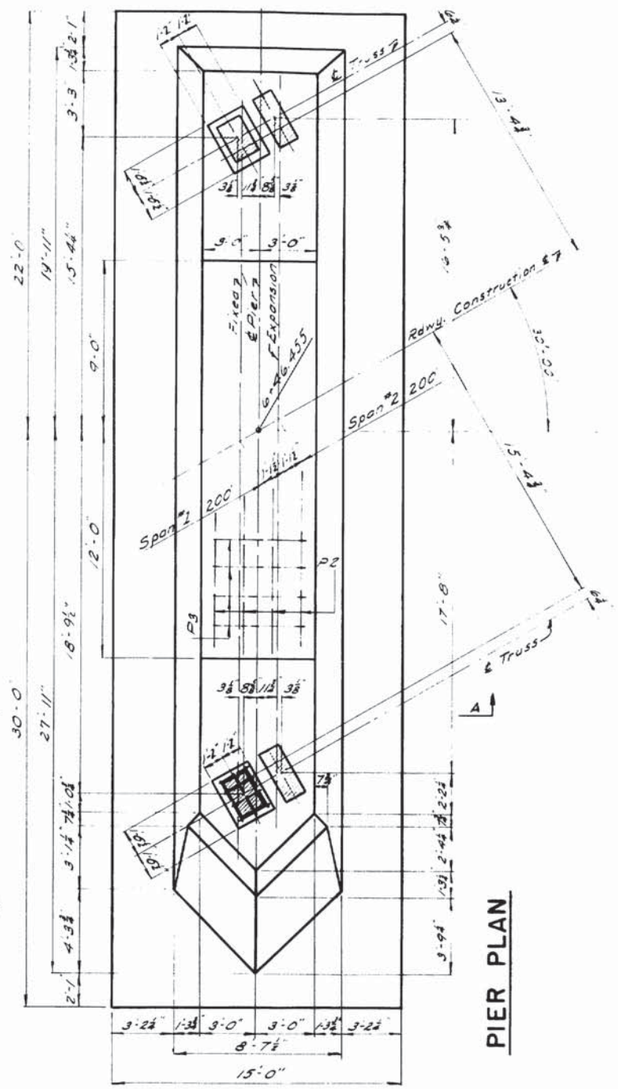
RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN
RUMFORD
OXFORD COUNTY

PILE PLAN-ABUTMENTS

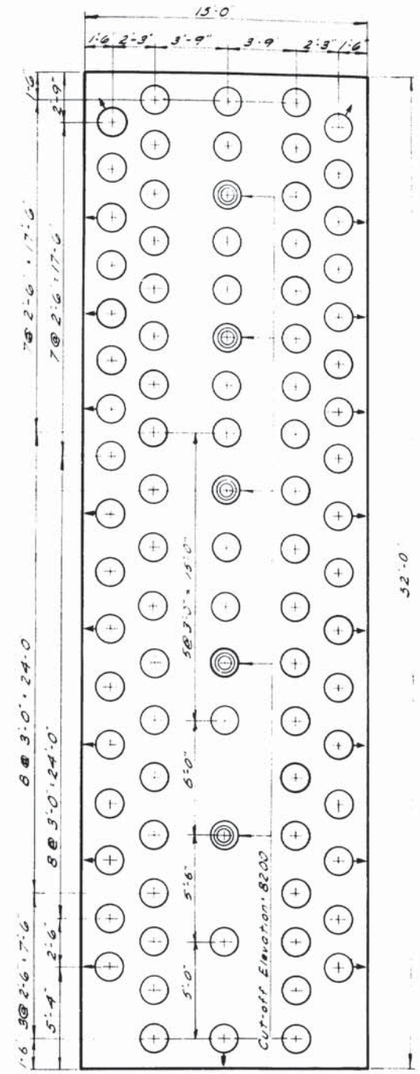
SHEET 9 OF 25 AUGUSTA, MAINE APRIL 1954



SIDE ELEVATION

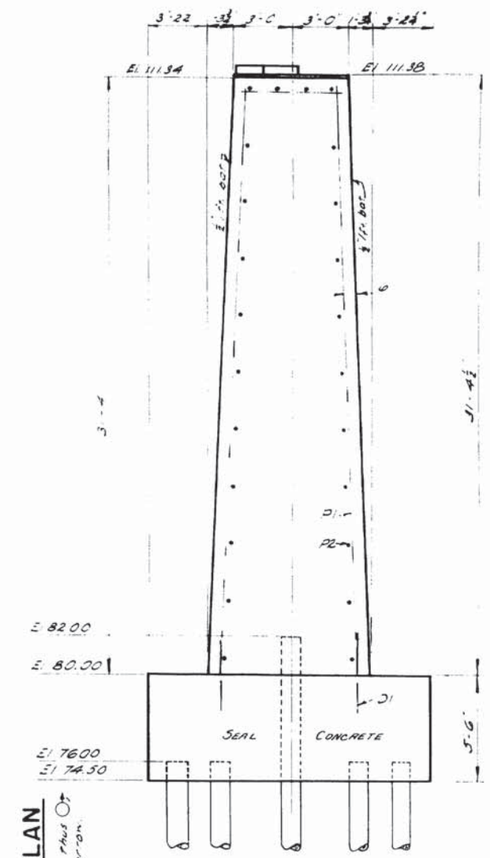


PIER PLAN



PILE PLAN

Borrow piles space thus ○ 2'ft. in direction of arrow



SECTION A-A

Note: Dress shaded areas on bridge seats to exact elevations shown, larger than bearing plates.

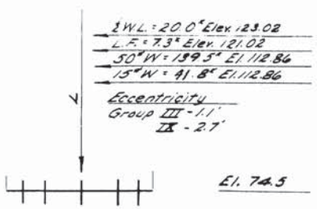
Place steel in top of piers so that it will not interfere with the anchor bolts.

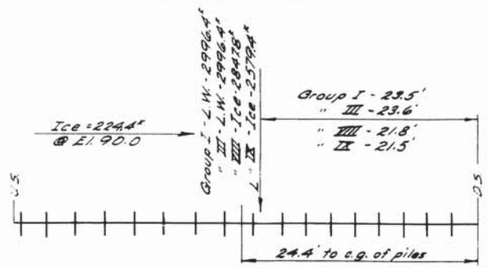
Piles to be round, wooden, untreated

Estimated length 30'-40 feet

Maximum pile load 20T

Superstructure Live Loads
Fixed DS - 72.6k
" US - 55.4
Exp. DS - 102.1
" US - 78.0
Superstructure Dead Loads
Fixed DS - 290.3k
" US - 270.3
Exp. DS - 238.4
" US - 263.5
Pier Dead Loads
H.W. 96.0 - 1,458.3
Ice 90.0 - 1,576.9
L.W. 84.0 - 1,685.8





PIER ANALYSIS

GROUP	LOADS	STRESS	ALLOW.
I L.W.	D+L+B	18.6T	20T
III L.W.	Group I+L.F.+15'W+½W.L.	24.1T	25T
VIII	Group I + Ice	20.5T	28T
IX	Group II + Ice	29.4T	30.0T

NOTES

ORDER OF DRIVING PILES AND SPECIAL NOTES FOR CONSIDERATION

Due to the granular material of the foundation the pile driving operation will have the tendency to compact the ground so that the first piles driven may be expected to penetrate to somewhat greater depths than those driven later.

The order of driving piles in each foundation shall be:

1. Alternate piles of various locations of the unit until about one-half of the piles for the unit are driven.
2. The remaining piles.

In each of the above steps piles in the outside rows shall be driven first.

Stone Blanket around Piers - See Detail on Survey Sheet.

DESIGN - SHAILER
TRACE - GRAY
CHECK

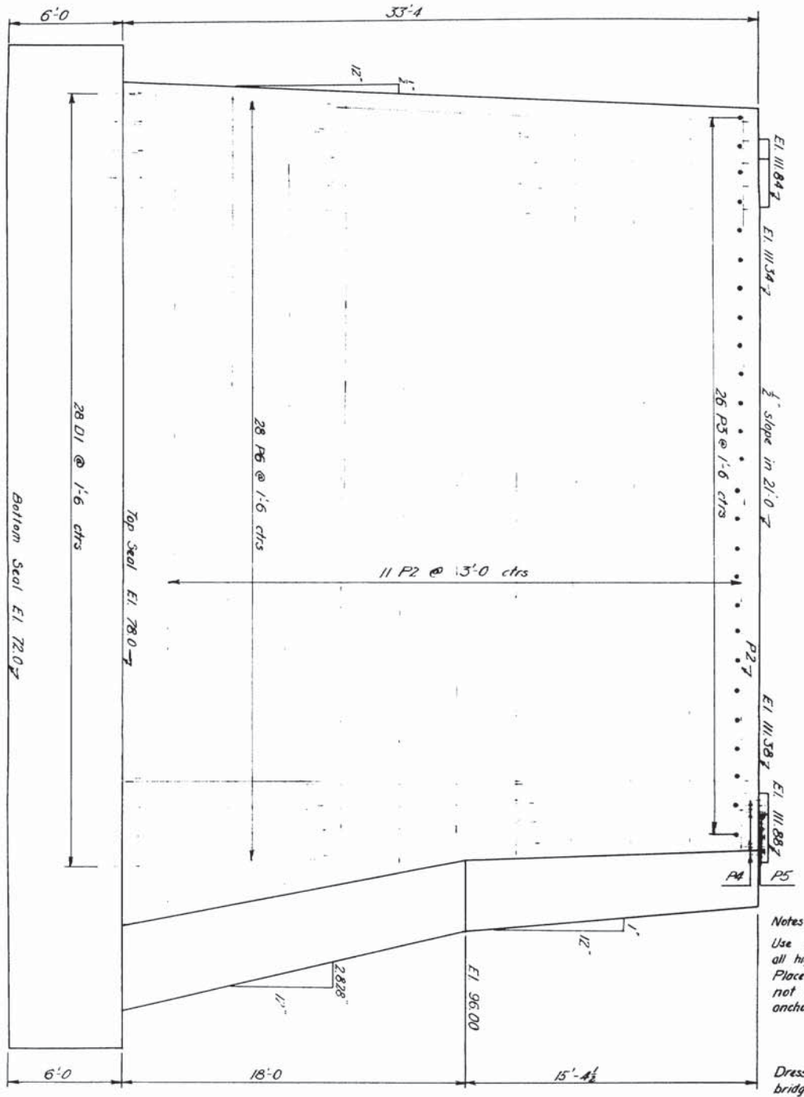
BRIDGE - 3248

STATE HIGHWAY COMMISSION
BRIDGE DIVISION

RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY

PIER NO. 1

SHEET 10 OF 25 AUGUSTA, MAINE MAR. 1954

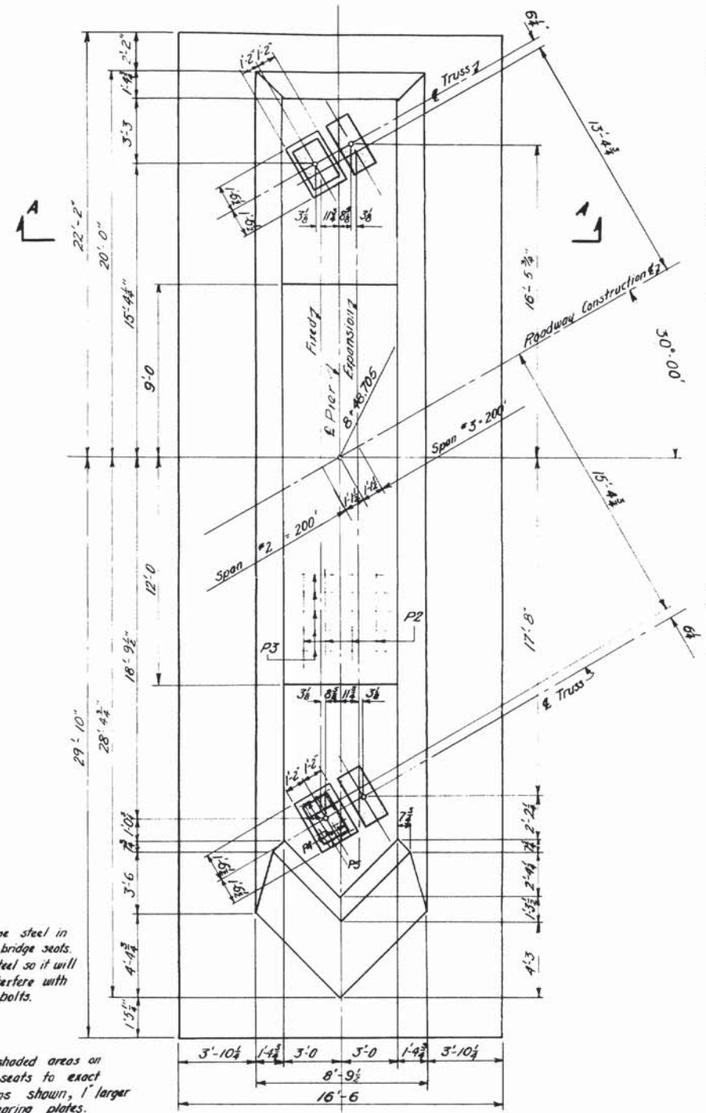


SIDE ELEVATION

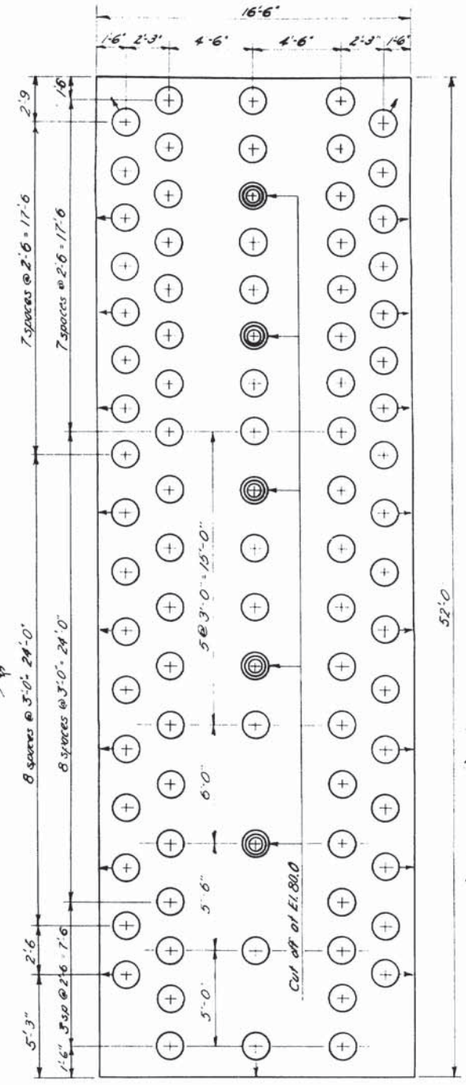
Notes:

Use same steel in all high bridge seats. Place steel so it will not interfere with anchor bolts.

Dress shaded areas on bridge seats to exact elevations shown, 1" larger than bearing plates.



PLAN PIER #2



PILE PLAN

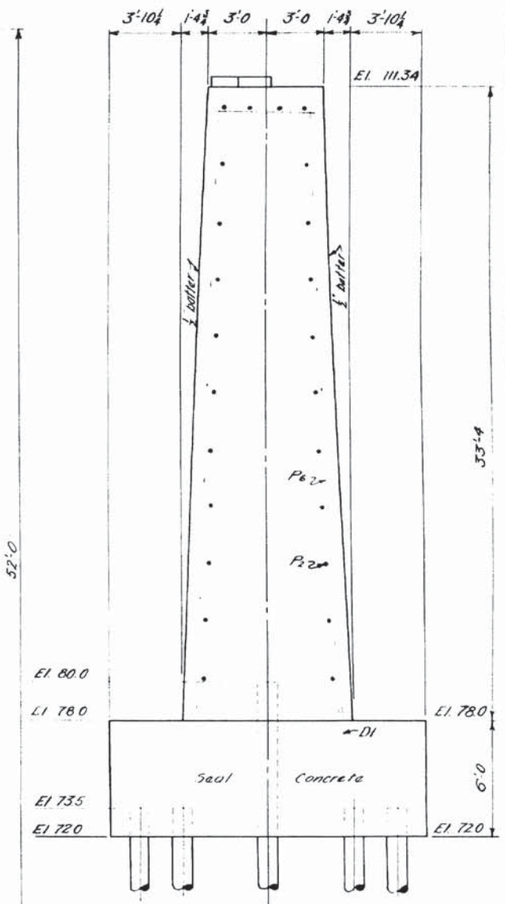
Batter piles shown thus, ⊕←, 2"/ft in direction of arrow.

See Note on Sheet 10 for Pile & Stone Blanket Data.

Piles to be round, wooden, untreated.

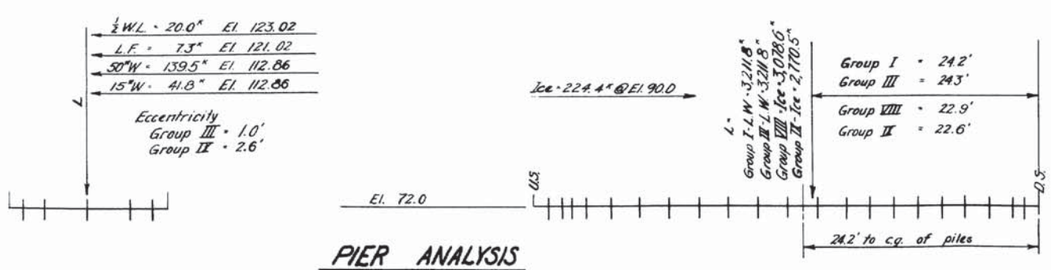
Estimated length 30-40 ft.

Maximum pile load 20 T.



SECTION A-A

Superstructure Live Loads
Fixed D.S. - 72.6"
Fixed U.S. - 55.4"
Expansion D.S. - 102.1"
Expansion U.S. - 78.0"
Superstructure Dead Loads
Fixed D.S. - 230.3"
Fixed U.S. - 270.3"
Expansion D.S. - 238.4"
Expansion U.S. - 263.5"
Pier Dead Loads
H.W. 96.0 - 1,647.4"
Ice 90.0 - 1,768.0"
L.W. 84.0 - 1,901.2"



PIER ANALYSIS

Group	Loads	Stress	Allow.
I L.W.	D + L + B	19.0 T	20 T
III L.W.	Group I + L.F. + 15"W. + ½ W.L.	23.5 T	25 T
VIII	Group I + Ice	20.5 T	28 T
II	Group II + Ice	29.4 T	30 T

DESIGN - SHAILER
TRACE - FOSTER
CHECK -

BRIDGE - 3248

STATE HIGHWAY COMMISSION
BRIDGE DIVISION

RUMFORD POINT BRIDGE
OVER
ANDROSCOGGIN RIVER
IN THE TOWN OF
RUMFORD
OXFORD COUNTY

PIER NO. 2

SHEET 11 OF 25 AUGUSTA, MAINE MAR 1954

APPENDIX E

Design Memoranda

- Preliminary Geotechnical Data Memorandum, dated 30 August 2012
- Preliminary Liquefaction Susceptibility Evaluation Memorandum, dated 9 November 2012

Haley & Aldrich
75 Washington Avenue
Suite 203
Portland, ME 04101-2617

Tel: 207.482.4600
Fax: 207.775.7666
HaleyAldrich.com

HALEY & ALDRICH

MEMORANDUM

30 August 2012
File No. 38799-000

TO: Maine Department of Transportation
Kate Maguire, P.E.

C: TranSystems
Christopher P. Gamache, P.E.; Evan C. Lowell, P.E.

FROM: Haley & Aldrich, Inc.
Bryan C. Steinert, P.E. Wayne A. Chadbourne, P.E.

SUBJECT: Preliminary Geotechnical Data Memorandum
Martin Memorial Bridge Replacement
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

STATE OF MAINE
WAYNE A. CHADBOURNE
No. 10820
LICENSED
PROFESSIONAL ENGINEER

This memorandum provides a brief description of the recently completed design phase subsurface exploration program and generally describes subsurface soil, bedrock and groundwater conditions encountered along the proposed approach roadway and bridge alignment. Geotechnical factors that may affect the proposed roadway and bridge design and construction are also presented. This memorandum has been prepared to support TranSystems' 50 percent design submission to the Maine Department of Transportation (MaineDOT).

SUBSURFACE EXPLORATIONS

Haley & Aldrich completed a design phase subsurface exploration program at the site in June and July 2012. A total of 23 test borings, designated BB-RAR-101 through BB-RAR-123, were drilled along the proposed approach roadway and bridge alignment, including two test borings at the extreme ends (north and south) of each proposed bridge substructure (i.e., abutment, pier).

Test borings were drilled by Maine Test Borings of Hermon, Maine using a CME 45 trailer-mounted drill rig and a CME 45 drill rig placed on an anchored barge. Test borings were advanced to depths ranging from approximately 10 to 146 ft below existing ground surface/mudline (BGS) using either 2.5 in. inside diameter (ID) hollow stem augers (HSAs) or a combination of 3 in. (NW-size) and 4 in. (HW-size) outside diameter (OD) steel casing.

Soil samples were collected continuously and/or at standard, 5-ft intervals. A bentonite drilling mud was used in select boreholes to aid in maintaining borehole stability and collection of quality standard penetration test (SPT) data. Test borings drilled at proposed bridge substructure locations were

Printed on 30% post-consumer recycled paper

advanced approximately 2 to 19 ft into bedrock using a 2.0-in. (NQ-size) ID diamond-tipped core barrel.

An observation well was installed in completed borehole along the west approach embankment (BB-RAR-109) to provide information on the static groundwater levels at the site. The observation well consisted of 2-in. ID, machine-slotted PVC pipe and solid PVC riser pipe extending approximately 3 ft above existing ground surface. The observation well was outfitted with a steel guardpipe and steel lock/cap assembly.

GENERALIZED SUBSURFACE CONDITIONS

Soil and Bedrock Conditions

In general, the subsurface soil conditions along the entire proposed approach roadway and bridge alignment are uniform and consist of thick deposits of very loose to medium dense alluvial soils. The deepest portions of the deposit, encountered in test borings drilled at proposed bridge substructure locations, are generally dense to very dense.

The alluvial soils typically consist of fine to coarse SAND with varying amounts of clay, silt and gravel. In general, the clay and silt (fines) content is low, typically representing up to approximately 10 percent of the recovered material.

Bedrock was encountered in each test boring drilled at a proposed bridge substructure location. A summary of top of bedrock elevations is provided below.

Substructure Location	Test Boring No.	Ground Surface/ Mudline Elevation (ft, NAVD 88)	Depth to Top of Bedrock (ft)	Elevation of Top of Bedrock (ft, NAVD 88)
Abutment 1	BB-RAR-110	615.8	136.5	479.3
	BB-RAR-111	615.7	130.5	485.2
Pier 1	BB-RAR-115	597.1	116.0	481.1
	BB-RAR-116	597.1	91.5	505.6
Pier 2	BB-RAR-117	596.1	119.5	476.6
	BB-RAR-118	596.8	70.0	526.8
Abutment 2	BB-RAR-119	599.6	88.3	511.3
	BB-RAR-120	600.1	86.0	514.1

In general, the bedrock surface slopes down from east (Route 2) to west and from south (down river) to north (up river). Significant variations in the top of bedrock were observed at both Pier 1 (25 ft) and Pier 2 (50 ft). In addition, the bedrock surface slopes steeply between test boring BB-RAR-121 (El. 587.1), which was drilled in the shoulder of Route 2, and the two test borings drilled near the proposed Abutment 2 location.

Bedrock encountered in test borings drilled at Pier 1, Pier 2 and Abutment 2 locations was typically highly fractured and/or decomposed. Based on rock quality designation (RQD) calculated from recovered bedrock samples the rock mass quality varies from very poor to fair, the majority of which is very poor to poor. Bedrock encountered in test borings drilled at Abutment 1 was not significantly fractured and/or decomposed and the rock mass quality was good.

Groundwater Conditions

One groundwater observation well was installed in completed borehole BB-RAR-109. Water levels measured during the subsurface exploration program (13 June to 13 July 2012) were generally measured between El. 604 and El. 607. It should be noted that there was very little precipitation during the subsurface exploration program, which may have impacted the water levels measured in the observation well.

Flood levels in the Androscoggin River, as provided by TranSystems, are summarized below.

Discharge	Headwater (ft, NAVD 88)
$Q_{1.1}$	El. 612.6
Q_{25}	El. 622.8
Q_{50}	El. 623.9
Q_{100}	El. 625.7
Record Flood (1936)	El. 630.7

Groundwater levels can be expected to fluctuate, subject to seasonal variation, local soil conditions, topography and precipitation. Water levels encountered during construction may differ from those observed in the test borings during drilling or the observation well.

LABORATORY TESTING PROGRAM

A geotechnical laboratory testing program has been undertaken on representative soil samples collected during the subsurface exploration program to assist in soil classification and determine engineering soil properties needed for final design. Laboratory testing is being performed in accordance with applicable American Society for Testing Materials (ASTM) testing procedures. All geotechnical laboratory soil testing is being performed by GeoTesting Express of Acton, Massachusetts.

The testing program includes the following:

- 28 natural water content tests,
- 5 Atterberg limits tests,
- 41 grain size analyses,
- 5 grain size analyses including hydrometer, and
- 14 direct shear tests.

We anticipate receiving laboratory test results by 12 September 2012.

GEOTECHNICAL FACTORS EFFECTING BRIDGE CONSTRUCTION

A design phase subsurface exploration program was conducted in June and July 2012, as discussed herein, to identify general subsurface conditions along the proposed approach roadway and bridge alignment. Based on the subsurface conditions encountered in the design phase subsurface explorations and our understanding of the proposed approach roadway and bridge construction, we offer the following general geotechnical "observations":

- Due to presence of very loose to medium dense alluvial soils below the water table, liquefaction susceptibility and the potential for lateral spreading to occur must be evaluated.
    - Liquefaction susceptibility evaluations will initially be conducted using the simplified procedures outlined in AASHTO LRFD.
    - If the results of the liquefaction susceptibility evaluation using the simplified procedures show that liquefaction potential is low, no additional work will be required.
    - If the results show that there is potential for liquefaction to occur three options exist: 1.) perform a more detailed site-specific seismic response analysis, the outcome of which may show that the potential for liquefaction to occur is decreased. Please note that the outcome of more detailed analyses may not result in decreased liquefaction potential, 2.) Rely on the results of the simplified procedures and design the proposed approach roadway and bridge to accommodate the resulting deformations (settlement, lateral spreading) and additional loads (downdrag and lateral loads on bridge foundations), and 3.) Rely on the results of the simplified procedures and mitigate the liquefaction potential by improving the subsurface soil conditions using ground improvement (e.g., reinforcement piles, grouting, densified aggregate piers, etc.).

- Due to the presence of very poor to moderately poor rock mass quality (highly fractured and/or decomposed bedrock) and the steepness of the bedrock surface at Pier 1, Pier 2 and Abutment 2, careful consideration of the use of batter piles and pile type (i.e., friction pile versus end bearing pile and displacement versus non-displacement piles) will be critical in limiting construction related issues.

- We do not anticipate approach embankment settlement and stability will be problematic under static (non-earthquake) conditions. However, these evaluations will be conducted under both the static and seismic conditions during final design.

We trust this information meets your present needs. Please do not hesitate to contact us if you have any questions, comments or concerns regarding the information presented herein.

Haley & Aldrich, Inc.
75 Washington Avenue
Suite 203
Portland, ME 04101

Tel: 207.482.4600
Fax: 207.775.7666
HaleyAldrich.com

MEMORANDUM

9 November 2012
File No. 38799-000

TO: Maine Department of Transportation
Kate Maguire, P.E.

C: TranSystems
Evan C. Lowell, P.E.

FROM: Haley & Aldrich, Inc.
Jean-Louis Locsin, Ph.D., Bryan C. Steinert, P.E., Wayne A Chadbourne, P.E.

SUBJECT: Preliminary Liquefaction Susceptibility Evaluation
Martin Memorial Bridge Replacement
MaineDOT WIN 19311.00
Route 232 - Rumford, Maine

As discussed during our 15 October 2012 conference call, we have preliminarily evaluated the liquefaction potential of the granular soil deposits present at the subject site. Preliminary liquefaction analyses for the subject project, as discussed and provided herein, were completed in accordance with the following documents:

- AASHTO LRFD Bridge Design Specifications (AASHTO LRFD), Sixth Edition, 2012 with Interim Revisions through 2012,
- AASHTO Guide Specifications for LRFD Seismic Bridge Design (AASHTO Guide Specifications), Second Edition, 2011, and
- MaineDOT Bridge Design Guide (MaineDOT BDG), August 2003, with Interim Revisions through August 2008.

ELEVATION DATUM

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

SUBSURFACE CONDITIONS

Soil Conditions

Haley & Aldrich completed a design-phase subsurface exploration program at the site in June and July 2012. A total of 23 test borings, designated BB-RAR-101 through BB-RAR-123, were drilled along the

proposed approach roadway and bridge alignment, including two test borings at the extreme ends (north and south) of each proposed bridge substructure (i.e., abutment, pier).

The preliminary liquefaction susceptibility evaluations summarized herein considered test borings drilled along the west approach embankment and those drilled at each proposed substructure location as summarized below.

Substructure Location	Station	Reference Test Borings
West Approach & Abutment 1	10+00 to 15+50	BB-RAR-107 through BB-RAR-114
Pier 1	16+71.50	BB-RAR-115, BB-RAR-116
Pier 2	18+63.50	BB-RAR-117, BB-RAR-118
Abutment 2	20+20	BB-RAR-119, BB-RAR-120

Please note that test borings drilled south of Sta. 10+00, where the proposed finish grade is at or near the existing ground surface, were not considered in the preliminary liquefaction evaluations.

In general, the subsurface soil conditions along the proposed approach roadway and bridge alignment consist of thick deposits of very loose to medium dense alluvial soils. The deepest portions of the deposit, encountered in test borings drilled at the proposed bridge substructure locations, are generally dense to very dense.

The alluvial soils typically consist of fine to coarse SAND with varying amounts of clay, silt and gravel. In general, the clay and silt (fines) content is low, typically representing up to approximately 10 percent of the recovered material.

Groundwater Conditions

One groundwater observation well was installed in completed borehole BB-RAR-109 within the limits of the proposed west approach embankment. Water levels measured during the subsurface exploration program (13 June to 13 July 2012) were measured between El. 604 and El. 607. It should be noted that there was very little precipitation during the subsurface exploration program, which may have influenced the water levels measured in the observation well.

In addition, flood level data for the Androscoggin River (River), as provided by TranSystems, are summarized below.

Discharge	Headwater Elevation (ft, NAVD 88)
$Q_{1.1}$	El. 612.6
Q_{25}	El. 622.8
Q_{50}	El. 623.9
Q_{100}	El. 625.7
Record Flood (1936)	El. 630.7

In accordance with AASHTO Guide Specifications Section 6.8, the "seasonally averaged groundwater elevation" should be used when determining the extent of soils that are adequately saturated for liquefaction to occur. As discussed above, the groundwater levels measured in the observation well during the exploration program are likely lower than the "seasonally averaged groundwater elevation" since very little precipitation was recorded/observed during that time period. As a result, the preliminary liquefaction analyses summarized herein are based on a water level equal to El. 612.6 ($Q_{1.1}$), which we judged to be representative of the "seasonally averaged groundwater elevation".

In general, groundwater levels can be expected to fluctuate, subject to seasonal variation, local soil conditions, topography and precipitation. Water levels encountered during/after construction may differ from those observed in the test borings and measured in the observation well.

SITE CLASS AND SEISMIC DESIGN PARAMETERS

Site class was determined in accordance with AASHTO Guide Specifications Section 3.4.2.1 and 3.4.2.2 using Method B for cohesionless soils. Only those test borings that were terminated in/on bedrock or that penetrated a minimum of 100 ft below ground surface/mudline were used in the evaluation. In instances where SPT N-values were equal to 0 or were in excess of 100 blows per foot (bpf), default values of 1 and 100 bpf were used, respectively.

Due to the nature and thickness of the overburden soils encountered in the design phase test borings, we recommend the site be considered "Site Class E" since the calculated average standard penetration resistance for the top 100 ft is less than 15 blows per foot (bpf). Spectral accelerations were determined based on the geographic site location and the assignment of "Site Class E" using the United States Geological Survey (USGS) software application Seismic Design Parameters v. 2.0 provided the recommended AASHTO response spectra for a 7 percent probability of exceedance in 75 years (approx. 1,000-year return period). The values are summarized below.

Design Parameter	Design Value
Site factor for short-period range of acceleration response spectrum, F_a =	2.50
Site factor for long-period range of acceleration response spectrum, F_v =	3.50
Horizontal response spectral acceleration coeff. at 0.2-s period on rock, S_S =	0.179
Horizontal response spectral acceleration coeff. at 1.0-s period on rock, S_1 =	0.049
Peak seismic ground acceleration coeff. on rock, PGA =	0.087
Site factor at zero-period on acceleration response spectrum, F_{pga} =	2.50
Horizontal response spectral acceleration coeff. at 0.2-s period modified by F_a, S_{DS} =	0.448
Horizontal response spectral acceleration coeff. at 1.0-s period modified by F_v, SD_1 =	0.173

In accordance with AASHTO Guide Specifications Section 3.5, the site is considered to be in Seismic Design Category (SDC) B based on the calculated value of SD_1 ($0.15 < 0.173 < 0.30$). As a result, liquefaction susceptibility evaluations are required. Please note that this information was previously transmitted to you by email on 18 September 2012.

Since the peak ground acceleration (PGA) defined in the table above is based on Site Class B, the ground surface acceleration (A_s) used in preliminary liquefaction susceptibility evaluations was determined by multiplying the PGA by the Site Class E site factor at zero-period on the acceleration response spectrum (F_{pga}). Preliminary liquefaction evaluations summarized herein were completed based on a ground surface acceleration (A_s) equal to 0.218 g.

PRELIMINARY DESIGN GROUND MOTION

The magnitude (M) for the design earthquake used to assess liquefaction susceptibility at the site was determined from earthquake deaggregation data obtained from the USGS in accordance with AASHTO Guide Specification Section 6.8. This data is based on a seismic event (earthquake) having a five percent probability of exceedance in 50 years (1,000-year return period). Based on our review of the USGS deaggregation data, we judged that the mean magnitude earthquake (M 5.85) was appropriate for use in assessing liquefaction susceptibility for this site.

PRELIMINARY LIQUEFACTION ANALYSES

The liquefaction susceptibility of the granular soils at the site was determined by calculating the ratio between the cyclic resistance ratio (CRR) of the in-situ soils at each sample location and equivalent uniform cyclic stress ratio (CSR) imposed by the design earthquake. This ratio was modified using a magnitude scaling factor (MSF) to account for earthquake magnitudes different from M 7.5 to obtain the factor of safety against liquefaction. Liquefaction of the in-situ granular soils will likely occur when the factor of safety is less than 1.0.

CRR is a function of clean sand-corrected SPT N-value ($N1_{60\text{-}CS}$) following the simplified methodology originally developed by Seed et al. (1985) and more recently updated by Youd and Idriss (2001). The CRR was estimated using raw SPT N-values that were corrected for various effects including overburden pressure, hammer energy, borehole diameter, drill rod length, sampling method and fines content. In cases where laboratory grain size analyses were available, that data was used in lieu of field observations/soil classifications made during drilling. Since the CRR calculated from $N1_{60\text{-}CS}$ using the simplified methodology is based on a M 7.5 earthquake, the CRR must be corrected to the design earthquake magnitude (M 5.85) using the MSF.

Since liquefaction is considered at the Extreme Event Limit State and AASHTO LRFD specifies that the overall goal in designing for any extreme event is to prevent structure collapse and protect life safety, calculated factors of safety greater than 1.0 are considered acceptable.

RESULTS OF PRELIMINARY LIQUEFACTION ANALYSES AND CONCLUSIONS

Raw and corrected SPT N-values as well as calculated factors of safety for each sample have been graphically summarized on the attached figures. Figures 1 and 2 show the data and results for test borings drilled along the west approach embankment and Abutment 1. Figures 3, 4, and 5 show the data and results for test borings drilled at Pier 1, Pier 2, and Abutment 2, respectively.

The results of the preliminary liquefaction analyses are summarized below.

- Figure 1 – West Approach/Abutment 1 indicates the in-situ soils are susceptible to liquefaction (FS < 1.0) down to approximately El. 575. The majority of data points above El. 595 (approximate) have calculated factors of safety that are equal to or less than 1.0 while the majority of data points below El. 595 have calculated factors of safety greater than 1.0. Data shown on this figure is from test borings BB-RAR-107 through BB-RAR-111, drilled within the "core" of the proposed approach embankment.
- Figure 2 - West Approach/Abutment 1 indicates the in-situ soils are susceptible to liquefaction down to approximately El. 565. The majority of data points have calculated factors of safety less than 1.0. Data shown on this figure is from test borings BB-RAR-112 through BB-RAR-114, drilled near the toe of the proposed approach embankment slopes. The difference in the calculated factors of safety shown on Figures 1 and 2 is primarily related to the thickness of proposed fill at the test boring location (i.e., test borings drilled within the "core" of the proposed approach embankment will have greater thicknesses of fill overlying them as compared to those drilled near at/near the toe of the proposed approach embankment slopes.
- Figure 3 – Pier 1 indicates the in-situ soils are susceptible to liquefaction from mudline down to approximately El. 565.
- Figure 4 – Pier 2 indicates the in-situ soils are susceptible to liquefaction from mudline down to approximately El. 565.
- Figure 5 – Abutment 2 indicates the in-situ soils are susceptible to liquefaction from mudline down to approximately El. 560. Please recall that test borings drilled for Abutment 2 were drilled within the limits of river since the actual Abutment 2 location could not be accessed by drilling equipment. As a result, it is possible that soils present at the Abutment 2 location from existing ground surface down to the mudline elevation could also be susceptible to liquefaction.

Based on the evaluations and results summarized herein and shown on the attached figures, we offer the following conclusions and recommendations:

- Liquefaction is likely to occur over certain depth intervals along the entire length of roadway/bridge considered (i.e., beneath the west approach embankment and at each proposed substructure location).
- Liquefaction induced downdrag loading on foundation piles should be considered during foundation design.
- A reduction in lateral soil resistance should be considered during pile foundation design to account for the liquefied soil.
- Bridge design should consider lateral spreading of the soil present on the banks of the Androscoggin River (River) and above El. 595 (approximate mudline elevation) into the River specifically as it relates to the resulting horizontal and vertical deformations of the approach embankments as well as increased lateral forces on bridge abutment and pier foundation piles.
- Ground improvement should be considered to mitigate liquefaction potential as an alternative to designing for downdrag, loss of lateral soil resistance, and increased lateral forces related to pile foundation design as well as permanent horizontal and vertical deformations along the approach roadways as a result of lateral spreading of the soil into the River. Ground improvement could consist of grouting or installation of densified aggregate piers.

- A more detailed site-specific seismic response analysis could be performed, the outcome of which may show decreased potential for liquefaction compared to the simplified procedure used in the evaluations described herein. However, please note that it is also possible that the outcome of a more detailed analysis may not result in decreased liquefaction potential.
- It is our opinion that collection of additional data (i.e., cone penetration testing) could provide more reliable information to use as a basis for evaluating liquefaction potential. However, given the accelerated project schedule, it is our opinion that there is not sufficient time to collect, process and re-evaluate liquefaction potential. As a result, we recommend that final design proceed with either a site-specific seismic response analysis or design of the proposed approach roadways and bridge to accommodate the additional forces, loss of resistance and permanent deformations.

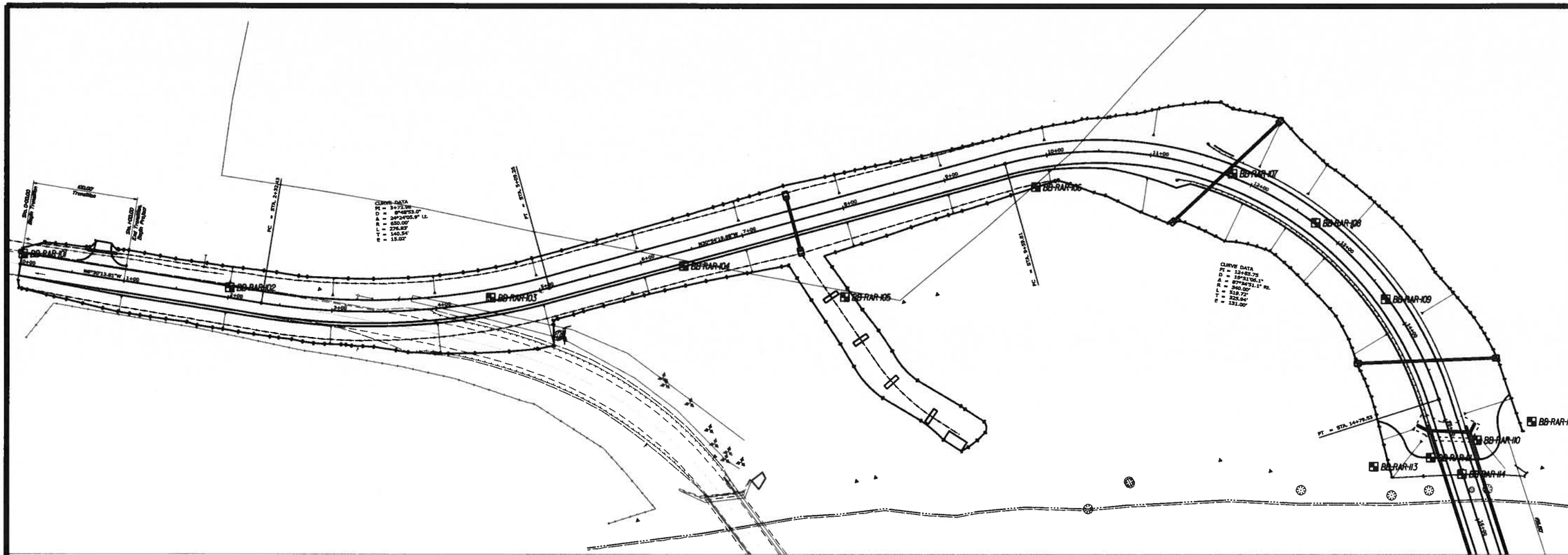
CLOSURE

We trust these comments are suitable for your present needs. Please do not hesitate to contact us if you have any questions about this memorandum or the preliminary engineering evaluations and results summarized herein.

Attachments:
Sketch No. 1 - Test Boring Location Plan (2 sheets)
Figure 1 - West Approach/Abutment 1 Liquefaction Triggering Assessment
Figure 2 - West Approach/Abutment 1 Liquefaction Triggering Assessment
Figure 3 - Pier 1 Liquefaction Triggering Assessment
Figure 4 - Pier 2 Liquefaction Triggering Assessment
Figure 5 - Abutment 2 Liquefaction Triggering Assessment

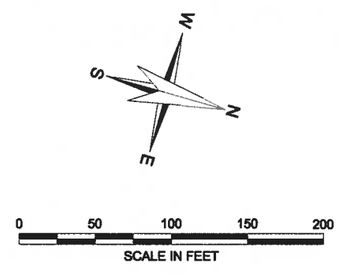
G:\PROJECTS\38799 - martin memorial bridge\Deliverables\2012_1102 - Prelim Liquefaction Memo\2012_1109_HAI_Prelim Liq Memo_f1.docx

STATE OF MAINE
WAYNE A. CHADBOURNE
No. 10620
LICENSED
PROFESSIONAL ENGINEER



NOTES:

1. THE SUBSURFACE PROFILE IS LOCATED ALONG THE PROPOSED PROPOSED ROUTE 232 CENTERLINE.
2. EXISTING AND PROPOSED GROUND SURFACE ELEVATIONS ALONG THE SUBSURFACE PROFILE LINE WERE TAKEN FROM THE ELECTRONIC AUTOCAD FILE ENTITLED, "BRIDGE.dgn", PROVIDED BY TRANSYSTEMS ON 17 AUGUST 2012.
3. THE "AS-DRILLED" TEST BORING LOCATIONS AND GROUND SURFACE ELEVATIONS WERE DETERMINED BY MAINEDOT USING OPTICAL SURVEY EQUIPMENT UPON THE COMPLETION OF DRILLING.
4. LINES REPRESENTING CHANGES IN STRATA ARE BASED ON LINEAR INTERPOLATION BETWEEN SUBSURFACE EXPLORATIONS. THESE INTERPRETED STRATA LINES DO NOT REPRESENT ACTUAL FIELD CONDITIONS OTHER THAN AT SPECIFIC EXPLORATION LOCATIONS. ACTUAL FIELD CONDITIONS ALONG THE SUBSURFACE PROFILE WILL VARY FROM THOSE SHOWN.
5. REFER TO SHEETS NO. 46 TO 58 FOR TEST BORING LOGS.
6. ELEVATIONS ARE IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BH-1510(500)X

PIN 16106.00

BRIDGE NO. 3248

BRIDGE PLANS

PROJ. MANAGER	B. CONDON	BY	DATE
DESIGN-DETAILED	B. STEINERT	B. STEINERT	09/2012
CHECKED-REVIEWED	W. CHABOURNE	W. CHABOURNE	09/2012
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

MARTIN MEMORIAL BRIDGE
ANDROSCOGGIN RIVER
RUMFORD OXFORD COUNTY

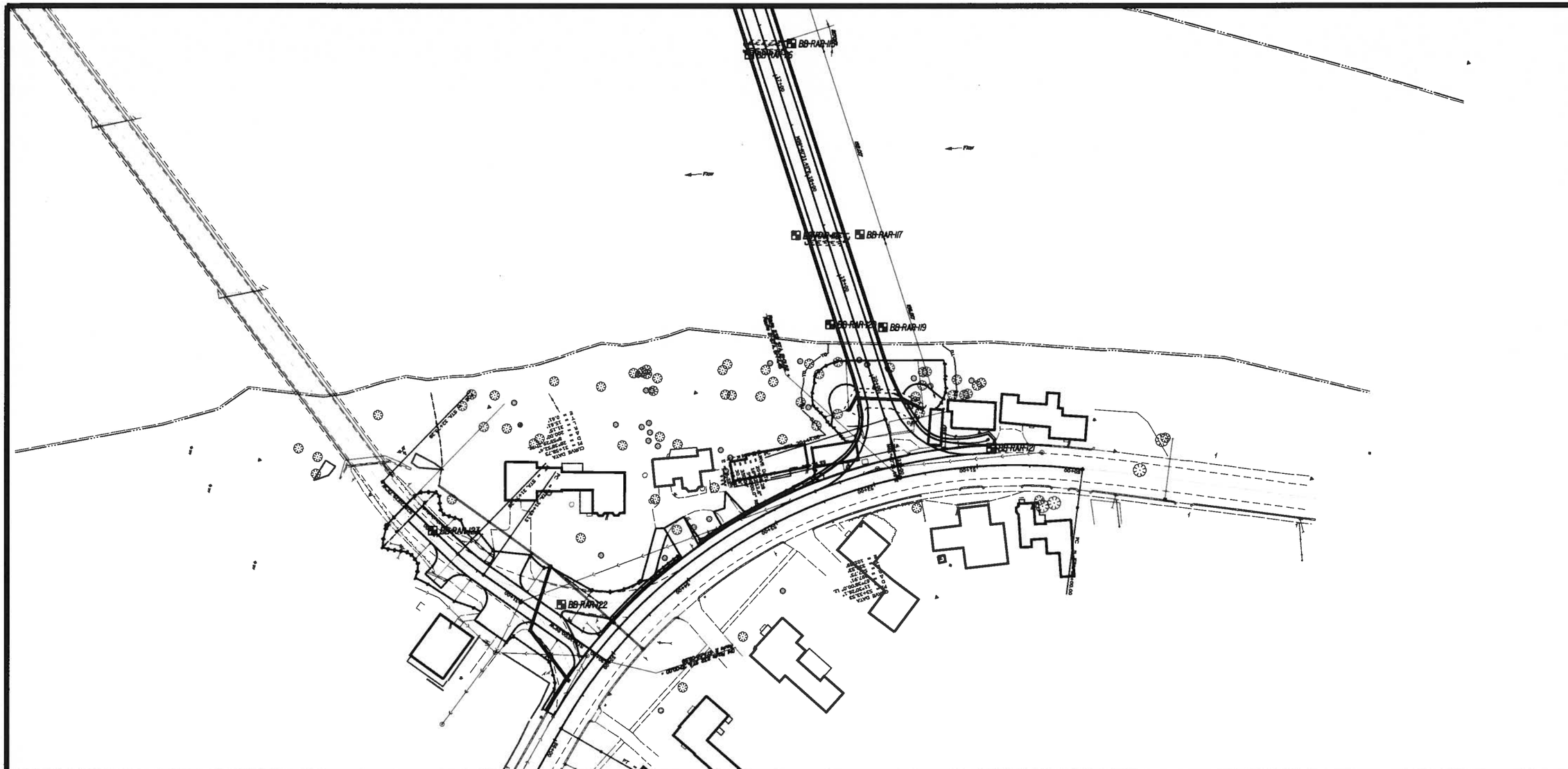
BORING LOCATION PLAN

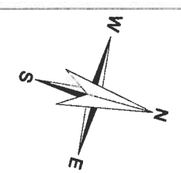
SHEET NUMBER

43

OF 64

Filename: ...\043_BoringLocationPlan.dgn Division: BRIDGE Username: T SANDELL Date:9/7/2012





0 50 100 150 200

SCALE IN FEET

NOTES:

1. THE SUBSURFACE PROFILE IS LOCATED ALONG THE PROPOSED PROPOSED ROUTE 232 CENTERLINE.
2. EXISTING AND PROPOSED GROUND SURFACE ELEVATIONS ALONG THE SUBSURFACE PROFILE LINE WERE TAKEN FROM THE ELECTRONIC AUTOCAD FILE ENTITLED, "BRIDGE.dgn", PROVIDED BY TRANSYSTEMS ON 17 AUGUST 2012.
3. THE "AS-DRILLED" TEST BORING LOCATIONS AND GROUND SURFACE ELEVATIONS WERE DETERMINED BY MAINEDOT USING OPTICAL SURVEY EQUIPMENT UPON THE COMPLETION OF DRILLING.
4. LINES REPRESENTING CHANGES IN STRATA ARE BASED ON LINEAR INTERPOLATION BETWEEN SUBSURFACE EXPLORATIONS. THESE INTERPRETED STRATA LINES DO NOT REPRESENT ACTUAL FIELD CONDITIONS OTHER THAN AT SPECIFIC EXPLORATION LOCATIONS. ACTUAL FIELD CONDITIONS ALONG THE SUBSURFACE PROFILE WILL VARY FROM THOSE SHOWN.
5. REFER TO SHEETS NO. 46 TO 58 FOR TEST BORING LOGS.
6. ELEVATIONS ARE IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BH-1510(500)X

PIN 15105.00

BRIDGE NO. 3248

BRIDGE PLANS

PROJ. MANAGER	B. CONDON			
DESIGN-DETAILED	B. STEINERT	B. STEINERT	09/2012	
CHECKED-REVIEWED	W. CHABOUNE	W. CHABOUNE	09/2012	
DESIGN2-DETAILED2				
DESIGN3-DETAILED3				
REVISIONS 1				
REVISIONS 2				
REVISIONS 3				
REVISIONS 4				
FIELD CHANGES				

SIGNATURE

P.E. NUMBER

DATE

MARTIN MEMORIAL BRIDGE
ANDROSCOGGIN RIVER
RUMFORD OXFORD COUNTY

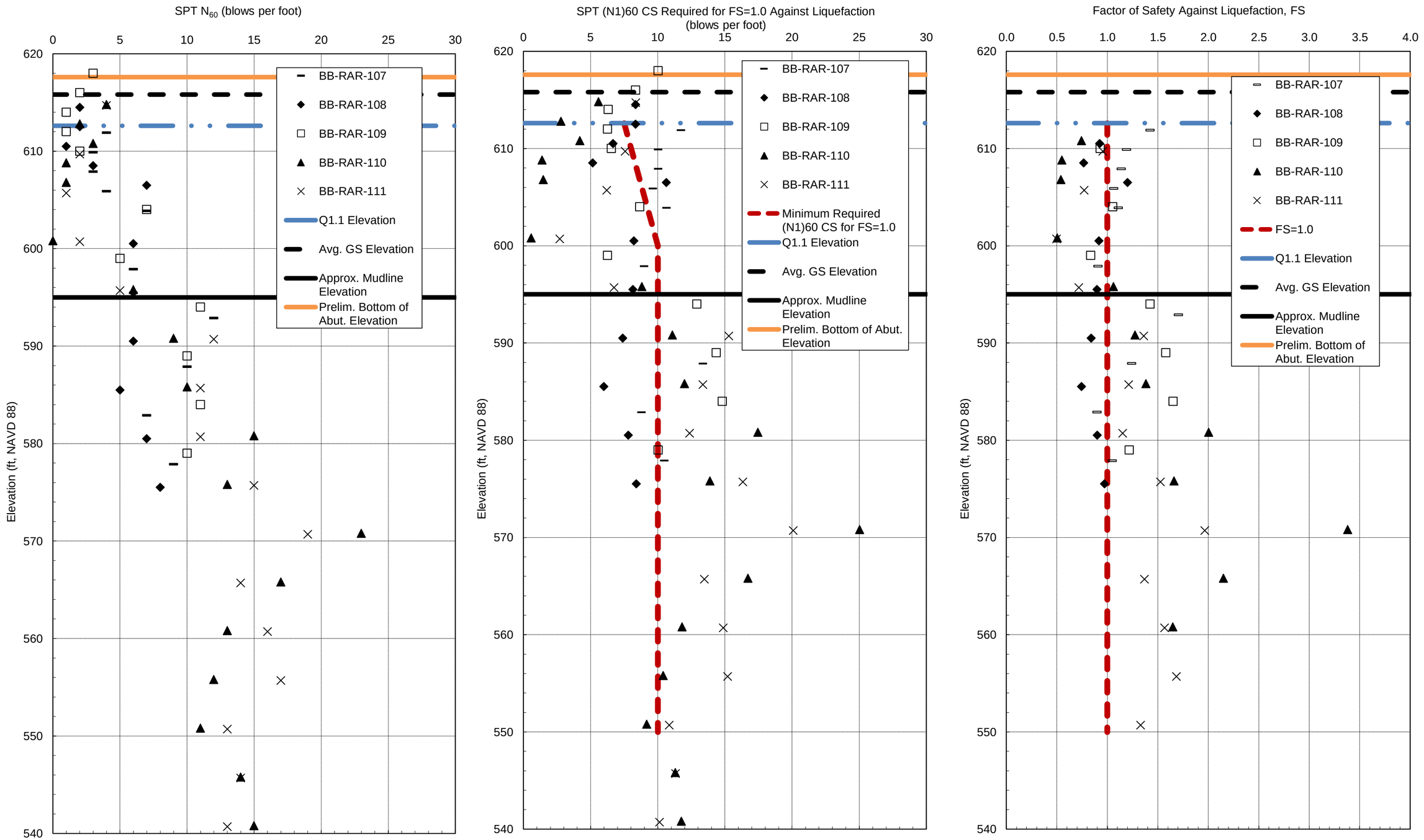
BORING LOCATION PLAN

SHEET NUMBER

44

OF 64

Filename: ...\044_BoringLocationPlan.dgn Division: BRIDGE Username: T SANDELL Date:9/7/2012



Notes:

1 Liquefaction susceptibility evaluation conducted in accordance with the AASHTO Guide Specification for LRFD Seismic Bridge Design 2nd Edition, 2011 and the simplified procedures presented by Youd & Idriss (2001).
2 All test borings were drilled as cased wash borings with a rope/cathead and safety hammer.
3 Design water surface elevation equal to El. 612.6 (Q1.1, "ordinary high water"). This was judged to be consistent with the "seasonally averaged groundwater elevation" in accordance with AASHTO LRFD Section 6.8.
4 N160(CS) = SPT N60-value corrected for overburden, drilling and sampling methods, and fines content for use in evaluating liquefaction susceptibility.
5 Design earthquake magnitude equal to 5.85 used to assess liquefaction potential determined from USGS earthquake deaggregation data for the site in accordance with AASHTO LRFD Section 6.8 and represents the mean magnitude earthquake located approximately 50 miles from the site.
6 Peak Ground Acceleration (PGA) used to assess liquefaction potential equal to 0.218 g and based on assignment of Site Class E in accordance with AASHTO LRFD Section 3.4.2.1.
7 Cyclic Stress Ratio (CSR) corresponds to cyclic shear stress induced by design earthquake (based on design earthquake parameters) and final grade elevation.
8 Cyclic Resistance Ratio (CRR, corrected for magnitude and overburden), corresponds to resistance of soil layer to cyclic shear stress (based on SPT and fines content).
9 Factor of Safety against liquefaction triggering = MSF(CRR / CSR) where MSF = magnitude scaling factor.
10 Some data points from test borings are not shown due to the following:
   A Simplied methods suited for use to a max. depth of approx. 75 ft below ground surface and extrapolation beyond this depth considered to be of uncertain validity.
   B Youd & Idriss (2001) considers N160CS > 30 blows per foot to be non-liquefiable.
   C Soil samples with fines content greater than 50 percent are assumed to be non-liquefiable.

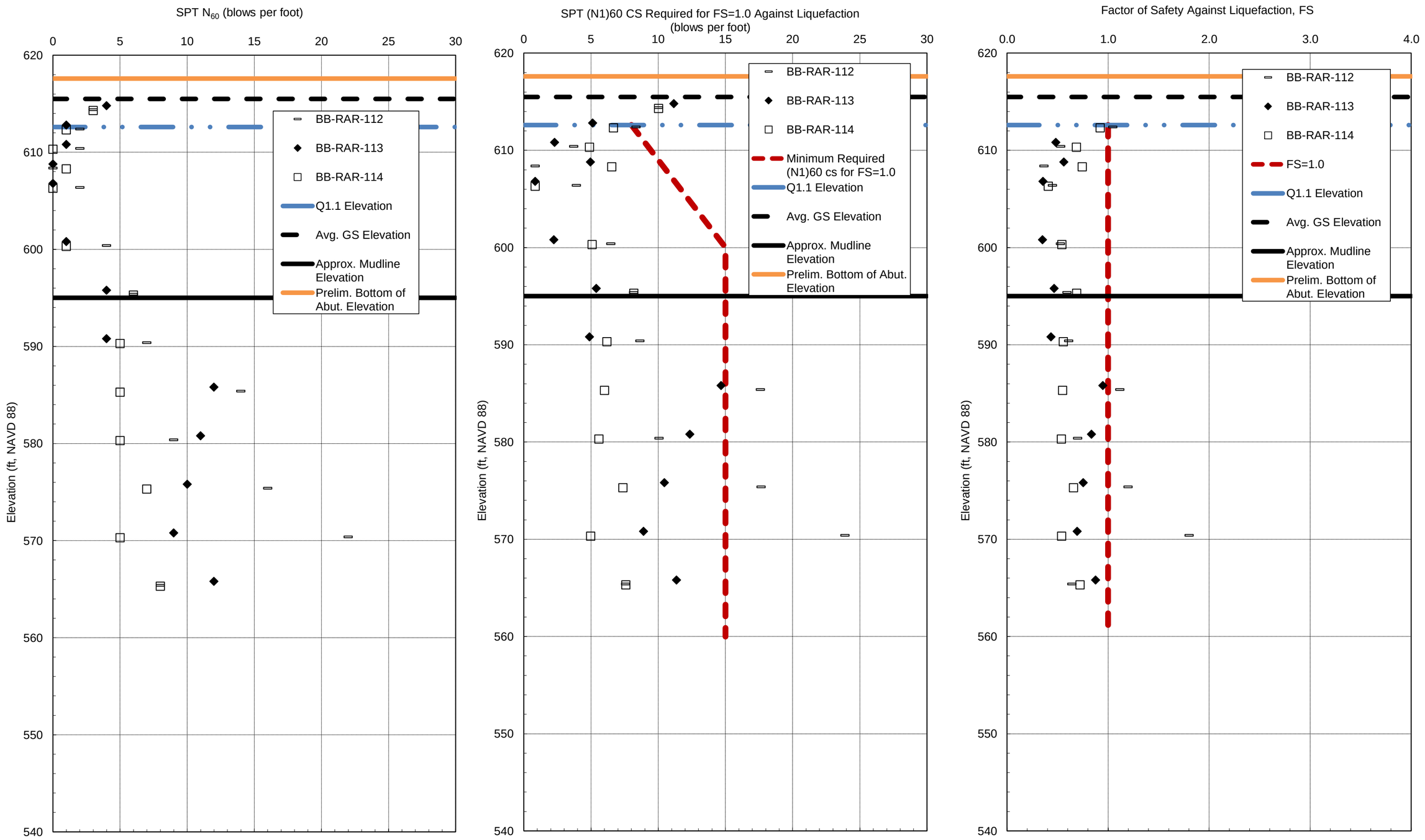
HALEY & ALDRICH

MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT PIN 15105.00
ROUTE 232 - RUMFORD, MAINE

WEST APPROACH / ABUTMENT 1
LIQUEFACTION TRIGGERING ASSESSMENT
BB-RAR-107 THROUGH BB-RAR-111

FIGURE 1

G:\PROJECTS\38799 - martin memorial bridge\Calculations\Seismic\Simplified Liquefaction\[2012_1008_HAI_15105 Prelim Liq Assessment-D2.xlsx]Plot - Abut 2



Notes:

1 Liquefaction susceptibility evaluation conducted in accordance with the AASHTO Guide Specification for LRFD Seismic Bridge Design 2nd Edition, 2011 and the simplified procedures presented by Youd & Idriss (2001).
2 All test borings were drilled as cased wash borings with a rope/cathead and safety hammer.
3 Design water surface elevation equal to El. 612.6 (Q1.1, "ordinary high water"). This was judged to be consistent with the "seasonally averaged groundwater elevation" in accordance with AASHTO LRFD Section 6.8.
4 N160(CS) = SPT N60-value corrected for overburden, drilling and sampling methods, and fines content for use in evaluating liquefaction susceptibility.
5 Design earthquake magnitude equal to 5.85 used to assess liquefaction potential determined from USGS earthquake deaggregation data for the site in accordance with AASHTO LRFD Section 6.8 and represents the mean magnitude earthquake located approximately 50 miles from the site.
6 Peak Ground Acceleration (PGA) used to assess liquefaction potential equal to 0.218 g and based on assignment of Site Class E in accordance with AASHTO LRFD Section 3.4.2.1.
7 Cyclic Stress Ratio (CSR) corresponds to cyclic shear stress induced by design earthquake (based on design earthquake parameters).
8 Cyclic Resistance Ratio (CRR, corrected for magnitude and overburden), corresponds to resistance of soil layer to cyclic shear stress (based on SPT and fines content).
9 Factor of Safety against liquefaction triggering = MSF(CRR / CSR) where MSF = magnitude scaling factor.
10 Some data points from test borings are not shown due to the following:
A Simplied methods suited for use to a max. depth of approx. 75 ft below ground surface and extrapolation beyond this depth considered to be of uncertain validity.
B Youd & Idriss (2001) considers N160CS > 30 blows per foot to be non-liquefiable.
C Soil samples with fines content greater than 50 percent are assumed to be non-liquefiable.

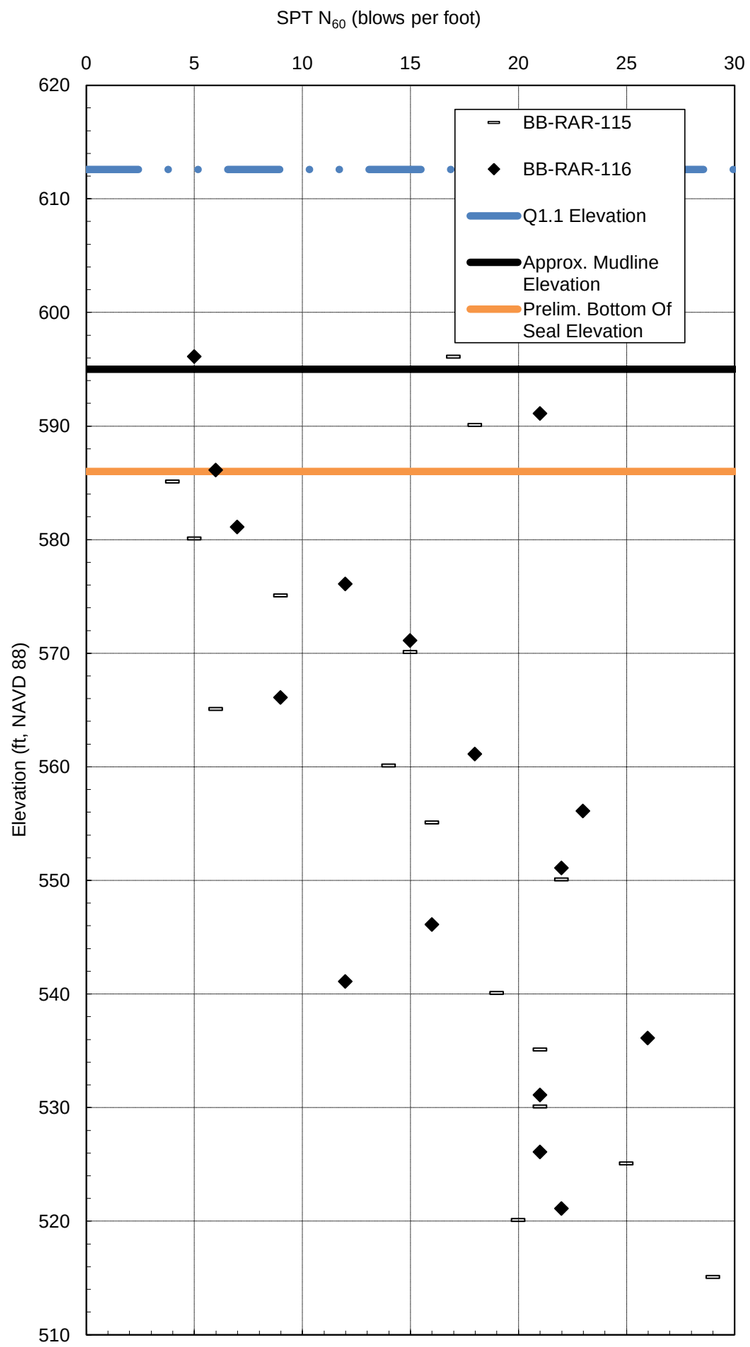
HALEY & ALDRICH

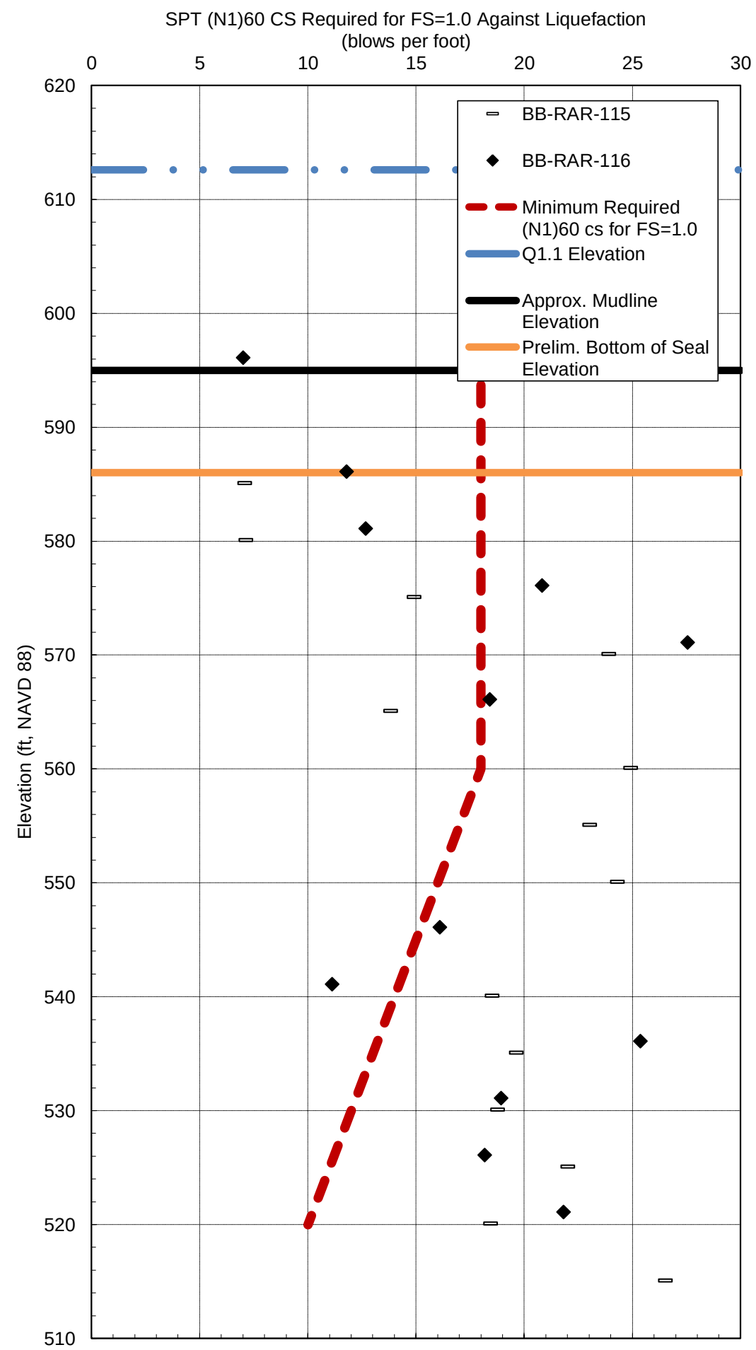
MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT PIN 15105.00
ROUTE 232 - RUMFORD, MAINE

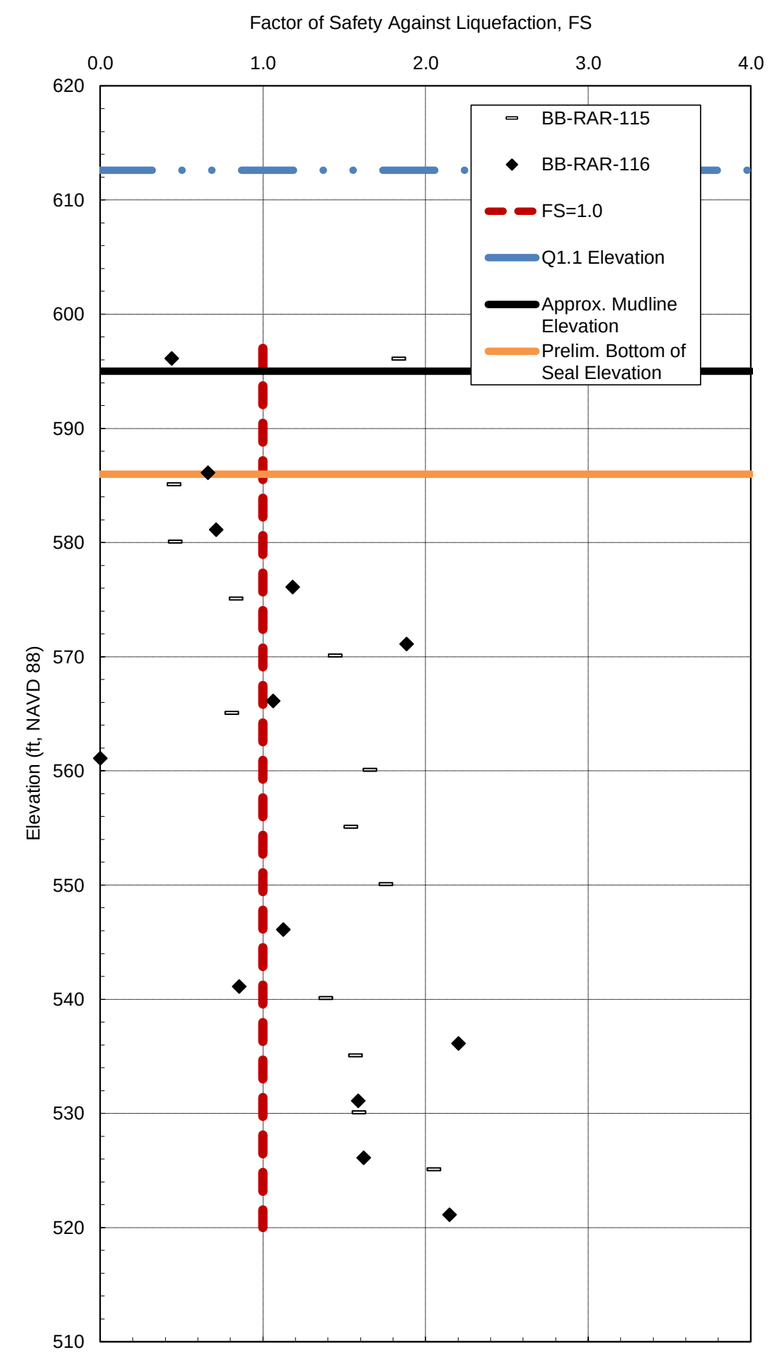
WEST APPROACH / ABUTMENT 1
LIQUEFACTION TRIGGERING ASSESSMENT
BB-RAR-112 THROUGH BB-RAR-114

FIGURE 2

G:\PROJECTS\38799 - martin memorial bridge\Calculations\Seismic\Simplified Liquefaction\[2012_1008_HAI_15105 Prelim Liq Assessment-D2.xlsx]Plot - Abut 2







Notes:

1 Liquefaction susceptibility evaluation conducted in accordance with the AASHTO Guide Specification for LRFD Seismic Bridge Design 2nd Edition, 2011 and the simplified procedures presented by Youd & Idriss (2001).
2 All test borings were drilled as cased wash borings with a rope/cathead and safety hammer.
3 Design water surface elevation equal to El. 612.6 (Q1.1, "ordinary high water"). This was judged to be consistent with the "seasonally averaged groundwater elevation" in accordance with AASHTO LRFD Section 6.8.
4 N160(CS) = SPT N60-value corrected for overburden, drilling and sampling methods, and fines content for use in evaluating liquefaction susceptibility.
5 Design earthquake magnitude equal to 5.85 used to assess liquefaction potential determined from USGS earthquake deaggregation data for the site in accordance with AASHTO LRFD Section 6.8 and represents the mean magnitude earthquake located approximately 50 miles from the site.
6 Peak Ground Acceleration (PGA) used to assess liquefaction potential equal to 0.218 g and based on assignment of Site Class E in accordance with AASHTO LRFD Section 3.4.2.1.
7 Cyclic Stress Ratio (CSR) corresponds to cyclic shear stress induced by design earthquake (based on design earthquake parameters).
8 Cyclic Resistance Ratio (CRR, corrected for magnitude and overburden), corresponds to resistance of soil layer to cyclic shear stress (based on SPT and fines content).
9 Factor of Safety against liquefaction triggering = MSF(CRR / CSR) where MSF = magnitude scaling factor.
10 Some data points from test borings are not shown due to the following:
   A Simplied methods suited for use to a max. depth of approx. 75 ft below ground surface and extrapolation beyond this depth considered to be of uncertain validity.
   B Youd & Idriss (2001) considers N160CS > 30 blows per foot to be non-liquefiable.
   C Soil samples with fines content greater than 50 percent are assumed to be non-liquefiable.

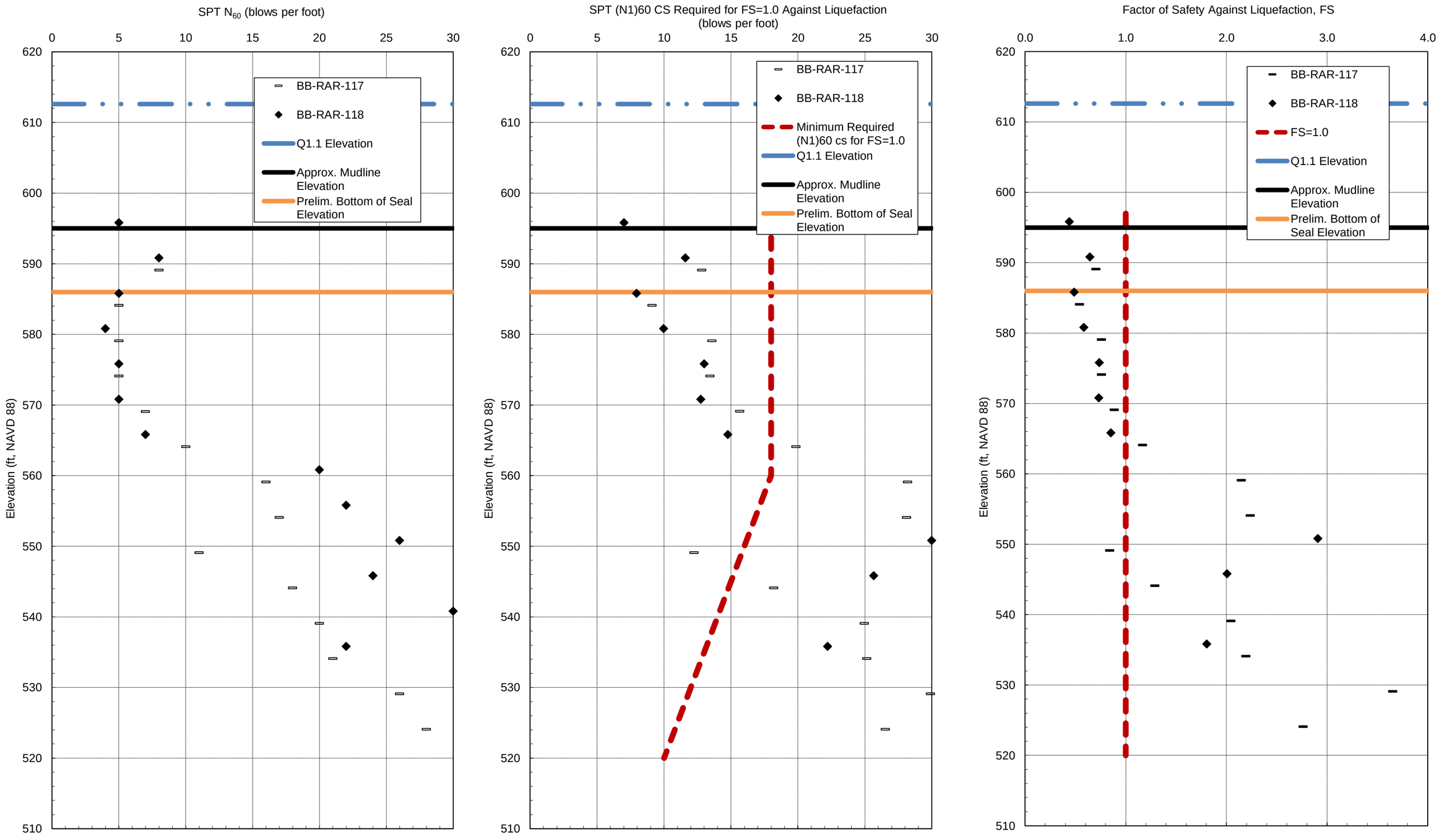
HALEY & ALDRICH

MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT PIN 15105.00
ROUTE 232 - RUMFORD, MAINE

PIER 1
LIQUEFACTION TRIGGERING ASSESSMENT
BB-RAR-115 AND BB-RAR-116

FIGURE 3

G:\PROJECTS\38799 - martin memorial bridge\Calculations\Seismic\Simplified Liquefaction\[2012_1008_HAI_15105 Prelim Liq Assessment-D2.xlsx]Plot - Abut 2



Notes:

1 Liquefaction susceptibility evaluation conducted in accordance with the AASHTO Guide Specification for LRFD Seismic Bridge Design 2nd Edition, 2011 and the simplified procedures presented by Youd & Idriss (2001).
2 All test borings were drilled as cased wash borings with a rope/cathead and safety hammer.
3 Design water surface elevation equal to El. 612.6 (Q1.1, "ordinary high water"). This was judged to be consistent with the "seasonally averaged groundwater elevation" in accordance with AASHTO LRFD Section 6.8.
4 N160(CS) = SPT N60-value corrected for overburden, drilling and sampling methods, and fines content for use in evaluating liquefaction susceptibility.
5 Design earthquake magnitude equal to 5.85 used to assess liquefaction potential determined from USGS earthquake deaggregation data for the site in accordance with AASHTO LRFD Section 6.8 and represents the mean magnitude earthquake located approximately 50 miles from the site.
6 Peak Ground Acceleration (PGA) used to assess liquefaction potential equal to 0.218 g and based on assignment of Site Class E in accordance with AASHTO LRFD Section 3.4.2.1.
7 Cyclic Stress Ratio (CSR) corresponds to cyclic shear stress induced by design earthquake (based on design earthquake parameters).
8 Cyclic Resistance Ratio (CRR, corrected for magnitude and overburden), corresponds to resistance of soil layer to cyclic shear stress (based on SPT and fines content).
9 Factor of Safety against liquefaction triggering = MSF(CRR / CSR) where MSF = magnitude scaling factor.
10 Some data points from test borings are not shown due to the following:
- A Simplied methods suited for use to a max. depth of approx. 75 ft below ground surface and extrapolation beyond this depth considered to be of uncertain validity.
- B Youd & Idriss (2001) considers N160CS > 30 blows per foot to be non-liquefiable.
- C Soil samples with fines content greater than 50 percent are assumed to be non-liquefiable.

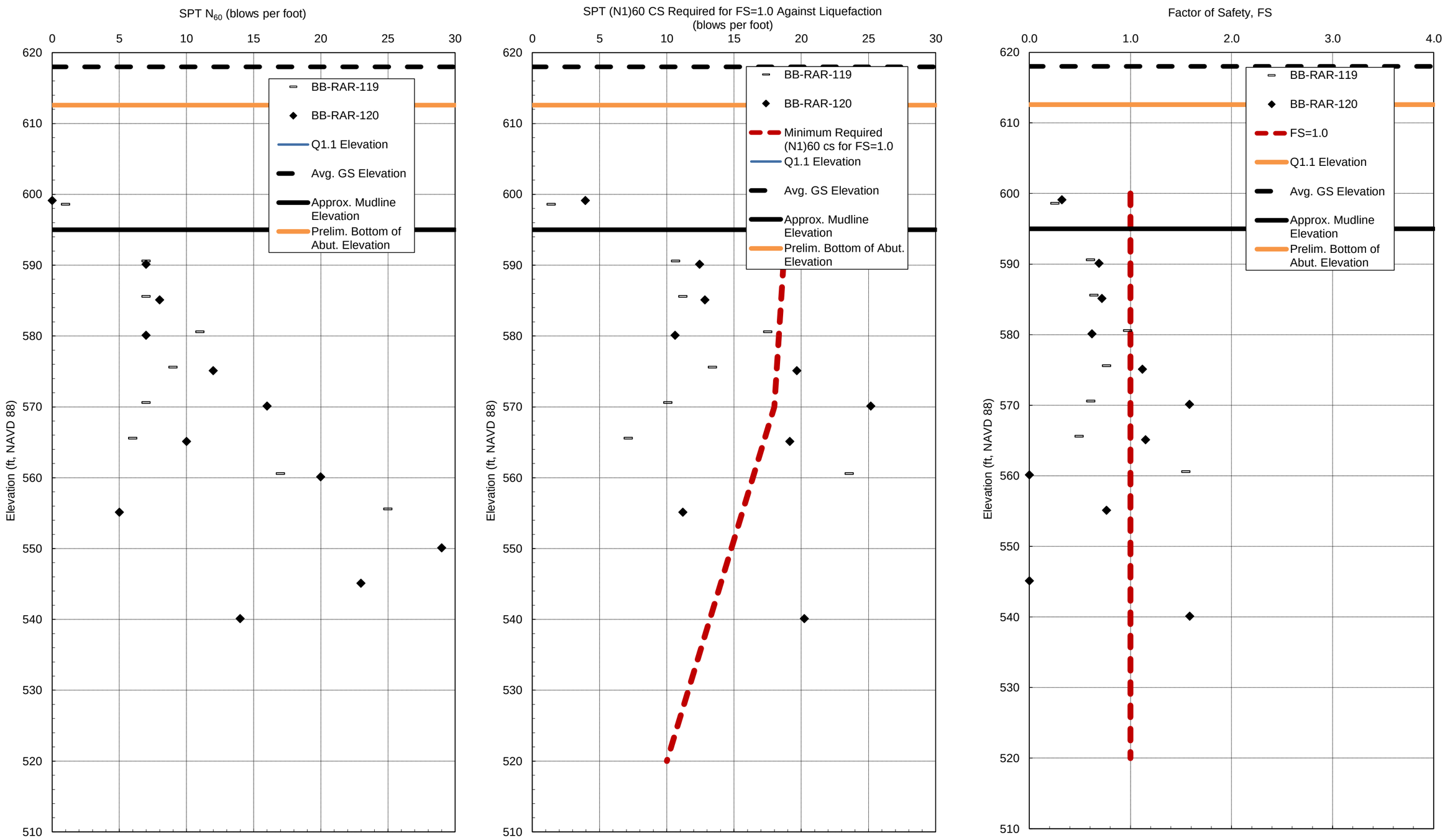
HALEY & ALDRICH

MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT PIN 15105.00
ROUTE 232 - RUMFORD, MAINE

PIER 2
LIQUEFACTION TRIGGERING ASSESSMENT
BB-RAR-117 AND BB-RAR-118

FIGURE 4

G:\PROJECTS\38799 - martin memorial bridge\Calculations\Seismic\Simplified Liquefaction\[2012_1008_HAI_15105 Prelim Liq Assessment-D2.xlsx]Plot - Abut 2



Notes:

1 Liquefaction susceptibility evaluation conducted in accordance with the AASHTO Guide Specification for LRFD Seismic Bridge Design 2nd Edition, 2011 and the simplified procedures presented by Youd & Idriss (2001).
2 All test borings were drilled as cased wash borings with a rope/cathead and safety hammer.
3 Design water surface elevation equal to El. 612.6 (Q1.1, "ordinary high water"). This was judged to be consistent with the "seasonally averaged groundwater elevation" in accordance with AASHTO LRFD Section 6.8.
4 N160(CS) = SPT N60-value corrected for overburden, drilling and sampling methods, and fines content for use in evaluating liquefaction susceptibility.
5 Design earthquake magnitude equal to 5.85 used to assess liquefaction potential determined from USGS earthquake deaggregation data for the site in accordance with AASHTO LRFD Section 6.8 and represents the mean magnitude earthquake located approximately 50 miles from the site.
6 Peak Ground Acceleration (PGA) used to assess liquefaction potential equal to 0.218 g and based on assignment of Site Class E in accordance with AASHTO LRFD Section 3.4.2.1.
7 Cyclic Stress Ratio (CSR) corresponds to cyclic shear stress induced by design earthquake (based on design earthquake parameters).
8 Cyclic Resistance Ratio (CRR, corrected for magnitude and overburden), corresponds to resistance of soil layer to cyclic shear stress (based on SPT and fines content).
9 Factor of Safety against liquefaction triggering = MSF(CRR / CSR) where MSF = magnitude scaling factor.
10 Some data points from test borings are not shown due to the following:
- A Simplied methods suited for use to a max. depth of approx. 75 ft below ground surface and extrapolation beyond this depth considered to be of uncertain validity.
- B Youd & Idriss (2001) considers N160CS > 30 blows per foot to be non-liquefiable.
- C Soil samples with fines content greater than 50 percent are assumed to be non-liquefiable.

HALEY & ALDRICH

MARTIN MEMORIAL BRIDGE REPLACEMENT
MAINEDOT PIN 15105.00
ROUTE 232 - RUMFORD, MAINE

ABUTMENT 2
LIQUEFACTION TRIGGERING ASSESSMENT
BB-RAR-119 AND BB-RAR-120

FIGURE 5

G:\PROJECTS\38799 - martin memorial bridge\Calculations\Seismic\Simplified Liquefaction\[2012_1008_HAI_15105 Prelim Liq Assessment-D2.xlsx]Plot - Abut 2

APPENDIX F

Calculations

- Subgrade Resilient Modulus Calculations
- Frost Penetration Calculations
- Simplified Liquefaction Calculations
- Seismic Acceleration Calculations
- Embankment Stability Calculations
- Design Friction Angle Profiles
- Post Improvement Friction Angle Criteria
- Pile Corrosion Calculations
- Static (Compression) Pile Resistance, Pile Uplift Resistance and Downdrag Calculations
- Lateral Pile Calculations
- Pile Driveability Calculations
- Elastic Pile Compression Calculations

Subgrade Resilient Modulus Calculations

HALEY & ALDRICH

CALCULATIONS

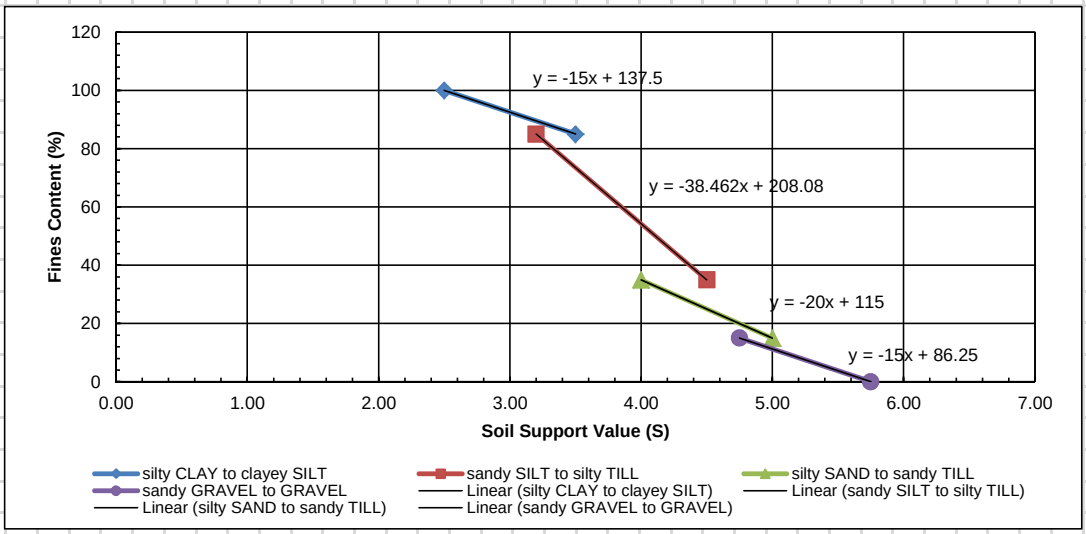
File No.	38799-000		
Sheet	1 of 3		
Client	Maine Department of Transportation	**Date**	10/10/2012
Project	Martin Memorial Bridge Replacement	**Computed By**	BCS
Subject	Subgrade Resilient Modulus Estimates	**Checked By**	EFW

OBJECTIVE: Estimate subgrade resilient modulus values for use in pavement design based on MaineDOT standard practice.

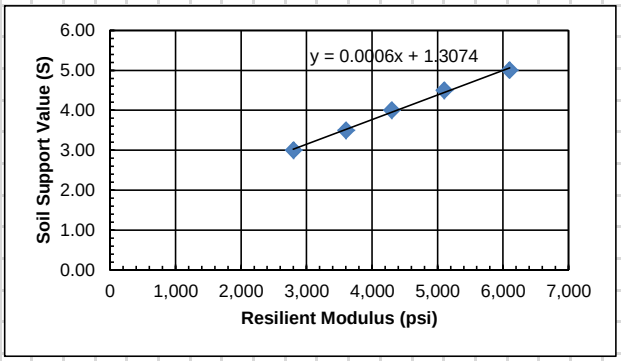
EVALUATION:

Define station limits for cut/fill areas and magnitude of cut/fill based on centerline profile provided by TranSystems on 9/10/12. Determine subgrade material type based on "as-drilled" test borings completed within the defined station limits. A summary of this information is provided in the attached table. Determine resilient modulus values for each of the material types anticipated at the design subgrade level based on an assumed 30-in. thick pavement section. Subgrade resilient modulus values are determined based on relating subgrade material type to a soil support value (S), which is then related to subgrade resilient modulus based on correlations provided by MaineDOT.

No.	Soil Type	Fines Content (%)	Soil Support Value (S)	
			Low	High
1	silty CLAY to clayey SILT	85 to 100	2.50	3.50
2	sandy SILT to silty Till	35 to 85	3.20	4.50
3	silty SAND to sandy Till	15 to 35	4.00	5.00
4	sandy GRAVEL to GRAVEL	0 to 15	4.75	5.75



Soil Support Value (S)	Subgrade Resilient Modulus (psi)
3.0	2,800
3.5	3,600
4.0	4,300
4.5	5,100
5.0	6,100



EVALUATION: (CONT.)

Soil Type	Fines Content (%)	Soil Support Value (S)	Resilient Modulus (psi)
silty CLAY to clayey SILT	100	2.50	1,988
	85	3.50	3,654
sandy SILT to silty Till	85	3.20	3,154
	35	4.50	5,321
silty SAND to sandy Till	35	4.00	4,488
	15	5.00	6,154
sandy GRAVEL to GRAVEL	15	4.75	5,738
	0	5.75	7,404

Summarize material types anticipated at proposed subgrade level……

Existing Fill: test borings BB-RAR-101, BB-RAR-102, BB-RAR-122, BB-RAR-123

1. Fine to coarse SAND, trace to little fine gravel, trace to little silt (SW, SW-SM)
2. Two grain size analyses conducted on samples collected from BB-RAR-101 and -102 had fines content ranging from 9.9 percent to 17.1 percent.
3. Assume material is consistent with the middle of the resilient modulus range for silty SAND to sandy TILL.

Topsoil: BB-RAR-103, BB-RAR-104, BB-RAR-106

1. Elastic SILT, trace fine to medium sand (MH, ML)
2. Three grain size analyses and three Atterberg limits tests conducted on samples obtained from referenced test borings. Fines content ranged from 75.8 to 97.3%. LL ranged from 41 to 53; PL ranged from 29 to 39; PI ranged from 12 to 15.
3. Assume material is consistent with the low end of the resilient modulus range for silty CLAY to clayey SILT.

Alluvial Deposit: BB-RAR-101, BB-RAR-102, BB-RAR-121

1 Fine to coarse SAND, little silt and fine gravel (SM) to silty fine to medium SAND, some fine gravel, trace c SAND (SM) to fine to medium SAND, trace c sand and silt, little f gravel (SP).
2 Three grain size analyses conducted on samples obtained from referenced test borings. Fines content were 5.2, 12.9 and 42.9 percent, respectively.
3 Assume material is consistent with middle of the resilient modulus range for silty SAND to sandy TILL.

Proposed Fill:

1. Assume embankment fill material consists primarily of granular borrow.
2. Material is methodically placed and compacted in engineered lifts.
3. Assume material is consistent with the upper end of the resilient modulus range for silty SAND to sandy TILL.

EVALUATION: (CONT.)

Provide recommendations for resilient modulus for anticipated subgrade conditions along portions of proposed alignment….

Soil Type	Resilient Modulus (psi)
Exist. Fill	5,000
Topsoil	2,000
Alluvial	5,000
Proposed Fill	6,000

Refer to the attached table for a summary of anticipated subgrade conditions along portions of proposed roadway alignment.

We recommend the following alternatives be evaluated for pavement design…..

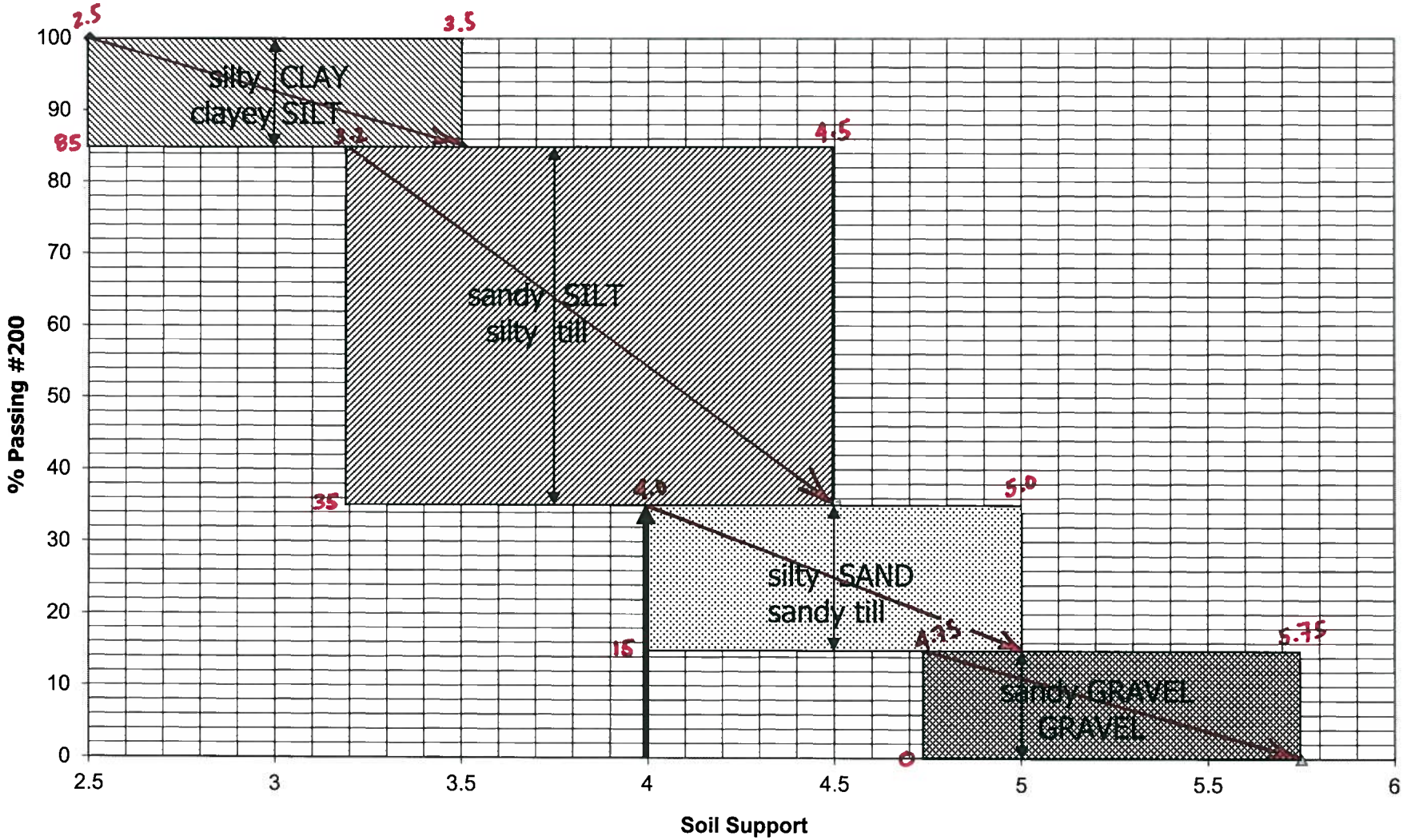
1 Design one pavement section for the entire roadway alignment based on an assumed topsoil subgrade (Mr=2,000 psi).

2 Design one pavement section for the entire roadway alignment based on an assumed existing fill/alluvial subgrade (Mr=5,000 psi). This alternative would require topsoil present at subgrade level between approximately Sta. 4+33 and Sta. 10+25 be over-excavated and replaced with granular borrow (proposed fill).

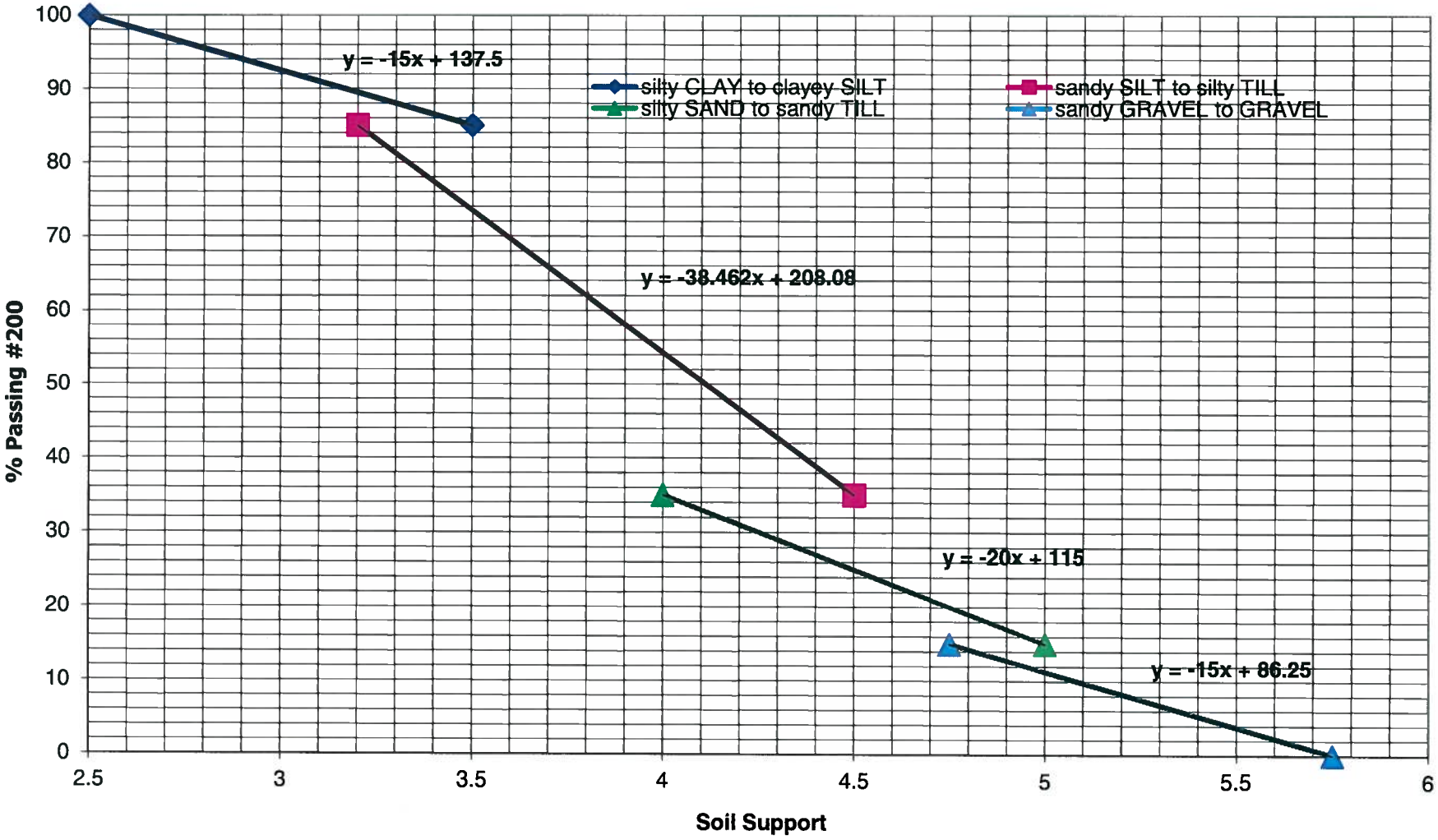
3 Design two pavement sections for different portions of the roadway alignment assuming that the subgrade consists of existing fill/ alluvial soils and proposed fill. The portion of the roadway alignment between the following station limits would be designed based on an assumed existing fill/alluvial subgrade (Mr=5,000 psi): Sta. 0+00 to Sta. 4+33; Sta. 20+57 to Sta. 20+89; Sta. 30+20 to Sta. 32+30. The portion of the roadway alignment between the following station limits would be designed based on an assumed granular borrow (proposed fill) subgrade (Mr=6,000 psi): Sta. 4+33 to Sta. 15+15; Sta. 20+20 to Sta. 20+57. This alternative would require topsoil present at subgrade level between approximately Sta. 4+33 and Sta. 10+25 be over-excavated and replaced with granular borrow (proposed fill).

4 Design three pavement sections for different portions of the roadway alignment assuming that the subgrade consists of existing fill/alluvial soils, topsoil, and proposed fill. The portion of the roadway alignment between the following station limits would be designed based on an assumed existing fill/alluvial subgrade (Mr=5,000 psi): Sta. 0+00 to Sta. 4+33; Sta 20+57 to Sta. 20+89; Sta. 30+20 to Sta. 32+30. The portion of the roadway alignment between the following station limits would be designed based on an assumed topsoil subgrade (Mr=2,000 psi): Sta. 4+33 to Sta. 10+25. The portion of the roadway alignment between the following station limits would be designed based on an assumed proposed fill subgrade (Mr=6,000 psi): Sta. 10+25 to Sta. 15+15; Sta. 20+20 to Sta. 20+57.

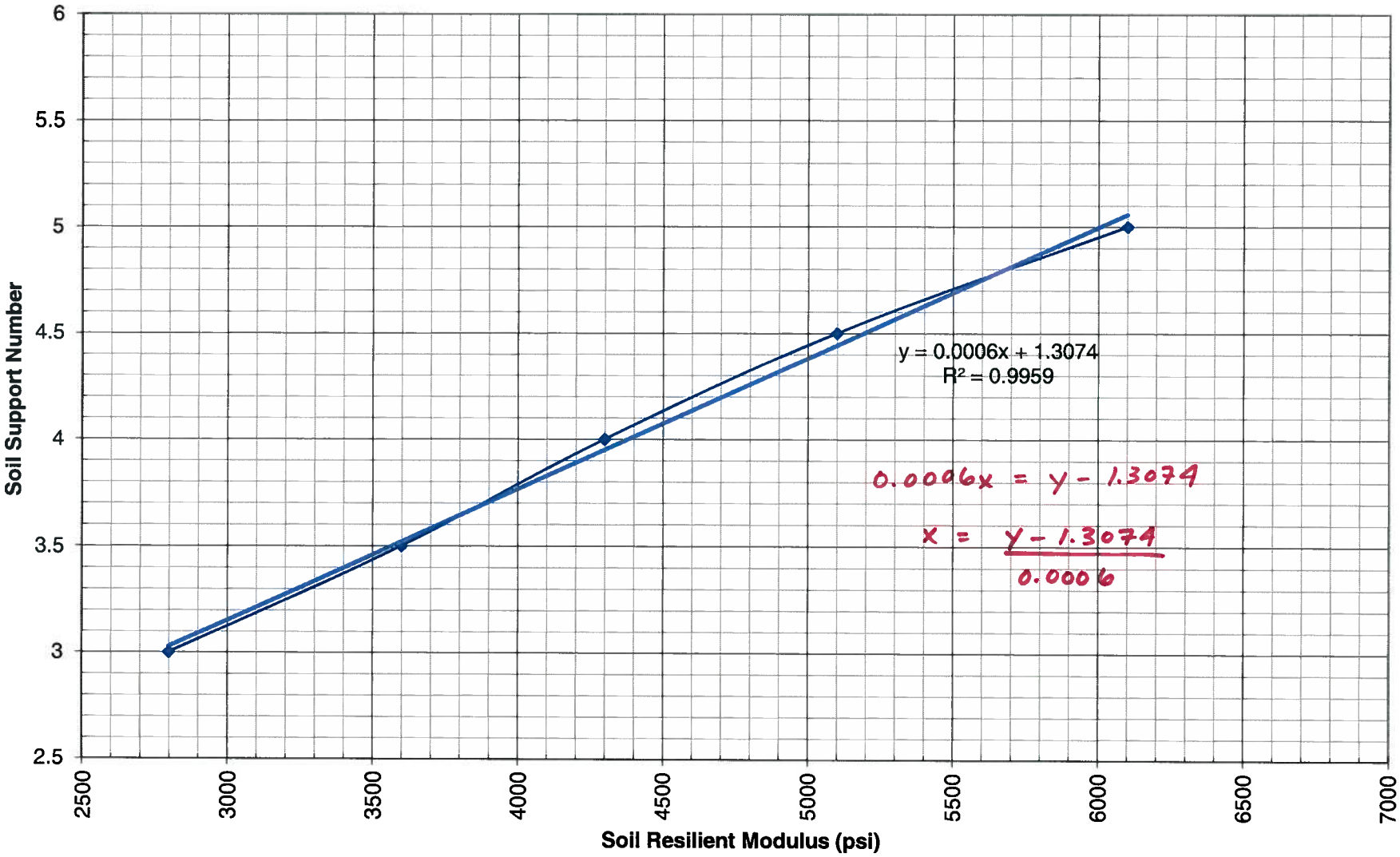
Guidelines for Selection of Soil Support Values for Pavement Design



Guidelines for Selection of Soil Support Values for Pavement Design



Determination of Soil Resilient Mondulus



$0.0006x = y - 1.3074$

$x = \frac{y - 1.3074}{0.0006}$

Frost Penetration Calculations

HALEY & ALDRICH

CALCULATIONS

File No.	38799-000		
Sheet	1 of 2		
Client	Maine Department of Transportation	**Date**	10/10/2012
Project	Martin Memorial Bridge Replacement	**Computed By**	BCS
Subject	Evaluation of Maximum Frost Penetration Depth	**Checked By**	EFW

OBJECTIVE:

Evaluate maximum depth of frost penetration based on soil and groundwater conditions as well as geographic site location.

METHODOLOGY:

1 Based on project site location determine freezing design parameters from ModBerg v. 99.2 computer program, which uses weather data collected local to the project. Compare freezing design parameters to those obtained from the MaineDOT BDG. Select the most appropriate freezing design parameters for use in determining maximum depth of frost penetration.

2 Break the entire proposed roadway alignment into different sections based on the soil unit anticipated to be present at the subgrade level. This will be based on an assumed 30-in. thick pavement section as shown on the 50 percent design drawings prepared by TranSystems, the subsurface conditions encountered in the design phase test borings and laboratory test results.

3 Calculate the maximum depth of frost penetration for each section and select the value most appropriate for the project.

EVALUATION:

Geographic Location:

The site is located on Route 232 near the intersection with U.S. Route 2 in Rumford, Maine. The nearest weather recording station to the site has the following design data:

Mean Annual Temperature = 43.5 °F
Design Air Freezing Index = 1,631 °F-days
Design Length of Freezing Season = 136 days

Note: Data obtained from ModBerg v. 99.2 application developed by the USACE CRREL.

From MaineDOT BDG Figure 5-1 the design freezing index for Rumford, ME. is estimated to be 1,650 °F-days.

Recommend using weather data from ModBerg (1,631 °F-days).

Typical Cross Sections:

Based on an assumed pavement section thickness of 30-in. and the subsurface conditions encountered in the design phase test borings, the proposed roadway alignment can be broken into three different sections with different subgrade conditions; Alluvial Deposit, Topsoil and Granular Borrow. Summarize layer thicknesses under consideration….

Section	Bit. Concrete	Type B Base	Type D Subbase	Subgrade
	Thick. (in.)	Thick. (in.)	Thick. (in.)	Thick. (in.)
1, 2, 3	6	6	18	> 48

Note:

1 Subgrade material for Sections 1, 2 and 3 consist of Alluvial Deposit, Topsoil and Granular Borrow, respectively.

2 Subgrade layer thickness limited to 48 in. since the maximum depth of frost penetration is likely to be less than 78 in. (30 in. + 48 in.).

EVALUATION: (CONT.)

Soil Properties:

Summarize soil properties for use in estimating maximum depth of frost penetration. Soil properties are partially based on the results of laboratory testing, where available. In instances where there is insufficient laboratory test results, soil properties are assumed based on experience. See summary below….

Soil Unit	Moisture Content (%)	Dry Unit Weight (pcf)
Bit. Concrete	0%	140
Type B Base	6%	130
Type D Subbase	8%	125
Alluvial Deposit	12%	115
Topsoil	35%	110
Granular Borrow	10%	120

Note: Moisture content values taken as average of laboratory test results for each layer. Unit weight values are assumed.

Frost Penetration Calculation:

Maximum depth of seasonal frost penetration into the ground evaluated using the computer program ModBerg version 99.2 using input data summarized above. Program output is attached. Results are summarized below.

Section No.	Subgrade Material	Maximum Depth of Frost Penetration (in.)	
1	Alluvial	57.4	
2	Topsoil	41.8	
3	Granular Borrow	60.0	
	Average =	53.1	inches
	Average =	4.4	feet

Recommend using a maximum depth of frost penetration equal to 5 ft since the majority of the roadway alignment will have Alluvial or Granular Borrow subgrade.

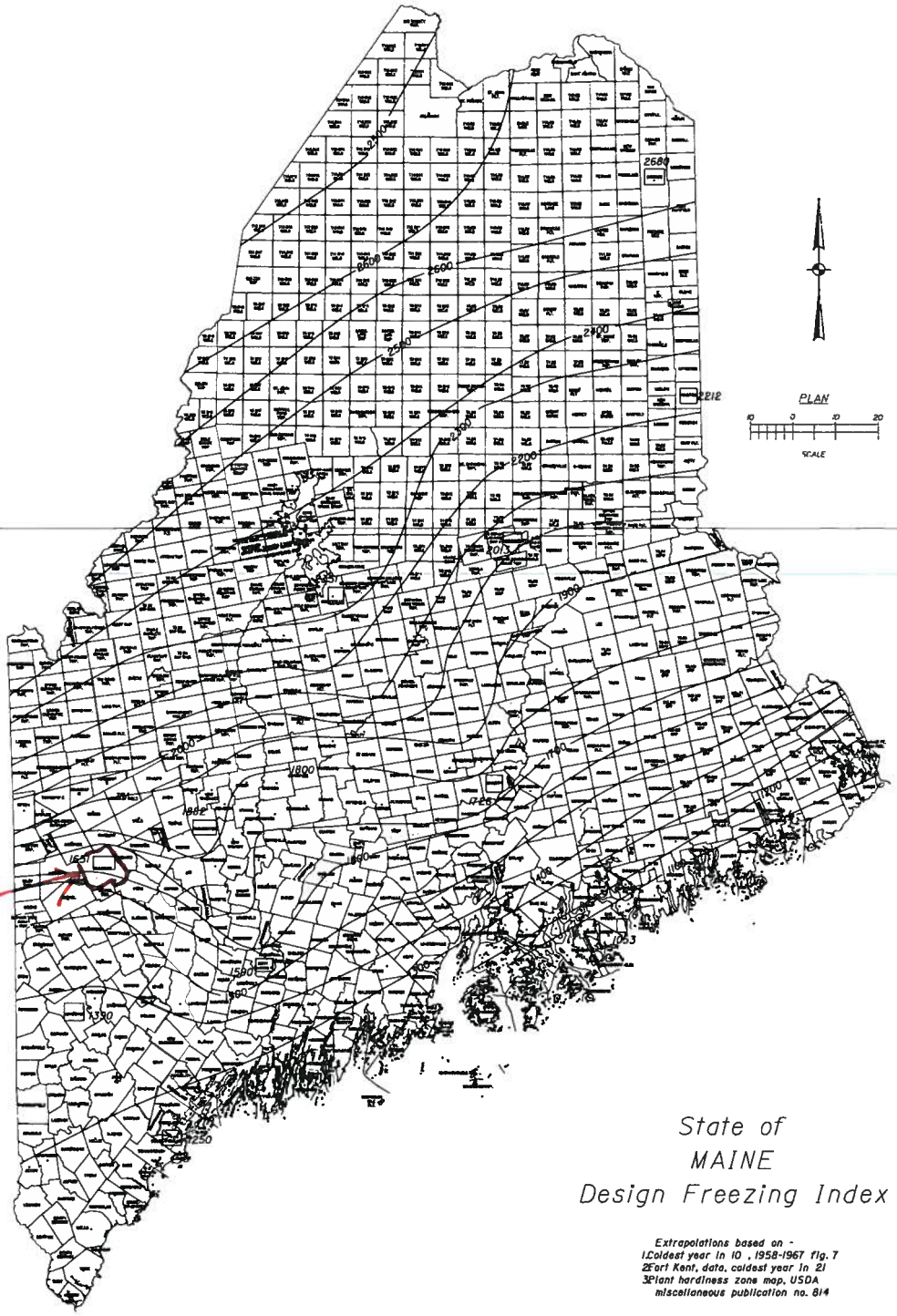


Figure 5-1 Maine Design Freezing Index Map

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

Project Location: Rumford 1 SSE, Maine

Air Design Freezing Index        =  1631 F-days
N-Factor                         =  0.70
Surface Design Freezing Index    =  1142 F-days
Mean Annual Temperature          =  43.5 deg F
Design Length of Freezing Season =  136 days

-------------------------------------------------------
Layer
#:Type          t    w%    d    Cf  Cu   Kf   Ku     L
-------------------------------------------------------
1-Asphalt       6.0   .0 140.0  28  28    .9   .9      0
2-Coarse        6.0  6.0 130.0  26  30   1.6  1.6  1,123
3-Coarse       18.0  8.0 125.0  26  31   1.7  1.5  1,440
4-Coarse       27.4 12.0 115.0  26  33   1.7  1.4  1,987
-------------------------------------------------------

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

*******************************************************
  Total Depth of Frost Penetration = 4.78 ft = 57.4 in.
*******************************************************
```

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

Project Location: Rumford 1 SSE, Maine

Air Design Freezing Index        =  1631 F-days
N-Factor                         =  0.70
Surface Design Freezing Index    =  1142 F-days
Mean Annual Temperature          =  43.5 deg F
Design Length of Freezing Season =  136 days

-------------------------------------------------------
Layer
#:Type          t    w%    d    Cf  Cu   Kf   Ku     L
-------------------------------------------------------
1-Asphalt       6.0   .0 140.0  28  28    .9   .9      0
2-Coarse        6.0  6.0 130.0  26  30   1.6  1.6  1,123
3-Coarse       18.0  8.0 125.0  26  31   1.7  1.5  1,440
4-Fine         11.8 35.0 110.0  38  57   2.1  1.3  5,544
-------------------------------------------------------

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

*******************************************************
  Total Depth of Frost Penetration = 3.48 ft = 41.8 in.
*******************************************************
```

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

Project Location: Rumford 1 SSE, Maine

Air Design Freezing Index        =  1631 F-days
N-Factor                         =  0.70
Surface Design Freezing Index    =  1142 F-days
Mean Annual Temperature          =  43.5 deg F
Design Length of Freezing Season =  136 days

-------------------------------------------------------
Layer
#:Type          t    w%    d    Cf  Cu   Kf   Ku     L
-------------------------------------------------------
1-Asphalt       6.0   .0 140.0  28  28    .9   .9      0
2-Coarse        6.0  6.0 130.0  26  30   1.6  1.6  1,123
3-Coarse       18.0  8.0 125.0  26  31   1.7  1.5  1,440
4-Coarse       30.0 10.0 120.0  26  32   1.7  1.5  1,728
-------------------------------------------------------

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

*******************************************************
  Total Depth of Frost Penetration = 5.00 ft = 60.0 in.
*******************************************************
```

Simplified Liquefaction Calculations

STANDARD PENETRATION TEST CORRECTIONS - WEST APPROACH & ABUTMENT 1

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

BOREHOLE DRILLING PROCESS VARIABLES:

borehole diameter =	4.0	inches
sampling method =	no liner	(liner or no liner)
hammer type =	safety	(safety, doughnut or automatic)
hammer weight =	140	(140 or 300 lb.)
hammer drop =	30	(typically 30 in.)

BB-RAR-107

Ground Surface Elevation = 612.9

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	611.9	4	71	1.70	7	1.00	1.00	4.0	0.75	1.10	6	80	5.00	1.20	12
2D	3.0	609.9	3	177	1.70	5	1.00	1.00	6.0	0.75	1.10	4	80	5.00	1.20	10
3D	5.0	607.9	3	282	1.70	5	1.00	1.00	8.0	0.75	1.10	4	65	5.00	1.20	10
4D	7.0	605.9	4	387	1.70	7	1.00	1.00	10.0	0.75	1.10	6	20	3.61	1.08	10
5D	9.0	603.9	7	492	1.70	12	1.00	1.00	12.0	0.80	1.12	11	5	0.00	1.00	11
6D	15.0	597.9	6	808	1.61	10	1.00	1.00	18.0	0.85	1.10	9	0	0.00	1.00	9
7D	20.0	592.9	12	1,071	1.40	17	1.00	1.00	23.0	0.95	1.17	19	0	0.00	1.00	19
8D	25.0	587.9	10	1,334	1.25	13	1.00	1.00	28.0	0.95	1.13	13	5	0.00	1.00	13
9D	30.0	582.9	7	1,597	1.14	8	1.00	1.00	33.0	1.00	1.10	9	0	0.00	1.00	9
10D	35.0	577.9	9	1,860	1.06	10	1.00	1.00	38.0	1.00	1.10	10	0	0.00	1.00	10

BB-RAR-108

Ground Surface Elevation = 615.5

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.5	2	115	1.70	3	1.00	1.00	4.0	0.75	1.10	3	60	5.00	1.20	8
2D	3.0	612.5	2	339	1.70	3	1.00	1.00	6.0	0.75	1.10	3	80	5.00	1.20	8
3D	5.0	610.5	1	444	1.70	2	1.00	1.00	8.0	0.75	1.10	1	75	5.00	1.20	7
4D	7.0	608.5	3	549	1.70	5	1.00	1.00	10.0	0.75	1.10	4	10	0.87	1.02	5
5D	9.0	606.5	7	654	1.70	12	1.00	1.00	12.0	0.80	1.12	11	0	0.00	1.00	11
6D	15.0	600.5	6	970	1.47	9	1.00	1.00	18.0	0.85	1.10	8	0	0.00	1.00	8
7D	20.0	595.5	6	1,233	1.30	8	1.00	1.00	23.0	0.95	1.10	8	0	0.00	1.00	8
8D	25.0	590.5	6	1,496	1.18	7	1.00	1.00	28.0	0.95	1.10	7	0	0.00	1.00	7
9D	30.0	585.5	5	1,759	1.09	5	1.00	1.00	33.0	1.00	1.10	6	5	0.00	1.00	6
10D	35.0	580.5	7	2,022	1.02	7	1.00	1.00	38.0	1.00	1.10	8	0	0.00	1.00	8
11D	40.0	575.5	8	2,285	0.96	8	1.00	1.00	43.0	1.00	1.10	8	0	0.00	1.00	8

BB-RAR-109

Ground Surface Elevation = 619.0

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	618.0	3	115	1.70	5	1.00	1.00	4.0	0.75	1.10	4	65	5.00	1.20	10
2D	3.0	616.0	2	345	1.70	3	1.00	1.00	6.0	0.75	1.10	3	40	5.00	1.20	8
3D	5.0	614.0	1	575	1.70	2	1.00	1.00	8.0	0.75	1.10	1	30	4.71	1.15	6
4D	7.0	612.0	1	768	1.65	2	1.00	1.00	10.0	0.75	1.10	1	30	4.71	1.15	6
5D	9.0	610.0	2	873	1.55	3	1.00	1.00	12.0	0.80	1.10	3	20	3.61	1.08	7
6D	15.0	604.0	7	1,188	1.33	9	1.00	1.00	18.0	0.85	1.10	9	0	0.00	1.00	9
7D	20.0	599.0	5	1,451	1.20	6	1.00	1.00	23.0	0.95	1.10	6	0	0.00	1.00	6
8D	25.0	594.0	11	1,714	1.10	12	1.00	1.00	28.0	0.95	1.12	13	5	0.00	1.00	13
9D	30.0	589.0	10	1,977	1.03	10	1.00	1.00	33.0	1.00	1.10	11	15	2.50	1.05	14
10D	35.0	584.0	11	2,240	0.97	11	1.00	1.00	38.0	1.00	1.11	12	15	2.50	1.05	15
11D	40.0	579.0	10	2,503	0.91	9	1.00	1.00	43.0	1.00	1.10	10	5	0.00	1.00	10

BB-RAR-110

Ground Surface Elevation = 615.8

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.8	4	115	1.70	7	1.00	1.00	4.0	0.75	1.10	6		0.00	1.00	6
2D	3.0	612.8	2	345	1.70	3	1.00	1.00	6.0	0.75	1.10	3		0.00	1.00	3
3D	5.0	610.8	3	463	1.70	5	1.00	1.00	8.0	0.75	1.10	4		0.00	1.00	4
4D	7.0	608.8	1	568	1.70	2	1.00	1.00	10.0	0.75	1.10	1		0.00	1.00	1
5D	9.0	606.8	1	673	1.70	2	1.00	1.00	12.0	0.80	1.10	1		0.00	1.00	1
6D	15.0	600.8	0	989	1.45	0	1.00	1.00	18.0	0.85	1.10	0	9.1	0.59	1.02	1
7D	20.0	595.8	6	1,252	1.29	8	1.00	1.00	23.0	0.95	1.10	8	9.1	0.59	1.02	9
8D	25.0	590.8	9	1,515	1.17	11	1.00	1.00	28.0	0.95	1.11	11	0	0.00	1.00	11
9D	30.0	585.8	10	1,778	1.08	11	1.00	1.00	33.0	1.00	1.11	12	0	0.00	1.00	12
10D	35.0	580.8	15	2,041	1.01	15	1.00	1.00	38.0	1.00	1.15	17	0	0.00	1.00	17
11D	40.0	575.8	13	2,304	0.95	12	1.00	1.00	43.0	1.00	1.12	14	0	0.00	1.00	14
12D	45.0	570.8	23	2,567	0.90	21	1.00	1.00	48.0	1.00	1.21	25	0	0.00	1.00	25
13D	50.0	565.8	17	2,830	0.86	15	1.00	1.00	53.0	1.00	1.15	17	0	0.00	1.00	17
14D	55.0	560.8	13	3,093	0.82	11	1.00	1.00	58.0	1.00	1.11	12	1.7	0.00	1.00	12
15D	60.0	555.8	12	3,356	0.79	9	1.00	1.00	63.0	1.00	1.10	10	1.7	0.00	1.00	10
16D	65.0	550.8	11	3,619	0.76	8	1.00	1.00	68.0	1.00	1.10	9	0	0.00	1.00	9
17D	70.0	545.8	14	3,882	0.73	10	1.00	1.00	73.0	1.00	1.10	11	0	0.00	1.00	11
18D	75.0	540.8	15	4,145	0.71	11	1.00	1.00	78.0	1.00	1.11	12	0	0.00	1.00	12
19D	80.0	535.8	20	4,408	0.69	14	1.00	1.00	83.0	1.00	1.14	16	2.5	0.00	1.00	16
20D	85.0	530.8	18	4,671	0.67	12	1.00	1.00	88.0	1.00	1.12	13	2.5	0.00	1.00	13
21D	90.0	525.8	12	4,934	0.65	8	1.00	1.00	93.0	1.00	1.10	9	0	0.00	1.00	9
22D	95.0	520.8	15	5,197	0.63	10	1.00	1.00	98.0	1.00	1.10	10	0	0.00	1.00	10
23D	100.0	515.8	16	5,460	0.62	10	1.00	1.00	103.0	1.00	1.10	11	1.3	0.00	1.00	11
24D	105.0	510.8	11	5,723	0.60	7	1.00	1.00	108.0	1.00	1.10	7	1.3	0.00	1.00	7
25D	110.0	505.8	30	5,986	0.59	18	1.00	1.00	113.0	1.00	1.18	21	0	0.00	1.00	21
26D	115.0	500.8	43	6,249	0.58	25	1.00	1.00	118.0	1.00	1.25	31	0	0.00	1.00	31
27D	120.0	495.8	23	6,512	0.57	13	1.00	1.00	123.0	1.00	1.13	15	0	0.00	1.00	15

BB-RAR-111

Ground Surface Elevation = 615.7

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.7	4	115	1.70	7	1.00	1.00	4.0	0.75	1.10	6	15	2.50	1.05	8
2D	6.0	609.7	2	509	1.70	3	1.00	1.00	9.0	0.75	1.10	3	26.4	4.43	1.13	8
3D	10.0	605.7	1	719	1.70	2	1.00	1.00	13.0	0.85	1.10	2	26.4	4.43	1.13	6
4D	15.0	600.7	2	982	1.46	3	1.00	1.00	18.0	0.85	1.10	3	5	0.00	1.00	3
5D	20.0	595.7	5	1,245	1.29	6	1.00	1.00	23.0	0.95	1.10	7	5	0.00	1.00	7
6D	25.0	590.7	12	1,508	1.18	14	1.00	1.00	28.0	0.95	1.14	15	5	0.00	1.00	15
7D	30.0	585.7	11	1,771	1.09	12	1.00	1.00	33.0	1.00	1.12	13	5	0.00	1.00	13
8D	35.0	580.7	11	2,034	1.01	11	1.00	1.00	38.0	1.00	1.11	12	5	0.00	1.00	12
9D	40.0	575.7	15	2,297	0.95	14	1.00	1.00	43.0	1.00	1.14	16	5	0.00	1.00	16
10D	45.0	570.7	19	2,560	0.90	17	1.00	1.00	48.0	1.00	1.17	20	5	0.00	1.00	20
11D	50.0	565.7	14	2,823	0.86	12	1.00	1.00	53.0	1.00	1.12	13	5	0.00	1.00	13
12D	55.0	560.7	16	3,086	0.82	13	1.00	1.00	58.0	1.00	1.13	15	5	0.00	1.00	15
13D	60.0	555.7	17	3,349	0.79	13	1.00	1.00	63.0	1.00	1.13	15	5	0.00	1.00	15
14D	65.0	550.7	13	3,612	0.76	10	1.00	1.00	68.0	1.00	1.10	11	5	0.00	1.00	11
15D	70.0	545.7	14	3,875	0.73	10	1.00	1.00	73.0	1.00	1.10	11	2.4	0.00	1.00	11
16D	75.0	540.7	13	4,138	0.71	9	1.00	1.00	78.0	1.00	1.10	10	2.4	0.00	1.00	10
17D	80.0	535.7	7	4,401	0.69	5	1.00	1.00	83.0	1.00	1.10	5	5	0.00	1.00	5
18D	86.0	529.7	16	4,717	0.67	11	1.00	1.00	89.0	1.00	1.11	12	5	0.00	1.00	12
19D	91.0	524.7	21	4,980	0.65	14	1.00	1.00	94.0	1.00	1.14	15	2.9	0.00	1.00	15
20D	96.0	519.7	16	5,243	0.63	10	1.00	1.00	99.0	1.00	1.10	11	2.9	0.00	1.00	11
21D	101.0	514.7	21	5,506	0.62	13	1.00	1.00	104.0	1.00	1.13	15	5	0.00	1.00	15
22D	111.0	504.7	26	6,032	0.59	15	1.00	1.00	114.0	1.00	1.15	18	5	0.00	1.00	18
23D	120.0	495.7	22	6,505	0.57	12	1.00	1.00	123.0	1.00	1.12	14	10	0.87	1.02	15
24D	130.5	485.2	80	7,058	0.54	44	1.00	1.00	133.5	1.00	1.30	57	10	0.87	1.02	59

BB-RAR-112

Ground Surface Elevation = 615.4

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.4	3	115	1.70	5	1.00	1.00	4.0	0.75	1.10	4	65	5.00	1.20	10
2D	3.0	612.4	2	333	1.70	3	1.00	1.00	6.0	0.75	1.10	3	40	5.00	1.20	8
3D	5.0	610.4	2	438	1.70	3	1.00	1.00	8.0	0.75	1.10	3	10	0.87	1.02	4
4D	7.0	608.4	0	543	1.70	0	1.00	1.00	10.0	0.75	1.10	0	10	0.87	1.02	1
5D	9.0	606.4	2	648	1.70	3	1.00	1.00	12.0	0.80	1.10	3	10	0.87	1.02	4
6D	15.0	600.4	4	964	1.47	6	1.00	1.00	18.0	0.85	1.10	6	10	0.87	1.02	6
7D	20.0	595.4	6	1,227	1.30	8	1.00	1.00	23.0	0.95	1.10	8	0	0.00	1.00	8
8D	25.0	590.4	7	1,490	1.18	8	1.00	1.00	28.0	0.95	1.10	9	2.1	0.00	1.00	9
9D	30.0	585.4	14	1,753	1.09	15	1.00	1.00	33.0	1.00	1.15	18	2.1	0.00	1.00	18
10D	35.0	580.4	9	2,016	1.02	9	1.00	1.00	38.0	1.00	1.10	10	0	0.00	1.00	10
11D	40.0	575.4	16	2,279	0.96	15	1.00	1.00	43.0	1.00	1.15	18	5	0.00	1.00	18
12D	45.0	570.4	22	2,542	0.91	20	1.00	1.00	48.0	1.00	1.20	24	0	0.00	1.00	24
13D	50.0	565.4	8	2,805	0.86	7	1.00	1.00	53.0	1.00	1.10	8	0	0.00	1.00	8

BB-RAR-113

Ground Surface Elevation = 615.8

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.8	4	115	1.70	7	1.00	1.00	4.0	0.75	1.10	6	30	4.71	1.15	11
2D	3.0	612.8	1	345	1.70	2	1.00	1.00	6.0	0.75	1.10	1	20	3.61	1.08	5
3D	5.0	610.8	1	463	1.70	2	1.00	1.00	8.0	0.75	1.10	1	10	0.87	1.02	2
4D	7.0	608.8	0	568	1.70	0	1.00	1.00	10.0	0.75	1.10	0	35	4.98	1.20	5
5D	9.0	606.8	0	673	1.70	0	1.00	1.00	12.0	0.80	1.10	0	10	0.87	1.02	1
6D	15.0	600.8	1	989	1.45	1	1.00	1.00	18.0	0.85	1.10	1	10	0.87	1.02	2
7D	20.0	595.8	4	1,252	1.29	5	1.00	1.00	23.0	0.95	1.10	5	5	0.00	1.00	5
8D	25.0	590.8	4	1,515	1.17	5	1.00	1.00	28.0	0.95	1.10	5	0	0.00	1.00	5
9D	30.0	585.8	12	1,778	1.08	13	1.00	1.00	33.0	1.00	1.13	15	1.6	0.00	1.00	15
10D	35.0	580.8	11	2,041	1.01	11	1.00	1.00	38.0	1.00	1.11	12	1.6	0.00	1.00	12
11D	40.0	575.8	10	2,304	0.95	10	1.00	1.00	43.0	1.00	1.10	10	0	0.00	1.00	10
12D	45.0	570.8	9	2,567	0.90	8	1.00	1.00	48.0	1.00	1.10	9	0	0.00	1.00	9
13D	50.0	565.8	12	2,830	0.86	10	1.00	1.00	53.0	1.00	1.10	11	0	0.00	1.00	11

BB-RAR-114

Ground Surface Elevation = 615.3

Groundwater Elevation = 612.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	614.3	3	115	1.70	5	1.00	1.00	4.0	0.75	1.10	4	40	5.00	1.20	10
2D	3.0	612.3	1	326	1.70	2	1.00	1.00	6.0	0.75	1.10	1	60	5.00	1.20	7
3D	5.0	610.3	0	431	1.70	0	1.00	1.00	8.0	0.75	1.10	0	33.3	4.90	1.18	5
4D	7.0	608.3	1	537	1.70	2	1.00	1.00	10.0	0.75	1.10	1	33.3	4.90	1.18	7
5D	9.0	606.3	0	642	1.70	0	1.00	1.00	12.0	0.80	1.10	0	10	0.87	1.02	1
6D	15.0	600.3	1	957	1.48	1	1.00	1.00	18.0	0.85	1.10	1	20	3.61	1.08	5
7D	20.0	595.3	6	1,220	1.31	8	1.00	1.00	23.0	0.95	1.10	8	0	0.00	1.00	8
8D	25.0	590.3	5	1,483	1.19	6	1.00	1.00	28.0	0.95	1.10	6	0	0.00	1.00	6
9D	30.0	585.3	5	1,746	1.09	5	1.00	1.00	33.0	1.00	1.10	6	0	0.00	1.00	6
10D	35.0	580.3	5	2,009	1.02	5	1.00	1.00	38.0	1.00	1.10	6	0	0.00	1.00	6
11D	40.0	575.3	7	2,272	0.96	7	1.00	1.00	43.0	1.00	1.10	7	1.6	0.00	1.00	7
12D	45.0	570.3	5	2,535	0.91	5	1.00	1.00	48.0	1.00	1.10	5	1.6	0.00	1.00	5
13D	50.0	565.3	8	2,798	0.86	7	1.00	1.00	53.0	1.00	1.10	8	0	0.00	1.00	8

CALCULATION OF CSR AND CRR IN ACCORDANCE WITH IDRISS & BOULANGER (2008) - WEST APPROACH & ABUTMENT 1

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

INPUT PARAMETERS:

peak ground acceleration (amax) =	0.218	g
EQ magnitude =	5.85	
magnitude scaling factor (MSF) =	1.54	
Min FS required =	1	

BB-RAR-107

Ground Surface Elevation =	612.9	ft, NAVD 88
Groundwater Elevation =	612.6	ft, NAVD 88
Height of Finish Grade Above Existing =	15	ft
Final Ground Surface Elevation =	627.9	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,cs}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	611.9	16.0	6	12	0.071	1.871	1.915	0.963	1.023	0.139	0.129	1.4
2D	3.0	609.9	18.0	4	10	0.177	1.977	2.145	0.958	1.085	0.147	0.114	1.2
3D	5.0	607.9	20.0	4	10	0.282	2.082	2.375	0.953	1.141	0.154	0.114	1.1
4D	7.0	605.9	22.0	6	10	0.387	2.187	2.605	0.949	1.191	0.160	0.110	1.1
5D	9.0	603.9	24.0	11	11	0.492	2.292	2.835	0.944	1.237	0.165	0.119	1.1
6D	15.0	597.9	30.0	9	9	0.808	2.608	3.525	0.930	1.352	0.178	0.105	0.9
7D	20.0	592.9	35.0	19	19	1.071	2.871	4.100	0.889	1.428	0.180	0.199	1.7
8D	25.0	587.9	40.0	13	13	1.334	3.134	4.675	0.848	1.492	0.179	0.144	1.2
9D	30.0	582.9	45.0	9	9	1.597	3.397	5.250	0.808	1.546	0.176	0.103	0.9
10D	35.0	577.9	50.0	10	10	1.860	3.660	5.825	0.767	1.592	0.173	0.117	1.0

BB-RAR-108

Ground Surface Elevation =	615.5	ft, NAVD 88
Groundwater Elevation =	612.6	ft, NAVD 88
Height of Finish Grade Above Existing =	16	ft
Final Ground Surface Elevation =	631.5	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,cs}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	614.5	17.0	3	8	0.115	2.035	2.035	0.960	1.000	0.136	0.099	1.1
2D	3.0	612.5	19.0	3	8	0.339	2.259	2.265	0.956	1.003	0.135	0.099	1.1
3D	5.0	610.5	21.0	1	7	0.444	2.364	2.495	0.951	1.055	0.142	0.085	0.9
4D	7.0	608.5	23.0	4	5	0.549	2.469	2.725	0.946	1.104	0.148	0.073	0.8
5D	9.0	606.5	25.0	11	11	0.654	2.574	2.955	0.942	1.148	0.153	0.119	1.2
6D	15.0	600.5	31.0	8	8	0.970	2.890	3.645	0.922	1.261	0.164	0.098	0.9
7D	20.0	595.5	36.0	8	8	1.233	3.153	4.220	0.881	1.338	0.167	0.097	0.9
8D	25.0	590.5	41.0	7	7	1.496	3.416	4.795	0.840	1.404	0.167	0.091	0.8
9D	30.0	585.5	46.0	6	6	1.759	3.679	5.370	0.800	1.460	0.165	0.080	0.7
10D	35.0	580.5	51.0	8	8	2.022	3.942	5.945	0.759	1.508	0.162	0.094	0.9
11D	40.0	575.5	56.0	8	8	2.285	4.205	6.520	0.718	1.551	0.157	0.099	1.0

BB-RAR-109

Ground Surface Elevation =	619.0	ft, NAVD 88
Groundwater Elevation =	612.6	ft, NAVD 88
Height of Finish Grade Above Existing =	18	ft
Final Ground Surface Elevation =	637.0	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,cs}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	618.0	19.0	4	10	0.115	2.275	2.275	0.956	1.000	0.135	0.114	1.3
2D	3.0	616.0	21.0	3	8	0.345	2.505	2.505	0.951	1.000	0.134	0.099	1.1
3D	5.0	614.0	23.0	1	6	0.575	2.735	2.735	0.946	1.000	0.134	0.082	0.9
4D	7.0	612.0	25.0	1	6	0.768	2.928	2.965	0.942	1.013	0.135	0.082	0.9
5D	9.0	610.0	27.0	3	7	0.873	3.033	3.195	0.937	1.053	0.140	0.084	0.9
6D	15.0	604.0	33.0	9	9	1.188	3.348	3.885	0.905	1.160	0.149	0.102	1.1
7D	20.0	599.0	38.0	6	6	1.451	3.611	4.460	0.865	1.235	0.151	0.082	0.8
8D	25.0	594.0	43.0	13	13	1.714	3.874	5.035	0.824	1.300	0.151	0.140	1.4
9D	30.0	589.0	48.0	11	14	1.977	4.137	5.610	0.783	1.356	0.150	0.154	1.6
10D	35.0	584.0	53.0	12	15	2.240	4.400	6.185	0.743	1.406	0.148	0.158	1.7
11D	40.0	579.0	58.0	10	10	2.503	4.663	6.760	0.702	1.450	0.144	0.114	1.2

BB-RAR-110

Ground Surface Elevation = 615.8 ft, NAVD 88
Groundwater Elevation = 612.6 ft, NAVD 88
Height of Finish Grade Above Existing = 22 ft
Final Ground Surface Elevation = 637.8 ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	614.8	23.0	6	6	0.115	2.755	2.755	0.946	1.000	0.134	0.077	0.9
2D	3.0	612.8	25.0	3	3	0.345	2.985	2.985	0.942	1.000	0.133	0.057	0.7
3D	5.0	610.8	27.0	4	4	0.463	3.103	3.215	0.937	1.036	0.137	0.066	0.7
4D	7.0	608.8	29.0	1	1	0.568	3.208	3.445	0.932	1.074	0.142	0.050	0.5
5D	9.0	606.8	31.0	1	1	0.673	3.313	3.675	0.922	1.109	0.145	0.051	0.5
6D	15.0	600.8	37.0	0	1	0.989	3.629	4.365	0.873	1.203	0.148	0.049	0.5
7D	20.0	595.8	42.0	8	9	1.252	3.892	4.940	0.832	1.269	0.149	0.103	1.1
8D	25.0	590.8	47.0	11	11	1.515	4.155	5.515	0.791	1.327	0.149	0.123	1.3
9D	30.0	585.8	52.0	12	12	1.778	4.418	6.090	0.751	1.379	0.146	0.131	1.4
10D	35.0	580.8	57.0	17	17	2.041	4.681	6.665	0.710	1.424	0.143	0.186	2.0
11D	40.0	575.8	62.0	14	14	2.304	4.944	7.240	0.669	1.464	0.139	0.149	1.7
12D	45.0	570.8	67.0	25	25	2.567	5.207	7.815	0.629	1.501	0.133	0.293	3.4
13D	50.0	565.8	72.0	17	17	2.830	5.470	8.390	0.588	1.534	0.127	0.178	2.2
14D	55.0	560.8	77.0	12	12	3.093	5.733	8.965	0.547	1.564	0.121	0.130	1.6
15D	60.0	555.8	82.0	10	10	3.356	5.996	9.540	0.507	1.591	0.114	0.117	1.6
16D	65.0	550.8	87.0	9	9	3.619	6.259	10.115	0.466	1.616	0.106	0.106	1.5
17D	70.0	545.8	92.0	11	11	3.882	6.522	10.690	0.425	1.639	0.099	0.125	2.0
18D	75.0	540.8	97.0	12	12	4.145	6.785	11.265	0.384	1.660	0.090	0.129	2.2
19D	80.0	535.8	102.0	16	16	4.408	7.048	11.840	0.344	1.680	0.082	0.167	3.1
20D	85.0	530.8	107.0	13	13	4.671	7.311	12.415	0.303	1.698	0.073	0.145	3.1
21D	90.0	525.8	112.0	9	9	4.934	7.574	12.990	0.262	1.715	0.064	0.101	2.4
22D	95.0	520.8	117.0	10	10	5.197	7.837	13.565	0.222	1.731	0.054	0.117	3.3
23D	100.0	515.8	122.0	11	11	5.460	8.100	14.140	0.181	1.746	0.045	0.121	4.2
24D	105.0	510.8	127.0	7	7	5.723	8.363	14.715	0.140	1.760	0.035	0.090	4.0
25D	110.0	505.8	132.0	21	21	5.986	8.626	15.290	0.099	1.773	0.025	0.226	14.0
26D	115.0	500.8	137.0	31	31	6.249	8.889	15.865	0.059	1.785	0.015	no liq	
27D	120.0	495.8	142.0	15	15	6.512	9.152	16.440	0.018	1.796	0.005	0.157	52.7

BB-RAR-111

Ground Surface Elevation = 615.7 ft, NAVD 88
Groundwater Elevation = 612.6 ft, NAVD 88
Height of Finish Grade Above Existing = 11 ft
Final Ground Surface Elevation = 626.7 ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	614.7	12.0	6	8	0.115	1.435	1.435	0.972	1.000	0.137	0.099	1.1
2D	6.0	609.7	17.0	3	8	0.509	1.829	2.010	0.960	1.099	0.149	0.092	1.0
3D	10.0	605.7	21.0	2	6	0.719	2.039	2.470	0.951	1.211	0.163	0.081	0.8
4D	15.0	600.7	26.0	3	3	0.982	2.302	3.045	0.939	1.323	0.176	0.057	0.5
5D	20.0	595.7	31.0	7	7	1.245	2.565	3.620	0.922	1.411	0.184	0.086	0.7
6D	25.0	590.7	36.0	15	15	1.508	2.828	4.195	0.881	1.483	0.185	0.163	1.4
7D	30.0	585.7	41.0	13	13	1.771	3.091	4.770	0.840	1.543	0.183	0.144	1.2
8D	35.0	580.7	46.0	12	12	2.034	3.354	5.345	0.800	1.593	0.180	0.135	1.2
9D	40.0	575.7	51.0	16	16	2.297	3.617	5.920	0.759	1.637	0.176	0.174	1.5
10D	45.0	570.7	56.0	20	20	2.560	3.880	6.495	0.718	1.674	0.170	0.217	2.0
11D	50.0	565.7	61.0	13	13	2.823	4.143	7.070	0.677	1.706	0.163	0.145	1.4
12D	55.0	560.7	66.0	15	15	3.086	4.406	7.645	0.637	1.735	0.156	0.159	1.6
13D	60.0	555.7	71.0	15	15	3.349	4.669	8.220	0.596	1.760	0.148	0.162	1.7
14D	65.0	550.7	76.0	11	11	3.612	4.932	8.795	0.555	1.783	0.140	0.121	1.3
15D	70.0	545.7	81.0	11	11	3.875	5.195	9.370	0.515	1.804	0.131	0.125	1.5
16D	75.0	540.7	86.0	10	10	4.138	5.458	9.945	0.474	1.822	0.122	0.115	1.4
17D	80.0	535.7	91.0	5	5	4.401	5.721	10.520	0.433	1.839	0.113	0.074	1.0
18D	86.0	529.7	97.0	12	12	4.717	6.037	11.210	0.384	1.857	0.101	0.129	2.0
19D	91.0	524.7	102.0	15	15	4.980	6.300	11.785	0.344	1.871	0.091	0.165	2.8
20D	96.0	519.7	107.0	11	11	5.243	6.563	12.360	0.303	1.883	0.081	0.123	2.4
21D	101.0	514.7	112.0	15	15	5.506	6.826	12.935	0.262	1.895	0.070	0.156	3.4
22D	111.0	504.7	122.0	18	18	6.032	7.352	14.085	0.181	1.916	0.049	0.188	5.9
23D	120.0	495.7	131.0	14	15	6.505	7.825	15.120	0.108	1.932	0.029	0.162	8.5
24D	130.5	485.2	141.5	57	59	7.058	8.378	16.328	0.022	1.949	0.006	no liq	

BB-RAR-112

Ground Surface Elevation = 615.4 ft, NAVD 88
Groundwater Elevation = 612.6 ft, NAVD 88
Height of Finish Grade Above Existing = 0 ft
Final Ground Surface Elevation = 615.4 ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	FS = MSF(CRR7.5/CSR)
1D	1.0	614.4	1.0	4	10	0.115	0.115	0.115	0.998	1.000	0.141	0.114	1.2
2D	3.0	612.4	3.0	3	8	0.333	0.333	0.345	0.993	1.038	0.146	0.099	1.0
3D	5.0	610.4	5.0	3	4	0.438	0.438	0.575	0.988	1.314	0.184	0.063	0.5
4D	7.0	608.4	7.0	0	1	0.543	0.543	0.805	0.984	1.483	0.206	0.049	0.4
5D	9.0	606.4	9.0	3	4	0.648	0.648	1.035	0.979	1.597	0.221	0.064	0.4
6D	15.0	600.4	15.0	6	6	0.964	0.964	1.725	0.965	1.790	0.244	0.084	0.5
7D	20.0	595.4	20.0	8	8	1.227	1.227	2.300	0.953	1.875	0.253	0.097	0.6
8D	25.0	590.4	25.0	9	9	1.490	1.490	2.875	0.942	1.930	0.257	0.102	0.6
9D	30.0	585.4	30.0	18	18	1.753	1.753	3.450	0.930	1.968	0.259	0.188	1.1
10D	35.0	580.4	35.0	10	10	2.016	2.016	4.025	0.889	1.997	0.251	0.114	0.7
11D	40.0	575.4	40.0	18	18	2.279	2.279	4.600	0.848	2.019	0.242	0.188	1.2
12D	45.0	570.4	45.0	24	24	2.542	2.542	5.175	0.808	2.036	0.232	0.272	1.8
13D	50.0	565.4	50.0	8	8	2.805	2.805	5.750	0.767	2.050	0.222	0.093	0.6

BB-RAR-113

Ground Surface Elevation = 615.8 ft, NAVD 88
Groundwater Elevation = 612.6 ft, NAVD 88
Height of Finish Grade Above Existing = 0 ft
Final Ground Surface Elevation = 615.8 ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR)
1D	1.0	614.8	1.0	6	11	0.115	0.115	0.115	0.998	1.000	0.141	0.124	1.4
2D	3.0	612.8	3.0	1	5	0.345	0.345	0.345	0.993	1.000	0.140	0.073	0.8
3D	5.0	610.8	5.0	1	2	0.463	0.463	0.575	0.988	1.243	0.174	0.054	0.5
4D	7.0	608.8	7.0	0	5	0.568	0.568	0.805	0.984	1.418	0.197	0.072	0.6
5D	9.0	606.8	9.0	0	1	0.673	0.673	1.035	0.979	1.538	0.213	0.049	0.4
6D	15.0	600.8	15.0	1	2	0.989	0.989	1.725	0.965	1.745	0.238	0.054	0.4
7D	20.0	595.8	20.0	5	5	1.252	1.252	2.300	0.953	1.838	0.248	0.075	0.5
8D	25.0	590.8	25.0	5	5	1.515	1.515	2.875	0.942	1.898	0.253	0.071	0.4
9D	30.0	585.8	30.0	15	15	1.778	1.778	3.450	0.930	1.941	0.255	0.157	0.9
10D	35.0	580.8	35.0	12	12	2.041	2.041	4.025	0.889	1.972	0.248	0.135	0.8
11D	40.0	575.8	40.0	10	10	2.304	2.304	4.600	0.848	1.997	0.239	0.117	0.8
12D	45.0	570.8	45.0	9	9	2.567	2.567	5.175	0.808	2.016	0.230	0.104	0.7
13D	50.0	565.8	50.0	11	11	2.830	2.830	5.750	0.767	2.032	0.220	0.125	0.9

BB-RAR-114

Ground Surface Elevation = 615.3 ft, NAVD 88
Groundwater Elevation = 612.6 ft, NAVD 88
Height of Finish Grade Above Existing = 4 ft
Final Ground Surface Elevation = 619.3 ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR)
1D	1.0	614.3	5.0	4	10	0.115	0.595	0.595	0.988	1.000	0.140	0.114	1.3
2D	3.0	612.3	7.0	1	7	0.326	0.806	0.825	0.984	1.023	0.142	0.085	0.9
3D	5.0	610.3	9.0	0	5	0.431	0.911	1.055	0.979	1.157	0.160	0.071	0.7
4D	7.0	608.3	11.0	1	7	0.537	1.017	1.285	0.974	1.264	0.174	0.084	0.7
5D	9.0	606.3	13.0	0	1	0.642	1.122	1.515	0.970	1.350	0.185	0.049	0.4
6D	15.0	600.3	19.0	1	5	0.957	1.437	2.205	0.956	1.534	0.207	0.073	0.5
7D	20.0	595.3	24.0	8	8	1.220	1.700	2.780	0.944	1.635	0.218	0.098	0.7
8D	25.0	590.3	29.0	6	6	1.483	1.963	3.355	0.932	1.709	0.225	0.081	0.6
9D	30.0	585.3	34.0	6	6	1.746	2.226	3.930	0.897	1.765	0.224	0.080	0.5
10D	35.0	580.3	39.0	6	6	2.009	2.489	4.505	0.857	1.810	0.219	0.077	0.5
11D	40.0	575.3	44.0	7	7	2.272	2.752	5.080	0.816	1.846	0.213	0.091	0.7
12D	45.0	570.3	49.0	5	5	2.535	3.015	5.655	0.775	1.875	0.206	0.072	0.5
13D	50.0	565.3	54.0	8	8	2.798	3.278	6.230	0.734	1.900	0.197	0.093	0.7

STANDARD PENETRATION TEST CORRECTIONS - PIER 1

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

BOREHOLE DRILLING PROCESS VARIABLES:

borehole diameter =	4.0	inches
sampling method =	no liner	(liner or no liner)
hammer type =	safety	(safety, doughnut or automatic)
hammer weight =	140	(140 or 300 lb.)
hammer drop =	30	(typically 30 in.)

BB-RAR-115

Ground Surface Elevation = 597.1

Groundwater Elevation = 597.1

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	596.1	17	53	1.70	29	1.00	1.00	4.0	0.75	1.29	28	0	0.00	1.00	28
2D	7.0	590.1	18	368	1.70	31	1.00	1.00	10.0	0.75	1.30	30	9.2	0.62	1.02	31
3D	12.0	585.1	4	631	1.70	7	1.00	1.00	15.0	0.85	1.10	6	9.2	0.62	1.02	7
4D	17.0	580.1	5	894	1.53	8	1.00	1.00	20.0	0.85	1.10	7	5	0.00	1.00	7
5D	22.0	575.1	9	1,157	1.34	12	1.00	1.00	25.0	0.95	1.12	13	12.2	1.62	1.03	15
6D	27.0	570.1	15	1,420	1.21	18	1.00	1.00	30.0	0.95	1.18	20	15	2.50	1.05	24
7D	32.0	565.1	6	1,683	1.11	7	1.00	1.00	35.0	1.00	1.10	7	42.2	5.00	1.20	14
8D	37.0	560.1	14	1,946	1.04	15	1.00	1.00	40.0	1.00	1.15	17	42.2	5.00	1.20	25
9D	42.0	555.1	16	2,209	0.97	16	1.00	1.00	45.0	1.00	1.16	18	20	3.61	1.08	23
10D	47.0	550.1	22	2,472	0.92	20	1.00	1.00	50.0	1.00	1.20	24	0	0.00	1.00	24
11D	52.0	545.1	36	2,735	0.87	31	1.00	1.00	55.0	1.00	1.30	41	6.2	0.04	1.01	41
12D	57.0	540.1	19	2,998	0.83	16	1.00	1.00	60.0	1.00	1.16	18	6.2	0.04	1.01	19
13D	62.0	535.1	21	3,261	0.80	17	1.00	1.00	65.0	1.00	1.17	20	5	0.00	1.00	20
14D	67.0	530.1	21	3,524	0.77	16	1.00	1.00	70.0	1.00	1.16	19	0	0.00	1.00	19
15D	72.0	525.1	25	3,787	0.74	19	1.00	1.00	75.0	1.00	1.19	22	5	0.00	1.00	22
16D	77.0	520.1	20	4,050	0.72	14	1.00	1.00	80.0	1.00	1.14	16	11.9	1.52	1.03	18
17D	82.0	515.1	29	4,313	0.70	20	1.00	1.00	85.0	1.00	1.20	24	11.9	1.52	1.03	27
18D	87.0	510.1	46	4,576	0.68	31	1.00	1.00	90.0	1.00	1.30	40	17.4	3.10	1.06	46
19D	92.0	505.1	55	4,839	0.66	36	1.00	1.00	95.0	1.00	1.30	47	17.4	3.10	1.06	53
20D	97.0	500.1	39	5,102	0.64	25	1.00	1.00	100.0	1.00	1.25	31	17.4	3.10	1.06	36
21D	102.0	495.1	48	5,365	0.62	30	1.00	1.00	105.0	1.00	1.30	39	15.1	2.53	1.05	43
22D	107.0	490.1	45	5,628	0.61	27	1.00	1.00	110.0	1.00	1.27	35	15.1	2.53	1.05	39

BB-RAR-116

Ground Surface Elevation = 597.1

Groundwater Elevation = 597.1

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	596.1	5	53	1.70	9	1.00	1.00	4.0	0.75	1.10	7	0	0.00	1.00	7
2D	6.0	591.1	21	316	1.70	36	1.00	1.00	9.0	0.75	1.30	35	5	0.00	1.00	35
3D	11.0	586.1	6	579	1.70	10	1.00	1.00	14.0	0.85	1.10	10	13.0	1.89	1.04	12
4D	16.0	581.1	7	842	1.58	11	1.00	1.00	19.0	0.85	1.11	10	13.0	1.89	1.04	13
5D	21.0	576.1	12	1,105	1.37	16	1.00	1.00	24.0	0.95	1.16	18	13.0	1.89	1.04	21
6D	26.0	571.1	15	1,368	1.24	19	1.00	1.00	29.0	0.95	1.19	21	25	4.29	1.12	28
7D	31.0	566.1	9	1,631	1.13	10	1.00	1.00	34.0	1.00	1.10	11	35	4.98	1.20	18
8D	36.0	561.1	18	1,894	1.05	19	1.00	1.00	39.0	1.00	1.19	22	35	4.98	1.20	32
9D	41.0	556.1	23	2,157	0.98	23	1.00	1.00	44.0	1.00	1.23	28	31.2	4.78	1.16	37
10D	46.0	551.1	22	2,420	0.93	20	1.00	1.00	49.0	1.00	1.20	25	31.2	4.78	1.16	33
11D	51.0	546.1	16	2,683	0.88	14	1.00	1.00	54.0	1.00	1.14	16	5	0.00	1.00	16
12D	56.0	541.1	12	2,946	0.84	10	1.00	1.00	59.0	1.00	1.10	11	5	0.00	1.00	11
13D	61.0	536.1	26	3,209	0.81	21	1.00	1.00	64.0	1.00	1.21	25	5	0.00	1.00	25
14D	66.0	531.1	21	3,472	0.78	16	1.00	1.00	69.0	1.00	1.16	19	5	0.00	1.00	19
15D	71.0	526.1	21	3,735	0.75	16	1.00	1.00	74.0	1.00	1.16	18	5	0.00	1.00	18
16D	76.0	521.1	22	3,998	0.72	16	1.00	1.00	79.0	1.00	1.16	18	15	2.50	1.05	22
17D	81.0	516.1	51	4,261	0.70	36	1.00	1.00	84.0	1.00	1.30	46	15	2.50	1.05	51
18D	86.0	511.1	42	4,524	0.68	29	1.00	1.00	89.0	1.00	1.29	37	5	0.00	1.00	37

CALCULATION OF CSR AND CRR IN ACCORDANCE WITH IDRISS & BOULANGER (2008) - PIER 1

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

INPUT PARAMETERS:

peak ground acceleration (amax) =	0.218	g
EQ magnitude =	5.85	
magnitude scaling factor (MSF) =	1.54	
Min FS required =	1	

BB-RAR-115

Ground Surface Elevation =	597.1	ft, NAVD 88
Groundwater Elevation =	597.1	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	597.1	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	596.1	1.0	28	28	0.053	0.053	0.115	0.998	2.186	0.308	0.367	1.8
2D	7.0	590.1	7.0	30	31	0.368	0.368	0.805	0.984	2.186	0.304	no liq	
3D	12.0	585.1	12.0	6	7	0.631	0.631	1.380	0.972	2.186	0.300	0.088	0.5
4D	17.0	580.1	17.0	7	7	0.894	0.894	1.955	0.960	2.186	0.297	0.089	0.5
5D	22.0	575.1	22.0	13	15	1.157	1.157	2.530	0.949	2.186	0.293	0.159	0.8
6D	27.0	570.1	27.0	20	24	1.420	1.420	3.105	0.937	2.186	0.290	0.272	1.4
7D	32.0	565.1	32.0	7	14	1.683	1.683	3.680	0.914	2.186	0.282	0.148	0.8
8D	37.0	560.1	37.0	17	25	1.946	1.946	4.255	0.873	2.186	0.270	0.290	1.7
9D	42.0	555.1	42.0	18	23	2.209	2.209	4.830	0.832	2.186	0.257	0.257	1.5
10D	47.0	550.1	47.0	24	24	2.472	2.472	5.405	0.791	2.186	0.245	0.279	1.8
11D	52.0	545.1	52.0	41	41	2.735	2.735	5.980	0.751	2.186	0.232	no liq	
12D	57.0	540.1	57.0	18	19	2.998	2.998	6.555	0.710	2.186	0.219	0.198	1.4
13D	62.0	535.1	62.0	20	20	3.261	3.261	7.130	0.669	2.186	0.207	0.211	1.6
14D	67.0	530.1	67.0	19	19	3.524	3.524	7.705	0.629	2.186	0.194	0.201	1.6
15D	72.0	525.1	72.0	22	22	3.787	3.787	8.280	0.588	2.186	0.182	0.242	2.1
16D	77.0	520.1	77.0	16	18	4.050	4.050	8.855	0.547	2.186	0.169	0.197	1.8
17D	82.0	515.1	82.0	24	27	4.313	4.313	9.430	0.507	2.186	0.157	0.326	3.2
18D	87.0	510.1	87.0	40	46	4.576	4.576	10.005	0.466	2.186	0.144	no liq	
19D	92.0	505.1	92.0	47	53	4.839	4.839	10.580	0.425	2.186	0.131	no liq	
20D	97.0	500.1	97.0	31	36	5.102	5.102	11.155	0.384	2.186	0.119	no liq	
21D	102.0	495.1	102.0	39	43	5.365	5.365	11.730	0.344	2.186	0.106	no liq	
22D	107.0	490.1	107.0	35	39	5.628	5.628	12.305	0.303	2.186	0.094	no liq	

BB-RAR-116

Ground Surface Elevation =	597.1	ft, NAVD 88
Groundwater Elevation =	597.1	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	597.1	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	596.1	1.0	7	7	0.053	0.053	0.115	0.998	2.186	0.308	0.088	0.4
2D	6.0	591.1	6.0	35	35	0.316	0.316	0.690	0.986	2.186	0.305	no liq	
3D	11.0	586.1	11.0	10	12	0.579	0.579	1.265	0.974	2.186	0.301	0.129	0.7
4D	16.0	581.1	16.0	10	13	0.842	0.842	1.840	0.963	2.186	0.298	0.137	0.7
5D	21.0	576.1	21.0	18	21	1.105	1.105	2.415	0.951	2.186	0.294	0.226	1.2
6D	26.0	571.1	26.0	21	28	1.368	1.368	2.990	0.939	2.186	0.290	0.355	1.9
7D	31.0	566.1	31.0	11	18	1.631	1.631	3.565	0.922	2.186	0.285	0.196	1.1
8D	36.0	561.1	36.0	22	32	1.894	1.894	4.140	0.881	2.186	0.272	no liq	
9D	41.0	556.1	41.0	28	37	2.157	2.157	4.715	0.840	2.186	0.260	no liq	
10D	46.0	551.1	46.0	25	33	2.420	2.420	5.290	0.800	2.186	0.247	no liq	
11D	51.0	546.1	51.0	16	16	2.683	2.683	5.865	0.759	2.186	0.235	0.171	1.1
12D	56.0	541.1	56.0	11	11	2.946	2.946	6.440	0.718	2.186	0.222	0.123	0.9
13D	61.0	536.1	61.0	25	25	3.209	3.209	7.015	0.677	2.186	0.209	0.299	2.2
14D	66.0	531.1	66.0	19	19	3.472	3.472	7.590	0.637	2.186	0.197	0.203	1.6
15D	71.0	526.1	71.0	18	18	3.735	3.735	8.165	0.596	2.186	0.184	0.194	1.6
16D	76.0	521.1	76.0	18	22	3.998	3.998	8.740	0.555	2.186	0.172	0.239	2.1
17D	81.0	516.1	81.0	46	51	4.261	4.261	9.315	0.515	2.186	0.159	no liq	
18D	86.0	511.1	86.0	37	37	4.524	4.524	9.890	0.474	2.186	0.146	no liq	

STANDARD PENETRATION TEST CORRECTIONS - PIER 2

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

BOREHOLE DRILLING PROCESS VARIABLES:

borehole diameter =	4.0	inches
sampling method =	no liner	(liner or no liner)
hammer type =	safety	(safety, doughnut or automatic)
hammer weight =	140	(140 or 300 lb.)
hammer drop =	30	(typically 30 in.)

BB-RAR-117

Ground Surface Elevation = 596.1

Groundwater Elevation = 596.1

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	595.1	3	53	1.70	5	1.00	1.00	4.0	0.75	1.10	4	0	0.00	1.00	4
2D	7.0	589.1	8	368	1.70	14	1.00	1.00	10.0	0.75	1.14	12	10.3	0.97	1.02	13
3D	12.0	584.1	5	631	1.70	9	1.00	1.00	15.0	0.85	1.10	8	10.3	0.97	1.02	9
4D	17.0	579.1	5	894	1.53	8	1.00	1.00	20.0	0.85	1.10	7	42.1	5.00	1.20	14
5D	22.0	574.1	5	1,157	1.34	7	1.00	1.00	25.0	0.95	1.10	7	42.1	5.00	1.20	13
6D	27.0	569.1	7	1,420	1.21	8	1.00	1.00	30.0	0.95	1.10	9	62.8	5.00	1.20	16
7D	32.0	564.1	10	1,683	1.11	11	1.00	1.00	35.0	1.00	1.11	12	62.8	5.00	1.20	20
8D	37.0	559.1	16	1,946	1.04	17	1.00	1.00	40.0	1.00	1.17	19	40.5	5.00	1.20	28
9D	42.0	554.1	17	2,209	0.97	17	1.00	1.00	45.0	1.00	1.17	19	40.5	5.00	1.20	28
10D	47.0	549.1	11	2,472	0.92	10	1.00	1.00	50.0	1.00	1.10	11	10	0.87	1.02	12
11D	52.0	544.1	18	2,735	0.87	16	1.00	1.00	55.0	1.00	1.16	18	0	0.00	1.00	18
12D	57.0	539.1	20	2,998	0.83	17	1.00	1.00	60.0	1.00	1.17	19	21.1	3.79	1.09	25
13D	62.0	534.1	21	3,261	0.80	17	1.00	1.00	65.0	1.00	1.17	20	21.1	3.79	1.09	25
14D	67.0	529.1	26	3,524	0.77	20	1.00	1.00	70.0	1.00	1.20	24	21.1	3.79	1.09	30
15D	72.0	524.1	28	3,787	0.74	21	1.00	1.00	75.0	1.00	1.21	25	10	0.87	1.02	27
16D	77.0	519.1	32	4,050	0.72	23	1.00	1.00	80.0	1.00	1.23	28	20	3.61	1.08	34

BB-RAR-118

Ground Surface Elevation = 596.8

Groundwater Elevation = 596.8

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	595.8	5	53	1.70	9	1.00	1.00	4.0	0.75	1.10	7	5.0	0.00	1.00	7
2D	6.0	590.8	8	316	1.70	14	1.00	1.00	9.0	0.75	1.14	12	5.0	0.00	1.00	12
3D	11.0	585.8	5	579	1.70	9	1.00	1.00	14.0	0.85	1.10	8	5	0.00	1.00	8
4D	16.0	580.8	4	842	1.58	6	1.00	1.00	19.0	0.85	1.10	6	20	3.61	1.08	10
5D	21.0	575.8	5	1,105	1.37	7	1.00	1.00	24.0	0.95	1.10	7	30	4.71	1.15	13
6D	26.0	570.8	5	1,368	1.24	6	1.00	1.00	29.0	0.95	1.10	6	45	5.00	1.20	13
7D	31.0	565.8	7	1,631	1.13	8	1.00	1.00	34.0	1.00	1.10	9	30	4.71	1.15	15
8D	36.0	560.8	20	1,894	1.05	21	1.00	1.00	39.0	1.00	1.21	25	25	4.29	1.12	33
9D	41.0	555.8	22	2,157	0.98	22	1.00	1.00	44.0	1.00	1.22	26	30	4.71	1.15	35
10D	46.0	550.8	26	2,420	0.93	24	1.00	1.00	49.0	1.00	1.24	30	5	0.00	1.00	30
11D	51.0	545.8	24	2,683	0.88	21	1.00	1.00	54.0	1.00	1.21	26	0	0.00	1.00	26
12D	56.0	540.8	30	2,946	0.84	25	1.00	1.00	59.0	1.00	1.25	32	15	2.50	1.05	36
13D	61.0	535.8	22	3,209	0.81	18	1.00	1.00	64.0	1.00	1.18	21	10	0.87	1.02	22

CALCULATION OF CSR AND CRR IN ACCORDANCE WITH IDRISS & BOULANGER (2008) - PIER 2

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

INPUT PARAMETERS:

peak ground acceleration (amax) =	0.218	g
EQ magnitude =	5.85	
magnitude scaling factor (MSF) =	1.54	
Min FS required =	1	

BB-RAR-117

Ground Surface Elevation =	596.1	ft, NAVD 88
Groundwater Elevation =	596.1	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	596.1	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	595.1	1.0	4	4	0.053	0.053	0.115	0.998	2.186	0.308	0.066	0.3
2D	7.0	589.1	7.0	12	13	0.368	0.368	0.805	0.984	2.186	0.304	0.139	0.7
3D	12.0	584.1	12.0	8	9	0.631	0.631	1.380	0.972	2.186	0.300	0.105	0.5
4D	17.0	579.1	17.0	7	14	0.894	0.894	1.955	0.960	2.186	0.297	0.146	0.8
5D	22.0	574.1	22.0	7	13	1.157	1.157	2.530	0.949	2.186	0.293	0.145	0.8
6D	27.0	569.1	27.0	9	16	1.420	1.420	3.105	0.937	2.186	0.290	0.167	0.9
7D	32.0	564.1	32.0	12	20	1.683	1.683	3.680	0.914	2.186	0.282	0.214	1.2
8D	37.0	559.1	37.0	19	28	1.946	1.946	4.255	0.873	2.186	0.270	0.376	2.1
9D	42.0	554.1	42.0	19	28	2.209	2.209	4.830	0.832	2.186	0.257	0.373	2.2
10D	47.0	549.1	47.0	11	12	2.472	2.472	5.405	0.791	2.186	0.245	0.133	0.8
11D	52.0	544.1	52.0	18	18	2.735	2.735	5.980	0.751	2.186	0.232	0.194	1.3
12D	57.0	539.1	57.0	19	25	2.998	2.998	6.555	0.710	2.186	0.219	0.291	2.0
13D	62.0	534.1	62.0	20	25	3.261	3.261	7.130	0.669	2.186	0.207	0.294	2.2
14D	67.0	529.1	67.0	24	30	3.524	3.524	7.705	0.629	2.186	0.194	0.461	3.7
15D	72.0	524.1	72.0	25	27	3.787	3.787	8.280	0.588	2.186	0.182	0.326	2.8
16D	77.0	519.1	77.0	28	34	4.050	4.050	8.855	0.547	2.186	0.169	no liq	

BB-RAR-118

Ground Surface Elevation =	596.8	ft, NAVD 88
Groundwater Elevation =	596.8	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	596.8	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	595.8	1.0	7	7	0.053	0.053	0.115	0.998	2.186	0.308	0.088	0.4
2D	6.0	590.8	6.0	12	12	0.316	0.316	0.690	0.986	2.186	0.305	0.127	0.6
3D	11.0	585.8	11.0	8	8	0.579	0.579	1.265	0.974	2.186	0.301	0.095	0.5
4D	16.0	580.8	16.0	6	10	0.842	0.842	1.840	0.963	2.186	0.298	0.113	0.6
5D	21.0	575.8	21.0	7	13	1.105	1.105	2.415	0.951	2.186	0.294	0.141	0.7
6D	26.0	570.8	26.0	6	13	1.368	1.368	2.990	0.939	2.186	0.290	0.138	0.7
7D	31.0	565.8	31.0	9	15	1.631	1.631	3.565	0.922	2.186	0.285	0.158	0.9
8D	36.0	560.8	36.0	25	33	1.894	1.894	4.140	0.881	2.186	0.272	no liq	
9D	41.0	555.8	41.0	26	35	2.157	2.157	4.715	0.840	2.186	0.260	no liq	
10D	46.0	550.8	46.0	30	30	2.420	2.420	5.290	0.800	2.186	0.247	0.467	2.9
11D	51.0	545.8	51.0	26	26	2.683	2.683	5.865	0.759	2.186	0.235	0.305	2.0
12D	56.0	540.8	56.0	32	36	2.946	2.946	6.440	0.718	2.186	0.222	no liq	
13D	61.0	535.8	61.0	21	22	3.209	3.209	7.015	0.677	2.186	0.209	0.245	1.8

STANDARD PENETRATION TEST CORRECTIONS - ABUTMENT 2

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

BOREHOLE DRILLING PROCESS VARIABLES:

borehole diameter =	4.0	inches
sampling method =	no liner	(liner or no liner)
hammer type =	safety	(safety, doughnut or automatic)
hammer weight =	140	(140 or 300 lb.)
hammer drop =	30	(typically 30 in.)

BB-RAR-119

Ground Surface Elevation = 599.6

Groundwater Elevation = 599.6

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	598.6	1	53	1.70	2	1.00	1.00	4.0	0.75	1.10	1	0	0.00	1.00	1
2D	4.0	595.6	22	210	1.70	37	1.00	1.00	7.0	0.75	1.30	36	25	4.29	1.12	45
3D	9.0	590.6	7	473	1.70	12	1.00	1.00	12.0	0.80	1.12	11	5	0.00	1.00	11
4D	14.0	585.6	7	736	1.68	12	1.00	1.00	17.0	0.85	1.12	11	5	0.00	1.00	11
5D	19.0	580.6	11	999	1.45	16	1.00	1.00	22.0	0.95	1.16	18	5	0.00	1.00	18
6D	24.0	575.6	9	1,262	1.29	12	1.00	1.00	27.0	0.95	1.12	12	10	0.87	1.02	13
7D	29.0	570.6	7	1,525	1.17	8	1.00	1.00	32.0	1.00	1.10	9	10	0.87	1.02	10
8D	34.0	565.6	6	1,788	1.08	6	1.00	1.00	37.0	1.00	1.10	7	5	0.00	1.00	7
9D	39.0	560.6	17	2,051	1.01	17	1.00	1.00	42.0	1.00	1.17	20	15	2.50	1.05	24
10D	44.0	555.6	25	2,314	0.95	24	1.00	1.00	47.0	1.00	1.24	29	15	2.50	1.05	33
11D	48.5	551.1	39	2,551	0.90	35	1.00	1.00	51.5	1.00	1.30	46	15	2.50	1.05	51

BB-RAR-120

Ground Surface Elevation = 600.1

Groundwater Elevation = 600.1

Sample No.	Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Raw SPT N-Values (blows/ft)	Effective Stress (psf)	Overburden Correction Factor (C_N)	N1	Energy Ration Factor (C_E)	Borehole Diameter Factor (C_B)	Length of Rod (ft)	Rod Length Correction Factor (C_R)	Sampling Method Factor (C_S)	$(N1)_{60}$	Fines Content (%)	α	β	$(N1)_{60,CS}$
1D	1.0	599.1	0	53	1.70	0	1.00	1.00	4.0	0.75	1.10	0	22.2	3.95	1.09	4
2D	5.0	595.1	21	263	1.70	36	1.00	1.00	8.0	0.75	1.30	35	22.2	3.95	1.09	42
3D	10.0	590.1	7	526	1.70	12	1.00	1.00	13.0	0.85	1.12	11	10	0.87	1.02	12
4D	15.0	585.1	8	789	1.63	13	1.00	1.00	18.0	0.85	1.13	13	7.5	0.20	1.01	13
5D	20.0	580.1	7	1,052	1.41	10	1.00	1.00	23.0	0.95	1.10	10	7.5	0.20	1.01	11
6D	25.0	575.1	12	1,315	1.26	15	1.00	1.00	28.0	0.95	1.15	17	14.6	2.38	1.05	20
7D	30.0	570.1	16	1,578	1.15	18	1.00	1.00	33.0	1.00	1.18	22	14.6	2.38	1.05	25
8D	35.0	565.1	10	1,841	1.06	11	1.00	1.00	38.0	1.00	1.11	12	45.6	5.00	1.20	19
9D	40.0	560.1	20	2,104	1.00	20	1.00	1.00	43.0	1.00	1.20	24	45.6	5.00	1.20	34
10D	45.0	555.1	5	2,367	0.94	5	1.00	1.00	48.0	1.00	1.10	5	56.3	5.00	1.20	11
11D	50.0	550.1	29	2,630	0.89	26	1.00	1.00	53.0	1.00	1.26	33	56.3	5.00	1.20	44
12D	55.0	545.1	23	2,893	0.85	20	1.00	1.00	58.0	1.00	1.20	23	45.3	5.00	1.20	33
13D	60.0	540.1	14	3,156	0.81	11	1.00	1.00	63.0	1.00	1.11	13	45.3	5.00	1.20	20
14D	65.0	535.1	38	3,419	0.78	30	1.00	1.00	68.0	1.00	1.30	39	0	0.00	1.00	39

CALCULATION OF CSR AND CRR IN ACCORDANCE WITH IDRISS & BOULANGER (2008) - ABUTMENT 2

MARTIN MEMORIAL BRIDGE REPLACEMENT

MAINEDOT PIN 15105.00

ROUTE 232 - RUMFORD, MAINE

HALEY & ALDRICH, INC. FILE NO.: 38799-000

INPUT PARAMETERS:

peak ground acceleration (amax) =	0.218	g
EQ magnitude =	5.85	
magnitude scaling factor (MSF) =	1.54	
Min FS required =	1	

BB-RAR-119

Ground Surface Elevation =	599.6	ft, NAVD 88
Groundwater Elevation =	599.6	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	599.6	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	598.6	1.0	1	1	0.053	0.053	0.115	0.998	2.186	0.308	0.050	0.3
2D	4.0	595.6	4.0	36	45	0.210	0.210	0.460	0.991	2.186	0.306	no liq	
3D	9.0	590.6	9.0	11	11	0.473	0.473	1.035	0.979	2.186	0.303	0.119	0.6
4D	14.0	585.6	14.0	11	11	0.736	0.736	1.610	0.967	2.186	0.299	0.124	0.6
5D	19.0	580.6	19.0	18	18	0.999	0.999	2.185	0.956	2.186	0.295	0.186	1.0
6D	24.0	575.6	24.0	12	13	1.262	1.262	2.760	0.944	2.186	0.292	0.144	0.8
7D	29.0	570.6	29.0	9	10	1.525	1.525	3.335	0.932	2.186	0.288	0.114	0.6
8D	34.0	565.6	34.0	7	7	1.788	1.788	3.910	0.897	2.186	0.277	0.089	0.5
9D	39.0	560.6	39.0	20	24	2.051	2.051	4.485	0.857	2.186	0.265	0.266	1.5
10D	44.0	555.6	44.0	29	33	2.314	2.314	5.060	0.816	2.186	0.252	no liq	
11D	48.5	551.1	48.5	46	51	2.551	2.551	5.578	0.779	2.186	0.241	no liq	

BB-RAR-120

Ground Surface Elevation =	600.1	ft, NAVD 88
Groundwater Elevation =	600.1	ft, NAVD 88
Height of Finish Grade Above Existing =	0	ft
Final Ground Surface Elevation =	600.1	ft, NAVD 88

Sample No.	Current Depth Below Ground Surface (ft)	Elevation (ft, NAVD 88)	Final Depth Below Ground Surface (ft)	$(N1)_{60}$	$(N1)_{60,CS}$	Current Effective Stress (ksf)	Final Effective Stress (ksf)	Final Total Stress (ksf)	rd final GS	sv/s;v	CSR	CRR M=7.5	**FS =** MSF(CRR7.5/CSR
1D	1.0	599.1	1.0	0	4	0.053	0.053	0.115	0.998	2.186	0.308	0.065	0.3
2D	5.0	595.1	5.0	35	42	0.263	0.263	0.575	0.988	2.186	0.305	no liq	
3D	10.0	590.1	10.0	11	12	0.526	0.526	1.150	0.977	2.186	0.302	0.135	0.7
4D	15.0	585.1	15.0	13	13	0.789	0.789	1.725	0.965	2.186	0.298	0.139	0.7
5D	20.0	580.1	20.0	10	11	1.052	1.052	2.300	0.953	2.186	0.295	0.119	0.6
6D	25.0	575.1	25.0	17	20	1.315	1.315	2.875	0.942	2.186	0.291	0.211	1.1
7D	30.0	570.1	30.0	22	25	1.578	1.578	3.450	0.930	2.186	0.287	0.295	1.6
8D	35.0	565.1	35.0	12	19	1.841	1.841	4.025	0.889	2.186	0.275	0.205	1.1
9D	40.0	560.1	40.0	24	34	2.104	2.104	4.600	0.848	2.186	0.262	no liq	
10D	45.0	555.1	45.0	5	11	2.367	2.367	5.175	0.808	2.186	0.250	0.124	0.8
11D	50.0	550.1	50.0	33	44	2.630	2.630	5.750	0.767	2.186	0.237	no liq	
12D	55.0	545.1	55.0	23	33	2.893	2.893	6.325	0.726	2.186	0.224	no liq	
13D	60.0	540.1	60.0	13	20	3.156	3.156	6.900	0.686	2.186	0.212	0.218	1.6
14D	65.0	535.1	65.0	39	39	3.419	3.419	7.475	0.645	2.186	0.199	no liq	

Seismic Acceleration Calculations

HALEY & ALDRICH	CALCULATIONS	File No.	38799-000
		Sheet	1 of 1
Client	Maine Department of Transportation	Date	3/13/2013
Project	Martin Memorial Bridge Replacement - Rumford, Maine	Computed By	EK
Subject	Horizontal Seismic Acceleration for Slope Stability Analysis of Approaches and	Checked By	BCS

OBJECTIVE:

Calculate horizontal seismic acceleration coefficient in accordance with AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012 with 2012 Interim Revisions.

CALCULATIONS:

According to the recommended response spectrum for the 1000-yr event (equivalent to 7% probability of exceedance in 75 years) reported in the Site Specific Seismic Assessment Report:

PGA = 0.18 (g)

For the embankment slopes and abutments:

Method 1

Calculate seismic acceleration in accordance with Kavazanjian et al., (1997):

$$k_h = 0.74\, A_S \left(\frac{A_S}{d}\right)^{0.25}$$

where:

A_S = earthquake ground acceleration coefficient as specified in Eq. 3.10.4.2-2 (dim.)
k_h = horizontal seismic acceleration coefficient (dim.)
d = lateral wall displacement (in.)

A_s = 0.18 (dim.) A_s is equal to PGA
d = 1.0 (in) Assumed

Therefore:
k_h = 0.09 (dim.)

Method 2

Calculate seismic acceleration in accordance with Anderson et al., (2008):

k_{max} = 0.18 (dim.) F_vS_1 = 0.14 (dim.) (based on the site specific response spectrum) so, β = 0.78

For h = 20 (ft) so, α = 0.88 therefore, k_{ave} = 0.16 (dim.)
For h = 30 (ft) so, α = 0.82 therefore, k_{ave} = 0.15 (dim.)

PGV = 5.32 (in./sec)

From SLIDE analysis (assuming no liquefaction), yield acceleration (k_y) is equal or greater than: k_y = 0.10 (dim)

In this case; Slope/Abutment Displacement, d = 0.10 (in.) < 1 inch

where;

$$\log(d) = -1.51 - 0.74\log(k_y/k_{max}) + 3.27\log(1 - k_y/k_{max}) - 0.80\log(k_{max}) + 1.59\log(PGV)$$

Because of the height of the wall, kmax in the equation is replaced by kave to account for wave scattering effects.

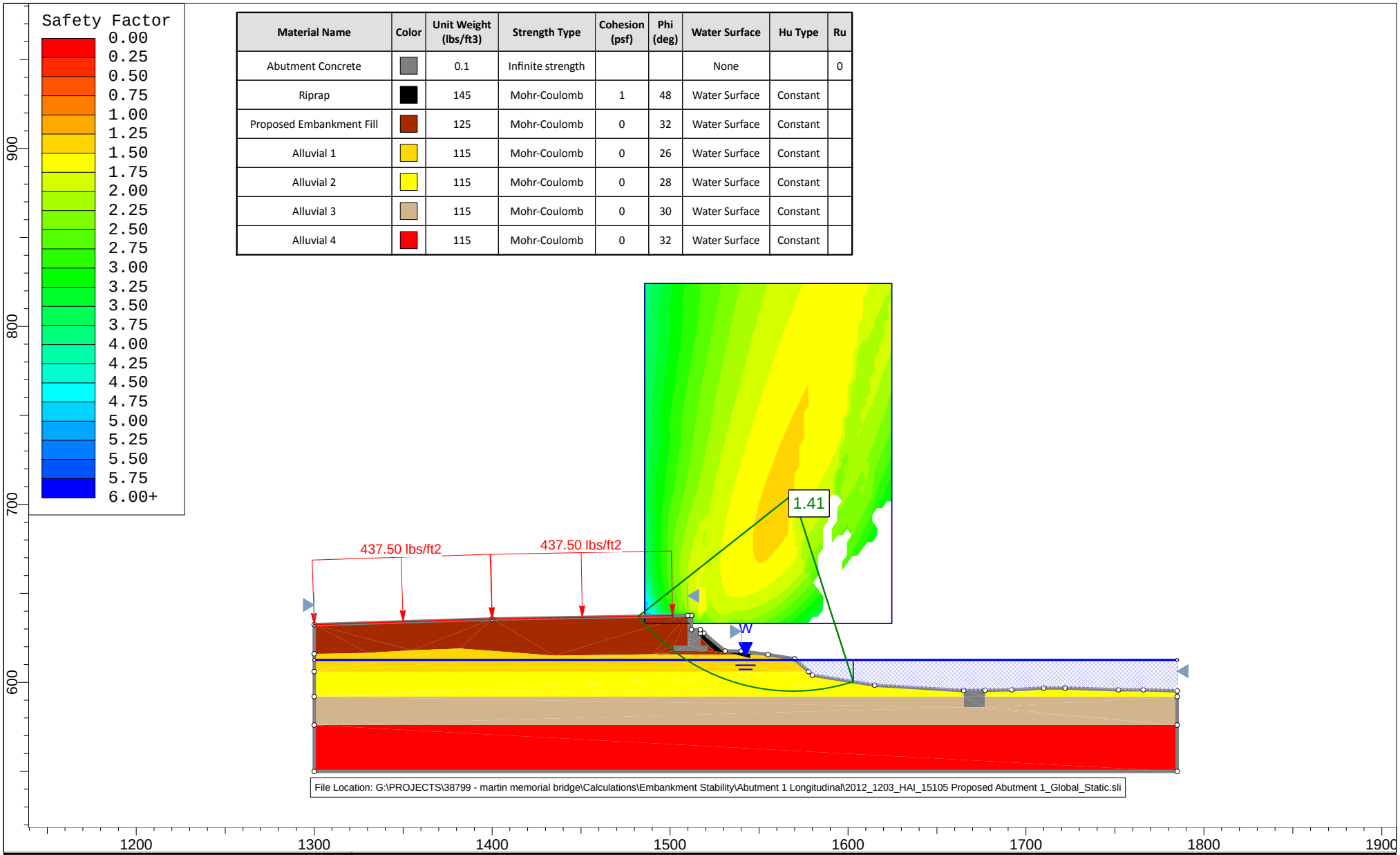
Therefore: $k_h = \alpha \cdot k_y$ = 0.09 (dim)

Recommended Seismic Coefficient Acceleration

k_h = 0.09 (dim.) If 1 inch of permanent displacement is permissible

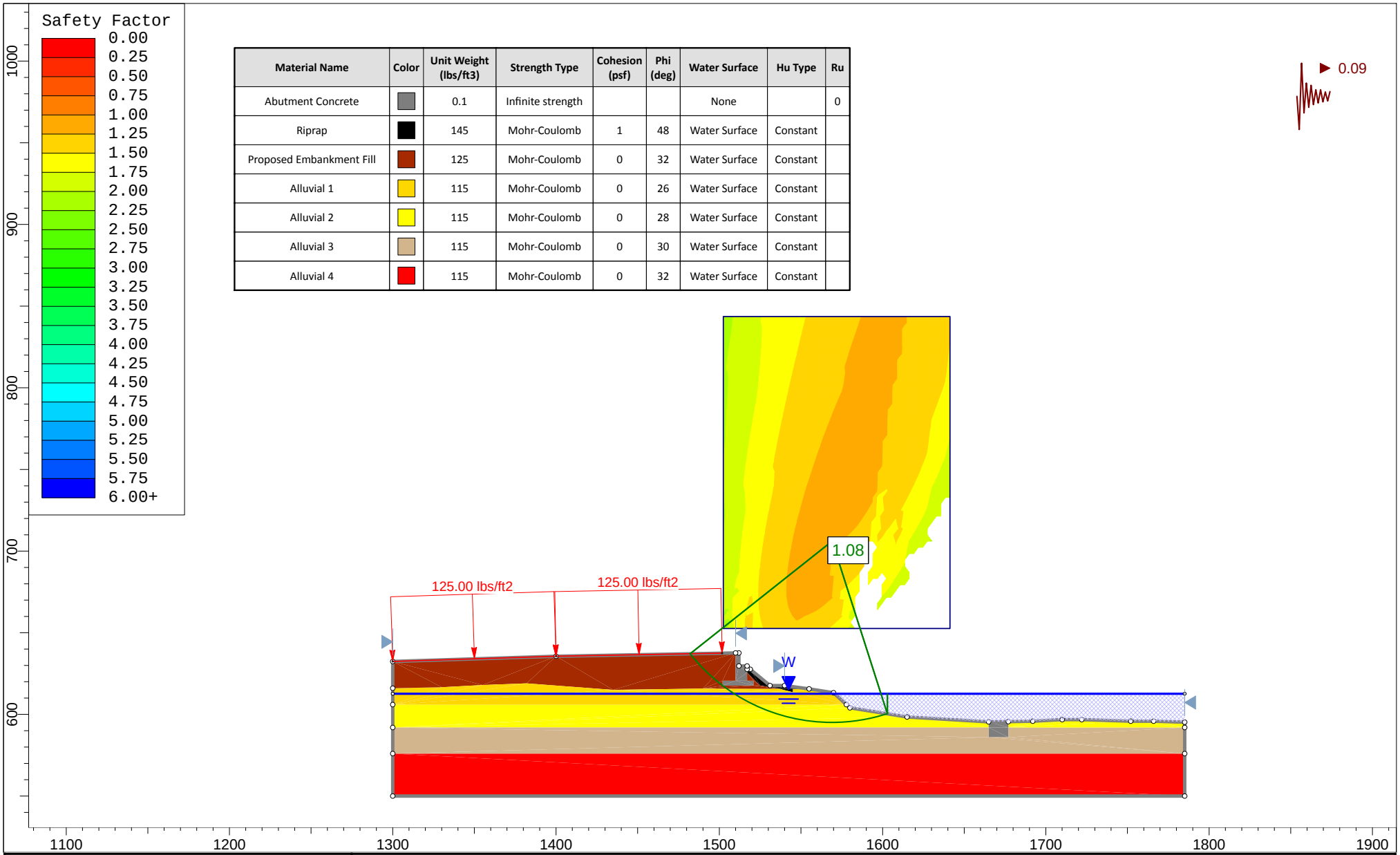
Embankment Stability Calculations

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	1	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant	
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant	



SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Site Condition - Longitudinal Static		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:895	*Company* Haley & Aldrich, Inc.
Date	1 February 2013		*File Name* 2012_1203_HAI_15105 Proposed Abutment 1_Global_Static.sli

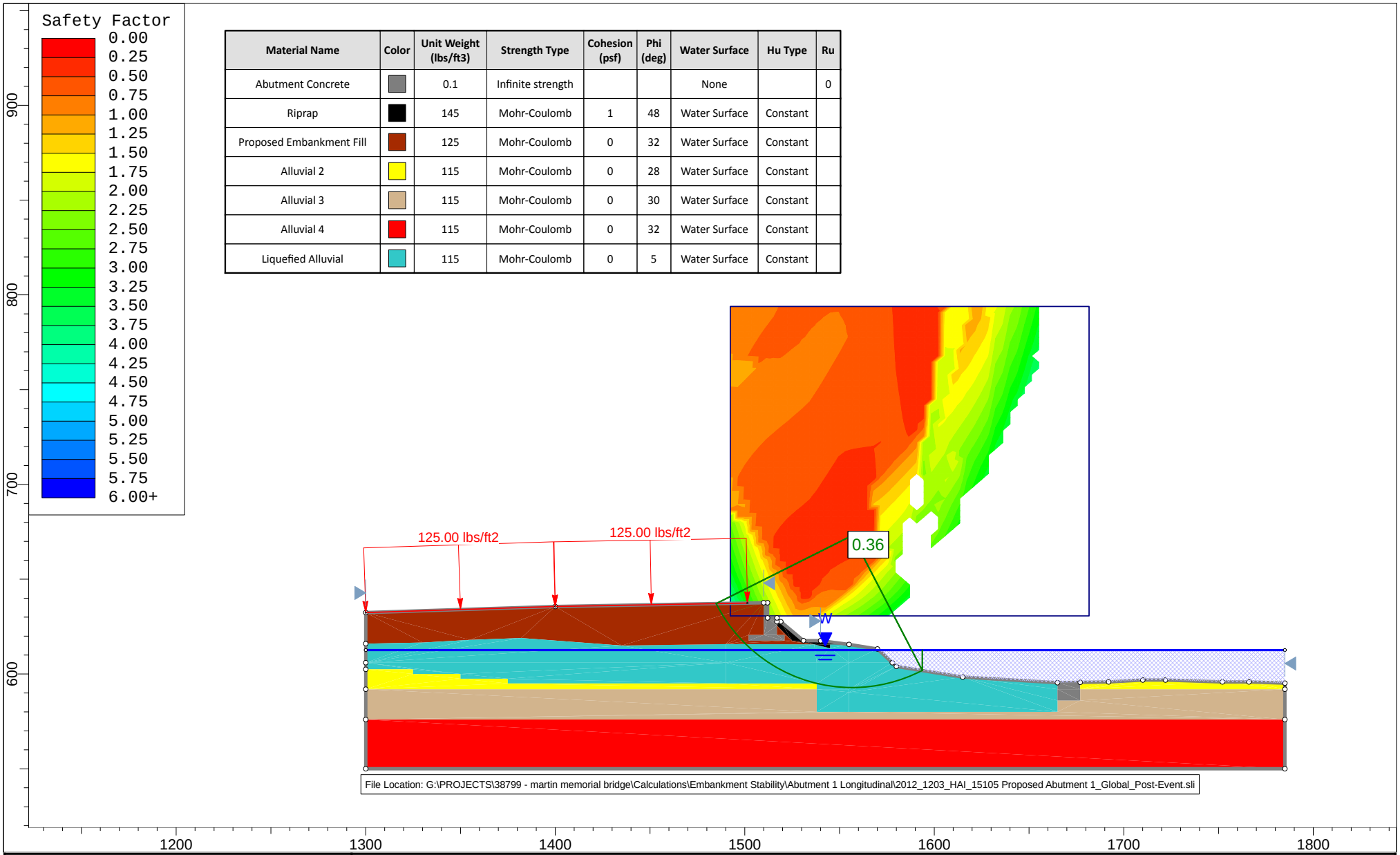


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	1	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant	
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant	

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Site Condition - Longitudinal Pseudo-Static		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:975	*Company* Haley & Aldrich, Inc.
Date	1 February 2013		*File Name* 2012_1203_HAI_15105 Proposed Abutment 1_Global_Pseudo Static.sli

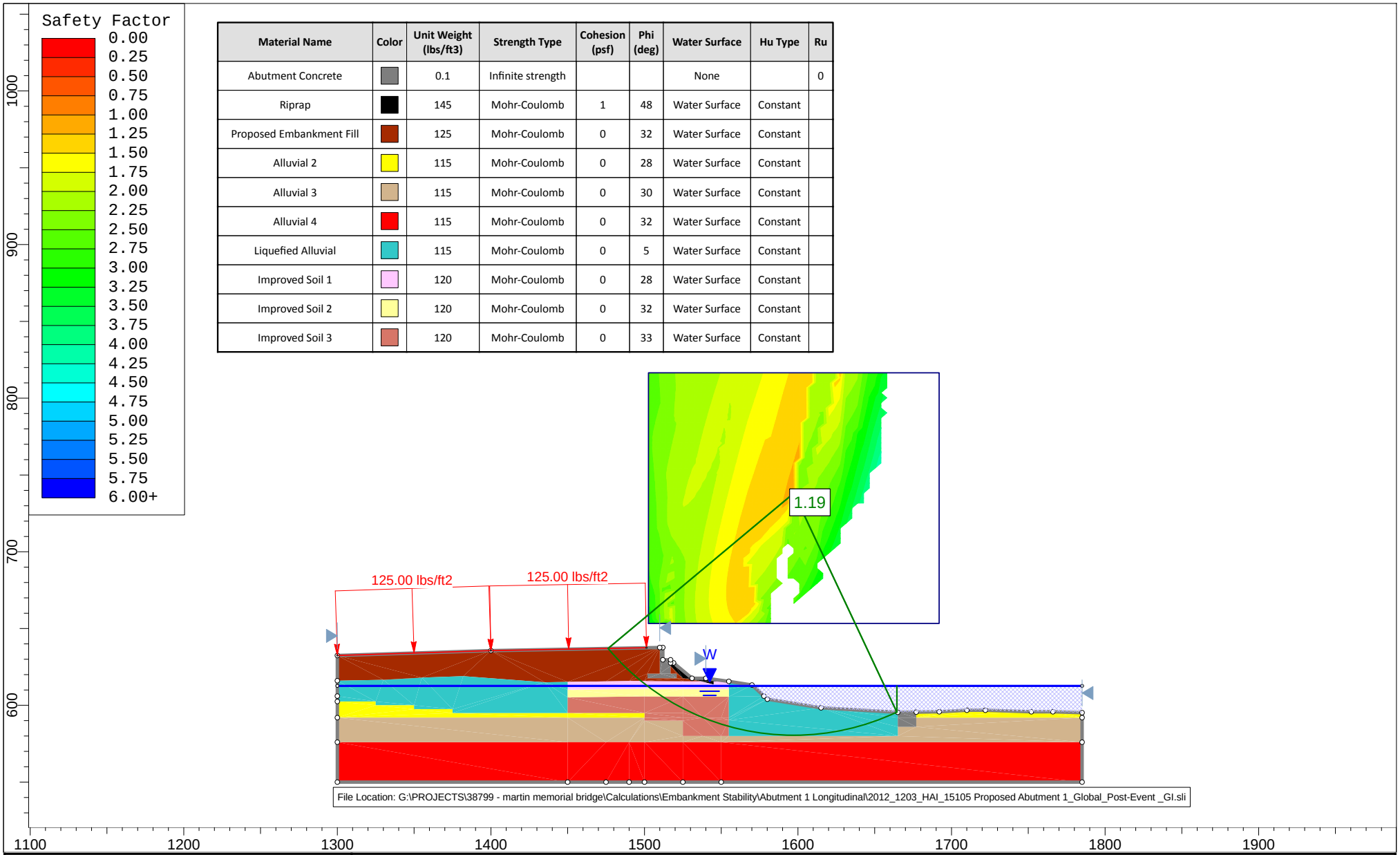
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	1	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant	
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant	



Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Site Condition - Longitudinal Post-Event		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:840	*Company* Haley & Aldrich, Inc.
Date	1 February 2013		*File Name* 2012_1203_HAI_15105 Proposed Abutment 1_Global_Post-Event.sli

SLIDEINTERPRET 6.021

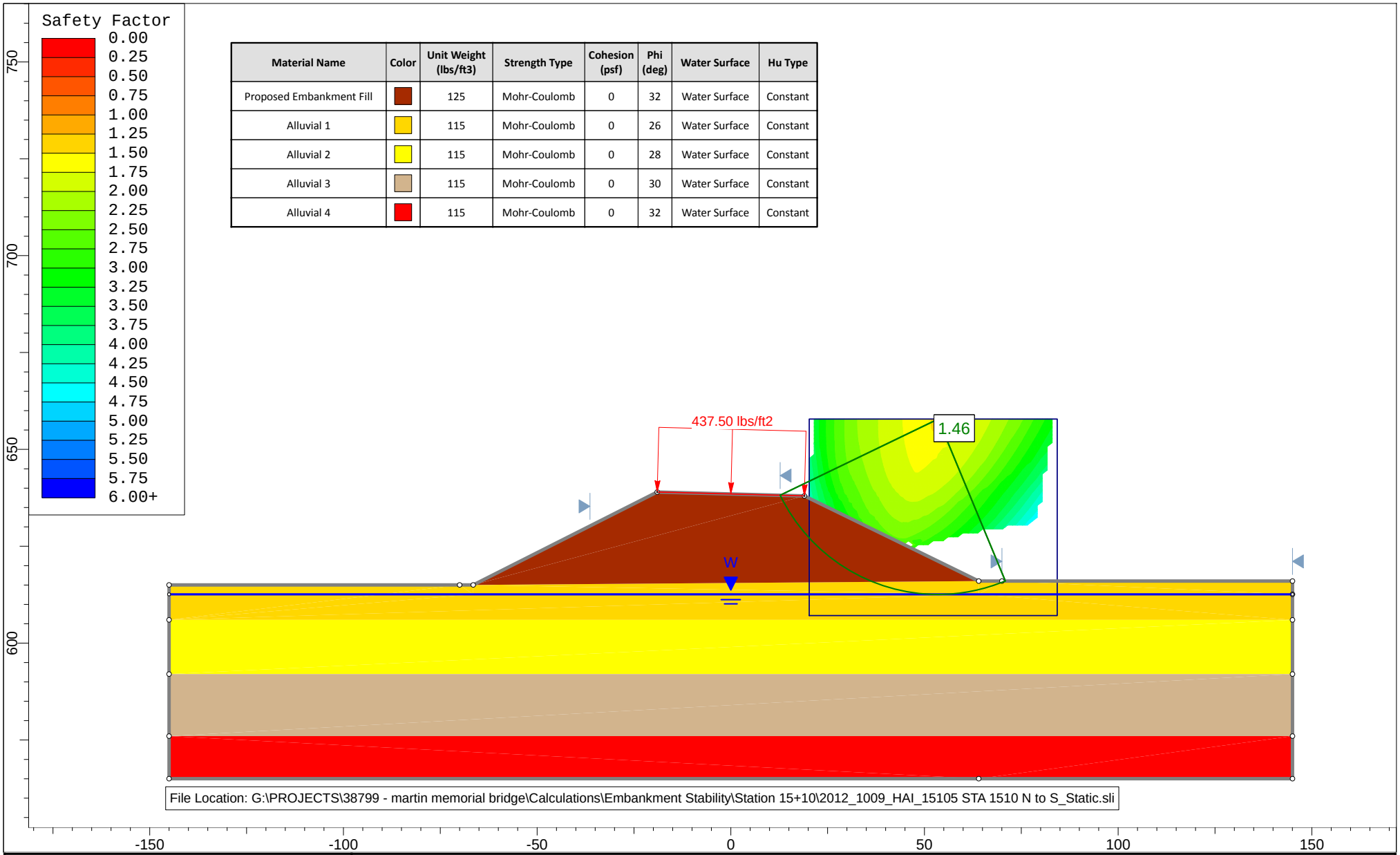
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	1	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant	
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant	
Improved Soil 1		120	Mohr-Coulomb	0	28	Water Surface	Constant	
Improved Soil 2		120	Mohr-Coulomb	0	32	Water Surface	Constant	
Improved Soil 3		120	Mohr-Coulomb	0	33	Water Surface	Constant	



SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine
Analysis Description	Abutment 1 Proposed Site Condition - Longitudinal, Post-Event Limited GI
Drawn By	Bryan C. Steinert, P.E.
Scale	1:1037
Company	Haley & Aldrich, Inc.
Date	5 February 2013
File Name	2012_1203_HAI_15105 Proposed Abutment 1_Global_Post-Event GI.sli

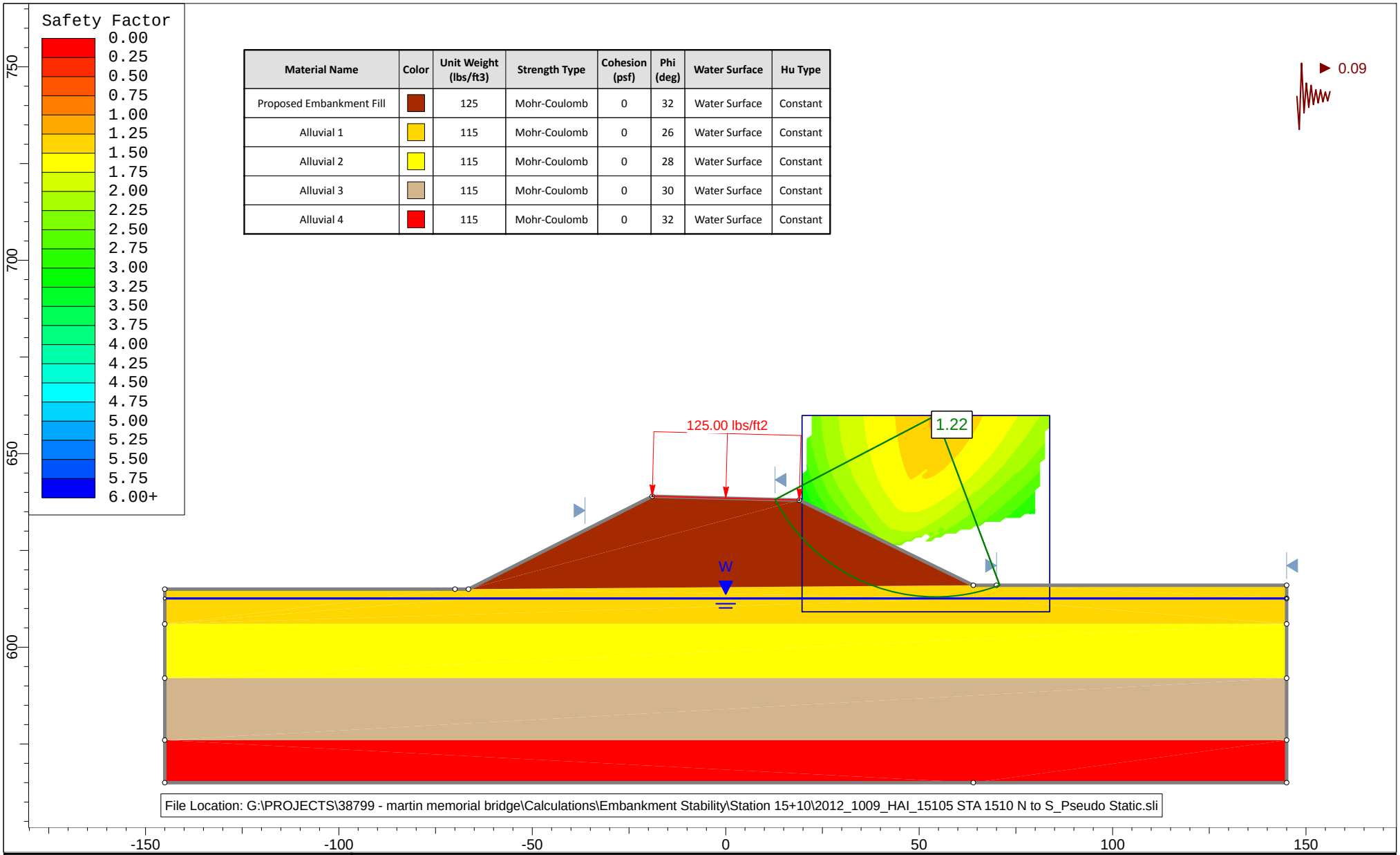
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant



Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 15+00, Static		
Drawn By: Bryan C. Steinert, P.E.	Scale: 1:411	Company: Haley & Aldrich, Inc.	
Date: 1 February 2013		File Name: 2012_1009_HAI_15105 STA 1510 N to S_Static.sli	

SLIDEINTERPRET 6.021

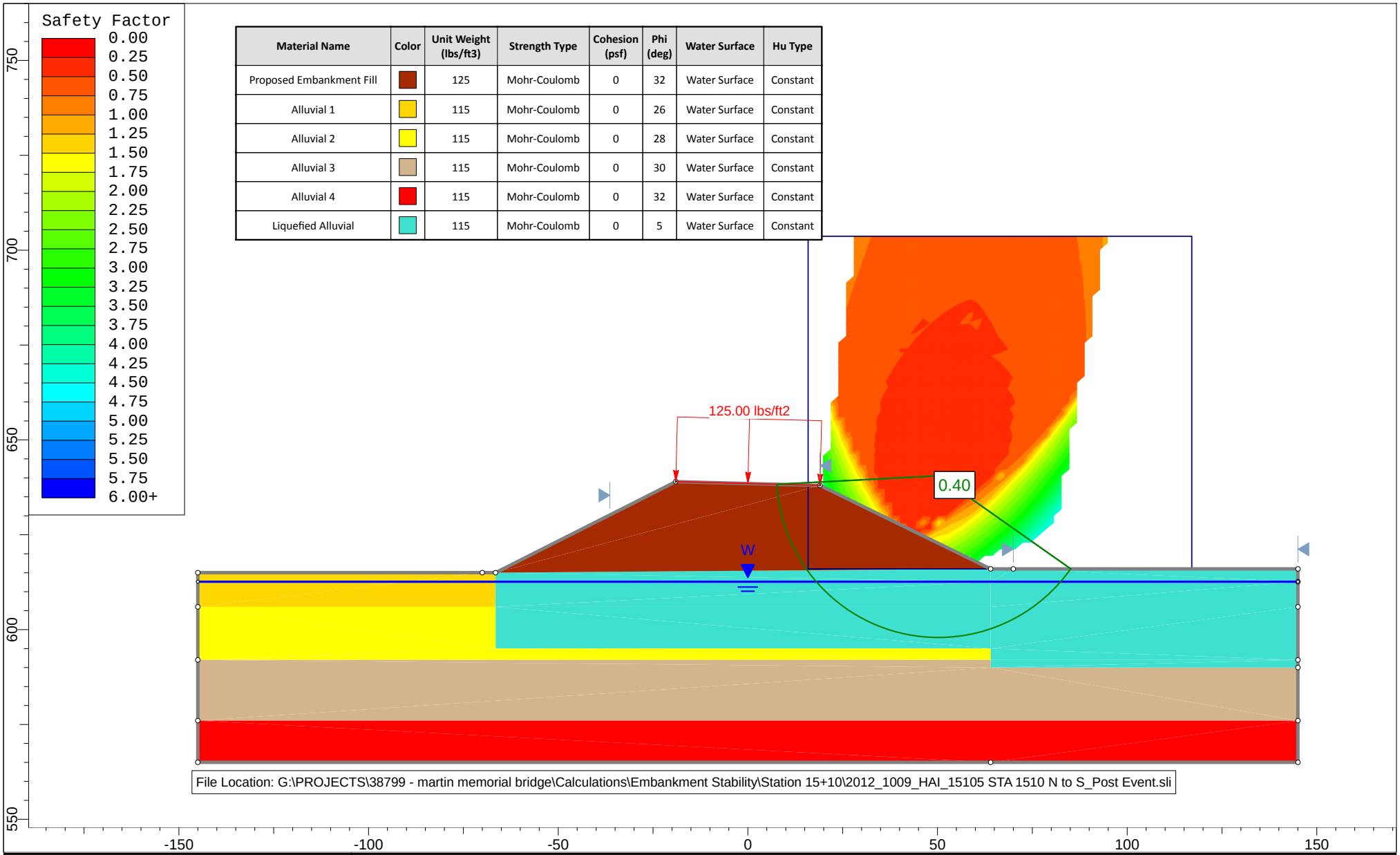
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant



SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 15+00, Pseudo-Static		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:412	Company Haley & Aldrich, Inc.
Date	1 February 2013		File Name 2012_1009_HAI_15105 STA 1510 N to S_Pseudo Static.sli

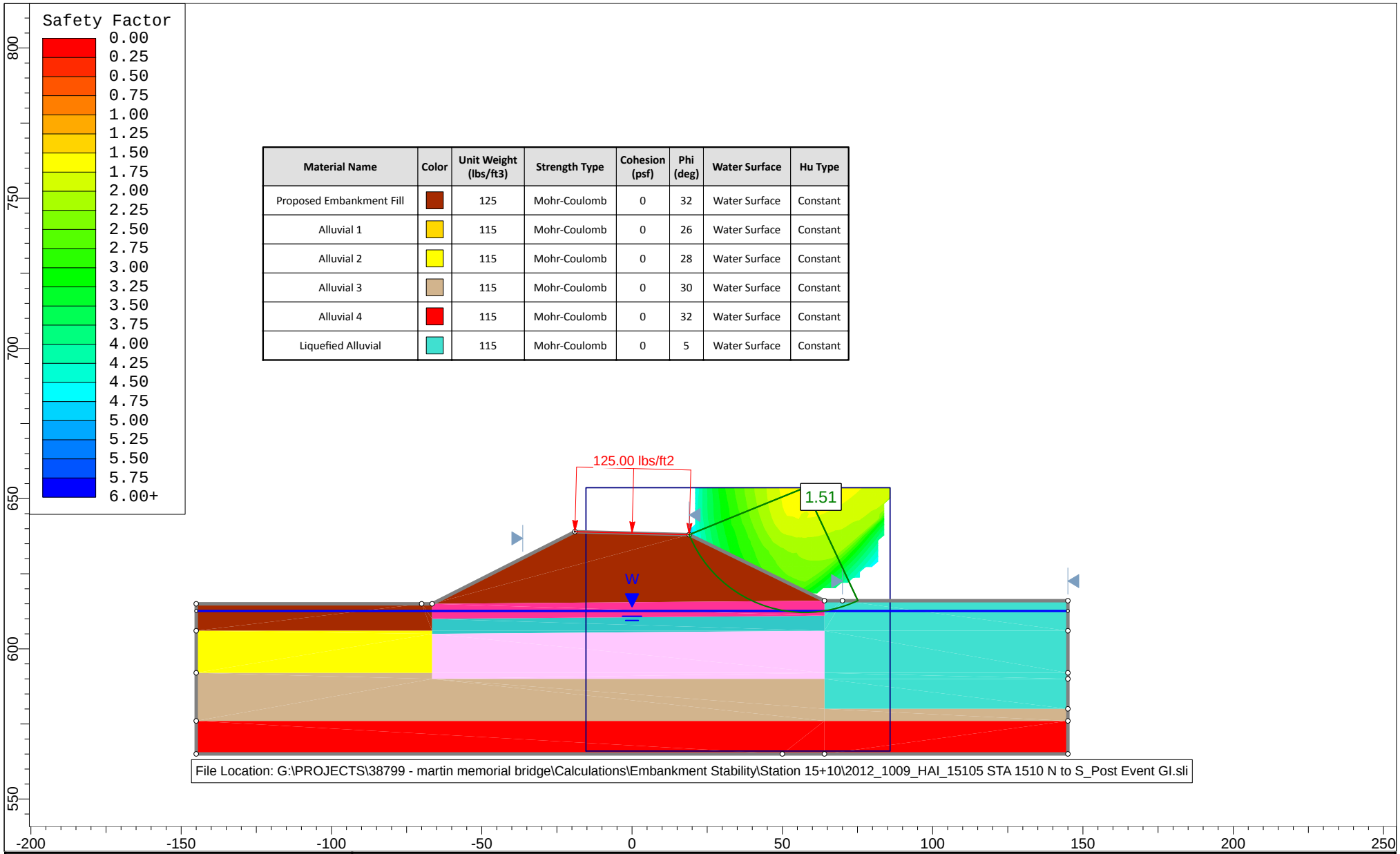
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant



File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 15+10\2012_1009_HAI_15105 STA 1510 N to S_Post Event.sli

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 15+00, Post-Event		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:420	Company Haley & Aldrich, Inc.
Date	1 February 2013		File Name 2012_1009_HAI_15105 STA 1510 N to S_Post Event.sli



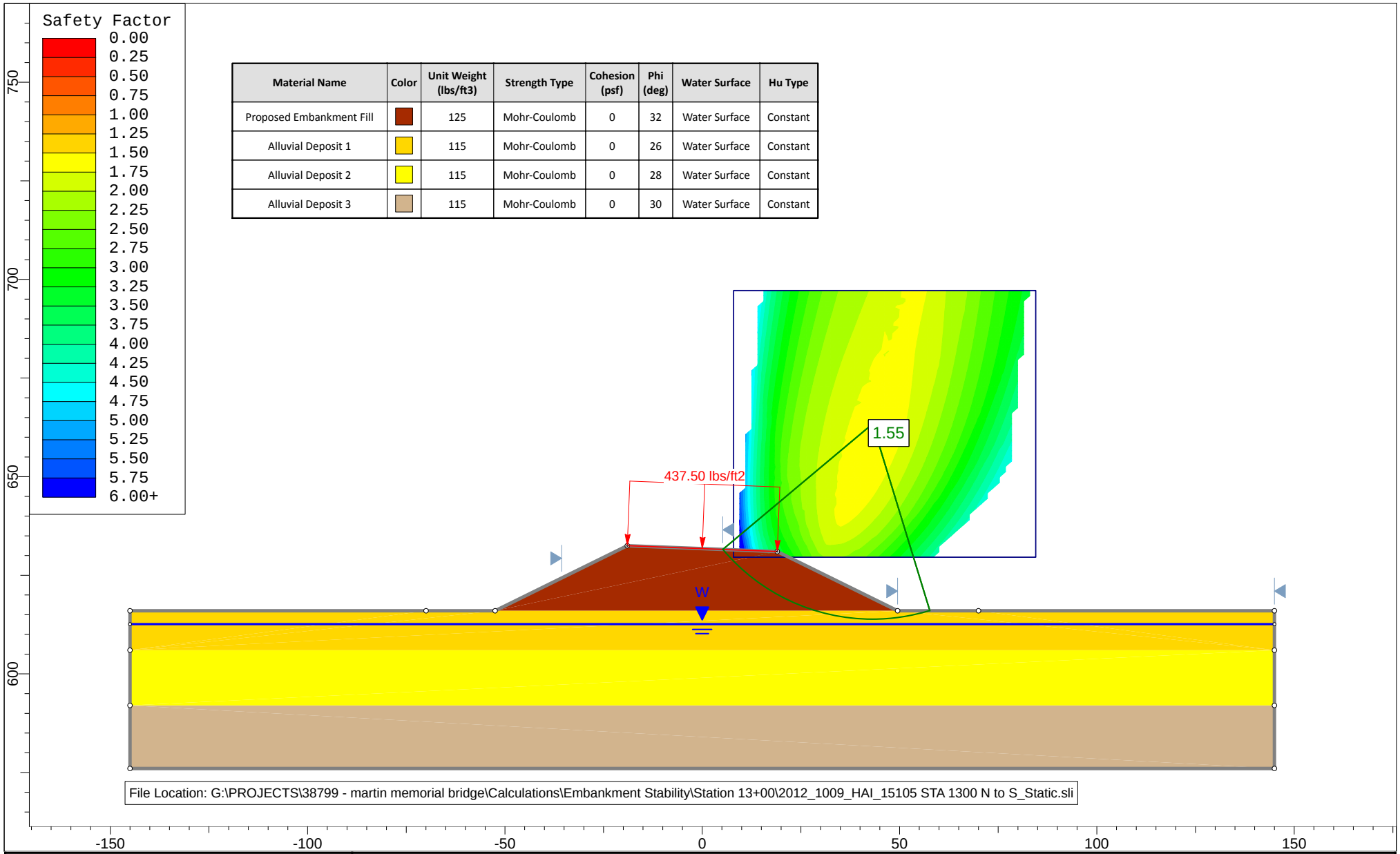
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant

File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 15+10\2012_1009_HAI_15105 STA 1510 N to S_Post Event GI.sli

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 15+00, Post-Event W/GI		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:529	*Company* Haley & Aldrich, Inc.
Date	1 February 2013		*File Name* 2012_1009_HAI_15105 STA 1510 N to S_Post Event GI.sli

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial Deposit 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant

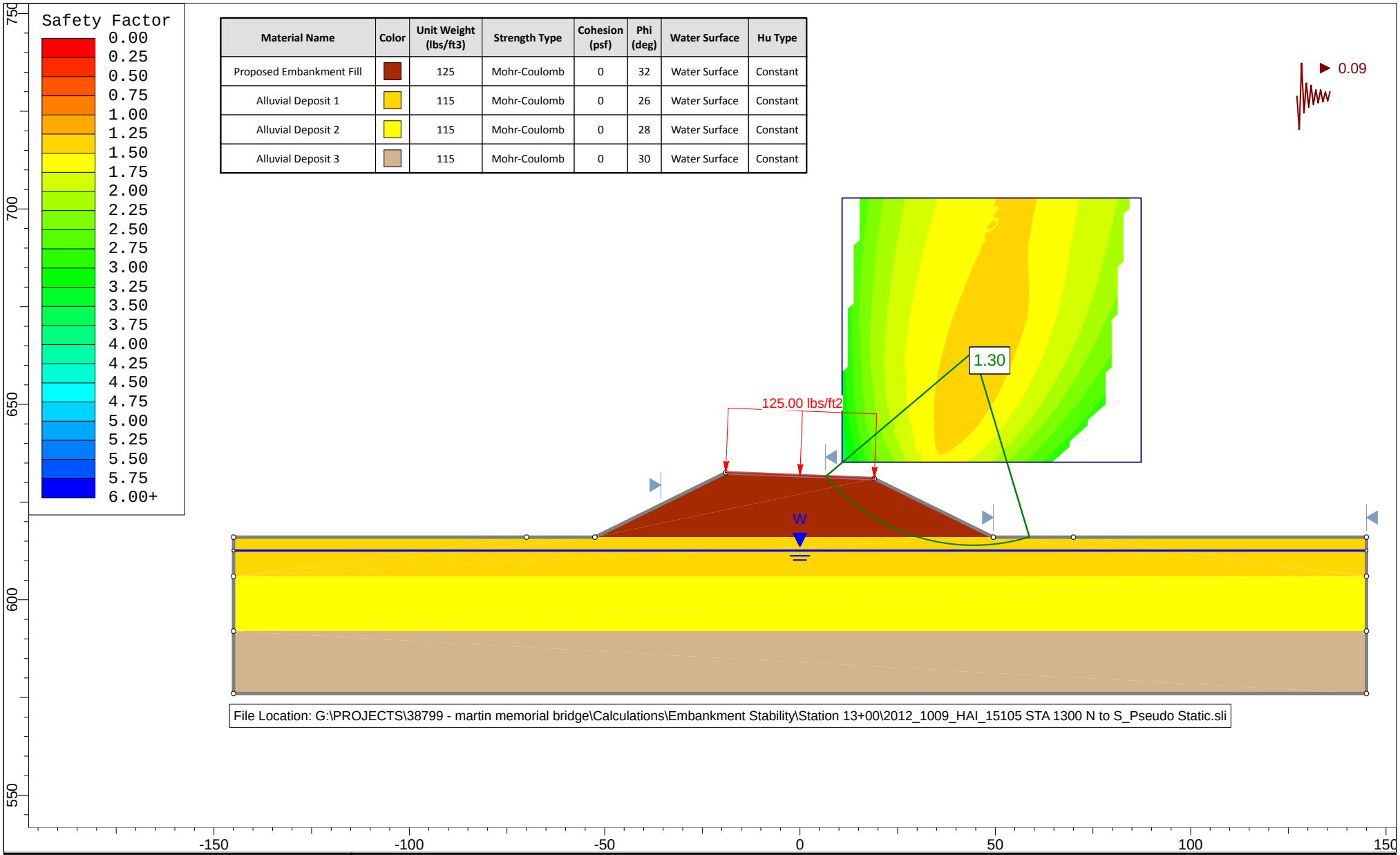


File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 13+00\2012_1009_HAI_15105 STA 1300 N to S_Static.sli

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 13+00, Static		
Drawn By	Bryan C. Steinert, P.E.	Scale	1:403
Company	Haley & Aldrich, Inc.		
Date	4 December 2012	File Name	2012_1009_HAI_15105 STA 1300 N to S_Static.sli

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial Deposit 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant

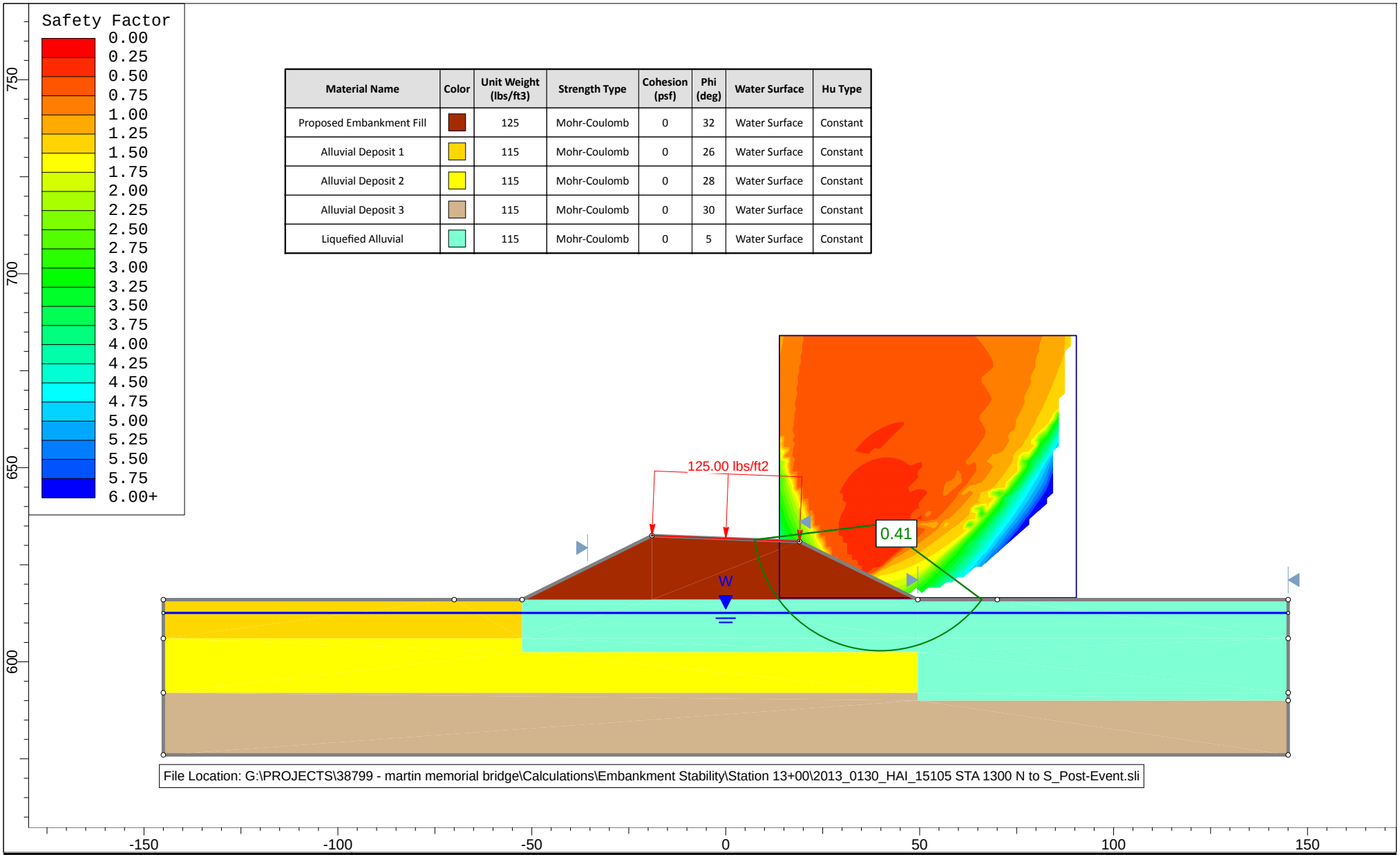


File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 13+00\2012_1009_HAI_15105 STA 1300 N to S_Pseudo Static.sli

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 13+00, Pseudo-Static		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:408	Company Haley & Aldrich, Inc.
Date	30 January 2013		File Name 2012_1009_HAI_15105 STA 1300 N to S_Pseudo Static.sli

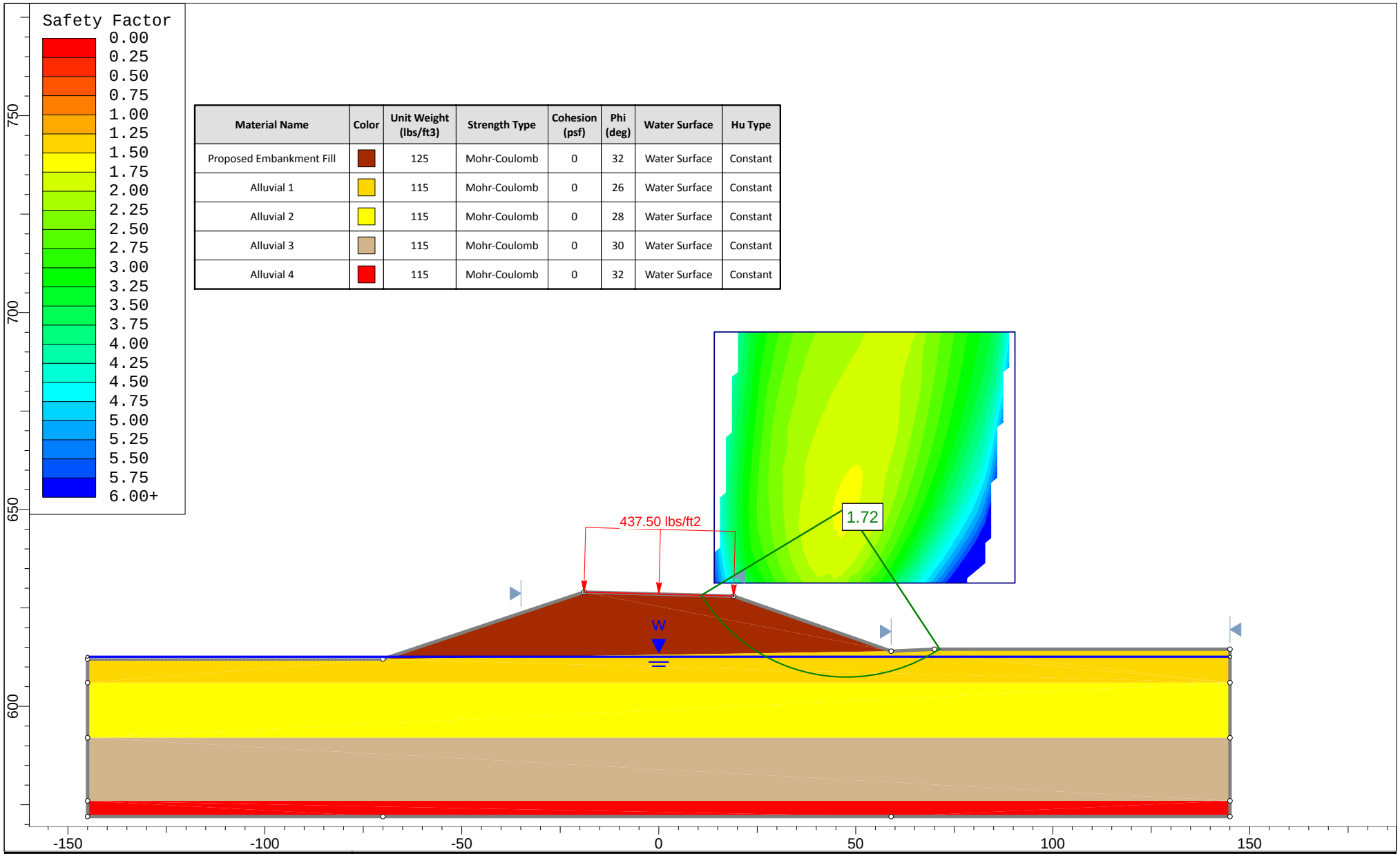
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial Deposit 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant



File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 13+00\2013_0130_HAI_15105 STA 1300 N to S_Post-Event.sli

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 13+00, Post-Event		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:410	Company Haley & Aldrich, Inc.
Date	30 January 2013		File Name 2013_0130_HAI_15105 STA 1300 N to S_Post-Event.sli

SLIDEINTERPRET 6.021

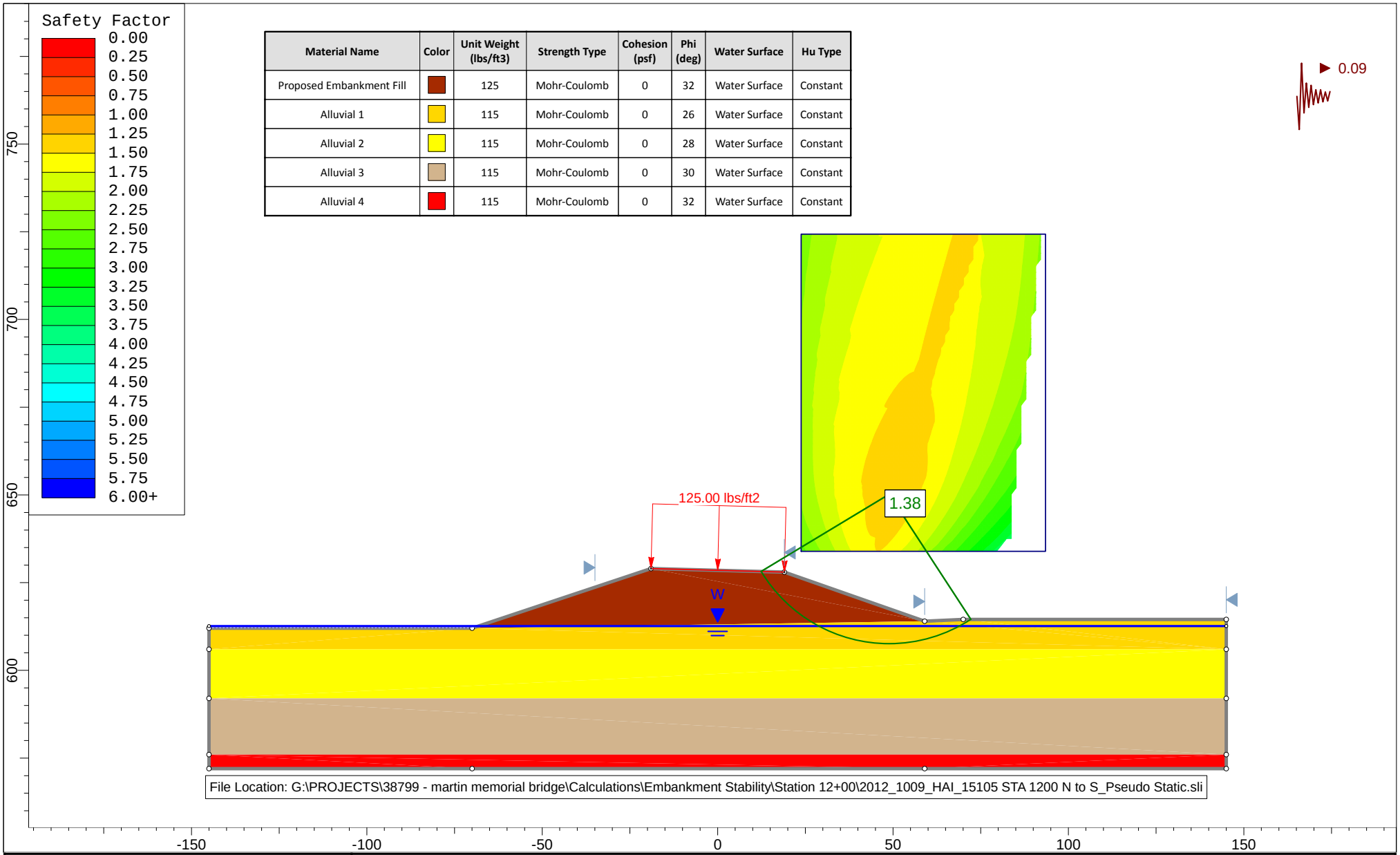


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 12+00, Static		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:404	*Company* Haley & Aldrich, Inc.
Date	4 December 2012		*File Name* 2012_1009_HAI_15105 STA 1200 N to S_Static.sli

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant

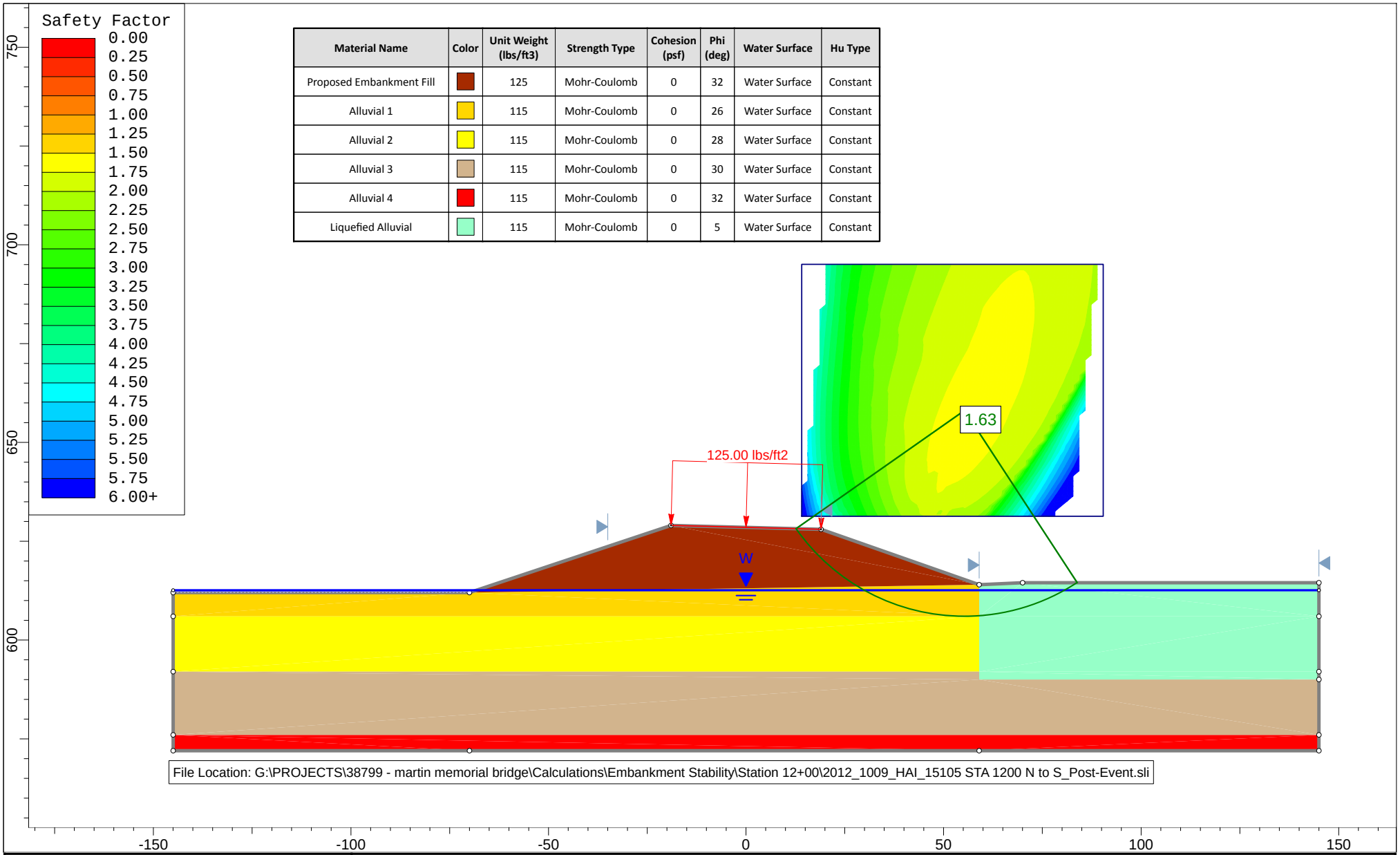


File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 12+00\2012_1009_HAI_15105 STA 1200 N to S_Pseudo Static.sli

SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 12+00, Pseudo-Static		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:454	Company Haley & Aldrich, Inc.
Date	4 December 2012		File Name 2012_1009_HAI_15105 STA 1200 N to S_Pseudo Static.sli

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant
Alluvial 1		115	Mohr-Coulomb	0	26	Water Surface	Constant
Alluvial 2		115	Mohr-Coulomb	0	28	Water Surface	Constant
Alluvial 3		115	Mohr-Coulomb	0	30	Water Surface	Constant
Alluvial 4		115	Mohr-Coulomb	0	32	Water Surface	Constant
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant

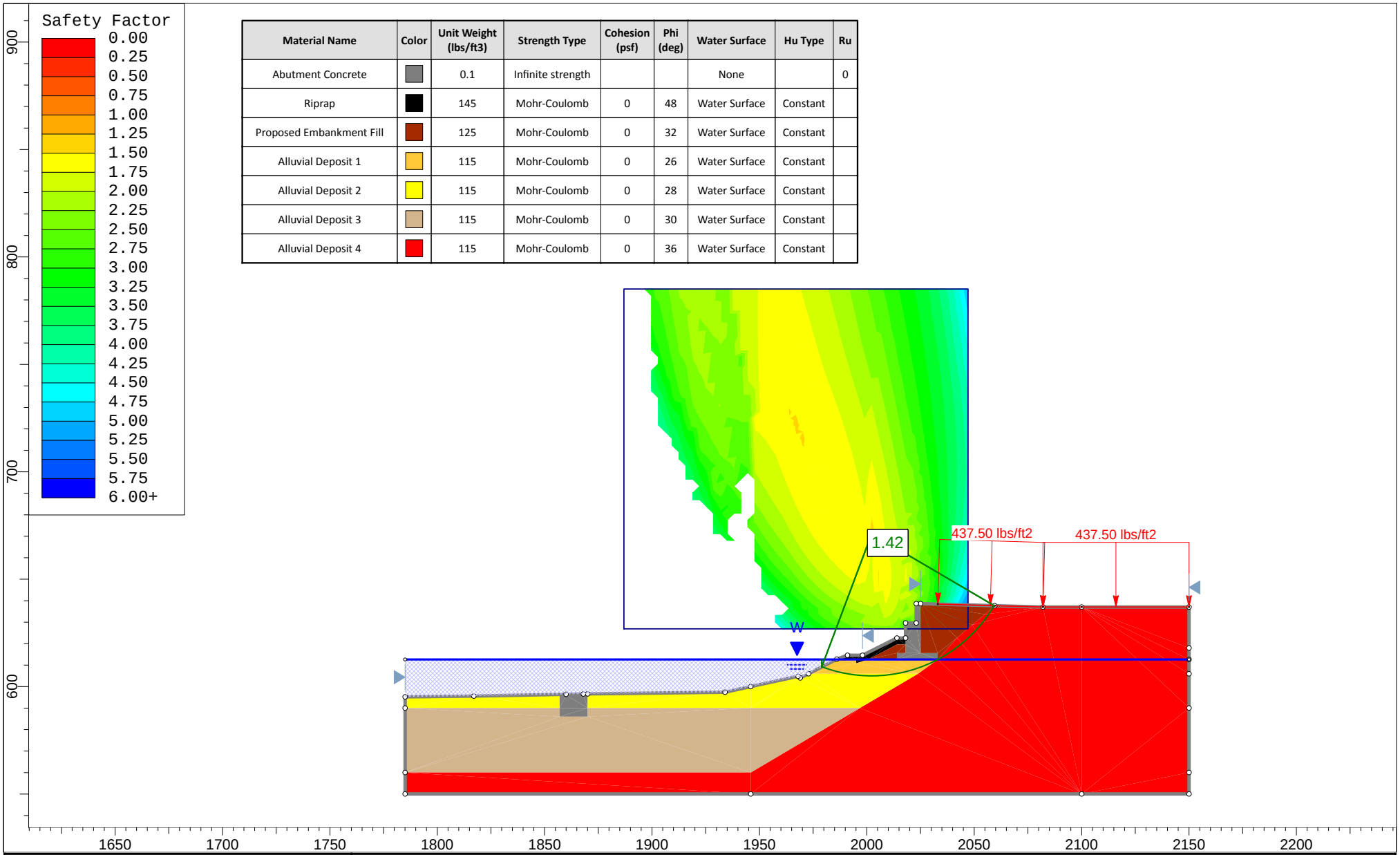


File Location: G:\PROJECTS\38799 - martin memorial bridge\Calculations\Embankment Stability\Station 12+00\2012_1009_HAI_15105 STA 1200 N to S_Post-Event.sli

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	STA 12+00, Post-Event		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:403	Company Haley & Aldrich, Inc.
Date	30 January 2013		File Name 2012_1009_HAI_15105 STA 1200 N to S_Post-Event.sli

SLIDEINTERPRET 6.021

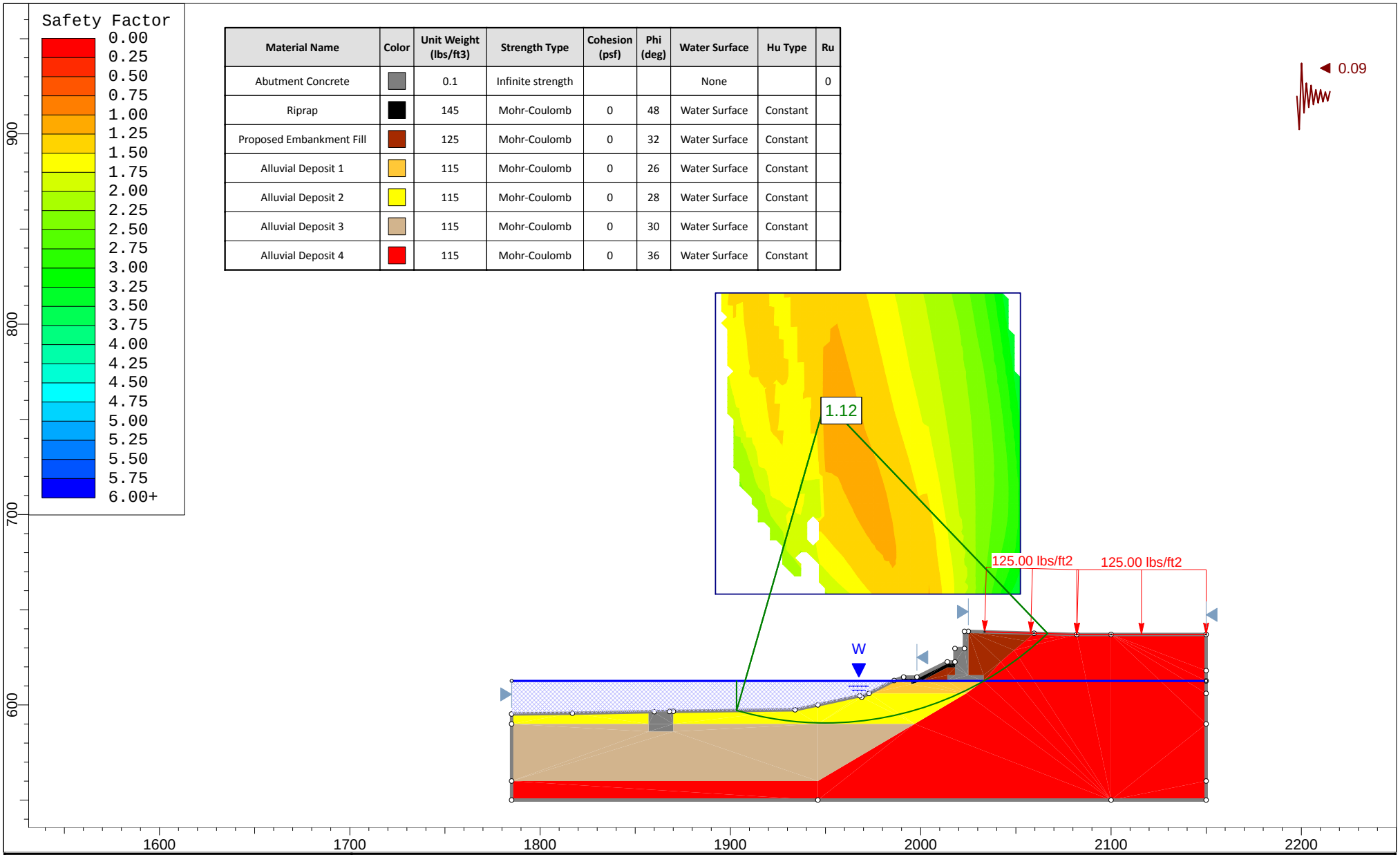
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	0	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial Deposit 1		115	Mohr-Coulomb	0	26	Water Surface	Constant	
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial Deposit 4		115	Mohr-Coulomb	0	36	Water Surface	Constant	



Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Abutment 2 Site Condition - Longitudinal, Static		
Drawn By: Bryan C. Steinert, P.E.	Scale: 1:741	Company: Haley & Aldrich, Inc.	
Date: 1 February 2013		File Name: 2012_1009_HAI_15105 Proposed Abutment 2_Static.sli	

SLIDEINTERPRET 6.021

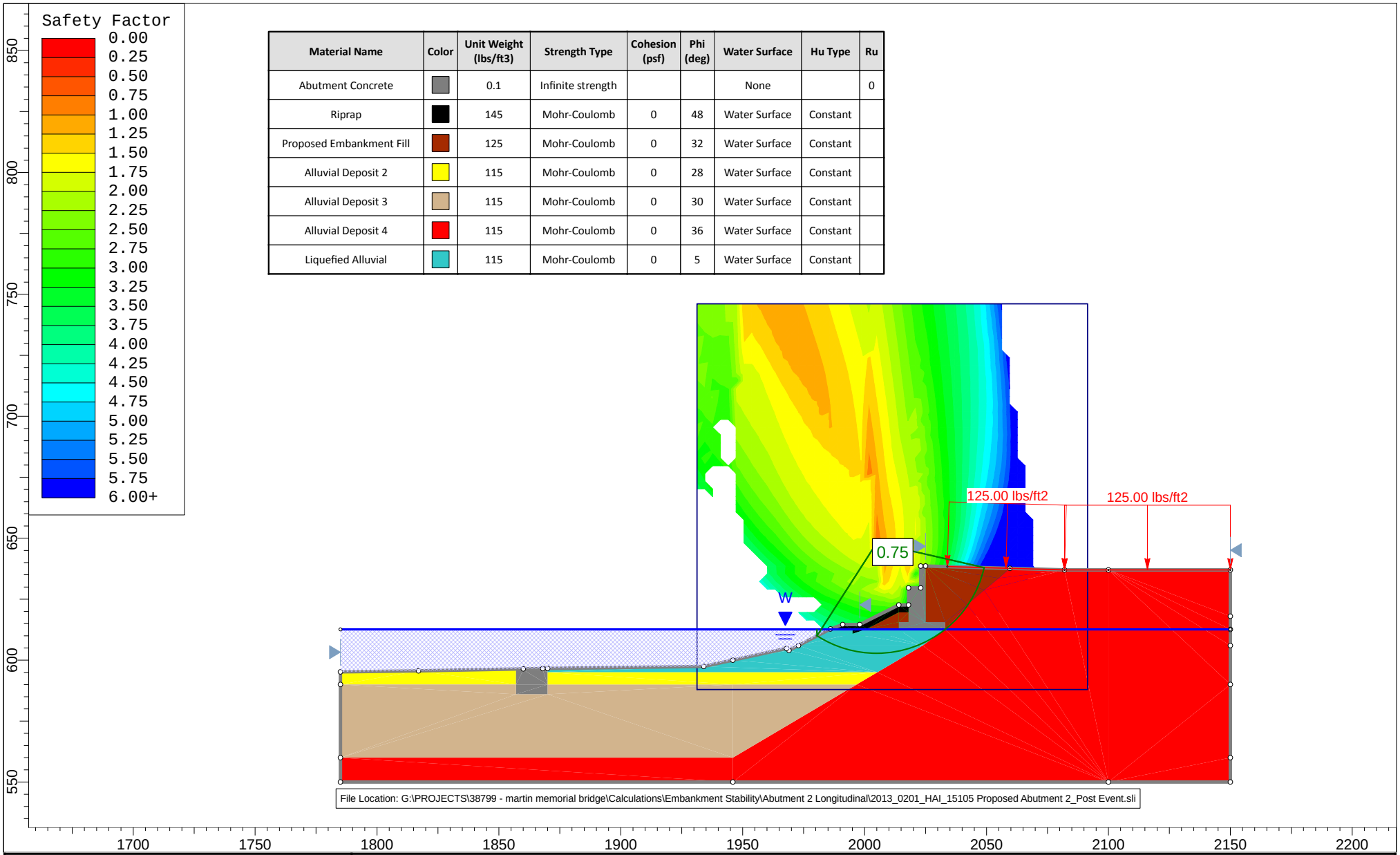
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	0	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial Deposit 1		115	Mohr-Coulomb	0	26	Water Surface	Constant	
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial Deposit 4		115	Mohr-Coulomb	0	36	Water Surface	Constant	



Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Site Condition - Longitudinal Pseudo-Static		
Drawn By	Bryan C. Steinert, P.E.	Scale 1:837	Company Haley & Aldrich, Inc.
Date	1 February 2013		File Name 2013_0201_HAI_15105 Proposed Abutment 2_Pseudo Static.sli

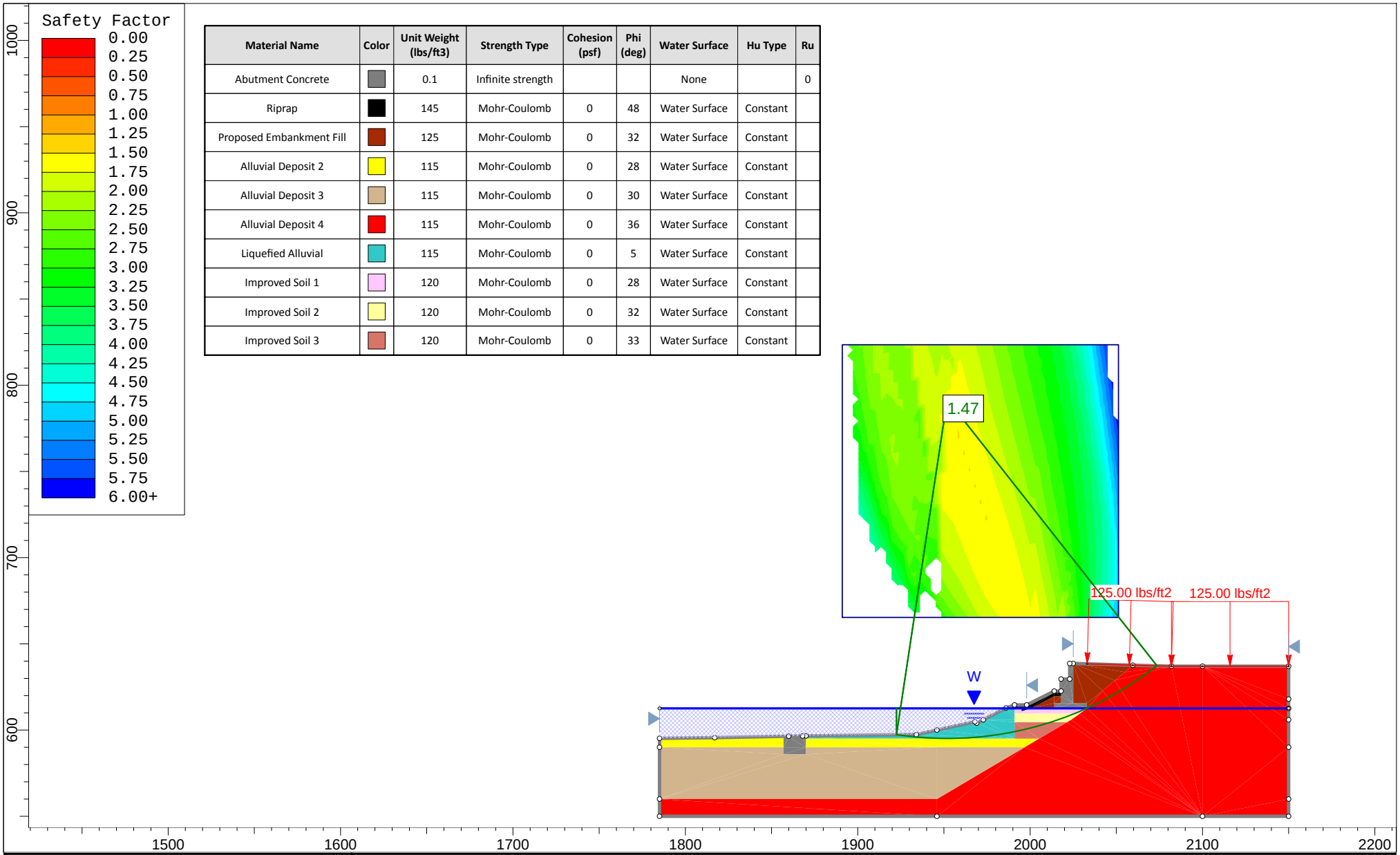
SLIDEINTERPRET 6.021

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	0	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial Deposit 4		115	Mohr-Coulomb	0	36	Water Surface	Constant	
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant	



SLIDEINTERPRET 6.021

Project	Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine		
Analysis Description	Proposed Site Condition - Longitudinal Post-Event		
Drawn By	Bryan C. Steinert, P.E.	*Scale* 1:653	*Company* Haley & Aldrich, Inc.
Date	1 February 2013		*File Name* 2013_0201_HAI_15105 Proposed Abutment 2_Post Event.sli



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Ru
Abutment Concrete		0.1	Infinite strength			None		0
Riprap		145	Mohr-Coulomb	0	48	Water Surface	Constant	
Proposed Embankment Fill		125	Mohr-Coulomb	0	32	Water Surface	Constant	
Alluvial Deposit 2		115	Mohr-Coulomb	0	28	Water Surface	Constant	
Alluvial Deposit 3		115	Mohr-Coulomb	0	30	Water Surface	Constant	
Alluvial Deposit 4		115	Mohr-Coulomb	0	36	Water Surface	Constant	
Liquefied Alluvial		115	Mohr-Coulomb	0	5	Water Surface	Constant	
Improved Soil 1		120	Mohr-Coulomb	0	28	Water Surface	Constant	
Improved Soil 2		120	Mohr-Coulomb	0	32	Water Surface	Constant	
Improved Soil 3		120	Mohr-Coulomb	0	33	Water Surface	Constant	

SLIDEINTERPRET 6.021

Project
Martin Memorial Bridge (WIN 15105.00) - Rumford, Maine

Analysis Description
Proposed Site Condition - Longitudinal Post-Event W/GI

Drawn By Bryan C. Steinert, P.E.

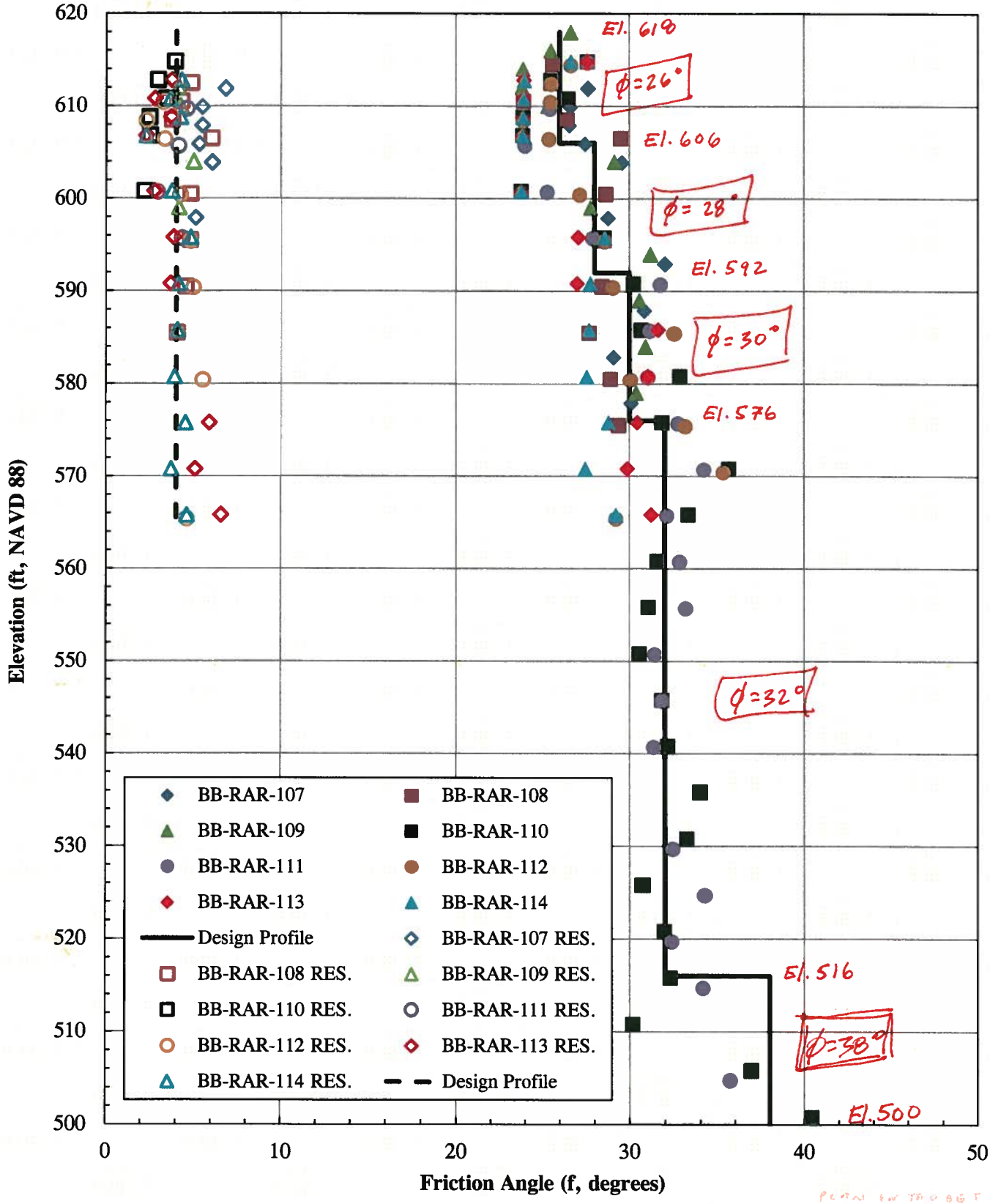
Scale 1:924

Company Haley & Aldrich. Inc.

Date 1 February 2013

File Name 2013_0201_HAI_15105 Proposed Abutment 2_Post Event GI.sli

Design Friction Angle Profiles



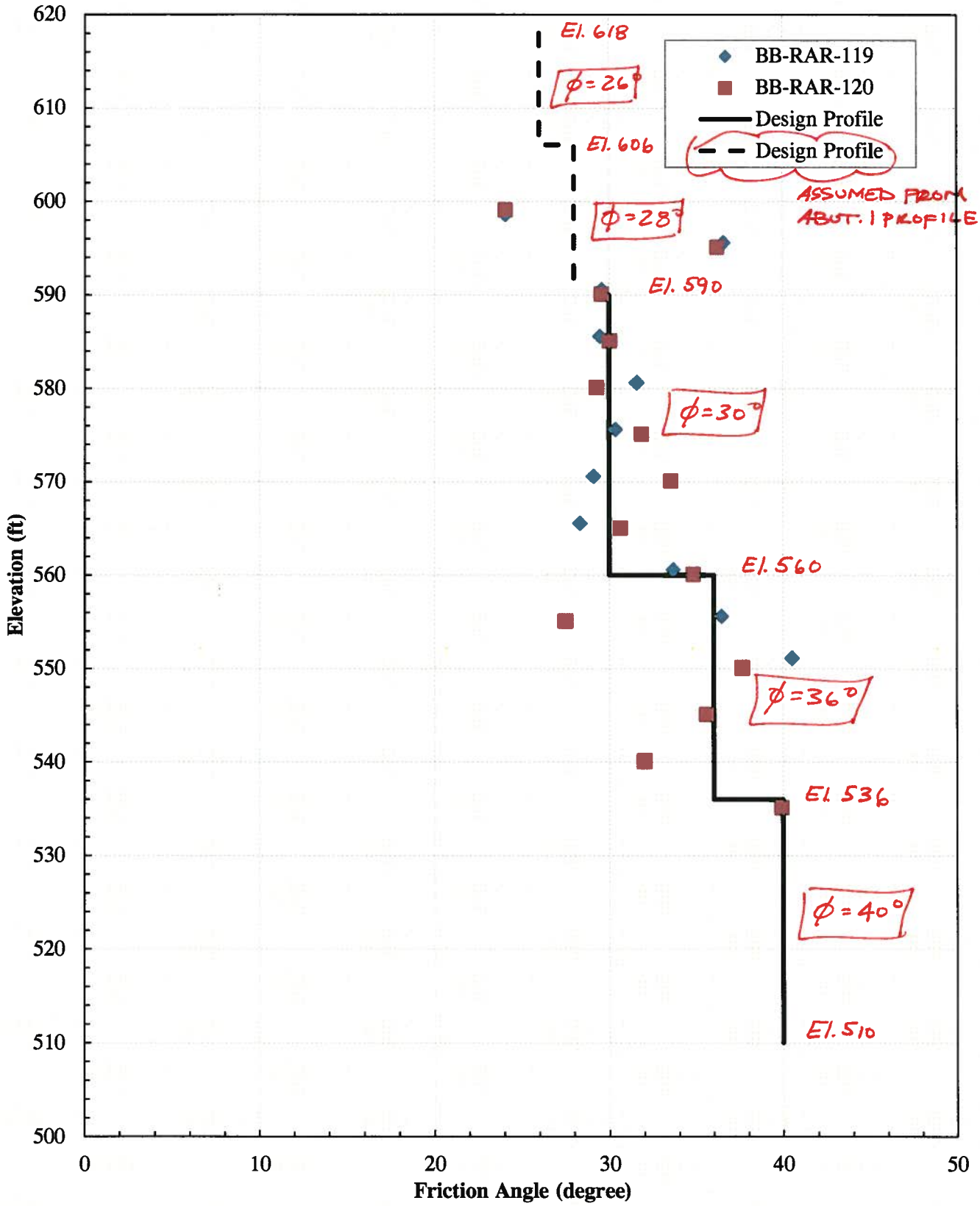
REPLACEMENT OF MARTIN MEMORIAL BRIDGE

MAINEDOT WIN 15105.00

ROUTE 232 - RUMFORD, MAINE

ABUTMENT 1

JANUARY 2013



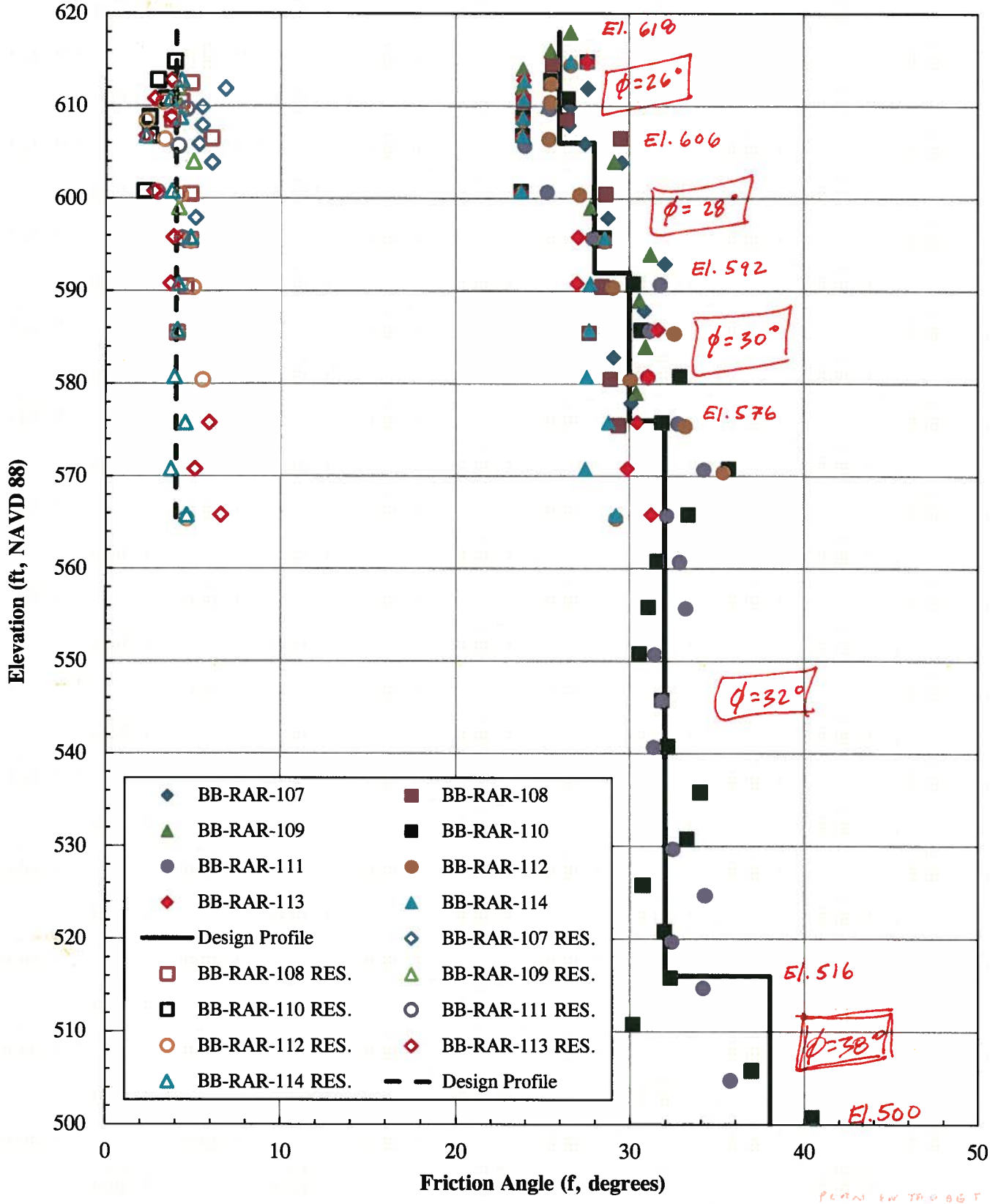
REPLACEMENT OF MARTIN MEMORIAL BRIDGE

MAINEDOT WIN 15105.00

ROUTE 232 - RUMFORD, MAINE

ABUTMENT 2

JANUARY 2013



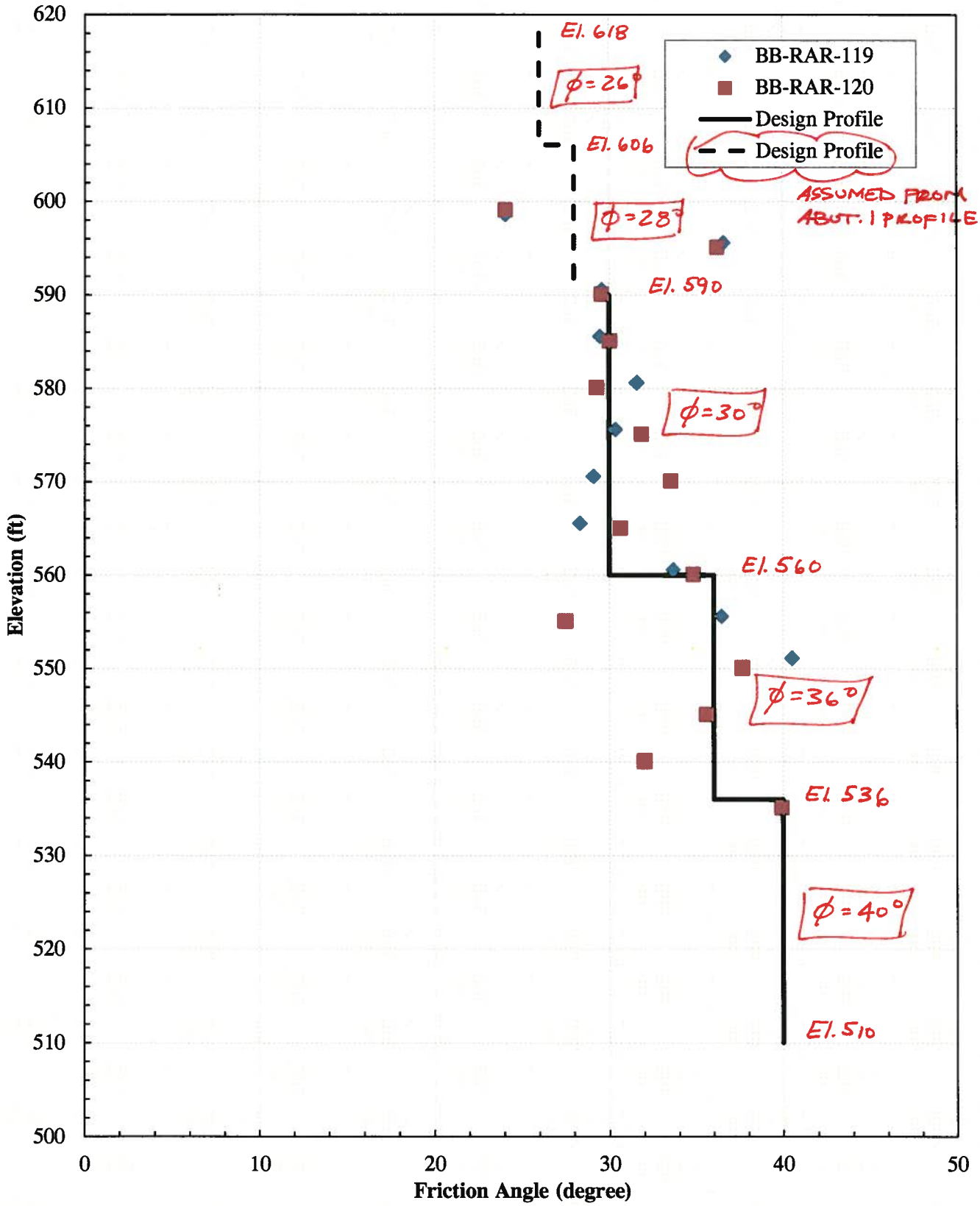
REPLACEMENT OF MARTIN MEMORIAL BRIDGE

MAINEDOT WIN 15105.00

ROUTE 232 - RUMFORD, MAINE

ABUTMENT 1

JANUARY 2013



REPLACEMENT OF MARTIN MEMORIAL BRIDGE

MAINEDOT WIN 15105.00

ROUTE 232 - RUMFORD, MAINE

ABUTMENT 2

JANUARY 2013

Post Improvement Friction Angle Criteria

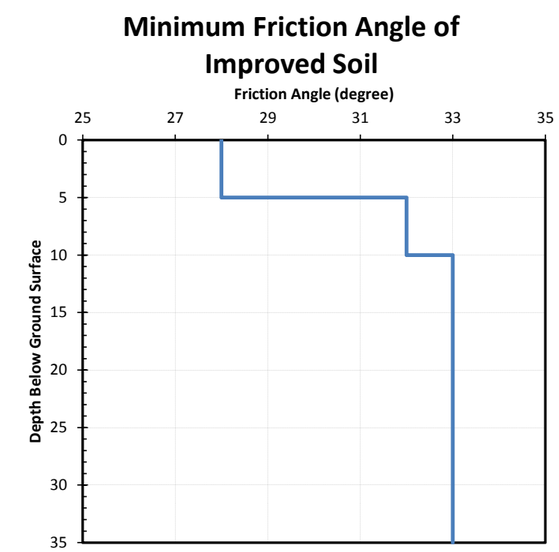
Project: Martin Memorial Bridge, Rumford, ME
Subject: Soil Parameters of Improved Soil Derived from Minimum Required N_{60} Post-Vibro-Replacement
Prepared by: EK
Checked by:
Date: #######
File No: 38799-000

HALEY & ALDRICH

GS El. (ft) = 615

GW Depth (ft) = 1.0

						Stress Calculations					SPT Correction												Friction Angle, ϕ (degree)												
Depth (ft)	El. (ft)	Original SPT N-Value	N-Value Used	PI (%)	Clay/ Sand	γt (pcf)	γw (pcf)	σv (psf)	pw (psf)	σ'v (psf)	N Value	Length of Rod	ERi	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	used
1	614	3	3	-	S	115	62.4	115	0	115	3	4	60	1.7	5	1	1	0.75	1.10	2	4	42	30.4	25.4	20.4	22.0	25.5	23.7	27.8	29.4	30.1	27.8	25.5	30.5	
3	612	3	3	-	S	115	62.4	345	125	220	3	6	60	1.7	5	1	1	0.75	1.10	2	4	40	30.4	25.4	20.4	22.0	25.5	23.7	27.8	28.8	30.1	27.8	25.5	30.5	28
5	610	3	3	-	S	115	62.4	575	250	325	3	8	60	1.7	5	1	1	0.75	1.10	2	4	39	30.4	25.4	20.4	22.0	25.5	23.7	27.8	28.2	30.1	27.8	25.5	30.5	
7	608	6	6	-	S	115	62.4	805	374	431	6	10	60	1.7	10	1	1	0.75	1.10	5	8	54	32.7	27.7	22.7	25.0	27.8	23.7	28.6	33.6	34.3	31.1	25.9	30.9	32
9	606	6	6	-	S	115	62.4	1035	499	536	6	12	60	1.7	10	1	1	0.8	1.10	5	9	52	33.0	28.0	23.0	25.3	28.0	23.9	28.7	33.6	34.3	31.8	25.9	30.9	
11	604	8	8	-	S	115	62.4	1265	624	641	8	14	60	1.7	14	1	1	0.85	1.14	8	13	59	34.6	29.6	24.6	27.4	29.7	25.8	29.4	36.5	36.5	34.1	26.2	31.2	
13	602	8	8	-	S	115	62.4	1495	749	746	8	16	60	1.6	13	1	1	0.85	1.13	8	13	57	34.6	29.6	24.6	27.4	29.7	25.7	29.4	36.0	36.2	34.1	26.2	31.2	
15	600	8	8	-	S	115	62.4	1725	874	851	8	18	60	1.5	12	1	1	0.85	1.12	8	12	56	34.6	29.6	24.6	27.4	29.7	25.7	29.4	35.4	35.7	33.6	26.2	31.2	
17	598	8	8	-	S	115	62.4	1955	998	957	8	20	60	1.4	12	1	1	0.85	1.12	8	11	55	34.5	29.5	24.5	27.3	29.6	25.7	29.3	34.9	35.2	33.0	26.2	31.2	
19	596	8	8	-	S	115	62.4	2185	1123	1062	8	22	60	1.4	11	1	1	0.95	1.11	8	12	54	35.1	30.1	25.1	28.0	30.2	26.2	29.6	35.4	34.8	33.6	26.2	31.2	
21	594	8	8	-	S	115	62.4	2415	1248	1167	8	24	60	1.3	10	1	1	0.95	1.10	8	11	52	35.0	30.0	25.0	28.0	30.1	26.2	29.6	35.0	34.5	33.0	26.2	31.2	
23	592	8	8	-	S	115	62.4	2645	1373	1272	8	26	60	1.3	10	1	1	0.95	1.10	8	10	51	35.0	30.0	25.0	27.9	30.1	26.2	29.6	34.5	34.2	32.4	26.2	31.2	33
25	590	8	8	-	S	115	62.4	2875	1498	1377	8	28	60	1.2	10	1	1	0.95	1.10	8	10	50	35.0	30.0	25.0	27.9	30.1	26.2	29.6	34.1	33.9	32.4	26.2	31.2	
27	588	8	8	-	S	115	62.4	3105	1622	1483	8	30	60	1.2	9	1	1	0.95	1.10	8	10	50	35.0	30.0	25.0	27.9	30.1	26.2	29.6	33.8	33.6	32.4	26.2	31.2	
29	586	8	8	-	S	115	62.4	3335	1747	1588	8	32	60	1.1	9	1	1	1	1.10	9	10	49	35.3	30.3	25.3	28.3	30.4	26.5	29.7	33.9	33.4	32.4	26.2	31.2	
31	584	8	8	-	S	115	62.4	3565	1872	1693	8	34	60	1.1	9	1	1	1	1.10	9	10	48	35.3	30.3	25.3	28.3	30.4	26.5	29.7	33.6	33.2	32.4	26.2	31.2	
33	582	8	8	-	S	115	62.4	3795	1997	1798	8	36	60	1.1	8	1	1	1	1.10	9	9	47	35.3	30.3	25.3	28.3	30.4	26.5	29.7	33.3	33.0	31.8	26.2	31.2	
35	580	9	9	-	S	115	62.4	4025	2122	1903	9	38	60	1.0	9	1	1	1	1.10	10	10	49	35.9	30.9	25.9	29.1	31.0	27.2	30.0	34.0	33.6	32.4	26.4	31.4	



Note:
Friction angle and undrained shear strenght is calcuated based on the following correlations:

Equation No.	Equation	Soil Type	Reference
E1	$\phi = (12N_{60})^{0.5} + 25$	Angular & Well-grained particles	Dunham (1954)
E2	$\phi = (12N_{60})^{0.5} + 20$	Round & Well-grained Angular & Uniform-grained	Dunham (1954)
E3	$\phi = (12N_{60})^{0.5} + 15$	Round & Uniform-grained	Dunham (1954)
E4	$\phi = (20N_{60})^{0.5} + 15$	Sandy	Ohsaki et al. (1959)
E5	$\phi = 3.5(N_{60})^{0.5} + 20$	Granular	Muromachi et al (1974)
E6	$\phi = (15N_{60})^{0.5} + 15 \leq 45$ (N_{60}>5)	Sandy	Japan Road Association (1990)
E7	$\phi' = 27.1 + 0.3N_{60} - 0.00054(N_{60})^2$	Granular	Peck, Hanson & Thornburn (1974) / Wolff, (1989)
E8	**$\phi' = \mathrm{ArcTan}[(N_{60}/(12.2+20.3(\sigma_o'/P_a))^{0.34}]$**	**Granular**	**Schmertmann (1975)/ Kulhawy and Mayne, 1990)/ GEC 5**
E9	$\phi = (20(N1))^{0.5} + 20$	Sandy	Hatanaka and Uchida (1996), Sampled Using Automatic Hammer
E10	**$\phi = (15.4(N1)_{60})^{0.5} + 20$**	**Sandy**	**Hatanaka and Uchida (1996), Reported in GEC 5, Adjusted for 60% Energy Ratio**
E11	$\phi = 0.15N + 25$	Sandy	Meyerhof (1956)
E12	$\phi = 0.15N + 30$	Sandy	Meyerhof (1956)

Pile Corrosion Calculations

HALEY & ALDRICH

Calculations

File No.	38799-000		
Sheet	1 of 1		
Client	MAINEDOT	Date	1/27/2012
Project	MARTIN MEMORIAL BRIDGE	Computed By	BCS
Subject	STEEL PILE CORROSION	Checked By	JLL

OBJECTIVE: ESTIMATE MAGNITUDE OF SACRIFICIAL STEEL FOR FOUNDATION PILES.

REFERENCES:

1. AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 6TH EDITION, 2012.
2. FHWA DESIGN & CONSTRUCTION OF DRIVEN PILE FOUNDATIONS, PUBLICATION NO. FHWA HI-97-013, DATED NOV. 1998.
3. MAINEDOT BDG, AUGUST 2003 WITH INTERIM REVISIONS THROUGH AUGUST 2008.
4. NCHRP REPORT 408, CORROSION OF STEEL PILING IN NON-MARINE APPLICATIONS, 1998.

EVALUATION:

SUMMARIZE PILE AND WATER LEVEL ELEVATIONS AT EACH SUBSTRUCTURE LOCATION...

SUBSTRUCTURE LOCATION	BOTTOM OF CAP/SEAL[1]	WATER LEVELS[1]		
		$Q_{1.1}$	Q_{50}	RECORD FLOOD
ABUTMENT 1	El. 618.5	El. 612.6	El. 623.9	El. 630.7
PIER 1	El. 582	↓	↓	↓
PIER 2	El. 582			
ABUTMENT 2	El. 613.5			

1 - INFORMATION PROVIDED BY TRANSYSTEMS.

∴ ABUTMENT PILES COULD BE SUBJECT TO PERIODIC WETTING/DRYING CYCLES.

SOIL CONDITIONS ALONG THE PROPOSED BRIDGE/ROADWAY ALIGNMENT CONSIST OF NATURALLY-DEPOSITED GRANULAR SOILS. NO CHEMICAL/ANALYTICAL TESTING WAS COMPLETED ON SOIL SAMPLES.

BASED ON REVIEW OF AVAILABLE LITERATURE, ASSUME A CORROSION LOSS EQUAL TO 0.02 MM/YR (0.0008 IN/YR) OR 1/16-IN. OVER THE DESIGN LIFE OF THE BRIDGE (75 YR). ≅ 1/8-IN. REDUCTION IN PIPE PILE OUTSIDE DIAMETER.

FOR PIPE PILES ASSUME SECTION LOSS ONLY ON EXTERIOR OF PILES SINCE THEY WILL BE FILLED W/CONCRETE.

Static (Compression) Pile Resistance, Pile Uplift Resistance and Downdrag Calculations

Project: Martin Memorial Bridge
Rumford, ME
Subject: Soil Parameters Derivation from SPT and Pile Geotechnical Resistance Calculations
Prepared by: EK/JLL
Checked by: JLL
Date: 03-Dec-2012
File No: 38799-000

Abutment 1
BB-RAR-110

GS El. (ft) = 615.8
GWr Depth (ft) = 3.2

D = 14 in
Atip = 1.07 ft^2

Lab/Field; Stress Calculations; SPT Correction

Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$
1D	Top Soil	1	614.8	4	4	ML				-	S	115	62.4	115	0	115	4	4	60	1.7	7	1	1	0.75	1.10	3	6
2D	Top Soil	3	612.8	2	2	ML				-	S	115	62.4	345	0	345	2	6	60	1.7	3	1	1	0.75	1.10	2	3
3D	Alluvial Deposits	5	610.8	3	3	SM				-	S	115	62.4	575	112	463	3	8	60	1.7	5	1	1	0.75	1.10	2	4
4D	Alluvial Deposits	7	608.8	1	1	SP-SM				-	S	115	62.4	805	237	568	1	10	60	1.7	2	1	1	0.75	1.10	1	1
5D	Alluvial Deposits	9	606.8	0	1	SM				-	S	115	62.4	1035	362	673	1	12	60	1.7	2	1	1	0.8	1.10	1	1
6D	Alluvial Deposits	15	600.8	1	1	SP-SM				-	S	115	62.4	1725	736	989	1	18	60	1.4	1	1	1	0.85	1.10	1	1
7D	Alluvial Deposits	20	595.8	6	6	SP-SM				-	S	115	62.4	2300	1048	1252	6	23	60	1.3	8	1	1	0.95	1.10	6	8
8D	Alluvial Deposits	25	590.8	9	9	SW				-	S	115	62.4	2875	1360	1515	9	28	60	1.1	10	1	1	0.95	1.10	9	11
9D	Alluvial Deposits	30	585.8	10	10	SW				-	S	115	62.4	3450	1672	1778	10	33	60	1.1	11	1	1	1	1.11	11	12
10D	Glaciofluvial Deposits	35	580.8	15	15	SW				-	S	120	62.4	4050	1984	2066	15	38	60	1.0	15	1	1	1	1.15	17	17
11D	Glaciofluvial Deposits	40	575.8	13	13	SW				-	S	120	62.4	4650	2296	2354	13	43	60	0.9	12	1	1	1	1.12	15	13
12D	Glaciofluvial Deposits	45	570.8	23	23	SW				-	S	120	62.4	5250	2608	2642	23	48	60	0.9	20	1	1	1	1.20	28	24
13D	Glaciofluvial Deposits	50	565.8	17	17	SW				-	S	120	62.4	5850	2920	2930	17	53	60	0.8	14	1	1	1	1.14	19	16
14D	Glaciofluvial Deposits	55	560.8	13	13	SP				-	S	120	62.4	6450	3232	3218	13	58	60	0.8	10	1	1	1	1.10	14	11
15D	Glaciofluvial Deposits	60	555.8	12	12	SP				-	S	120	62.4	7050	3544	3506	12	63	60	0.8	9	1	1	1	1.10	13	10
16D	Glaciofluvial Deposits	65	550.8	11	11	SW				-	S	120	62.4	7650	3856	3794	11	68	60	0.7	8	1	1	1	1.10	12	9
17D	Glaciofluvial Deposits	70	545.8	14	14	SW				-	S	120	62.4	8250	4168	4082	14	73	60	0.7	10	1	1	1	1.10	15	11
18D	Glaciofluvial Deposits	75	540.8	15	15	SW				-	S	120	62.4	8850	4480	4370	15	78	60	0.7	10	1	1	1	1.10	17	11
19D	Glaciofluvial Deposits	80	535.8	20	20	SP				-	S	120	62.4	9450	4792	4658	20	83	60	0.7	13	1	1	1	1.13	23	15
20D	Glaciofluvial Deposits	85	530.8	18	18	SP				-	S	120	62.4	10050	5104	4946	18	88	60	0.6	11	1	1	1	1.11	20	13
21D	Glaciofluvial Deposits	90	525.8	12	12	SW				-	S	120	62.4	10650	5416	5234	12	93	60	0.6	7	1	1	1	1.10	13	8
22D	Glaciofluvial Deposits	95	520.8	15	15	SW				-	S	120	62.4	11250	5728	5522	15	98	60	0.6	9	1	1	1	1.10	17	10
23D	Glaciofluvial Deposits	100	515.8	16	16	SW				-	S	120	62.4	11850	6040	5810	16	103	60	0.6	9	1	1	1	1.10	18	10
24D	Glaciofluvial Deposits	105	510.8	11	11	SW				-	S	120	62.4	12450	6352	6098	11	108	60	0.6	6	1	1	1	1.10	12	7
MD	Glaciofluvial Deposits	110	505.8	30	30	-				-	S	120	62.4	13050	6664	6386	30	113	60	0.6	17	1	1	1	1.17	35	20
25D	Glaciofluvial Deposits	115	500.8	43	43	SW				-	S	120	62.4	13650	6976	6674	43	118	60	0.5	24	1	1	1	1.24	53	29
MD	Glaciofluvial Deposits	120	495.8	23	23	-				-	S	120	62.4	14250	7288	6962	23	123	60	0.5	12	1	1	1	1.12	26	14
26D	Glacial Till	130	485.8	66	66	GW				-	S	130	62.4	15550	7912	7638	66	133	60	0.5	34	1	1	1	1.30	86	44
27D	Glacial Till	135	480.8	135	100	GW-GM				-	S	130	62.4	16200	8224	7976	100	138	60	0.5	50	1	1	1	1.30	130	65

ϕ (deg) Friction Angle

Sample Number	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	β (Bhushan, 1986)
1D	48	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	33.6	31.0	25.6	30.6	21.9	23.9	27.6	31.3	33.6		0.49
2D	32	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	26.4	27.7	25.3	30.3	19.9	22.1	25.5	28.9	30.3		0.39
3D	38	31.0	26.0	21.0	22.7	26.1	21.7	27.4	28.0	29.1	28.9	25.5	30.5	21.0	23.2	26.5	29.8	31.0		0.42
4D	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.5	24.5	25.2	30.2	18.5	20.0	23.9	27.8	30.2		0.32
5D	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.2	24.5	25.2	30.2	18.5	19.9	23.9	27.8	30.2	28	0.31
6D	19	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	19.2	24.5	25.2	30.2	18.5	19.7	23.8	27.8	30.2		0.30
7D	45	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	31.6	32.6	25.9	30.9	23.5	25.4	28.6	31.8	33.5		0.47
8D	52	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	34.3	34.8	26.4	31.4	25.4	26.9	30.2	33.6	35.4		0.52
9D	53	36.0	31.0	26.0	29.1	31.1	27.2	29.9	30.0	34.5	35.5	26.5	31.5	26.0	27.4	30.7	34.0	36.0		0.52
10D	62	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	37.4	38.4	27.3	32.3	27.3	29.2	32.9	36.5	38.4		0.58
11D	55	37.5	32.5	27.5	31.1	32.6	29.0	30.9	30.9	35.2	36.1	27.0	32.0	27.0	28.6	31.9	35.1	37.5		0.54
12D	71	41.6	36.6	31.6	36.4	36.8	33.6	34.0	33.7	39.9	41.9	28.5	33.5	28.5	31.6	35.7	39.7	41.9		0.64
13D	59	39.3	34.3	29.3	33.4	34.4	31.0	32.2	32.0	36.3	37.9	27.6	32.6	27.6	30.0	33.4	36.7	39.3		0.56
14D	50	37.5	32.5	27.5	31.1	32.6	29.0	30.9	30.9	33.3	34.8	27.0	32.0	27.0	28.6	31.6	34.5	37.5		0.50
15D	47	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	32.0	34.1	26.8	31.8	26.8	28.2	31.1	33.9	37.0		0.48
16D	43	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	30.7	33.4	26.7	31.7	26.5	27.8	30.6	33.4	36.5		0.46
17D	48	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	32.4	34.8	27.1	32.1	27.1	28.9	31.8	34.7	38.0		0.49
18D	48	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	32.5	34.8	27.3	32.3	27.3	29.2	32.2	35.1	38.4	32	0.49
19D	54	40.5	35.5	30.5	35.0	35.7	32.3	33.1	32.9	34.6	37.3	28.0	33.0	28.0	30.8	34.0	37.2	40.5		0.53
20D	50	39.7	34.7	29.7	34.0	34.8	31.4	32.5	32.3	33.2	36.1	27.7	32.7	27.7	30.2	33.2	36.3	39.7		0.51
21D	40	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	29.3	32.6	26.8	31.8	26.8	28.0	30.7	33.5	37.0		0.44
22D	44	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	30.9	34.1	27.3	32.3	27.3	29.1	32.0	34.9	38.4		0.47
23D	44	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	31.0	34.1	27.4	32.4	27.4	29.4	32.3	35.2	38.9		0.47
24D	36	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	27.6	31.8	26.7	31.7	26.5	27.4	30.2	33.0	36.5		0.41
MD	58	44.0	39.0	34.0	39.5	39.2	36.2	36.0	35.6	36.0	40.0	29.5	34.5	29.5	33.3	37.0	40.6	44.0		0.56
25D	69	47.7	42.7	37.7	44.3	43.0	40.4	39.3	39.0	39.0	44.1	31.5	36.5	31.5	36.1	40.4	44.7	47.7		0.63
MD	49	41.6	36.6	31.6	36.4	36.8	33.6	34.0	33.7	32.9	36.7	28.5	33.5	28.5	31.4	34.7	37.9	41.6		0.50
26D	81	53.1	48.1	43.1	51.3	48.4	45.0	43.9	44.5	42.0	49.7	34.9	39.9	34.9	40.2	45.3	50.5	53.1	45	0.70
27D	97	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	45.7	56.1	40.0	45.0	40.0	44.5	50.8	57.1	59.7		0.81

Geotechnical Resistance Calculations

Sample Number	ϕ used	V/V (ft^3/ft)	Kδ	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)
1D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.36	41	3.7	76	0	0.45	23	20	1	1	1	1	0.45	1
2D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.31	106	3.7	617	1	0.45	23	20	4	4	4	4	0.45	2
3D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.33	151	3.7	1560	2	0.45	23	20	5	5	5	7	0.45	3
4D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.27	155	3.7	2683	3	0.45	23	20	6	6	6	9	0.45	4
5D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.27	183	3.7	3921	4	0.45	23	20	7	7	7	11	0.45	5
6D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.27	264	3.7	8831	9	0.45	23	20	10	10	11	20	0.45	9
7D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.35	438	3.7	15259	15	0.45	23	20	13	13	14	29	0.45	13
8D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.37	567	3.7	24463	24	0.45	23	20	16	16	17	41	0.45	19
9D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.38	668	3.7	35778	36	0.45	23	20	18	18	20	55	0.45	25
10D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.46	942	3.7	50530	51	0.55	40	25	45	25	27	77	0.45	35
11D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	1023	3.7	68536	69	0.55	40	25	52	25	27	95	0.45	43
12D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.49	1283	3.7	89665	90	0.55	40	25	58	25	27	116	0.45	52
13D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.45	1308	3.7	113404	113	0.55	40	25	64	25	27	140	0.45	63
14D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.42	1342	3.7	137690	138	0.55	40	25	70	25	27	164	0.45	74
15D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	1424	3.7	163038	163	0.55	40	25	70	25	27	190	0.45	85
16D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.40	1501	3.7	189840	190	0.55	40	25	70	25	27	217	0.45	97
17D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	1672	3.7	218911	219	0.55	40	25	70	25	27	246	0.45	111
18D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	1796	3.7	250681	251	0.55	40	25	70	25	27	277	0.45	125
19D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	2006	3.7	285517	286	0.55	40	25	70	25	27	312	0.45	141
20D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.42	2067	3.7	322839	323	0.55	40	25	70	25	27	350	0.45	157
21D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.39	2015	3.7	360244	360	0.55	40	25	70	25	27	387	0.45	174
22D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.40	2194	3.7	398817	399	0.55	40	25	70	25	27	426	0.45	191
23D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.40	2319	3.7	440170	440	0.55	40	25	70	25	27	467	0.45	210
24D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.37	2269	3.7	482210	482	0.55	40	25	70	25	27	509	0.45	229
MD	32	1.07	1.29	0.79	0.59	18.9	0.33	0.44	2841	3.7	529039	529	0.55	40	25	70	25	27	556	0.45	250
25D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.48	3192	3.7	584326	584	0.55	40	25	70	25	27	611	0.45	275
MD	32	1.07	1.29	0.79	0.59	18.9	0.33	0.42	2893	3.7	640082	640	0.55	40	25	70	25	27	667	0.45	300
26D	45	1.07	2.7	0.65	0.59	26.6	0.78	0.74	5682	3.7	797219	797	0.8	500	700	1280	700	748	1546	0.45	695
27D	45	1.07	2.7	0.65	0.59	26.6	0.78	0.80	6369	3.7	907642	908	0.8	500	700	1280	700	748	1656	0.45	745

Abutment 1
BB-RAR-111

GS El. (ft)= 615.7
GWr Depth (ft) = 3.1 ft

D = 14 in
Atip = 1.07 ft^2

Lab/Field; Stress Calculations; SPT Correction

Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$
1D	Top Soil	1	614.7	4	4	SM				-	S	115	62.4	115	0	115	4	4	60	1.7	7	1	1	0.75	1.10	3	6
2D	Alluvial Deposits	6	609.7	2	2	SM				-	S	115	62.4	690	181	509	2	9	60	1.7	3	1	1	0.75	1.10	2	3
3D	Alluvial Deposits	10	605.7	1	1	SM				-	S	115	62.4	1150	431	719	1	13	60	1.7	2	1	1	0.85	1.10	1	2
4D	Alluvial Deposits	15	600.7	2	2	SP				-	S	115	62.4	1725	743	982	2	18	60	1.4	3	1	1	0.85	1.10	2	3
5D	Alluvial Deposits	20	595.7	5	5	SW				-	S	115	62.4	2300	1055	1245	5	23	60	1.3	6	1	1	0.95	1.10	5	7
MD	Alluvial Deposits	25	590.7	12	12	-				-	S	115	62.4	2875	1367	1508	12	28	60	1.2	14	1	1	0.95	1.14	13	15
6D	Alluvial Deposits	30	585.7	11	11	SW				-	S	115	62.4	3450	1679	1771	11	33	60	1.1	12	1	1	1	1.12	12	13
7D	Alluvial Deposits	35	580.7	11	11	SW				-	S	115	62.4	4025	1991	2034	11	38	60	1.0	11	1	1	1	1.11	12	12
8D	Alluvial Deposits	40	575.7	15	15	SW				-	S	120	62.4	4625	2303	2322	15	43	60	0.9	14	1	1	1	1.14	17	16
9D	Alluvial Deposits	45	570.7	19	19	SW				-	S	120	62.4	5225	2615	2610	19	48	60	0.9	17	1	1	1	1.17	22	19
10D	Alluvial Deposits	50	565.7	14	14	SW				-	S	120	62.4	5825	2927	2898	14	53	60	0.8	12	1	1	1	1.12	16	13
11D	Alluvial Deposits	55	560.7	16	16	SW				-	S	120	62.4	6425	3239	3186	16	58	60	0.8	13	1	1	1	1.13	18	14
12D	Alluvial Deposits	60	555.7	17	17	SW				-	S	120	62.4	7025	3551	3474	17	63	60	0.8	13	1	1	1	1.13	19	15
13D	Alluvial Deposits	65	550.7	13	13	SW				-	S	120	62.4	7625	3863	3762	13	68	60	0.7	9	1	1	1	1.10	14	10
14D	Alluvial Deposits	70	545.7	14	14	SW				-	S	120	62.4	8225	4175	4050	14	73	60	0.7	10	1	1	1	1.10	15	11
15D	Alluvial Deposits	75	540.7	13	13	SP				-	S	120	62.4	8825	4487	4338	13	78	60	0.7	9	1	1	1	1.10	14	10
16D	Alluvial Deposits	80	535.7	7	7	SP				-	S	120	62.4	9425	4799	4626	7	83	60	0.7	5	1	1	1	1.10	8	5
17D	Alluvial Deposits	86	529.7	16	16	SW				-	S	120	62.4	10145	5173	4972	16	89	60	0.6	10	1	1	1	1.10	18	11
18D	Alluvial Deposits	91	524.7	21	21	SW				-	S	120	62.4	10745	5485	5260	21	94	60	0.6	13	1	1	1	1.13	24	15
19D	Alluvial Deposits	96	519.7	16	16	SW				-	S	120	62.4	11345	5797	5548	16	99	60	0.6	10	1	1	1	1.10	18	11
20D	Alluvial Deposits	101	514.7	21	21	SW				-	S	120	62.4	11945	6109	5836	21	104	60	0.6	12	1	1	1	1.12	24	14
21D	Alluvial Deposits	111	504.7	26	26	SW				-	S	120	62.4	13145	6733	6412	26	114	60	0.6	15	1	1	1	1.15	30	17
22D	Alluvial Deposits	120	495.7	22	22	SW				-	S	120	62.4	14225	7295	6930	22	123	60	0.5	12	1	1	1	1.12	25	13
23D	Bedrock	130.5	485.2	80	80					-	S	140	62.4	15695	7950	7745	80	134	60	0.5	41	1	1	1	1.30	104	53

ϕ (deg) Friction Angle

Sample Number	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	β (Bhushan, 1986)
1D	48	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	33.6	31.0	25.6	30.6	21.9	23.9	27.6	31.3	33.6		0.49
2D	30	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	25.6	27.7	25.3	30.3	19.9	22.0	25.4	28.9	30.3		0.38
3D	20	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.0	26.3	25.2	30.2	18.5	20.0	24.0	28.0	30.2	28	0.31
4D	27	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	23.8	27.7	25.3	30.3	19.9	21.8	25.3	28.7	30.3		0.36
5D	41	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	30.1	31.8	25.8	30.8	22.7	24.7	27.9	31.1	32.7		0.45
MD	60	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	37.0	37.3	26.8	31.8	26.8	28.1	31.8	35.4	37.3		0.57
6D	55	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	35.4	36.1	26.7	31.7	26.5	27.8	31.2	34.6	36.5		0.54
7D	53	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	34.6	35.5	26.7	31.7	26.5	27.8	31.1	34.3	36.5		0.53
8D	60	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	36.7	37.9	27.3	32.3	27.3	29.3	32.8	36.3	38.4		0.57
9D	65	40.1	35.1	30.1	34.5	35.3	31.9	32.8	32.6	38.1	39.5	27.9	32.9	27.9	30.5	34.2	37.9	40.1		0.60
10D	54	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	34.6	36.1	27.1	32.1	27.1	29.0	32.1	35.3	38.0		0.53
11D	56	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	35.2	36.7	27.4	32.4	27.4	29.7	32.9	36.1	38.9		0.54
12D	56	39.3	34.3	29.3	33.4	34.4	31.0	32.2	32.0	35.2	37.3	27.6	32.6	27.6	30.0	33.2	36.5	39.3		0.54
13D	47	37.5	32.5	27.5	31.1	32.6	29.0	30.9	30.9	32.2	34.1	27.0	32.0	27.0	28.6	31.4	34.3	37.5		0.49
14D	48	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	32.4	34.8	27.1	32.1	27.1	28.9	31.8	34.8	38.0	32	0.49
15D	45	37.5	32.5	27.5	31.1	32.6	29.0	30.9	30.9	31.3	34.1	27.0	32.0	27.0	28.5	31.4	34.2	37.5		0.47
16D	32	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	25.8	30.0	26.1	31.1	24.2	25.5	28.3	31.1	34.2		0.39
17D	47	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	32.2	34.8	27.4	32.4	27.4	29.5	32.4	35.4	38.9		0.49
18D	53	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	34.2	37.3	28.2	33.2	28.2	31.0	34.3	37.5	40.9		0.52
19D	45	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	31.4	34.8	27.4	32.4	27.4	29.4	32.4	35.3	38.9		0.47
20D	51	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	33.4	36.7	28.2	33.2	28.2	31.0	34.2	37.4	40.9		0.51
21D	54	42.7	37.7	32.7	37.8	37.8	34.7	34.9	34.5	34.6	38.4	28.9	33.9	28.9	32.3	35.7	39.2	42.7		0.53
22D	48	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	32.5	36.1	28.3	33.3	28.3	31.1	34.3	37.5	41.2		0.49
23D	88	56.0	51.0	46.0	55.0	51.3	45.0	45.9	47.6	43.8	52.6	37.0	42.0	37.0	42.2	47.8	53.4	56.0		

Geotechnical Resistance Calculations

Sample Number	ϕ used	V/V (ft^3/ft)	Kδ	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)
1D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.36	41	3.7	76	0	0.45	23	20	1	1	1	1	0.45	1
2D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.30	154	3.7	1870	2	0.45	23	20	5	5	6	8	0.45	3
3D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.27	195	3.7	4428	4	0.45	23	20	7	7	8	12	0.45	6
4D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.29	288	3.7	8849	9	0.45	23	20	10	10	11	20	0.45	9
5D	28	1.07	0.97	0.83	0.59	16.5	0.23	0.34	420	3.7	15334	15	0.45	23	20	13	13	14	29	0.45	13
MD	32	1.07	1.29	0.79	0.59	18.9	0.33	0.45	680	3.7	25416	25	0.55	40	25	33	25	27	52	0.45	23
6D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	770	3.7	38708	39	0.55	40	25	39	25	27	65	0.45	29
7D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	870	3.7	53740	54	0.55	40	25	45	25	27	80	0.45	36
8D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.45	1043	3.7	71269	71	0.55	40	25	51	25	27	98	0.45	44
9D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.47	1215	3.7	91953	92	0.55	40	25	57	25	27	119	0.45	53
10D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	1245	3.7	114487	114	0.55	40	25	64	25	27	141	0.45	64
11D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.44	1388	3.7	138608	139	0.55	40	25	70	25	27	165	0.45	74
12D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.44	1513	3.7	165191	165	0.55	40	25	70	25	27	192	0.45	86
13D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	1537	3.7	193137	193	0.55	40	25	70	25	27	220	0.45	99
14D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	1661	3.7	222433	222	0.55	40	25	70	25	27	249	0.45	112
15D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.40	1738	3.7	253571	254	0.55	40	25	70	25	27	280	0.45	126
16D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.36	1662	3.7	284720	285	0.55	40	25	70	25	27	311	0.45	140
17D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	2030	3.7	325313	325	0.55	40	25	70	25	27	352	0.45	158
18D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	2245	3.7	364482	364	0.55	40	25	70	25	27	391	0.45	176
19D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.40	2229	3.7	405478	405	0.55	40	25	70	25	27	432	0.45	194
20D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.42	2450	3.7	448354	448	0.55	40	25	70	25	27	475	0.45	214
21D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.43	2767	3.7	543962	544	0.55	40	25	70	25	27	571	0.45	257
22D	32	1.07	1.29	0.79	0.59	18.9	0.33	0.41	2857	3.7	636722	637	0.55	40	25	70	25	27	663	0.45	299
23D																					

Abutment 1

BB-RAR-112

GS El. (ft) = 615.4

GWr Depth (ft) = 2.8

						Lab/Field						Stress Calculations					SPT Correction												ϕ (deg) Friction Angle																	
Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used
1D	Top Soil	1	614.4	3	3	ML				-	S	115	62.4	115	0	115	3	4	60	1.7	5	1	1	0.75	1.10	2	4	42	31.0	26.0	21.0	22.7	26.1	21.7	27.4	28.0	31.0	28.9	25.5	30.5	21.0	23.2	26.6	30.1	31.0	
2D	Top Soil	3	612.4	2	2	SM				-	S	115	62.4	345	12	333	2	6	60	1.7	3	1	1	0.75	1.10	2	3	32	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	26.5	27.7	25.3	30.3	19.9	22.1	25.5	28.9	30.3	
3D	Alluvial Deposits	5	610.4	2	2	SP-SM				-	S	115	62.4	575	137	438	2	8	60	1.7	3	1	1	0.75	1.10	2	3	31	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	25.9	27.7	25.3	30.3	19.9	22.0	25.5	28.9	30.3	28
4D	Alluvial Deposits	7	608.4	0	1	SP-SM				-	S	115	62.4	805	262	543	1	10	60	1.7	2	1	1	0.75	1.10	1	1	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.6	24.5	25.2	30.2	18.5	20.0	23.9	27.8	30.2	
5D	Alluvial Deposits	9	606.4	2	2	SP-SM				-	S	115	62.4	1035	387	648	2	12	60	1.7	3	1	1	0.8	1.10	2	3	29	29.9	24.9	19.9	21.3	24.9	20.5	27.0	27.7	25.0	27.7	25.3	30.3	19.9	21.9	25.4	28.8	30.3	
6D	Alluvial Deposits	15	600.4	4	4	SP-SM				-	S	115	62.4	1725	761	964	4	18	60	1.4	6	1	1	0.85	1.10	4	5	39	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	29.3	30.0	25.6	30.6	21.9	24.0	27.2	30.3	31.9	
7D	Alluvial Deposits	20	595.4	6	6	SP				-	S	115	62.4	2300	1073	1227	6	23	60	1.3	8	1	1	0.95	1.10	6	8	45	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	31.7	32.6	25.9	30.9	23.5	25.4	28.6	31.8	33.5	
8D	Alluvial Deposits	25	590.4	7	7	SP				-	S	115	62.4	2875	1385	1490	7	28	60	1.2	8	1	1	0.95	1.10	7	8	46	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	32.2	32.6	26.1	31.1	24.2	26.0	29.1	32.2	34.2	
9D	Alluvial Deposits	30	585.4	14	14	SP				-	S	115	62.4	3450	1697	1753	14	33	60	1.1	15	1	1	1	1.15	16	17	63	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	37.7	38.4	27.1	32.1	27.1	28.8	32.6	36.3	38.4	
10D	Alluvial Deposits	35	580.4	9	9	SP				-	S	115	62.4	4025	2009	2016	9	38	60	1.0	9	1	1	1	1.10	10	10	48	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	32.8	34.1	26.4	31.4	25.4	27.0	30.1	33.1	35.4	30
11D	Alluvial Deposits	40	575.4	16	16	SP				-	S	115	62.4	4600	2321	2279	16	43	60	0.9	15	1	1	1	1.15	18	17	62	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	37.4	38.4	27.4	32.4	27.4	29.6	33.2	36.8	38.9	
12D	Alluvial Deposits	45	570.4	22	22	SW				-	S	115	62.4	5175	2633	2542	22	48	60	0.9	20	1	1	1	1.20	26	23	70	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	39.7	41.4	28.3	33.3	28.3	31.4	35.4	39.3	41.4	
13D	Alluvial Deposits	50	565.4	8	8	SW				-	S	115	62.4	5750	2945	2805	8	53	60	0.8	7	1	1	1	1.10	9	7	41	34.8	29.8	24.8	27.6	29.9	26.0	29.2	29.5	29.9	31.8	26.2	31.2	24.8	26.4	29.2	32.0	34.8	

Abutment 1

BB-RAR-113

GS El. (ft) = 615.8

GWr Depth (ft) = 3.2

						Lab/Field						Stress Calculations					SPT Correction												ϕ (deg) Friction Angle																	
Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used
1D	Top Soil	1	614.8	4	4	SM				-	S	115	62.4	115	0	115	4	4	60	1.7	7	1	1	0.75	1.10	3	6	48	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	33.6	31.0	25.6	30.6	21.9	23.9	27.6	31.3	33.6	
2D	Alluvial Deposits	3	612.8	1	1	SM				-	S	115	62.4	345	0	345	1	6	60	1.7	2	1	1	0.75	1.10	1	1	22	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	21.4	24.5	25.2	30.2	18.5	20.1	24.0	27.8	30.2	
3D	Alluvial Deposits	5	610.8	1	1	SP-SM				-	S	115	62.4	575	112	463	1	8	60	1.7	2	1	1	0.75	1.10	1	1	22	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.9	24.5	25.2	30.2	18.5	20.0	23.9	27.8	30.2	28
4D	Alluvial Deposits	7	608.8	0	1	SM				-	S	115	62.4	805	237	568	1	10	60	1.7	2	1	1	0.75	1.10	1	1	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.5	24.5	25.2	30.2	18.5	20.0	23.9	27.8	30.2	
5D	Alluvial Deposits	9	606.8	0	1	SP-SM				-	S	115	62.4	1035	362	673	1	12	60	1.7	2	1	1	0.8	1.10	1	1	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.2	24.5	25.2	30.2	18.5	19.9	23.9	27.8	30.2	
6D	Alluvial Deposits	15	600.8	1	1	SP-SM				-	S	115	62.4	1725	736	989	1	18	60	1.4	1	1	1	0.85	1.10	1	1	19	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	19.2	24.5	25.2	30.2	18.5	19.7	23.8	27.8	30.2	
7D	Alluvial Deposits	20	595.8	4	4	SW				-	S	115	62.4	2300	1048	1252	4	23	60	1.3	5	1	1	0.95	1.10	4	5	36	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	28.2	30.0	25.6	30.6	21.9	24.0	27.1	30.2	31.9	
8D	Alluvial Deposits	25	590.8	4	4	SW				-	S	115	62.4	2875	1360	1515	4	28	60	1.1	5	1	1	0.95	1.10	4	5	35	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	27.4	30.0	25.6	30.6	21.9	23.9	27.0	30.1	31.9	
9D	Alluvial Deposits	30	585.8	12	12	SP				-	S	115	62.4	3450	1672	1778	12	33	60	1.1	13	1	1	1	1.13	14	14	58	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	36.1	36.7	26.8	31.8	26.8	28.1	31.6	35.1	37.0	
10D	Alluvial Deposits	35	580.8	11	11	SP				-	S	115	62.4	4025	1984	2041	11	38	60	1.0	11	1	1	1	1.11	12	12	53	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	34.6	35.5	26.7	31.7	26.5	27.8	31.1	34.3	36.5	30
11D	Alluvial Deposits	40	575.8	10	10	SW				-	S	115	62.4	4600	2296	2304	10	43	60	0.9	9	1	1	1	1.10	11	10	49	36.0	31.0	26.0	29.1	31.1	27.2	29.9	30.0	33.0	34.1	26.5	31.5	26.0	27.4	30.4	33.5	36.0	
12D	Alluvial Deposits	45	570.8	9	9	SW				-	S	115	62.4	5175	2608	2567	9	48	60	0.9	8	1	1	1	1.10	10	9	45	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	31.4	33.4	26.4	31.4	25.4	27.0	29.9	32.8	35.4	
13D	Alluvial Deposits	50	565.8	12	12	-				-	S	115	62.4	5750	2920	2830	12	53	60	0.8	10	1	1	1	1.10	13	11	50	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	33.4	34.8	26.8	31.8	26.8	28.2	31.2	34.3	37.0	

Abutment 1

BB-RAR-114

GS El. (ft) = 615.3

GWr Depth (ft) = 2.7

						Lab/Field						Stress Calculations					SPT Correction												ϕ (deg) Friction Angle																	
Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used
1D	Top Soil	1	614.8	3	3	SM				-	S	115	62.4	115	0	115	3	4	60	1.7	5	1	1	0.75	1.10	2	4	42	31.0	26.0	21.0	22.7	26.1	21.7	27.4	28.0	31.0	28.9	25.5	30.5	21.0	23.2	26.6	30.1	31.0	
2D	Top Soil	3	612.8	1	1	ML				-	S	115	62.4	345	19	326	1	6	60	1.7	2	1	1	0.75	1.10	1	1	23	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	21.5	24.5	25.2	30.2	18.5	20.1	24.0	27.8	30.2	
3D	Alluvial Deposits	5	610.8	0	1	SM				-	S	115	62.4	575	144	431	1	8	60	1.7	2	1	1	0.75	1.10	1	1	22	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	21.1	24.5	25.2	30.2	18.5	20.1	23.9	27.8	30.2	28
4D	Alluvial Deposits	7	608.8	1	1	SM				-	S	115	62.4	805	268	537	1	10	60	1.7	2	1	1	0.75	1.10	1	1	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.6	24.5	25.2	30.2	18.5	20.0	23.9	27.8	30.2	
5D	Alluvial Deposits	9	606.8	0	1	SP-SM				-	S	115	62.4	1035	393	642	1	12	60	1.7	2	1	1	0.8	1.10	1	1	21	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	20.3	24.5	25.2	30.2	18.5	19.9	23.9	27.8	30.2	
6D	Alluvial Deposits	15	600.8	1	1	SM				-	S	115	62.4	1725	768	957	1	18	60	1.4	1	1	1	0.85	1.10	1	1	19	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	19.3	24.5	25.2	30.2	18.5	19.8	23.8	27.8	30.2	
7D	Alluvial Deposits	20	595.8	6	6	SW				-	S	115	62.4	2300	1080	1220	6	23	60	1.3	8	1	1	0.95	1.10	6	8	45	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	31.8	32.6	25.9	30.9	23.5	25.4	28.6	31.8	33.5	
8D	Alluvial Deposits	25	590.8	5	5	SW				-	S	115	62.4	2875	1392	1483	5	28	60	1.2	6	1	1	0.95	1.10	5	6	39	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	29.3	31.0	25.8	30.8	22.7	24.7	27.8	30.8	32.7	
9D	Alluvial Deposits	30	585.8	5	5	SW				-	S	115	62.4	3450	1704	1746	5	33	60	1.1	5	1	1	1	1.10	6	6	37	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	28.6	31.0	25.8	30.8	22.7	24.7	27.7	30.7	32.7	
10D	Alluvial Deposits	35	580.8	5	5	SW				-	S	115	62.4	4025	2016	2009	5	38	60	1.0	5	1	1	1	1.10	6	5	36	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	27.9	30.0	25.8	30.8	22.7	24.7	27.6	30.5	32.7	28
11D	Alluvial Deposits	40	575.8	7	7	SW				-	S	115	62.4	4600	2328	2272	7	43	60	0.9	7	1	1	1	1.10	8	7	41	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	30.0	31.8	26.1	31.1	24.2	25.9	28.8	31.7	34.2	
12D	Alluvial Deposits	45	570.8	5	5	SW				-	S	115	62.4	5175	2640	2535	5	48	60	0.9	4	1	1	1	1.10	6	5	34	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	26.7	30.0	25.8	30.8	22.7	24.6	27.5	30.4	32.7	
13D	Alluvial Deposits	50	565.8	8	8	SW				-	S	115	62.4	5750	2952	2798	8	53	60	0.8	7	1	1	1	1.10	9	7	41	34.8	29.8	24.8	27.6	29.9	26.0	29.2	29.5	29.9	31.8	26.2	31.2	24.8	26.4	29.2	32.0	34.8	

Project: Martin Memorial Bridge
Rumford, ME
Subject: Soil Parameters Derivation from SPT and Pile Geotechnical Resistance Calculations
Prepared by: EK/JLL
Checked by: JLL
Date: 03-Dec-2012
File No: 38799-000

D = 24 in

Atip = 3.14 ft^2

Pier No. 1
BB-RAR-115

GS El. (ft) = 597.1

GW Depth (ft) = -15.5

						Lab/Field						Stress Calculations					SPT Correction										
Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$
1D	Alluvial Deposits	1	596.1	17	17	SW				-	S	115	62.4	1082.2	1030	53	17	4	60	1.7	29	1	1	0.75	1.29	16	28
2D	Alluvial Deposits	7	590.1	18	18	SP				-	S	115	62.4	1772.2	1404	368	18	10	60	1.7	31	1	1	0.75	1.30	18	30
3D	Alluvial Deposits	12	585.1	4	4	SP				-	S	115	62.4	2347.2	1716	631	4	15	60	1.7	7	1	1	0.85	1.10	4	6
4D	Alluvial Deposits	17	580.1	5	5	SP				-	S	115	62.4	2922.2	2028	894	5	20	60	1.5	7	1	1	0.85	1.10	5	7
5D	Alluvial Deposits	22	575.1	9	9	SP				-	S	115	62.4	3497.2	2340	1157	9	25	60	1.3	12	1	1	0.95	1.12	10	13
6D	Alluvial Deposits	27	570.1	15	15	SM				-	S	115	62.4	4072.2	2652	1420	15	30	60	1.2	18	1	1	0.95	1.18	17	20
7D	Alluvial Deposits	32	565.1	6	6	SM				-	S	115	62.4	4647.2	2964	1683	6	35	60	1.1	7	1	1	1	1.10	7	7
8D	Alluvial Deposits	37	560.1	14	14	SM				-	S	120	62.4	5247.2	3276	1971	14	40	60	1.0	14	1	1	1	1.14	16	16
9D	Alluvial Deposits	42	555.1	16	16	SM				-	S	120	62.4	5847.2	3588	2259	16	45	60	0.9	15	1	1	1	1.15	18	17
10D	Alluvial Deposits	47	550.1	22	22	SP				-	S	120	62.4	6447.2	3900	2547	22	50	60	0.9	19	1	1	1	1.19	26	23
11D	Alluvial Deposits	52	545.1	36	36	SW				-	S	120	62.4	7047.2	4212	2835	36	55	60	0.8	30	1	1	1	1.30	47	39
12D	Alluvial Deposits	57	540.1	19	19	SP				-	S	120	62.4	7647.2	4524	3123	19	60	60	0.8	15	1	1	1	1.15	22	18
13D	Alluvial Deposits	62	535.1	21	21	SP				-	S	120	62.4	8247.2	4836	3411	21	65	60	0.8	16	1	1	1	1.16	24	19
14D	Alluvial Deposits	67	530.1	21	21	SP				-	S	120	62.4	8847.2	5148	3699	21	70	60	0.7	15	1	1	1	1.15	24	18
15D	Alluvial Deposits	72	525.1	25	25	SP				-	S	120	62.4	9447.2	5460	3987	25	75	60	0.7	18	1	1	1	1.18	29	21
16D	Alluvial Deposits	77	520.1	20	20	SP				-	S	120	62.4	10047.2	5772	4275	20	80	60	0.7	14	1	1	1	1.14	23	16
17D	Alluvial Deposits	82	515.1	29	29	SP				-	S	120	62.4	10647.2	6084	4563	29	85	60	0.7	19	1	1	1	1.19	35	23
18D	Alluvial Deposits	87	510.1	46	46	SM				-	S	120	62.4	11247.2	6396	4851	46	90	60	0.6	30	1	1	1	1.30	60	38
19D	Alluvial Deposits	92	505.1	55	55	SM				-	S	120	62.4	11847.2	6708	5139	55	95	60	0.6	34	1	1	1	1.30	72	45
20D	Alluvial Deposits	97	500.1	39	39	SM				-	S	120	62.4	12447.2	7020	5427	39	100	61	0.6	24	1.02	2	1	1.24	98	60
21D	Alluvial Deposits	102	495.1	48	48	SM				-	S	120	62.4	13047.2	7332	5715	48	105	62	0.6	28	1.03	3	1	1.28	191	113
22D	Alluvial Deposits	107	490.1	45	45	SM				-	S	120	62.4	13647.2	7644	6003	45	110	63	0.6	26	1.05	4	1	1.26	238	137
24D	Glaciofluvial Deposits	111	486.1	-	100	SW-SM				-	S	120	62.4	14127.2	7894	6234	100	114	64	0.6	57	1.07	5	1	1.30	693	393
23D	Bedrock	116	481.1	-	100	-				-	S	140	62.4	14827.2	8206	6622	100	119	65	0.5	55	1.08	6	1	1.30	845	464

		ϕ (deg) Friction Angle																				Geotechnical Resistance Calculations					
Sample Number	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	k dry (pci)	k wet (pci)	k used (pci)	β (Bhushan, 1986)	ϕ used	24 in Diam PP V/V (ft^3/ft)	Kδ	Cf	δ/ϕ
1D	100	39.3	34.3	29.3	33.4	34.4	31.0	32.2	32.0	47.8	43.7	27.6	32.6	27.6	28.9	34.8	40.7	47.8		384	226		0.83	31	3.14	1.36	0.94	0.8
2D	95	39.7	34.7	29.7	34.0	34.8	31.4	32.5	32.3	46.2	44.5	27.7	32.7	27.7	29.4	35.0	40.7	46.2		344	202		0.79	31	3.14	1.36	0.94	0.8
3D	42	31.9	26.9	21.9	23.9	27.0	22.7	27.8	28.3	30.7	31.0	25.6	30.6	21.9	24.0	27.4	30.7	31.9		67	43		0.45	31	3.14	1.36	0.94	0.8
4D	44	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	31.4	31.8	25.8	30.8	22.7	24.7	28.0	31.3	32.7	31	74	47	60	0.46	31	3.14	1.36	0.94	0.8
5D	56	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	35.6	36.1	26.4	31.4	25.4	26.8	30.5	34.1	36.1		120	73		0.54	31	3.14	1.36	0.94	0.8
6D	69	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	39.4	40.0	27.3	32.3	27.3	29.0	33.2	37.3	40.0		181	109		0.63	31	3.14	1.36	0.94	0.8
7D	41	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	30.3	31.8	25.9	30.9	23.5	25.4	28.4	31.4	33.5		66	43		0.45	31	3.14	1.36	0.94	0.8
8D	61	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	37.0	37.9	27.1	32.1	27.1	28.9	32.5	36.1	38.0		141	86		0.57	33	3.14	1.62	0.93	0.8
9D	62	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	37.4	38.4	27.4	32.4	27.4	29.6	33.2	36.8	38.9		149	90		0.58	33	3.14	1.62	0.93	0.8
10D	70	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	39.7	41.4	28.3	33.3	28.3	31.4	35.3	39.3	41.4		190	114		0.64	33	3.14	1.62	0.93	0.8
11D	87	45.8	40.8	35.8	41.8	41.0	38.2	37.6	37.2	43.7	47.9	30.4	35.4	30.4	34.8	39.6	44.5	47.9		289	171		0.74	33	3.14	1.62	0.93	0.8
12D	61	40.1	35.1	30.1	34.5	35.3	31.9	32.8	32.6	37.0	39.0	27.9	32.9	27.9	30.6	34.1	37.6	40.1	33	143	87	100	0.58	33	3.14	1.62	0.93	0.8
13D	62	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	37.3	39.5	28.2	33.2	28.2	31.2	34.7	38.3	40.9		149	90		0.58	33	3.14	1.62	0.93	0.8
14D	60	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	36.7	39.0	28.2	33.2	28.2	31.2	34.6	38.1	40.9		141	85		0.57	33	3.14	1.62	0.93	0.8
15D	64	42.3	37.3	32.3	37.4	37.5	34.4	34.6	34.3	37.8	40.5	28.8	33.8	28.8	32.2	35.9	39.6	42.3		158	96		0.60	33	3.14	1.62	0.93	0.8
16D	56	40.5	35.5	30.5	35.0	35.7	32.3	33.1	32.9	35.2	37.9	28.0	33.0	28.0	30.8	34.1	37.4	40.5		120	74		0.54	33	3.14	1.62	0.93	0.8
17D	66	43.7	38.7	33.7	39.1	38.8	35.9	35.7	35.3	38.2	41.4	29.4	34.4	29.4	33.2	37.0	40.8	43.7		166	100		0.61	38	3.14	2.74	0.9	0.8
18D	81	48.5	43.5	38.5	45.3	43.7	41.3	40.0	39.8	42.2	47.6	31.9	36.9	31.9	37.0	41.6	46.2	48.5		251	149		0.71	38	3.14	2.74	0.9	0.8
19D	86	50.7	45.7	40.7	48.2	46.0	43.7	41.9	42.0	43.5	50.0	33.3	38.3	33.3	38.7	43.6	48.6	50.7		287	170		0.74	38	3.14	2.74	0.9	0.8
20D	71	46.6	41.6	36.6	42.9	41.9	39.2	38.4	38.0	39.7	54.6	30.9	35.9	30.9	34.6	40.5	46.5	54.6	38	195	117	125	0.64	38	3.14	2.74	0.9	0.8
21D	77	49.0	44.0	39.0	46.0	44.2	41.8	40.5	40.3	41.3	67.5	32.2	37.2	32.2	34.9	43.6	52.3	67.5		230	137		0.68	38	3.14	2.74	0.9	0.8
22D	73	48.2	43.2	38.2	45.0	43.5	41.0	39.8	39.5	40.3	72.3	31.8	36.8	31.8	33.2	43.3	53.4	72.3		208	124		0.66	38	3.14	2.74	0.9	0.8
24D	100	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	47.7	108.7	40.0	45.0	40.0	37.5	55.4	73.2	108.7		384	226		0.83	38	3.14	2.74	0.9	0.8
23D	100	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	47.2	116.3	40.0	45.0	40.0	36.0	56.0	75.9	116.3		384	226		0.83	38	3.14	2.74	0.9	0.8

																	with Scour (El. 561)	DD Load (Liquefied to El. 565)		
Sample Number	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)	RF*(Fs+Fp) (kip)	Unfactored DD (kip)	DD Load Factor	Factored DD (kip)
1D	24.8	0.54	0.68	36	6.3	113	0	0.50	35	20	1	1	3	3	0.45	1	0			
2D	24.8	0.54	0.67	245	6.3	5408	5	0.50	35	20	6	6	20	26	0.45	12	0			
3D	24.8	0.54	0.49	311	6.3	14149	14	0.50	35	20	11	11	35	49	0.45	22	0			
4D	24.8	0.54	0.50	448	6.3	26071	26	0.50	35	20	16	16	49	75	0.45	34	0			
5D	24.8	0.54	0.54	624	6.3	42902	43	0.50	35	20	20	20	63	106	0.45	48	0			
6D	24.8	0.54	0.58	825	6.3	65660	66	0.50	35	20	25	20	63	128	0.45	58	0			
7D	24.8	0.54	0.49	830	6.3	91648	92	0.50	35	20	29	20	63	154	0.45	70	0	92	1.05	96
8D	26.4	0.67	0.62	1226	6.3	123934	124	0.60	45	50	53	50	157	281	0.45	126	0			
9D	26.4	0.67	0.63	1417	6.3	165441	165	0.60	45	50	61	50	157	323	0.45	145	89			
10D	26.4	0.67	0.65	1664	6.3	213829	214	0.60	45	50	69	50	157	371	0.45	167	111			
11D	26.4	0.67	0.71	2004	6.3	271445	271	0.60	45	50	77	50	157	429	0.45	193	137			
12D	26.4	0.67	0.62	1946	6.3	333498	333	0.60	45	50	84	50	157	491	0.45	221	165			
13D	26.4	0.67	0.63	2139	6.3	397669	398	0.60	45	50	86	50	157	555	0.45	250	194			
14D	26.4	0.67	0.62	2298	6.3	467368	467	0.60	45	50	86	50	157	624	0.45	281	225			
15D	26.4	0.67	0.63	2525	6.3	543138	543	0.60	45	50	86	50	157	700	0.45	315	259			
16D	26.4	0.67	0.61	2593	6.3	623544	624	0.60	45	50	86	50	157	781	0.45	351	296			
17D	30.4	1.25	0.93	4232	6.3	730754	731	0.70	100	250	224	224	704	1434	0.45	646	590			
18D	30.4	1.25	0.98	4737	6.3	871638	872	0.70	100	250	224	224	704	1575	0.45	709	653			
19D	30.4	1.25	0.99	5112	6.3	1026346	1026	0.70	100	250	224	224	704	1730	0.45	779	723			
20D	30.4	1.25	0.95	5130	6.3	1187231	1187	0.70	100	250	224	224	704	1891	0.45	851	795			
21D	30.4	1.25	0.97	5517	6.3	1354487	1354	0.70	100	250	224	224	704	2058	0.45	926	870			
22D	30.4	1.25	0.95	5719	6.3	1530987	1531	0.70	100	250	224	224	704	2235	0.45	1006	950			
24D	30.4	1.25	1.04	6476	6.3	1684238	1684	0.70	100	250	224	224	704	2388	0.45	1075	1019			
23D	30.4	1.25	1.04	6879	6.3	1894030	1894	0.70	100	250	224	224	704	2598	0.45	1169	1113			

Pier No. 1
BB-RAR-116

GS El. (ft)= 597.1

GWr Depth (ft) = -15.5 ft

						Lab/Field						Stress Calculations					SPT Correction										
Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)	N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$
1D	Alluvial Deposits	1	596.1	5	5	SP				-	S	115	62.4	1082	1030	53	5	4	60	1.7	9	1	1	0.75	1.10	4	7
2D	Alluvial Deposits	6	591.1	21	21	SW				-	S	115	62.4	1657	1342	316	21	9	60	1.7	36	1	1	0.75	1.30	20	35
3D	Alluvial Deposits	11	586.1	6	6	SM				-	S	115	62.4	2232	1654	579	6	14	60	1.7	10	1	1	0.85	1.10	6	10
4D	Alluvial Deposits	16	581.1	7	7	SM				-	S	115	62.4	2807	1966	842	7	19	60	1.5	11	1	1	0.85	1.11	7	10
5D	Alluvial Deposits	21	576.1	12	12	SM				-	S	115	62.4	3382	2278	1105	12	24	60	1.3	16	1	1	0.95	1.16	13	18
6D	Alluvial Deposits	26	571.1	15	15	SM				-	S	115	62.4	3957	2590	1368	15	29	60	1.2	18	1	1	0.95	1.18	17	20
7D	Alluvial Deposits	31	566.1	9	9	SM				-	S	115	62.4	4532	2902	1631	9	34	60	1.1	10	1	1	1	1.10	10	11
8D	Alluvial Deposits	36	561.1	18	18	SM				-	S	115	62.4	5107	3214	1894	18	39	60	1.0	18	1	1	1	1.18	21	22
9D	Alluvial Deposits	41	556.1	23	23	SM				-	S	115	62.4	5682	3526	2157	23	44	60	1.0	22	1	1	1	1.22	28	27
10D	Glaciolacustrine Deposits	46	551.1	22	22	SM				-	S	115	62.4	6257	3838	2420	22	49	60	0.9	20	1	1	1	1.20	26	24
11D	Glaciolacustrine Deposits	51	546.1	16	16	SP				-	S	120	62.4	6857	4150	2708	16	54	60	0.9	14	1	1	1	1.14	18	16
12D	Glaciolacustrine Deposits	56	541.1	12	12	SP				-	S	120	62.4	7457	4462	2996	12	59	60	0.8	10	1	1	1	1.10	13	11
13D	Glaciolacustrine Deposits	61	536.1	26	26	SP				-	S	120	62.4	8057	4774	3284	26	64	60	0.8	20	1	1	1	1.20	31	24
14D	Glaciolacustrine Deposits	66	531.1	21	21	SP				-	S	120	62.4	8657	5086	3572	21	69	60	0.7	16	1	1	1	1.16	24	18
15D	Glaciolacustrine Deposits	71	526.1	21	21	SP				-	S	120	62.4	9257	5398	3860	21	74	60	0.7	15	1	1	1	1.15	24	17
16D	Glaciolacustrine Deposits	76	521.1	22	22	SP				-	S	120	62.4	9857	5710	4148	22	79	60	0.7	15	1	1	1	1.15	25	18
17D	Glaciolacustrine Deposits	81	516.1	51	51	SP				-	S	130	62.4	10507	6022	4486	51	84	60	0.7	34	1	1	1	1.30	66	44
18D	Glaciolacustrine Deposits	86	511.1	42	42	SP				-	S	130	62.4	11157	6334	4824	42	89	61	0.6	27	1.02	2	1	1.27	108	70
19D	Bedrock	91	506.1	75/3"	100					-	S	130	62.4	11807	6646	5162	100	94	62	0.6	62	1.03	3	1	1.30	403	251

		ϕ (deg) Friction Angle																									
Sample Number	Dr (%)	ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	k dry (pci)	k wet (pci)	k used (pci)	β (Bhushan, 1986)	ϕ used	24 in Diam PP V/V (ft^3/ft)	Kδ	Cf	δ/ϕ
1D	55	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	36.0	31.8	25.8	30.8	22.7	24.5	28.4	32.3	36.0		116	71		0.54	30	3.14	1.22	0.95	0.8
2D	100	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	48.0	46.5	28.2	33.2	28.2	30.2	36.2	42.2	48.0		384	226		0.83	30	3.14	1.22	0.95	0.8
3D	52	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	34.5	34.1	25.9	30.9	23.5	25.2	28.9	32.6	34.5		103	64		0.52	30	3.14	1.22	0.95	0.8
4D	52	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	34.7	34.1	26.1	31.1	24.2	25.8	29.4	32.9	34.7		106	66		0.52	30	3.14	1.22	0.95	0.8
5D	65	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	38.5	39.0	26.8	31.8	26.8	27.9	32.0	36.2	39.0	30	163	98	90	0.60	30	3.14	1.22	0.95	0.8
6D	69	38.4	33.4	28.4	32.3	33.6	30.0	31.5	31.5	39.6	40.0	27.3	32.3	27.3	29.0	33.2	37.4	40.0		184	110		0.63	30	3.14	1.22	0.95	0.8
7D	51	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	34.0	34.8	26.4	31.4	25.4	26.9	30.2	33.5	35.4		101	63		0.51	30	3.14	1.22	0.95	0.8
8D	70	39.7	34.7	29.7	34.0	34.8	31.4	32.5	32.3	39.6	41.0	27.7	32.7	27.7	30.1	34.2	38.3	41.0		186	111		0.63	30	3.14	1.22	0.95	0.8
9D	76	41.6	36.6	31.6	36.4	36.8	33.6	34.0	33.7	41.2	43.2	28.5	33.5	28.5	31.5	35.9	40.3	43.2		220	131		0.67	30	3.14	1.22	0.95	0.8
10D	71	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	40.0	41.9	28.3	33.3	28.3	31.3	35.4	39.5	41.9		196	117		0.64	34	3.14	1.76	0.93	0.8
11D	59	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	36.3	37.9	27.4	32.4	27.4	29.6	33.0	36.5	38.9		133	81		0.56	34	3.14	1.76	0.93	0.8
12D	49	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	33.0	34.8	26.8	31.8	26.8	28.2	31.2	34.2	37.0		93	58		0.50	34	3.14	1.76	0.93	0.8
13D	70	42.7	37.7	32.7	37.8	37.8	34.7	34.9	34.5	39.6	41.9	28.9	33.9	28.9	32.5	36.4	40.4	42.7		189	113		0.64	34	3.14	1.76	0.93	0.8
14D	61	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	37.0	39.0	28.2	33.2	28.2	31.2	34.6	38.1	40.9	34	144	88	100	0.58	34	3.14	1.76	0.93	0.8
15D	59	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	36.4	38.4	28.2	33.2	28.2	31.2	34.6	37.9	40.9		136	83		0.57	34	3.14	1.76	0.93	0.8
16D	59	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	36.3	39.0	28.3	33.3	28.3	31.4	34.9	38.3	41.2		135	83		0.57	34	3.14	1.76	0.93	0.8
17D	88	49.7	44.7	39.7	46.9	45.0	42.7	41.1	41.0	43.8	49.7	32.7	37.7	32.7	38.0	42.9	47.8	49.7		296	175		0.75	34	3.14	1.76	0.93	0.8
18D	77	47.4	42.4	37.4	44.0	42.7	40.1	39.1	38.7	41.3	57.4	31.3	36.3	31.3	35.1	41.5	48.0	57.4		230	137		0.68	34	3.14	1.76	0.93	0.8
19D	100	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	49.2	90.9	40.0	45.0	40.0	41.0	54.0	67.0	90.9		384	226		0.83	34	3.14	1.76	0.93	0.8

																	with Scour (El. 561)	DD Load (Liquefied to El. 565)		
Sample Number	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)	RF*(Fs+Fp) (kip)	Unfactored DD (kip)	DD Load Factor	Factored DD (kip)
1D	24.0	0.47	0.50	27	6.3	83	0	0.50	30	20	1	1	2	3	0.45	1	0			
2D	24.0	0.47	0.65	205	6.3	3726	4	0.5	30	20	5	5	15	19	0.45	8	0			
3D	24.0	0.47	0.49	286	6.3	11437	11	0.5	30	20	9	9	27	39	0.45	17	0			
4D	24.0	0.47	0.50	418	6.3	22482	22	0.5	30	20	13	13	40	62	0.45	28	0			
5D	24.0	0.47	0.54	593	6.3	38357	38	0.5	30	20	17	17	52	90	0.45	41	0			
6D	24.0	0.47	0.55	753	6.3	59499	59	0.5	30	20	21	20	63	122	0.45	55	0			
7D	24.0	0.47	0.49	803	6.3	83931	84	0.5	30	20	24	20	63	147	0.45	66	0	84	1.05	88
8D	24.0	0.47	0.55	1044	6.3	112943	113	0.5	30	20	28	20	63	176	0.45	79	0			
9D	24.0	0.47	0.57	1232	6.3	148709	149	0.5	30	20	32	20	63	212	0.45	95	44			
10D	27.2	0.75	0.70	1684	6.3	194524	195	0.6	55	75	80	75	236	430	0.45	194	143			
11D	27.2	0.75	0.65	1773	6.3	248835	249	0.6	55	75	89	75	236	484	0.45	218	167			
12D	27.2	0.75	0.62	1869	6.3	306046	306	0.6	55	75	99	75	236	542	0.45	244	193			
13D	27.2	0.75	0.69	2272	6.3	371094	371	0.6	55	75	106	75	236	607	0.45	273	222			
14D	27.2	0.75	0.66	2368	6.3	443978	444	0.6	55	75	106	75	236	680	0.45	306	255			
15D	27.2	0.75	0.66	2537	6.3	521026	521	0.6	55	75	106	75	236	757	0.45	340	290			
16D	27.2	0.75	0.66	2724	6.3	603673	604	0.6	55	75	106	75	236	839	0.45	378	327			
17D	27.2	0.75	0.75	3360	6.3	699236	699	0.6	55	75	106	75	236	935	0.45	421	370			
18D	27.2	0.75	0.72	3451	6.3	806224	806	0.6	55	75	106	75	236	1042	0.45	469	418			
19D	27.2	0.75	0.79	4073	6.3	924416	924	0.6	55	75	106	75	236	1160	0.45	522	471			

Project: Martin Memorial Bridge
Rumford, ME
Subject: Soil Parameters Derivation from SPT and Pile Geotechnical Resistance Calculations
Prepared by: EK/JLL
Checked by: JLL
Date: 03-Dec-2012
File No: 38799-000

Pier No. 2
BB-RAR-117

GS El. (ft) = 596.1
GW Depth (ft) = -16.5

D = 24 in
Atip = 3.14 ft^2

Sample Number	Field Description	Depth (ft)	El. (ft)	Lab/Field: Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/Sand	Stress Calculations: γt (pcf)	γw (pcf)	σv (psf)	pw (psf)	σ'v (psf)	SPT Correction: N Value	Length of Rod	Hammer Efficiency	CN	N1	CE	CB	CR	CS	N60	(N1)60	Dr (%)	ϕ (deg) Friction Angle: Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used
1D	Alluvial Deposits	1	595.1	3	3	SW				-	S	115	62.4	1145	1092	53	3	4	60	1.7	5	1	1	0.75	1.10	2	4	43	21.0	23.1	26.7	30.2	31.5	
2D	Alluvial Deposits	7	589.1	8	8	SP				-	S	115	62.4	1835	1466	368	8	10	60	1.7	14	1	1	0.75	1.14	7	12	63	24.8	26.1	30.2	34.4	38.3	
3D	Alluvial Deposits	12	584.1	5	5	SP				-	S	115	62.4	2410	1778	631	5	15	60	1.7	9	1	1	0.85	1.10	5	8	47	22.7	24.7	28.2	31.7	32.7	
4D	Alluvial Deposits	17	579.1	5	5	SP				-	S	115	62.4	2985	2090	894	5	20	60	1.5	7	1	1	0.85	1.10	5	7	44	22.7	24.7	28.0	31.3	32.7	28
5D	Alluvial Deposits	22	574.1	5	5	SP				-	S	115	62.4	3560	2402	1157	5	25	60	1.3	7	1	1	0.95	1.10	5	7	42	22.7	24.7	27.9	31.1	32.7	
6D	Alluvial Deposits	27	569.1	7	7	ML				-	S	115	62.4	4135	2714	1420	7	30	60	1.2	8	1	1	0.95	1.10	7	9	47	24.2	25.9	29.1	32.3	34.2	
7D	Alluvial Deposits	32	564.1	10	10	SP				-	S	115	62.4	4710	3026	1683	10	35	60	1.1	11	1	1	1.11	11	12	54	26.0	27.4	30.7	34.1	36.0	
8D	Alluvial Deposits	37	559.1	16	16	SM				-	S	120	62.4	5310	3338	1971	16	40	60	1.0	16	1	1	1.16	19	19	65	27.4	29.5	33.3	37.2	39.5	
9D	Alluvial Deposits	42	554.1	17	17	SM				-	S	120	62.4	5910	3650	2259	17	45	60	0.9	16	1	1	1.16	20	19	64	27.6	29.9	33.6	37.4	39.5	
10D	Alluvial Deposits	47	549.1	11	11	SP-SM				-	S	120	62.4	6510	3962	2547	11	50	60	0.9	10	1	1	1.10	12	11	50	26.5	27.8	30.9	33.9	36.5	
11D	Alluvial Deposits	52	544.1	18	18	SW				-	S	120	62.4	7110	4274	2835	18	55	60	0.8	15	1	1	1.15	21	17	61	27.7	30.3	33.8	37.2	39.7	
12D	Alluvial Deposits	57	539.1	20	20	SM				-	S	120	62.4	7710	4586	3123	20	60	60	0.8	16	1	1	1.16	23	19	63	28.0	30.9	34.4	38.0	40.5	32
13D	Alluvial Deposits	62	534.1	21	21	SM				-	S	120	62.4	8310	4898	3411	21	65	60	0.8	16	1	1	1.16	24	19	62	28.2	31.2	34.7	38.3	40.9	
14D	Alluvial Deposits	67	529.1	26	26	SM				-	S	120	62.4	8910	5210	3699	26	70	60	0.7	19	1	1	1.19	31	23	67	28.9	32.5	36.3	40.1	42.7	
15D	Alluvial Deposits	72	524.1	28	28	SP-SM				-	S	120	62.4	9510	5522	3987	28	75	60	0.7	20	1	1	1.20	34	24	68	29.2	33.0	36.9	40.7	43.3	
16D	Alluvial Deposits	77	519.1	32	32	SM				-	S	120	62.4	10110	5834	4275	32	80	60	0.7	22	1	1	1.22	39	27	71	29.8	33.9	38.0	42.1	44.6	
17D	Alluvial Deposits	82	514.1	108	100	SW-sM				-	S	125	62.4	10735	6146	4588	100	85	60	0.7	66	1	1	1.30	130	86	100	40.0	44.9	51.6	58.3	61.5	
18D	Alluvial Deposits	87	509.1	106	100	SW				-	S	125	62.4	11360	6458	4901	100	90	60	0.6	64	1	1	1.30	130	83	100	40.0	44.9	51.5	58.1	60.7	
19D	Alluvial Deposits	92	504.1	100/5"	100	SW				-	S	125	62.4	11985	6770	5214	100	95	60	0.6	62	1	1	1.30	130	81	100	40.0	44.9	51.4	58.0	60.2	45
20D	Alluvial Deposits	97	499.1	177/11"	100	SW				-	S	125	62.4	12610	7082	5527	100	100	61	0.6	60	1.02	2	1	1.30	264	159	100	40.0	43.2	52.7	62.3	76.4	
21D	Alluvial Deposits	101	495.1	100/5"	100	SW				-	S	125	62.4	13110	7332	5778	100	104	62	0.6	59	1.03	3	1	1.30	403	237	100	40.0	41.2	53.8	66.3	88.8	
22D	Glacial Till	106	490.1	100/5"	100	SM				-	S	130	62.4	13760	7644	6116	100	109	63	0.6	57	1.05	4	1	1.30	546	312	100	40.0	39.3	54.6	69.8	99.0	
23D	Glacial Till	111	485.1	100/3"	100	ML				-	S	130	62.4	14410	7956	6454	100	114	64	0.6	56	1.07	5	1	1.30	693	386	100	40.0	37.6	55.3	72.9	107.9	45
24D	Glacial Till	116	480.1	150	100	-				-	S	130	62.4	15060	8268	6792	100	119	65	0.5	54	1.08	6	1	1.30	845	459	100	40.0	36.1	55.9	75.7	115.8	

Sample Number	Dr (%)	ϕ used	Geotechnical Resistance Calculations: k dry (pci)	k wet (pci)	k used (pci)	β (Bhushan, 1986)	ϕ used	24 in Diam PP V/V (ft^3/ft)	KB	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)	RF*(Fs+Fp) (kip)	with Scour (El. 561) Unfactored DD (kip)	DD Load (Liquefied to El. 565) DD Load Factor	Factored DD (kip)
1D	43		70	45		0.46	28	3.14	1.09	0.95	0.8	22.4	0.39	0.43	22	6.3	70	0	0.40	23	20	0	0	2	2	0.45	1	0			
2D	63		153	93		0.59	28	3.14	1.09	0.95	0.8	22.4	0.39	0.49	181	6.3	3908	4	0.4	23	20	3	3	11	15	0.45	7	0			
3D	47		83	53		0.48	28	3.14	1.09	0.95	0.8	22.4	0.39	0.44	277	6.3	11103	11	0.4	23	20	6	6	18	29	0.45	13	0			
4D	44		74	47	55	0.46	28	3.14	1.09	0.95	0.8	22.4	0.39	0.43	384	6.3	21486	21	0.4	23	20	8	8	26	47	0.45	21	0			
5D	42		66	43		0.45	28	3.14	1.09	0.95	0.8	22.4	0.39	0.42	489	6.3	35197	35	0.4	23	20	11	11	33	69	0.45	31	0			
6D	47		84	53		0.48	28	3.14	1.09	0.95	0.8	22.4	0.39	0.44	624	6.3	52676	53	0.4	23	20	13	13	41	94	0.45	42	0			
7D	54		110	68		0.53	28	3.14	1.09	0.95	0.8	22.4	0.39	0.46	776	6.3	74674	75	0.4	23	20	15	15	49	123	0.45	55	0	75	1.05	78
8D	65		162	97		0.60	32	3.14	1.49	0.94	0.8	25.6	0.61	0.60	1189	6.3	105544	106	0.55	40	25	43	25	79	184	0.45	83	0			
9D	64		158	96		0.60	32	3.14	1.49	0.94	0.8	25.6	0.61	0.60	1358	6.3	145543	146	0.55	40	25	50	25	79	224	0.45	101	53			
10D	50		95	59		0.50	32	3.14	1.49	0.94	0.8	25.6	0.61	0.55	1411	6.3	189034	189	0.55	40	25	56	25	79	268	0.45	120	73			
11D	61		145	88		0.58	32	3.14	1.49	0.94	0.8	25.6	0.61	0.59	1678	6.3	237562	238	0.55	40	25	62	25	79	316	0.45	142	95			
12D	63	95	151	91	95	0.59	32	3.14	1.49	0.94	0.8	25.6	0.61	0.60	1861	6.3	293162	293	0.55	40	25	69	25	79	372	0.45	167	120			
13D	62		149	90		0.58	32	3.14	1.49	0.94	0.8	25.6	0.61	0.59	2029	6.3	354265	354	0.55	40	25	70	25	79	433	0.45	195	147			
14D	67		174	105		0.62	32	3.14	1.49	0.94	0.8	25.6	0.61	0.61	2260	6.3	421636	422	0.55	40	25	70	25	79	500	0.45	225	178			
15D	68		177	107		0.62	32	3.14	1.49	0.94	0.8	25.6	0.61	0.61	2445	6.3	495547	496	0.55	40	25	70	25	79	574	0.45	258	211			
16D	71		192	115		0.64	32	3.14	1.49	0.94	0.8	25.6	0.61	0.62	2661	6.3	575747	576	0.55	40	25	70	25	79	654	0.45	294	247			
17D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	5787	6.3	708448	708	0.8	500	700	1280	700	2199	2908	0.45	1308	1261			
18D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	6182	6.3	896460	896	0.8	500	700	1280	700	2199	3096	0.45	1393	1346			
19D	100		384	226	125	0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	6577	6.3	1096874	1097	0.8	500	700	1280	700	2199	3296	0.45	1483	1436			
20D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	6972	6.3	1309691	1310	0.8	500	700	1280	700	2199	3509	0.45	1579	1531			
21D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	7287	6.3	1488875	1489	0.8	500	700	1280	700	2199	3688	0.45	1660	1612			
22D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	7714	6.3	1724513	1725	0.8	500	700	1280	700	2199	3924	0.45	1766	1718			
23D	100		384	226	125	0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	8140	6.3	1973544	1974	0.8	500	700	1280	700	2199	4173	0.45	1878	1830			
24D	100		384	226		0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	8566	6.3	2235969	2236	0.8	500	700	1280	700	2199	4435	0.45	1996	1948			

Pier No. 2
BB-RAR-118

GS El. (ft)= 596.8
GWr Depth (ft) = -15.8 ft

Sample Number	Field Description	Depth (ft)	El. (ft)	Lab/Field: Original SPT	SPT or RQD Used	ASTM	AASHTO	PL	LL	PI (%)	Clay/Sand	Stress Calculations: γt (pcf)	γw (pcf)	σv (psf)	pw (psf)	σ'v (psf)	SPT Correction: N Value	Length of Rod	Hammer Efficiency	CN	N1	CE	CB	CR	CS	N60	(N1)60	Dr (%)	ϕ (deg) Friction Angle: Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used
1D	Alluvial Deposits	1	595.8	5	5	SW				-	S	115	62.4	1101	1048	53	5	4	60	1.7	9	1	1	0.75	1.10	4	7	55	22.7	24.5	28.4	32.3	36.0	
2D	Alluvial Deposits	6	590.8	8	8	SW				-	S	115	62.4	1676	1360	316	8	9	60	1.7	14	1	1	0.75	1.14	7	12	64	24.8	26.1	30.3	34.5	38.7	
3D	Alluvial Deposits	11	585.8	5	5	SP				-	S	115	62.4	2251	1672	579	5	14	60	1.7	9	1	1	0.85	1.10	5	8	47	22.7	24.7	28.2	31.7	32.9	
4D	Alluvial Deposits	16	580.8	4	4	SM				-	S	115	62.4	2826	1984	842	4	19	60	1.5	6	1	1	0.85	1.10	4	6	40	21.9	24.0	27.3	30.5	31.9	28
5D	Alluvial Deposits	21	575.8	5	5	SM				-	S	115	62.4	3401	2296	1105	5	24	60	1.3	7	1	1	0.95	1.10	5	7	42	22.7	24.7	27.9	31.1	32.7	
6D	Alluvial Deposits	26	570.8	5	5	SM				-	S	115	62.4	3976	2608	1368	5	29	60	1.2	6	1	1	0.95	1.10	5	6	40	22.7	24.8	27.8	30.8	32.7	
7D	Alluvial Deposits	31	565.8	7	7	SM				-	S	115	62.4	4551	2920	1631	7	34	60	1.1	8	1	1	1.10	8	9	45	24.2	25.9	29.1	32.2	34.2	
8D	Alluvial Deposits	36	560.8	20	20	SM				-	S	120	62.4	5151	3232	1919	20	39	60	1.0	20	1	1	1.20	24	25	73	28.0	30.6	34.9	39.3	42.4	
9D	Alluvial Deposits	41	555.8	22	22	SM				-	S	120	62.4	5751	3544	2207	22	44	60	1.0	21	1	1	1.21	27	25	73	28.3	31.3	35.5	39.7	42.4	
10D	Alluvial Deposits	46	550.8	26	26	SP				-	S	120	62.4	6351	3856	2495	26	49	60	0.9	23	1	1	1.23	32	29	77	28.9	32.4	36.8	41.2	44.1	
11D	Alluvial Deposits	51	545.8	24	24	SW				-	S	120	62.4	6951	4168	2783	24	54	60	0.8	20	1	1	1.20	29	24	71	28.6	31.9	35.9	40.0	42.0	
12D	Alluvial Deposits	56	540.8	30	30	SM				-	S	120	62.4	7551	4480	3071	30	59	60	0.8	24	1	1	1.24	37	30	77	29.5	33.4	37.8	42.1	44.5	
13D	Alluvial Deposits	61	535.8	22	22	SP-SM				-	S	120	62.4	8151	4792	3359	22	64	60	0.8	17	1	1	1.17	26	20	64	28.3	31.4	35.1	38.7	41.2	
14D	Glaciofluvial Deposits	66	530.8	100/2"	100	SW				-	S	125	62.4	8776	5104	3672	100	69	60	0.7	74	1	1	1.30	130	96	100	40.0	44.9	52.0	59.0	63.8	45
MD	Bedrock	71	525.8	50/0"	100	-				-	S	140	62.4	9476	5416	4060	100	74	60	0.7	70	1	1	1.30	130	91	100	40.0	45.0	51.8	58.6	62.7	

Sample Number	Dr (%)	ϕ used	Geotechnical Resistance Calculations: k dry (pci)	k wet (pci)	k used (pci)	β (Bhushan, 1986)	ϕ used	24 in Diam PP V/V (ft^3/ft)	KB	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)	RF*(Fs+Fp) (kip)	with Scour (El. 561) Unfactored DD (kip)	DD Load (Liquefied to El. 565) DD Load Factor	Factored DD (kip)
1D	55		116	71		0.54	28	3.14	1.09	0.95	0.8	22.4	0.39	0.47	24	6.3	77	0	0.40	23	20	0	0	2	2	0.45	1	0			
2D	64		158	95		0.60	28	3.14	1.09	0.95	0.8	22.4	0.39	0.50	156	6.3	2917	3	0.4	23	20	3	3	9	12	0.45	5	0			
3D	47		86	54		0.49	28	3.14	1.09	0.95	0.8	22.4	0.39	0.44	255	6.3	9376	9	0.4	23	20	5	5	17	26	0.45	12	0			
4D	44		61	40	55	0.44	28	3.14	1.09	0.95	0.8	22.4	0.39	0.42	350	6.3	18881	19	0.4	23	20	8	8	24	43	0.45	19	0			
5D	42		68	44		0.45	28	3.14	1.09	0.95	0.8	22.4	0.39	0.42	468	6.3	31733	32	0.4	23	20	10	10	32	64	0.45	29	0			
6D	40		61	40		0.44	28	3.14	1.09	0.95	0.8	22.4	0.39	0.42	570	6.3	48043	48	0.4	23	20	13	13	40	88	0.45	39	0			
7D	45		79	50		0.47	28	3.14	1.09	0.95	0.8	22.4	0.39	0.43	708	6.3	68122	68	0.4	23	20	15	15	47	115	0.45	52	0	68	1.05	72
8D	73		205	122		0.65	33	3.14	1.62	0.93	0.8	26.4	0.67	0.66	1270	6.3	99195	99	0.6	45	50	52	50	157	256	0.45	115	0			
9D	73		208	124		0.66	33	3.14	1.62	0.93	0.8	26.4	0.67	0.66	1464	6.3	142154	142	0.6	45	50	60	50	157	299	0.45	135	90			
10D	77	33	227	135	120	0.68	33	3.14	1.62	0.93	0.8	26.4	0.67	0.67	1683	6.3	191596	192	0.6	45	50	67	50	157	349	0.45	157	112			
11D	71		195	117		0.64	33	3.14	1.62	0.93	0.8	26.4	0.67	0.66	1827	6.3	246734	247	0.6	45	50	75	50	157	404	0.45	182	137			
12D	77		229	136		0.68	33	3.14	1.62	0.93	0.8	26.4	0.67	0.68	2074	6.3	308012	308	0.6	45	50	83	50	157	465	0.45	209	165			
13D	64		158	95		0.60	33	3.14	1.62	0.93	0.8	26.4	0.67	0.63	2126	6.3	373984	374	0.6	45	50	86	50	157	531	0.45	239	194			
14D	100		384	226	125	0.83	45	3.14	3.31	0.87	0.8	36.0	1.69	1.26	4631	6.3	480120	480	0.8	500	700	1280	700	2199	2679	0.45	1206	1161			
MD	100		384	226																											

Project: Martin Memorial Bridge
Rumford, ME
Subject: Soil Parameters Derivation from SPT and Pile Geotechnical Resistance Calculations
Prepared by: EK/JLL
Checked by: JLL
Date: 03-Dec-2012
File No: 38799-000

D = 14 in

Atip = 1.07 ft^2

Abutment 2
BB-RAR-119

GS El. (ft) = 599.6

GWr Depth (ft) = 0.0

Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	Lab/Field: ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	Stress Calculations: gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)
1D	Alluvial Deposits	1	598.6	1	1	SP				-	S	115	62.4	115	62	53
2D	Alluvial Deposits	4	595.6	22	22	SP				-	S	115	62.4	460	250	210
3D	Alluvial Deposits	9	590.6	7	7	SP				-	S	115	62.4	1035	562	473
4D	Alluvial Deposits	14	585.6	7	7	SP				-	S	115	62.4	1610	874	736
5D	Alluvial Deposits	19	580.6	11	11	SP				-	S	115	62.4	2185	1186	999
6D	Alluvial Deposits	24	575.6	9	9	SP				-	S	115	62.4	2760	1498	1262
7D	Alluvial Deposits	29	570.6	7	7	SP				-	S	115	62.4	3335	1810	1525
8D	Alluvial Deposits	34	565.6	6	6	SP				-	S	115	62.4	3910	2122	1788
9D	Glaciofluvial Deposits	39	560.6	17	17	SW				-	S	120	62.4	4510	2434	2076
10D	Glaciofluvial Deposits	44	555.6	25	25	SM				-	S	120	62.4	5110	2746	2364
11D	Glaciofluvial Deposits	48.5	551.1	39	39	SM				-	S	120	62.4	5650	3026	2624
12D	Glaciofluvial Deposits	54	545.6	-	-	SP				-	S	120	62.4	6310	3370	2940
13D	Glaciofluvial Deposits	59	540.6	-	-	SP				-	S	120	62.4	6910	3682	3228
14D	Glaciofluvial Deposits	53.5	546.1	154	100	SP				-	S	120	62.4	6250	3338	2912
15D	Glacial Till	69	530.6	-	100	SW				-	S	130	62.4	8265	4306	3959
16D	Glacial Till	74	525.6	-	100	SW				-	S	130	62.4	8915	4618	4297
17D	Glacial Till	79	520.6	-	100	SW				-	S	130	62.4	9565	4930	4635
18D	Glacial Till	83	516.6	-	100	SM				-	S	130	62.4	10085	5179	4906
19D	Glacial Till	88	511.6	-	100	SM				-	S	130	62.4	10735	5491	5244

Sample Number	SPT Correction: N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)
1D	1	4	60	1.7	2	1	1	0.75	1.10	1	1	25
2D	22	7	60	1.7	37	1	1	0.75	1.30	21	36	100
3D	7	12	60	1.7	12	1	1	0.8	1.12	6	11	57
4D	7	17	60	1.6	12	1	1	0.85	1.12	7	11	54
5D	11	22	60	1.4	16	1	1	0.95	1.16	12	17	64
6D	9	27	60	1.3	11	1	1	0.95	1.11	10	12	55
7D	7	32	60	1.1	8	1	1	1	1.10	8	9	46
8D	6	37	60	1.1	6	1	1	1	1.10	7	7	41
9D	17	42	60	1.0	17	1	1	1	1.17	20	19	66
10D	25	47	60	0.9	23	1	1	1	1.23	31	28	77
11D	39	52	60	0.9	34	1	1	1	1.30	51	44	93
12D	-	57	60	0.8	#VALUE!	1	1	1	####	####	######	#VALUE!
13D	-	62	60	0.8	#VALUE!	1	1	1	####	####	######	#VALUE!
14D	100	57	60	0.8	83	1	1	1	1.30	130	108	100
15D	100	72	60	0.7	71	1	1	1	1.30	130	92	100
16D	100	77	60	0.7	68	1	1	1	1.30	130	89	100
17D	100	82	60	0.7	66	1	1	1	1.30	130	85	100
18D	100	86	60	0.6	64	1	1	1	1.30	130	83	100
19D	100	91	60	0.6	62	1	1	1	1.30	130	80	100

Sample Number	ϕ (deg) Friction Angle: ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	k dry (pci)	k wet (pci)	k used (pci)
1D	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	22.8	24.5	25.2	30.2	18.5	20.3	24.1	27.9	30.2		23	19	
2D	41.2	36.2	31.2	36.0	36.4	33.2	33.7	33.4	49.2	46.8	28.3	33.3	28.3	30.4	36.6	42.8	49.2		384	226	
3D	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	36.5	34.8	26.1	31.1	24.2	25.7	29.6	33.5	36.5		126	77	
4D	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	35.1	34.8	26.1	31.1	24.2	25.8	29.5	33.2	35.1	28	111	69	60
5D	36.5	31.5	26.5	29.8	31.6	27.8	30.2	30.3	38.2	38.4	26.7	31.7	26.5	27.5	31.6	35.7	38.4		156	94	
6D	35.4	30.4	25.4	28.4	30.5	26.6	29.5	29.8	35.2	35.5	26.4	31.4	25.4	26.9	30.4	33.9	35.5		115	71	
7D	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	32.1	33.4	26.1	31.1	24.2	25.9	29.1	32.3	34.2		81	52	
8D	33.5	28.5	23.5	26.0	28.6	24.5	28.5	28.9	30.0	31.8	25.9	30.9	23.5	25.4	28.4	31.4	33.5		64	42	
9D	39.3	34.3	29.3	33.4	34.4	31.0	32.2	32.0	38.5	39.5	27.6	32.6	27.6	29.9	33.7	37.5	39.5		166	100	
10D	42.3	37.3	32.3	37.4	37.5	34.4	34.6	34.3	41.4	43.7	28.8	33.8	28.8	32.1	36.5	40.8	43.7		226	135	
11D	46.6	41.6	36.6	42.9	41.9	39.2	38.4	38.0	45.0	49.7	30.9	35.9	30.9	35.4	40.6	45.7	49.7	34	330	194	125
12D	######	#VALUE!	#VALUE!	######	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-		-	-	-		#VALUE!	#VALUE!	
13D	######	#VALUE!	#VALUE!	######	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-		-	-	-		#VALUE!	#VALUE!	
14D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	53.4	66.5	40.0	45.0	40.0	44.9	52.3	59.8	66.5		384	226	
15D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	51.2	62.9	40.0	45.0	40.0	45.0	51.8	58.7	62.9		384	226	
16D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	50.6	62.2	40.0	45.0	40.0	44.9	51.7	58.5	62.2		384	226	
17D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	50.1	61.2	40.0	45.0	40.0	44.9	51.6	58.3	61.2	45	384	226	125
18D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	49.6	60.7	40.0	45.0	40.0	44.9	51.5	58.1	60.7		384	226	
19D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	49.1	60.0	40.0	45.0	40.0	44.9	51.4	58.0	60.0		384	226	

Sample Number	Geotechnical Resistance Calculations: β (Bhushan, 1986)	ϕ used	V/V (ft^3/ft)	Kδ	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)
1D	0.34	28	1.07	0.97	0.83	0.59	16.5	0.23	0.28	15	3.7	27	0	0.45	23	20	1	1	1	1	0.45	0
2D	0.83	28	1.07	0.97	0.83	0.59	16.5	0.23	0.53	111	3.7	722	1	0.45	23	20	2	2	2	3	0.45	1
3D	0.55	28	1.07	0.97	0.83	0.59	16.5	0.23	0.39	185	3.7	3438	3	0.45	23	20	5	5	5	9	0.45	4
4D	0.53	28	1.07	0.97	0.83	0.59	16.5	0.23	0.38	279	3.7	7690	8	0.45	23	20	8	8	8	16	0.45	7
5D	0.59	28	1.07	0.97	0.83	0.59	16.5	0.23	0.41	411	3.7	14011	14	0.45	23	20	10	10	11	25	0.45	11
6D	0.53	28	1.07	0.97	0.83	0.59	16.5	0.23	0.38	482	3.7	22194	22	0.45	23	20	13	13	14	36	0.45	16
7D	0.48	28	1.07	0.97	0.83	0.59	16.5	0.23	0.35	540	3.7	31558	32	0.45	23	20	16	16	17	48	0.45	22
8D	0.45	28	1.07	0.97	0.83	0.59	16.5	0.23	0.34	603	3.7	42026	42	0.45	23	20	19	19	20	62	0.45	28
9D	0.61	34	1.07	1.5	0.77	0.59	20.1	0.40	0.50	1042	3.7	57095	57	0.65	55	75	74	74	79	136	0.45	61
10D	0.68	34	1.07	1.5	0.77	0.59	20.1	0.40	0.54	1270	3.7	78281	78	0.65	55	75	85	75	80	158	0.45	71
11D	0.78	34	1.07	1.5	0.77	0.59	20.1	0.40	0.59	1546	3.7	101501	102	0.65	55	75	94	75	80	182	0.45	82
12D	0.78	34	1.07	1.5	0.77	0.59	20.1	0.40	0.59	1732	3.7	134538	135	0.65	55	75	105	75	80	215	0.45	97
13D	0.78	34	1.07	1.5	0.77	0.59	20.1	0.40	0.59	1902	3.7	167837	168	0.65	55	75	114	75	80	248	0.45	112
14D	0.83	34	1.07	1.5	0.77	0.59	20.1	0.40	0.61	1785	3.7	130676	131	0.65	55	75	104	75	80	211	0.45	95
15D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3196	3.7	272167	272	0.8	500	700	1280	700	748	1020	0.45	459
16D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3469	3.7	333239	333	0.8	500	700	1280	700	748	1082	0.45	487
17D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3742	3.7	399311	399	0.8	500	700	1280	700	748	1148	0.45	516
18D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3960	3.7	455769	456	0.8	500	700	1280	700	748	1204	0.45	542
19D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	4233	3.7	530841	531	0.8	500	700	1280	700	748	1279	0.45	576

Abutment 2
BB-RAR-120

GS El. (ft)= 600.1

GWr Depth (ft) = 0.0 ft

Sample Number	Field Description	Depth (ft)	El. (ft)	Original SPT	SPT or RQD Used	Lab/Field: ASTM	AASHTO	PL	LL	PI (%)	Clay/ Sand	Stress Calculations: gt (pcf)	gw (pcf)	σ_v (psf)	pw (psf)	σ'_v (psf)
1D	Alluvial Deposits	1	599.1	0	1	SM				-	S	115	62.4	115	62	53
2D	Alluvial Deposits	5	595.1	21	21	SM				-	S	115	62.4	575	312	263
3D	Alluvial Deposits	10	590.1	7	7	SP-SM				-	S	115	62.4	1150	624	526
4D	Alluvial Deposits	15	585.1	8	8	SP				-	S	115	62.4	1725	936	789
5D	Alluvial Deposits	20	580.1	7	7	SP				-	S	115	62.4	2300	1248	1052
6D	Alluvial Deposits	25	575.1	12	12	SM				-	S	115	62.4	2875	1560	1315
7D	Alluvial Deposits	30	570.1	16	16	SM				-	S	115	62.4	3450	1872	1578
8D	Alluvial Deposits	35	565.1	10	10	SM				-	S	115	62.4	4025	2184	1841
9D	Alluvial Deposits	40	560.1	20	20	SM				-	S	115	62.4	4600	2496	2104
10D	Glaciofluvial Deposits	45	555.1	5	5	ML				-	S	115	62.4	5175	2808	2367
11D	Glaciofluvial Deposits	50	550.1	29	29	ML				-	S	120	62.4	5775	3120	2655
12D	Glaciofluvial Deposits	55	545.1	23	23	SM				-	S	120	62.4	6375	3432	2943
13D	Glaciofluvial Deposits	60	540.1	14	14	SM				-	S	120	62.4	6975	3744	3231
14D	Glaciofluvial Deposits	65	535.1	38	38	SW				-	S	120	62.4	7575	4056	3519
15D	Glaciofluvial Deposits	75	525.1	100/5"	100	SM				-	S	120	62.4	8775	4680	4095
16D	Glaciofluvial Deposits	79.5	520.6	100/6"	100	SW-SM				-	S	120	62.4	9315	4961	4354
MD	Glacial Till	84	516.1	100/6"	100	-				-	S	130	62.4	9900	5242	4658

Sample Number	SPT Correction: N Value	Length of Rod	Hammer Efficiency	C_N	N_1	C_E	C_B	C_R	C_S	N_{60}	$(N1)_{60}$	Dr (%)
1D	1	4	60	1.7	2	1	1	0.75	1.10	1	1	25
2D	21	8	60	1.7	36	1	1	0.75	1.30	20	35	100
3D	7	13	60	1.7	12	1	1	0.85	1.12	7	11	57
4D	8	18	60	1.6	13	1	1	0.85	1.13	8	12	57
5D	7	23	60	1.4	10	1	1	0.95	1.10	7	10	50
6D	12	28	60	1.2	15	1	1	0.95	1.15	13	16	62
7D	16	33	60	1.1	18	1	1	1	1.18	19	21	69
8D	10	38	60	1.0	10	1	1	1	1.10	11	12	52
9D	20	43	60	1.0	19	1	1	1	1.19	24	23	71
10D	5	48	60	0.9	5	1	1	1	1.10	6	5	34
11D	29	53	60	0.9	25	1	1	1	1.25	36	32	80
12D	23	58	60	0.8	19	1	1	1	1.19	27	23	68
13D	14	63	60	0.8	11	1	1	1	1.11	16	12	52
14D	38	68	60	0.8	29	1	1	1	1.29	49	37	83
15D	100	78	60	0.7	70	1	1	1	1.30	130	91	100
16D	100	83	60	0.7	68	1	1	1	1.30	130	88	100
MD	100	87	60	0.7	66	1	1	1	1.30	130	85	100

Sample Number	ϕ (deg) Friction Angle: ϕ1 (deg)	ϕ2 (deg)	ϕ3 (deg)	ϕ4 (deg)	ϕ5 (deg)	ϕ6 (deg)	PHT 1974 (deg)	PHT 1974 (2)	Schmertmann (1975)	H&U (1996)	Meyerhof 1 (deg)	Meyerhof 2 (deg)	Min	Ave - 1SD	Ave	Ave + 1SD	Max	ϕ used	k dry (pci)	k wet (pci)	k used (pci)
1D	28.5	23.5	18.5	19.5	23.5	18.9	26.7	27.4	22.8	24.5	25.2	30.2	18.5	20.3	24.1	27.9	30.2		23	19	
2D	40.9	35.9	30.9	35.5	36.0	32.7	33.4	33.2	48.4	46.5	28.2	33.2	28.2	30.1	36.2	42.3	48.4		384	226	
3D	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	36.2	34.8	26.1	31.1	24.2	25.7	29.6	33.4	36.2	28	123	75	60
4D	34.8	29.8	24.8	27.6	29.9	26.0	29.2	29.5	36.1	35.5	26.2	31.2	24.8	26.3	30.0	33.8	36.1		124	76	
5D	34.2	29.2	24.2	26.8	29.3	25.2	28.8	29.2	33.8	34.1	26.1	31.1	24.2	25.9	29.3	32.8	34.2		97	61	
6D	37.0	32.0	27.0	30.5	32.1	28.4	30.5	30.6	37.7	37.9	26.8	31.8	26.8	28.0	31.9	35.7	37.9		150	91	
7D	38.9	33.9	28.9	32.9	34.0	30.5	31.8	31.8	39.5	40.5	27.4	32.4	27.4	29.4	33.5	37.7	40.5	31	183	110	95
8D	36.0	31.0	26.0	29.1	31.1	27.2	29.9	30.0	34.3	35.5	26.5	31.5	26.0	27.4	30.7	34.0	36.0		105	65	
9D	40.5	35.5	30.5	35.0	35.7	32.3	33.1	32.9	40.0	41.4	28.0	33.0	28.0	30.7	34.8	38.9	41.4		194	116	
10D	32.7	27.7	22.7	25.0	27.8	23.7	28.1	28.6	27.0	30.0	25.8	30.8	22.7	24.6	27.5	30.4	32.7		45	31	
11D	43.7	38.7	33.7	39.1	38.8	35.9	35.7	35.3	42.1	45.3	29.4	34.4	29.4	33.1	37.7	42.2	45.3		244	145	
12D	41.6	36.6	31.6	36.4	36.8	33.6	34.0	33.7	39.2	41.4	28.5	33.5	28.5	31.7	35.6	39.5	41.6	33	180	108	100
13D	38.0	33.0	28.0	31.7	33.1	29.5	31.2	31.2	33.9	35.5	27.1	32.1	27.1	29.0	32.0	35.1	38.0		103	64	
14D	46.4	41.4	36.4	42.6	41.6	38.9	38.1	37.7	42.7	47.2	30.7	35.7	30.7	35.3	39.9	44.6	47.2		263	156	
15D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	51.0	62.7	40.0	45.0	40.0	44.9	51.8	58.6	62.7	45	384	226	125
16D	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	50.5	62.0	40.0	45.0	40.0	44.9	51.7	58.5	62.0		384	226	
MD	59.6	54.6	49.6	59.7	55.0	45.0	47.5	51.7	50.0	61.2	40.0	45.0	40.0	44.9	51.6	58.3	61.2	45	384	226	125

Sample Number	β (Bhushan, 1986)	ϕ used	V/V (ft^3/ft)	Kδ	Cf	δ/ϕ	δ	β (N/T)	β (ave)	fs (psf)	P (ft)	Fs (lbf)	Fs (kip)	at	N'q	qL (ksf)	at*Nq*s'v (ksf)	qp (ksf)	Fp (kip)	Fs+Fp (kip)	RF	RF*(Fs+Fp) (kip)
1D	0.34	28	1.07	0.97	0.83	0.59	16.5	0.23	0.28	15	3.7	27	0	0.45	23	20	1	1	1	1	0.45	0
2D	0.83	28	1.07	0.97	0.83	0.59	16.5	0.23	0.53	139	3.7	1158	1	0.45	23	20	3	3	3	4	0.45	2
3D	0.55	28	1.07	0.97	0.83	0.59	16.5	0.23	0.39	204	3.7	4305	4	0.45	23	20	5	5	6	10	0.45	5
4D	0.55	28	1.07	0.97	0.83	0.59	16.5	0.23	0.39	307	3.7	8987	9	0.45	23	20	8	8	9	18	0.45	8
5D	0.51	28	1.07	0.97	0.83	0.59	16.5	0.23	0.37	387	3.7	15340	15	0.45	23	20	11	11	12	27	0.45	12
6D	0.59	31	1.07	1.19	0.81	0.59	18.3	0.30	0.44	584	3.7	24235	24	0.55	40	25	29	25	27	51	0.45	23
7D	0.63	31	1.07	1.19	0.81	0.59	18.3	0.30	0.47	734	3.7	36313	36	0.55	40	25	35	25	27	63	0.45	28
8D	0.52	31	1.07	1.19	0.81	0.59	18.3	0.30	0.41	757	3.7	49971	50	0.55	40	25	41	25	27	77	0.45	35
9D	0.64	31	1.07	1.19	0.81	0.59	18.3	0.30	0.47	993	3.7	66005	66	0.55	40	25	46	25	27	93	0.45	42
10D	0.40	33	1.07	1.4	0.78	0.59	19.5	0.36	0.38	907	3.7	83422	83	0.65	45	50	69	50	53	137	0.45	62
11D	0.70	33	1.07	1.4	0.78	0.59	19.5	0.36	0.53	1409	3.7	104644	105	0.65	45	50	78	50	53	158	0.45	71
12D	0.63	33	1.07	1.4	0.78	0.59	19.5	0.36	0.49	1455	3.7	130887	131	0.65	45	50	86	50	53	184	0.45	83
13D	0.52	33	1.07	1.4	0.78	0.59	19.5	0.36	0.44	1422	3.7	157255	157	0.65	45	50	94	50	53	211	0.45	95
14D	0.72	33	1.07	1.4	0.78	0.59	19.5	0.36	0.54	1903	3.7	187726	188	0.65	45	50	94	50	53	241	0.45	109
15D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3306	3.7	283184	283	0.8	500	700	1280	700	748	1031	0.45	464
16D	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3515	3.7	339430	339	0.8	500	700	1280	700	748	1088	0.45	489
MD	0.83	45	1.07	2.7	0.65	0.59	26.6	0.78	0.81	3760	3.7	399426	399	0.8	500	700	1280	700	748	1148	0.45	516

HALEY & ALDRICH	CALCULATIONS	File No.	38799-000
		Sheet	1 of 1
Client	Maine Department of Transportation	Date	21FEB2013
Project	Martin Memorial Bridge, Rumford, Maine	Computed by	JLL
Subject	Pier 1 and 2 Pile Drag Load Calculation	Checked by	BCS

Objective:

Estimate the liquefaction-induced drag load (DD) on the piles at Piers 1 and 2 with consideration for the drag load on the tremie seal (i.e., adjust DD loads in previous pages to account for the tremie side area).

Assumptions:

- Mudline at El. 595.
- Bottom of liquefied zone is at El. 565.
- Bottom of tremie seal is at El. 582.
- Load factor for DD = 1.05

Calculations:

Total side area of piles between El. 595 and 582 = 2π*(595-582)ft*18 piles =	1470	ft^2
Area of tremie seal sides between El. 595 and 582 =	1820	ft^2

For Pier 1:

Unfactored Pile DD down to El. 582 = 20 to 21 kips, say =	21	kips
Unfactored Pile DD from calculations in previous pages =	88	kips
Factored Pile DD from calculations in previous pages = 1.05*DD =	92	kips
DD Adjusted for tremie seal side area = 88-21+(1820/1470)*21 =	93	kips
Factored DD adjusted for tremie seal side area = 1.05*93 kips =	98	kips

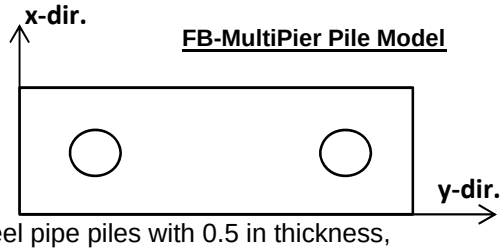
For Pier 2:

Unfactored Pile DD down to El. 582 = 15 to 16 kips, say =	16	kips
Unfactored Pile DD from calculations in previous pages =	72	kips
Factored Pile DD from calculations in previous pages = 1.05*DD =	75	kips
DD Adjusted for tremie seal side area = 72-16+(1820/1470)*16 =	76	kips
Factored DD adjusted for tremie seal side area = 1.05*76 kips =	80	kips

Lateral Pile Calculations

HALEY & ALDRICH	CALCULATIONS	File No.	38799-000
		Sheet	1 of 1
Client	Maine Department of Transportation	Date	08MAY2013
Project	Martin Memorial Bridge Replacement	Computed by	JLL
Subject	Abutment 1 FB-MultiPier Pile Group Analyses	Checked by	BCS

Files: G:\38799\Calculations\FB-MPier\Abutments\Abutment 1\2013-0213-HAI-MMB-Abutment 1-11 ft Cap-14 in PP-STR IA-D1.XML
G:\38799\Calculations\FB-MPier\Abutments\Abutment 1\2013-0213-HAI-MMB-Abutment 1-11 ft Cap-14 in PP-EE I-D1.XML
G:\38799\Calculations\FB-MPier\Abutments\Abutment 1\2013-0213-HAI-MMB-Abutment 1-11 ft Cap-14 in PP-SER I-D1.XML



Loads in FB-Multipier nodes 9

ASSUMPTIONS:
- Two rows of 14-in diameter concrete-filled plumb (vertical) steel pipe piles with 0.5 in thickness, total of 25 piles at Abutment 1. However, we analyzed a two-pile model in FB-MultiPier.
- 1/16 in thickness reduction due to corrosion taken from outer surface of piles
- Gross concrete properties assumed for pile cap (i.e., "flexible" cap)
- Fixed pile-to-cap connection
- 13FEB2013 loads (per unit width of wall) from TransSystems were used
- Piles are spaced approx. 5 ft along the abutment wall and 7 ft between front and back rows
- Piles were analyzed in groups of two (one for front row, one for back row) with loads for 5 ft of wall applied (because piles are spaced 5 ft along the abutment)
- Of the Strength Limit State cases, STR IA had the highest loading and was the only Strength Limit State loading case that was analyzed in FB-MultiPier
- Water is assumed to be at El. 613
- x-direction parallel to abutment wall
- y-direction perpendicular to abutment wall

Load Case	Model GS El. (ft)	Fx [kip/5 ft]	Fy [kip/5 ft]	Fz [kip/5 ft]	Mx [kip-ft/5 ft]	My [kip-ft/5 ft]	Mz [kip-ft/5 ft]
STR IA	618.5	0	103	306	0	0	0
EE I	618.5	0	70	181	0	0	0
SER I	618.5	0	82	225	0	0	0

Notes: GS - ground surface; Loads are shown per 5 ft width of wall supported by two piles.

RESULTS

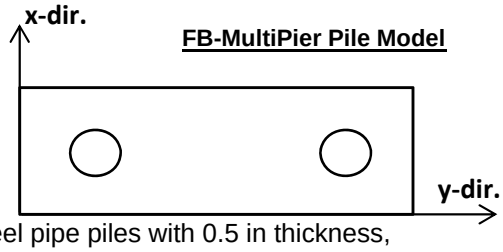
Load Case	Model GS El. (ft)	δx (1) [in]	δy (1) [in]	$M_{x\,max}$ (2) [kip-ft]	$M_{y\,max}$ (2) [kip-ft]	N_{max} (3) [kip]	N_{min} (4) [kip]
STR IA	618.5	0.00	1.15	269	0	226	79
EE I	618.5	0.00	0.64	171	0	137	44
SER I	618.5	0.00	0.81	206	0	168	56

Notes:
(1) - Estimated lateral displacement at cap level for the two-pile model (reported for SER I)
(2) - Maximum pile moment in the two-pile model
(3) - Maximum pile axial force in the two-pile model
(4) - Minimum pile axial force in the two-pile model

HALEY & ALDRICH	CALCULATIONS	File No.	38799-000
		Sheet	1 of 1
Client	Maine Department of Transportation	Date	08MAY2013
Project	Martin Memorial Bridge Replacment	Computed by	JLL
Subject	Abutment 2 FB-MultiPier Pile Group Analyses	Checked by	BCS

Files: G:\38799\Calculations\FB-MPier\Abutments\Abutment 2\2013-0213-HAI-MMB-Abutment 2-11ft Cap-14 in PP-STR IA-D1.XML
G:\38799\Calculations\FB-MPier\Abutments\Abutment 2\2013-0213-HAI-MMB-Abutment 2-11ft Cap-14 in PP-EE I-D1.XML
G:\38799\Calculations\FB-MPier\Abutments\Abutment 2\2013-0213-HAI-MMB-Abutment 2-11ft Cap-14 in PP-SER I-D1.XML

FB-MultiPier Pile Model



Loads in FB-Multipier nodes 9

ASSUMPTIONS:
- Two rows of 14-in diameter concrete-filled plumb (vertical) steel pipe piles with 0.5 in thickness, total of 32 piles at Abutment 2. However, we analyzed a two-pile model in FB-MultiPier.
- 1/16 in thickness reduction due to corrosion taken from outer surface of piles
- Gross concrete properties assumed for pile cap (i.e., "flexible" cap)
- Fixed pile-to-cap connection
- 13FEB2013 loads (per unit width of wall) from TransSystems were used
- Piles are spaced approx. 5 ft along the abutment wall and 7 ft between front and back rows
- Piles were analyzed in groups of two (one for front row, one for back row) with loads for 5 ft of wall applied (because piles are spaced 5 ft along the abutment)
- Of the Strength Limit State cases, STR IA had the highest loading and was the only Strength Limit State loading case that was analyzed in FB-MultiPier
- Water is assumed to be at El. 613
- x-direction parallel to abutment wall
- y-direction perpendicular to abutment wall

Load Case	Model GS El. (ft)	Fx [kip/5 ft]	Fy [kip/5 ft]	Fz [kip/5 ft]	Mx [kip-ft/5 ft]	My [kip-ft/5 ft]	Mz [kip-ft/5 ft]
STR IA	618	0	147	358	0	0	0
EE I	618	0	101	220	122	0	0
SER I	618	0	114	265	0	0	0

Notes: GS - ground surface; Loads are shown per 5 ft width of wall supported by two piles.

RESULTS

Load Case	Model GS El. (ft)	δx (1) [in]	δy (1) [in]	$M_{x\,max}$ (2) [kip-ft]	$M_{y\,max}$ (2) [kip-ft]	N_{max} (3) [kip]	N_{min} (4) [kip]
STR IA	618	0.00	0.95	264	0	248	105
EE I	618	0.00	0.55	156	0	168	49
SER I	618	0.00	0.61	190	0	182	80

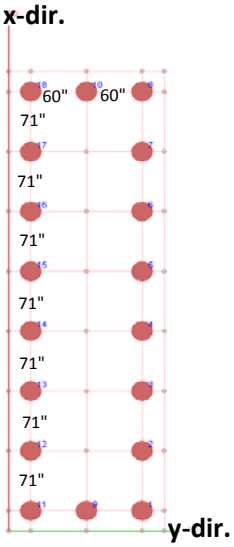
Notes:
(1) - Estimated lateral displacement at cap level for the two-pile model (reported for SER I)
(2) - Maximum pile moment in the two-pile model
(3) - Maximum pile axial force in the two-pile model
(4) - Minimum pile axial force in the two-pile model

HALEY & ALDRICH	CALCULATIONS	File No.	38799-000
		Sheet	1 of 1
Client	Maine Department of Transportation	Date	08MAY2013
Project	Martin Memorial Bridge, Rumford, Maine	Computed by	JLL
Subject	Pier 1 & 2 FB-MultiPier Pile Group Analyses	Checked by	BCS

Files: G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-STR-LayoutTrials-D1.XML
G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-STR-LayoutTrials-D1.XML
G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-STR-LayoutTrials-D1.XML
G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-EE-LayoutTrials-D1.XML
G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-EE-LayoutTrials-D1.XML
G:\38799\Calculations\FB-MPier\Pier 1 and 2\2013-0213-HAI-MMB-Pier-24 in PP-100yr-SER-LayoutTrials-D1.XML

Loads in FB-Multipier nodes 111

Pile Layout



ASSUMPTIONS:
- 14 24-in concrete-filled diameter plumb steel pipe piles with 5/8 in wall thickness
- 1/16 in thickness reduction due to corrosion taken from outer surface of piles
- Rigid cap
- Fixed pile-to-cap connection
- 12FEB2013 loads from TransSystems was used; Factored buoyant weight of tremie seal was added
- Loads applied at plan center of cap
- 100-year scour level at El. 561 used for Strength and Service Limit States
- Liquefied soil parameters were used from El. 582 to El. 565 in the Extreme Event Limit States
- x-direction parallel to bridge transverse direction
- y-direction parallel to bridge longitudinal direction

Load Case	Mudline El. (ft)	Fx [kip]	Fy [kip]	Fz [kip]	Mx [kip-ft]	My [kip-ft]	Mz [kip-ft]
STR I	561	0	58	5,687	2,690	0	0
STR III	561	0	163	2,921	7,479	0	0
STR V	561	0	104	3,575	4,726	0	0
EE I	582	0	446	3,046	14,096	0	0
EE II	582	0	96	3,288	2,923	0	0
SER I	561	0	109	4,076	5,347	0	0

RESULTS

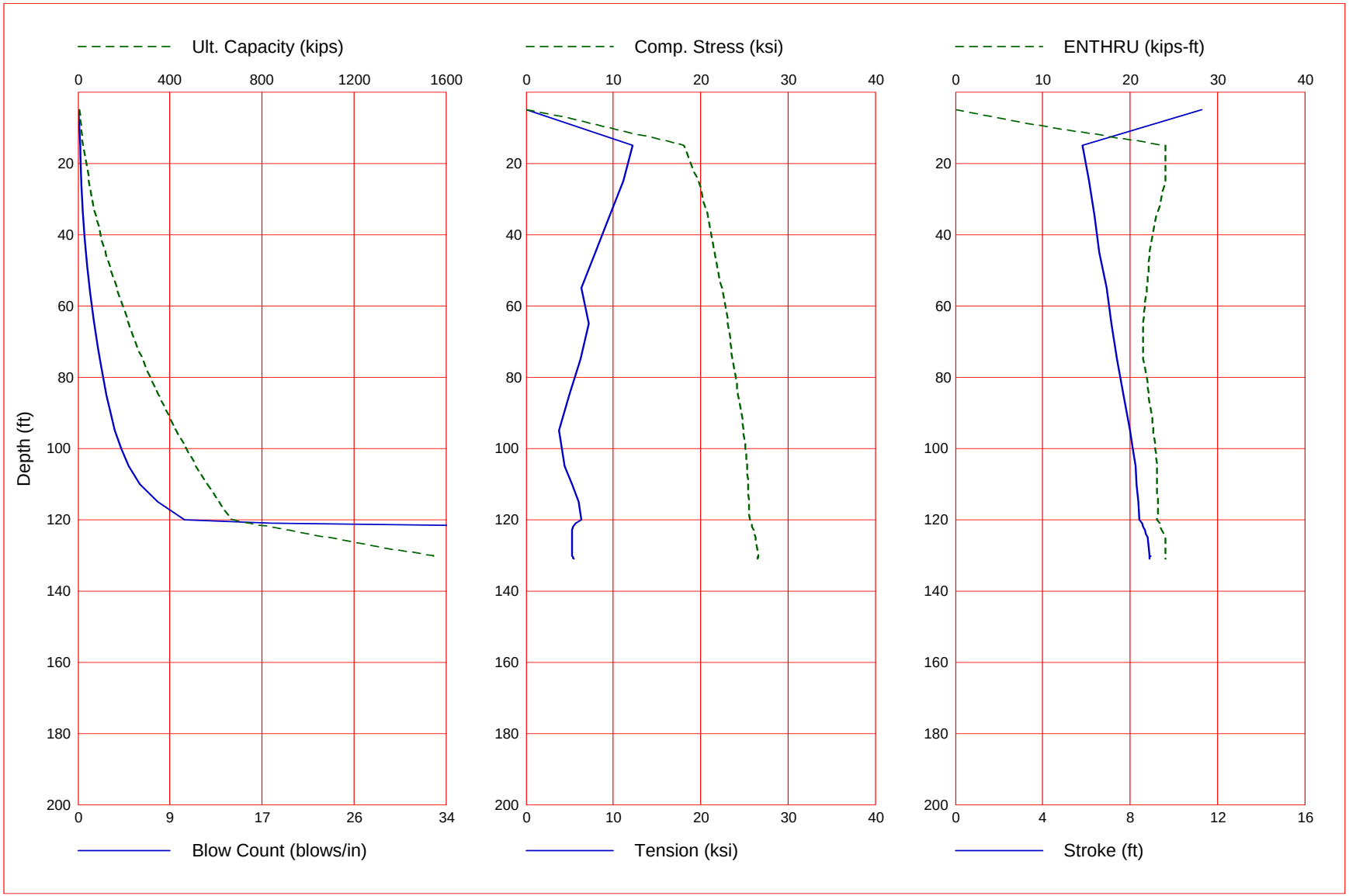
Load Case	Mudline El. (ft)	δx (1) [in]	δy (1) [in]	$M_{x\ max}$ (2) [kip-ft]	$M_{y\ max}$ (2) [kip-ft]	N_{max} (3) [kip]	N_{min} (4) [kip]
STR I	561	0.00	0.65	97	0	327	261
STR III	561	0.00	1.69	221	0	237	36
STR V	561	0.00	1.06	146	0	235	111
EE I	582	0.00	2.62	497	0	329	-47 (uplift)
EE II	582	0.00	0.49	105	0	197	121
SER I	561	0.00	0.84	123	0	278	125

Notes:
(1) - Estimated lateral displacement at cap level
(2) - Maximum moment over all the piles
(3) - Maximum axial force (over all piles) at mudline or scoured elevation
(4) - Minimum axial force (over all piles) at mudline or scoured elevation

Pile Driveability Calculations

Haley & Aldrich, Inc. May 08 2013

Martin Memorial Bridge - Abutment 1 Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 GRLWEAP(TM) Version 2005



Haley & Aldrich, Inc. May 08 2013
Martin Memorial Bridge - Abutment 1 GRLWEAP(TM) Version 2005

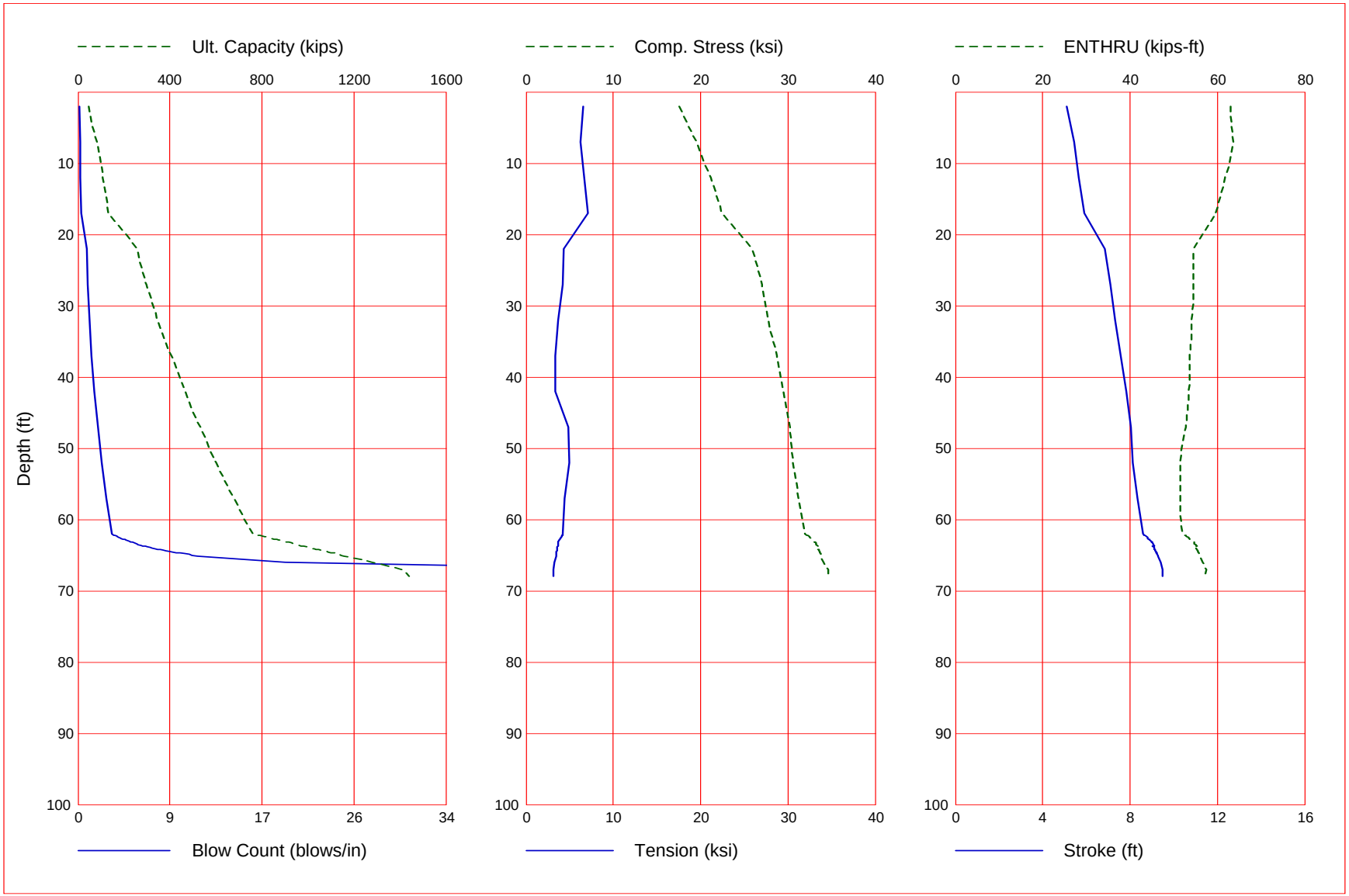
Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/in	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
5.0	6.4	1.4	5.0	0.0	0.000	0.000	11.30	0.0
15.0	20.3	9.3	11.0	0.2	18.075	-12.177	5.83	24.1
25.0	47.7	25.7	22.0	0.3	19.771	-11.098	6.13	24.0
35.0	80.8	53.8	27.0	0.4	20.870	-9.561	6.38	23.0
45.0	120.4	93.4	27.0	0.7	21.625	-7.998	6.61	22.2
55.0	168.4	141.4	27.0	1.1	22.506	-6.318	6.93	21.9
65.0	221.3	194.3	27.0	1.5	23.103	-7.189	7.16	21.5
75.0	281.6	254.6	27.0	2.0	23.625	-6.208	7.39	21.5
85.0	351.3	324.3	27.0	2.6	24.231	-4.963	7.68	22.1
95.0	428.6	401.6	27.0	3.4	24.889	-3.746	7.98	22.7
100.0	469.9	442.9	27.0	4.0	25.132	-4.096	8.12	22.9
105.0	512.4	485.4	27.0	4.6	25.358	-4.451	8.24	23.1
110.0	559.7	532.7	27.0	5.7	25.435	-5.309	8.31	23.1
115.0	612.0	585.0	27.0	7.4	25.577	-5.974	8.39	23.2
120.0	664.6	637.6	27.0	9.8	25.600	-6.343	8.43	23.1
121.0	747.8	648.7	99.1	17.9	25.845	-5.679	8.56	23.4
122.0	831.9	660.7	171.2	44.0	25.872	-5.433	8.58	23.4
123.0	917.1	673.8	243.3	832.9	26.055	-5.327	8.67	23.6
124.0	1003.3	687.9	315.4	832.9	26.205	-5.306	8.74	23.8
125.0	1090.6	703.1	387.5	832.9	26.307	-5.321	8.80	24.0
130.0	1542.3	794.3	748.0	832.9	26.578	-5.265	8.91	24.1
130.1	1544.1	796.1	748.0	832.9	26.561	-5.264	8.91	24.1
130.2	1545.9	797.9	748.0	832.9	26.565	-5.281	8.91	24.1
130.2	1547.8	799.8	748.0	832.9	26.569	-5.298	8.92	24.1
130.3	1549.7	801.7	748.0	832.9	26.571	-5.318	8.91	24.1
130.4	1551.5	803.5	748.0	832.9	26.571	-5.338	8.91	24.1
130.5	1553.4	805.4	748.0	832.9	26.557	-5.349	8.91	24.1
130.6	1555.3	807.3	748.0	832.9	26.562	-5.368	8.91	24.1
130.6	1557.1	809.1	748.0	832.9	26.562	-5.386	8.91	24.1
130.7	1559.0	811.0	748.0	832.9	26.566	-5.402	8.91	24.1
130.8	1560.9	812.9	748.0	832.9	26.551	-5.415	8.91	24.1
130.9	1562.7	814.7	748.0	832.9	26.553	-5.433	8.91	24.1
131.0	1564.6	816.6	748.0	832.9	26.556	-5.450	8.91	24.1

Refusal occurred; no driving time output possible

Haley & Aldrich, Inc. May 08 2013

Martin Memorial Bridge - Pier 1 Upstream Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 GRLWEAP(TM) Version 2005



Haley & Aldrich, Inc. May 08 2013
Martin Memorial Bridge - Pier 1 Upstream GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/in	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	46.8	2.8	44.0	0.1	17.521	-6.524	5.09	63.0
7.0	82.7	19.7	63.0	0.2	19.560	-6.276	5.44	63.7
12.0	105.4	42.4	63.0	0.2	21.194	-6.663	5.67	61.7
17.0	131.4	68.4	63.0	0.3	22.436	-7.130	5.91	59.6
22.0	257.7	100.7	157.0	0.8	25.904	-4.370	6.86	54.5
27.0	299.2	142.2	157.0	0.9	27.001	-4.234	7.12	54.6
32.0	347.6	190.6	157.0	1.0	27.802	-3.700	7.33	54.1
37.0	405.2	248.2	157.0	1.2	28.716	-3.308	7.57	53.6
42.0	468.2	311.2	157.0	1.5	29.526	-3.348	7.82	53.4
47.0	533.3	376.3	157.0	1.9	30.202	-4.821	8.03	52.9
52.0	603.0	446.0	157.0	2.2	30.591	-4.921	8.13	51.6
57.0	678.7	521.7	157.0	2.6	31.251	-4.436	8.33	51.5
62.0	759.1	602.1	157.0	3.1	31.994	-4.230	8.58	52.0
62.1	769.2	603.4	165.8	3.2	32.060	-4.254	8.62	52.4
62.2	780.5	604.9	175.6	3.3	32.199	-4.204	8.66	52.5
62.2	790.6	606.2	184.4	3.4	32.281	-4.154	8.70	52.7
62.3	800.7	607.6	193.1	3.5	32.352	-4.105	8.73	52.9
62.4	810.8	609.0	201.9	3.6	32.434	-4.070	8.76	53.1
62.5	822.2	610.5	211.7	3.8	32.515	-4.018	8.79	53.4
62.6	832.4	611.9	220.5	3.9	32.565	-3.962	8.81	53.4
62.7	842.5	613.3	229.2	4.0	32.657	-3.928	8.83	53.7
62.8	854.0	614.9	239.1	4.2	32.708	-3.874	8.86	53.7
62.8	864.1	616.3	247.8	4.3	32.770	-3.841	8.89	54.0
62.9	874.3	617.8	256.6	4.5	32.854	-3.796	8.91	54.0
63.0	885.8	619.4	266.4	4.6	32.893	-3.764	8.94	54.3
63.1	896.1	620.9	275.2	4.8	32.987	-3.731	8.96	54.3
63.2	906.3	622.4	283.9	4.9	33.075	-3.710	8.99	54.6
63.2	916.6	623.9	292.7	5.1	33.062	-3.692	9.01	54.7
63.3	928.1	625.6	302.5	5.2	33.206	-3.673	9.04	54.7
63.4	938.4	627.1	311.3	5.4	33.248	-3.658	9.06	54.8
63.5	948.7	628.7	320.0	5.6	33.257	-3.653	9.08	55.1
63.6	960.3	630.4	329.9	5.8	33.378	-3.635	9.10	55.2
63.7	970.6	632.0	338.6	6.0	33.447	-3.627	9.12	55.3
63.7	980.9	633.6	347.4	6.3	33.228	-3.632	9.04	54.6
63.8	992.6	635.4	357.2	6.4	33.330	-3.617	9.08	55.0
63.9	1002.9	637.0	366.0	6.7	33.380	-3.598	9.09	55.0
64.0	1013.3	638.6	374.7	6.9	33.429	-3.584	9.10	55.1
64.1	1025.0	640.4	384.6	7.1	33.390	-3.570	9.12	55.2
64.2	1035.4	642.1	393.3	7.3	33.492	-3.562	9.13	55.3
64.2	1045.8	643.8	402.1	7.6	33.521	-3.542	9.15	55.3
64.3	1056.3	645.4	410.8	7.9	33.529	-3.534	9.16	55.4
64.4	1068.0	647.3	420.7	8.1	33.587	-3.529	9.17	55.5
64.5	1078.5	649.1	429.4	8.5	33.616	-3.511	9.18	55.5
64.6	1088.9	650.8	438.2	8.7	33.608	-3.509	9.19	55.6
64.7	1100.7	652.7	448.0	9.1	33.698	-3.490	9.21	55.7
64.7	1111.2	654.5	456.8	9.4	33.690	-3.486	9.22	55.8
64.8	1121.7	656.2	465.5	9.8	33.715	-3.471	9.23	55.8
64.9	1133.6	658.2	475.4	10.3	33.741	-3.456	9.24	55.7
65.0	1144.1	660.0	484.1	10.6	33.748	-3.447	9.26	56.0
65.1	1154.7	661.8	492.9	11.1	33.768	-3.437	9.26	56.0

Haley & Aldrich, Inc. May 08 2013
Martin Memorial Bridge - Pier 1 Upstream GRLWEAP(TM) Version 2005

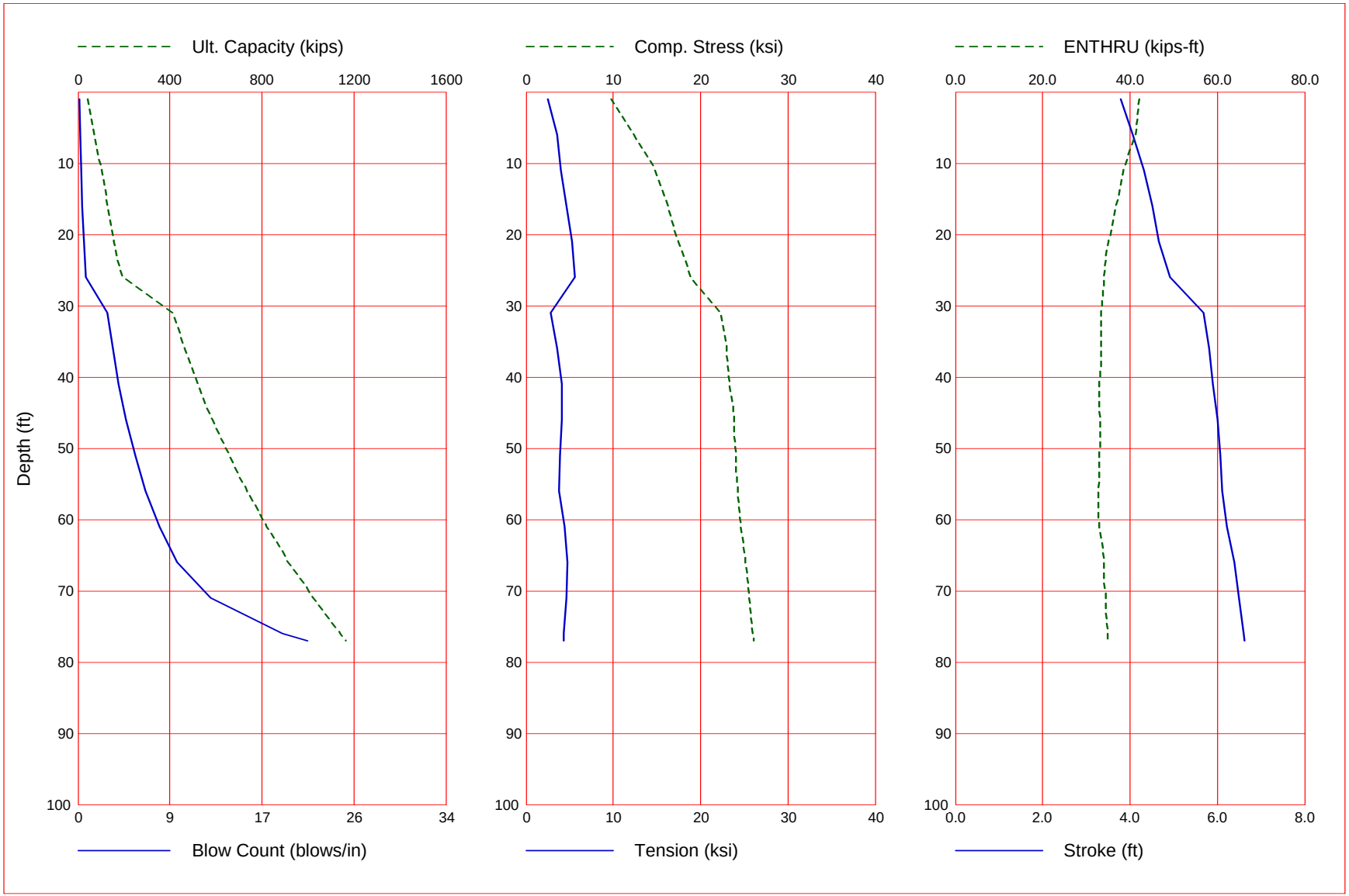
Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 (Continued)

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/in	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
64.6	1088.9	650.8	438.2	8.7	33.608	-3.509	9.19	55.6
64.7	1100.7	652.7	448.0	9.1	33.698	-3.490	9.21	55.7
64.7	1111.2	654.5	456.8	9.4	33.690	-3.486	9.22	55.8
64.8	1121.7	656.2	465.5	9.8	33.715	-3.471	9.23	55.8
64.9	1133.6	658.2	475.4	10.3	33.741	-3.456	9.24	55.7
65.0	1144.1	660.0	484.1	10.6	33.748	-3.447	9.26	56.0
65.1	1154.7	661.8	492.9	11.1	33.768	-3.437	9.26	56.0
66.0	1278.4	683.7	594.6	19.2	34.088	-3.291	9.39	56.7
67.0	1413.3	709.3	704.0	55.5	34.585	-3.187	9.50	57.4
68.0	1439.9	735.9	704.0	73.3	34.645	-3.164	9.51	57.2

Total Continuous Driving Time 63.00 minutes; Total Number of Blows 2492

Haley & Aldrich, Inc. May 08 2013

Martin Memorial Bridge - Pier 1 Downstre Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 GRLWEAP(TM) Version 2005



Haley & Aldrich, Inc. May 08 2013
Martin Memorial Bridge - Pier 1 Downstre GRLWEAP(TM) Version 2005

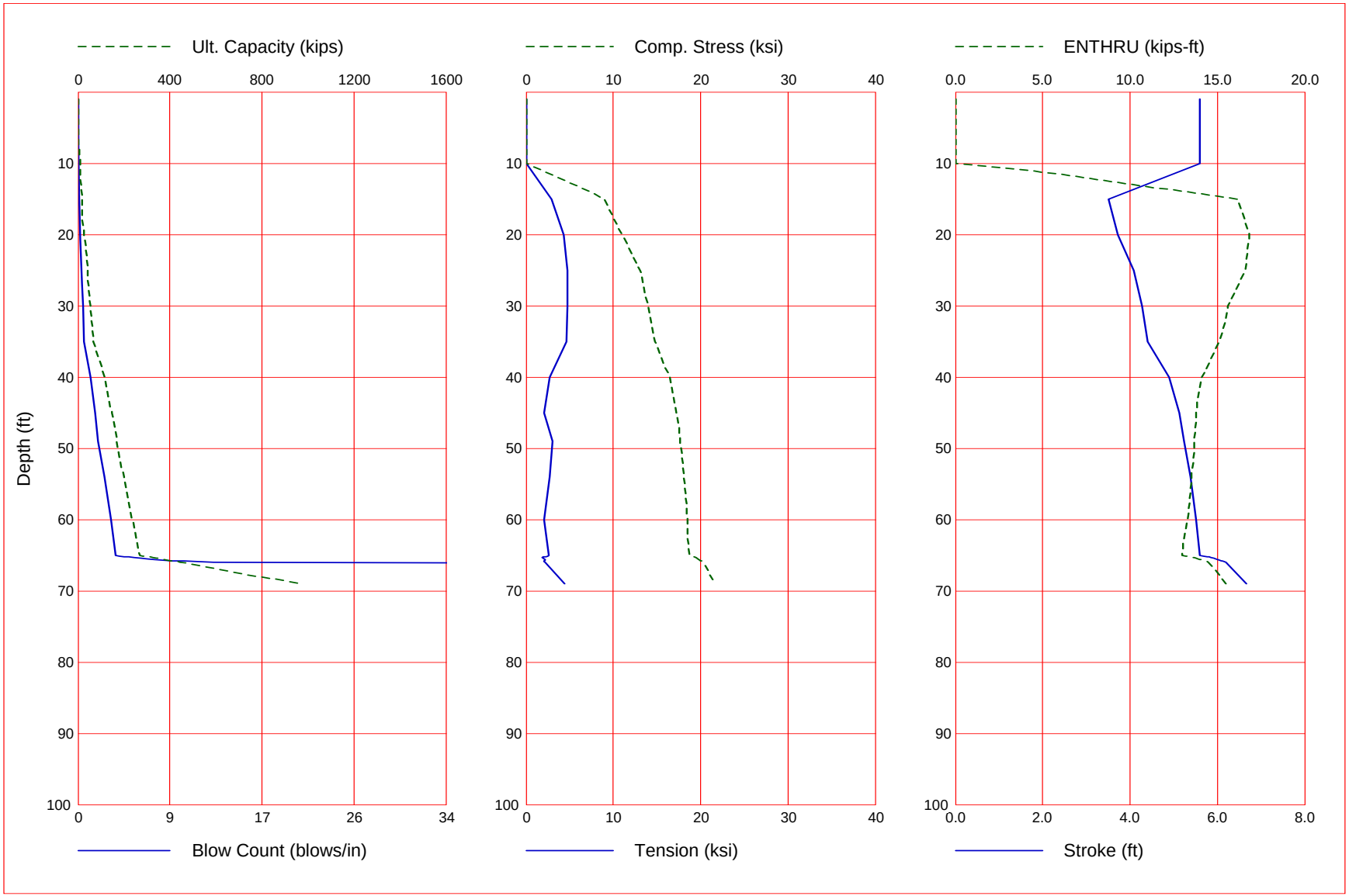
Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/in	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
1.0	41.3	1.3	40.0	0.1	9.741	-2.486	3.78	42.2
6.0	69.2	17.2	52.0	0.2	12.357	-3.531	4.07	41.3
11.0	101.3	38.3	63.0	0.3	14.727	-4.013	4.33	38.5
16.0	125.8	62.8	63.0	0.4	16.300	-4.687	4.51	36.7
21.0	154.8	91.8	63.0	0.5	17.422	-5.244	4.66	35.1
26.0	190.5	127.5	63.0	0.7	18.847	-5.625	4.91	34.1
31.0	409.3	173.3	236.0	2.7	22.357	-2.782	5.69	33.4
36.0	463.6	227.6	236.0	3.2	22.952	-3.603	5.82	33.4
41.0	520.8	284.8	236.0	3.8	23.346	-4.111	5.90	33.0
46.0	585.9	349.9	236.0	4.4	23.798	-4.108	6.01	33.2
51.0	658.8	422.8	236.0	5.3	24.048	-3.852	6.06	33.0
56.0	735.8	499.8	236.0	6.3	24.225	-3.764	6.11	32.7
61.0	818.5	582.5	236.0	7.6	24.613	-4.381	6.21	33.0
66.0	914.0	678.0	236.0	9.1	25.162	-4.705	6.38	34.0
71.0	1021.0	785.0	236.0	12.3	25.587	-4.621	6.50	34.4
76.0	1139.2	903.2	236.0	18.9	25.952	-4.349	6.61	34.8
77.0	1164.8	928.8	236.0	21.2	26.053	-4.283	6.63	34.8

Total Continuous Driving Time 90.00 minutes; Total Number of Blows 4223

Haley & Aldrich, Inc. May 09 2013

Martin Memorial Bridge - Abutment 2 Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 GRLWEAP(TM) Version 2005



Haley & Aldrich, Inc. May 09 2013
Martin Memorial Bridge - Abutment 2 GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/in	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
1.0	1.0	0.0	1.0	0.0	0.000	0.000	5.60	0.0
5.0	4.0	1.0	3.0	0.0	0.000	0.000	5.60	0.0
10.0	10.0	4.0	6.0	0.0	0.000	0.000	5.60	0.0
15.0	16.4	8.4	8.0	0.1	8.970	-2.940	3.50	16.2
20.0	25.7	14.7	11.0	0.2	11.045	-4.310	3.73	16.8
25.0	43.2	23.2	20.0	0.3	13.060	-4.716	4.08	16.6
30.0	56.6	34.1	22.5	0.4	14.023	-4.703	4.27	15.6
35.0	68.7	46.2	22.5	0.5	14.750	-4.637	4.41	15.1
40.0	114.6	61.6	53.0	1.1	16.512	-2.758	4.89	14.1
45.0	147.9	80.9	67.0	1.6	17.273	-2.115	5.12	13.8
49.0	166.8	99.8	67.0	1.8	17.629	-3.077	5.23	13.7
54.0	199.5	128.5	71.0	2.4	18.120	-2.710	5.39	13.5
60.0	236.1	165.1	71.0	3.0	18.504	-2.110	5.52	13.3
65.0	268.7	197.7	71.0	3.5	18.739	-2.646	5.60	13.0
65.1	282.8	198.2	84.5	3.8	18.969	-2.502	5.69	13.2
65.2	298.6	198.9	99.8	4.3	19.163	-2.242	5.76	13.4
65.2	312.8	199.4	113.3	4.7	19.293	-2.004	5.81	13.5
65.3	326.9	200.0	126.9	5.2	19.449	-1.862	5.86	13.7
65.4	342.8	200.7	142.1	5.8	19.588	-2.006	5.92	13.8
65.5	356.9	201.3	155.6	6.4	19.723	-2.091	5.97	13.9
65.6	371.1	201.9	169.2	7.0	19.834	-2.137	6.01	14.0
65.7	385.2	202.5	182.7	7.8	19.929	-2.141	6.05	14.1
65.8	401.2	203.2	197.9	8.8	20.036	-2.121	6.09	14.2
65.8	415.3	203.9	211.5	9.8	20.120	-2.085	6.12	14.3
65.9	429.5	204.5	225.0	11.0	20.211	-2.110	6.16	14.4
66.0	445.5	205.2	240.2	12.5	20.299	-2.146	6.19	14.5
69.0	983.1	235.1	748.0	832.9	21.575	-4.413	6.66	15.5

Refusal occurred; no driving time output possible

Elastic Pile Compression Calculations

Elastic Pile Compression Calculation

Martin Memorial Bridge Replacement Project
MaineDOT WIN 15105.00
Route 232 - Rumford, Maine

Calculated By: JLL 5/9/2013
Checked By: BCS 5/24/2013

Substructure	Pile Location Within Substructure	Pile Type	Estimated Pile Tip Elevation (ft, NAVD 88)	100 yr Scour Elevation (ft, NAVD 88)	Top of Pile Elevation (ft, NAVD 88)	Unsupported Length, Lu (ft)	Embedded Length, Lemb (ft)	SER Vert. Load (kips)	Pile AE (kips)	δ_v of Lu (in)	δ_v of Lemb (in)	δ_v Total (in)
Abutment 1	All piles (25 piles)	14 in x 1/2 in concrete-filled steel pipe piles	505	-	618.5	0	113.5	168	949997	0.00	0.24	0.24
Pier 1	Northern 1/3 (7 piles)	24 in x 5/8 in concrete-filled steel pipe piles	485	560.9	582	21.1	75.9	278	2463779	0.03	0.10	0.13
	Central 1/3 (6 piles)		495	560.9	582	21.1	65.9	278	2463779	0.03	0.09	0.12
	Southern 1/3 (5 piles)		505	560.9	582	21.1	55.9	278	2463779	0.03	0.08	0.10
Pier 2	Northern 1/3 (7 piles)		510	560.9	582	21.1	50.9	278	2463779	0.03	0.07	0.10
	Central 1/3 (6 piles)		520	560.9	582	21.1	40.9	278	2463779	0.03	0.06	0.08
	Southern 1/3 (5 piles)		530	560.9	582	21.1	30.9	278	2463779	0.03	0.04	0.07
Abutment 2	All piles (32 piles)	14 in x 1/2 in concrete-filled steel pipe piles	535	-	613.5	0	78.5	182	949997	0.00	0.18	0.18

Notes:

1. δ_v Total is the estimated axial compression of an individual pile under the Service Limit State axial load.

\\BOS\common\38799\Calculations\FB-MPier\[2013-0509-HAI-MMB-Pile Vertical Compression Calculations-F.xlsx]Sheet1