Geotechnical Engineering Report

Replacement of Bridge Nos. 03163 and 03164 Route 160 Over I-91 NB and SB
Rocky Hill, Connecticut

State Bridge Program
Project Number 118-169

Prepared for:
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March 21, 2017

Sign-off Sheet

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1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) is under contract with the State of Connecticut Department of Transportation (CTDOT) to provide consulting engineering services for the replacement of Bridge Nos. 03163 and 03164, carrying Route 160 over I-91 Southbound and I-91 Northbound in Rocky Hill, CT. The project is included in the State Bridge Program administered by CTDOT, and coordinated through a Consultant Liaison Engineer. This Geotechnical Engineering Report provides proposed design information as required by the CTDOT Project Development Manual.

This report presents the results of our geotechnical exploration and analysis for the replacement of Bridge Nos. 03163 and 03164 located in Rocky Hill, CT. Bridge No. 03163 was built in 1965 has a length of 193 feet and carries Route 160 over the south bound lanes of I-91. Bridge No. 03164 was also built in 1965, has a length of 261 feet and carries Route 160 over the north bound lanes of I-91. Both bridges are steel 3 span multi-girder structures with reinforced concrete decks. Based on historic plans, the abutments and piers are founded on footings bearing on bedrock. The bridges are being replaced due to the poor condition of the steel superstructure, corrosion of the bearings, and because Bridge No. 03163 is functionally obsolete. The replacement of the bridge will also allow a reduction in the number of spans.

Our scope of work consisted of drilling test borings, performing laboratory testing on selected soil and rock samples, evaluating the subsurface conditions, and providing geotechnical engineering recommendations for the support of the proposed bridge design.

Geotechnical design recommendations were made for the proposed bridge using the following documents:

- *Connecticut Department of Transportation, Geotechnical Engineering Manual, 2005 Edition;*
- *Connecticut Department of Transportation, Bridge Design Manual, 2003 Edition; and*
- *AASHTO LRFD Bridge Design Specifications, 7th Edition/2014 (AASHTO).*

Background information was provided in the following documents:

- *Rehabilitation Study Report, Bridge Nos. 03163 & 03164, Route 160 over I-91, Town of Rocky Hill,* prepared by Close, Jensen & Miller, P.C., issued December 2014, revised February 2015 and revised March 2015. (Rehabilitation Study Report)

Elevations in this report are in feet and referenced to the vertical datum NAVD88. The horizontal datum is NAD 83/11.

2.0 SITE AND PROJECT INFORMATION

The existing three span bridges are to be completely replaced with single span bridges consisting of steel girder superstructures founded on reinforced concrete substructures. The abutments will be U-back type abutments. The new bridges will be approximately 130 feet long. The superstructures for the new bridges will be partially constructed in staging areas located to the north of Bridge No. 01363 and to the south of Bridge No. 01364. Once the existing bridges are removed the abutments will be constructed and new bridge superstructures will be moved into place and the construction completed. The site location is shown in Figure 1 entitled "Site Location Plan".

We anticipate the abutment footings for the new bridges will bear at elevations similar to the elevations of the existing piers. The abutment wing walls will extend back towards the existing rock cuts and will step up in elevation. Abutment No. 1 of Bridge No. 03164 will be constructed approximately 85 feet east of the existing abutment. At this location an embankment will be constructed between the location of the proposed abutment and the new abutment. The embankment will be approximately 20 feet in height.

Table 1 – Summary of Footing Bearing Elevation

Bridge No.	Substructure No.	Assumed Proposed Footing Elevation
03163	Abutment No .1	175.0
03163	Abutment No. 2	173.0
03164	Abutment No. 1	194.0
03164	Abutment No. 2	195.0

3.0 SUBSURFACE INFORMATION

3.1 LOCAL GEOLOGY

Based on the Surficial Materials Map of Connecticut dated 1992, the local geology consists predominately of glacial till deposits. Based on the Bedrock Geologic Map of Connecticut dated 1985, the bedrock in the area of the site consists of siltstone, silty shale and sandy shale, and fine grained silty sandstone, generally well laminated and commonly well indurated of the East Berlin Formation. Rock cuts for the roadway are located along both sides of the northbound and southbound lanes of I-91.

3.2 SUBSURFACE EXPLORATION

The exploration program consisted of the drilling of a total of 22 test borings. Eight test borings were drilled at each bridge and three borings were drilled in each of the two staging areas. The test borings were drilled between August 29 and September 15, 2016. The tests borings for the bridges are designated as B-1 through B-16. The test borings for the staging areas are designated S-1 through S-6. The location of the test borings is shown on the attached Figures 2 and Figure 3. The test borings were drilled by New England Boring Contractors of Glastonbury, Connecticut. A truck-mounted drill rig equipped with 4-inch diameter flush-joint steel casing or 4.25-inch inside diameter hollow stem augers was used to advance the borings through the soil overburden. Bedrock was cored using a NQ double-walled core barrel.

Soil samples were obtained by driving a 24-inch long, 2-inch outside diameter split spoon sampler with a 140-pound safety hammer falling 30 inches, in substantial accordance with ASTM D1586, the Standard Penetration Test (SPT). The blows for each 6-inches of penetration are recorded for a total of 24-inches. The sum of the blows required to drive the sampler from 6-inches to 18-inches penetration is referred to as the Standard Penetration Resistance, or N-value, which is an index of measure of in-situ soil density or consistency. In accordance with FHWA practice, N values for granular soils less than 5 are considered to be very loose, between 5 and 10 loose; between 11 and 24 medium dense; between 25 and 50 dense; and greater than 50 very dense. The SPTs were conducted using a safety hammer driven with a rope and cathead; as such a value of 1.0 was used for the hammer energy correction factor (CE). Soil samples from the test borings were visually classified in the field by Stantec personnel and confirmed using laboratory test data results. The boring logs include the visual descriptions. The locations were determined by measuring from existing site features. Boring logs are provided in Appendix A. Photographs of the rock cores are presented in Appendix B. A summary of the boring locations is provided in the table below.

Table 2 – Boring Locations and Elevations

Boring	Substructure	Northing (ft)	Easting (ft)	Grnd Elev. (ft)	Bedrock Elev. (ft)	Depth to Bedrock (ft)
	Bridge 03163	Over South Bound Lanes of I-91				
B-1	Abut No. 1	800849.7602	1021423.5049	201.23	190.73	10.5
B-2	Abut No. 1	800864.4890	1021432.5358	201.83	196.83	5.0
B-3	Abut No. 1	800835.4364	1021468.9394	179.91	173.91	6.0
B-4	Abut No. 1	800889.5693	1021490.4288	180.03	175.03	5.0
B-5	Abut No. 2	800882.7689	1021615.4730	195.93	190.93	5.0
B-6	Abut No. 2	800889.9089	1021619.0493	195.22	189.97	5.25
B-7	Abut No. 2	800889.1885	1021663.4641	213.29	208.29	5.0
B-8	Abut No. 2	800905.1856	1021677.3570	214.01	206.01	8.0
	Bridge 03164	Over North Bound lanes of I-91				
B-9	Abut No. 1	800896.6102	1021821.3521	197.52	194.52	3.0
B-10	Abut No. 1	800948.9367	1021836.8488	197.05	193.55	3.5
B-11	Abut No. 1	800905.0906	1021853.1311	198.60	194.85	3.75
B-12	Abut No. 1	800954.2202	1021874.7239	198.29	193.29	5.0
B-13	Abut No. 2	800947.2297	1021995.7489	200.09	198.59	1.5
B-14	Abut No. 2	800957.5620	1022005.9317	201.94	201.94	0.0
B-15	Abut No. 2	800953.0100	1022035.7169	229.77	220.52	9.25
B-16	Abut No. 2	800966.8251	1022059.2055	230.48	221.48	9.0
	Staging Areas					
S-1	I-91 South Bound	801686.6738	1021788.7988	171.79	165.69	6.1
S-2	I-91 South Bound	801740.4450	1021795.1234	172.27	159.27	13.0
S-3	I-91 South Bound	801820.2550	1021807.7682	172.60	155.60	17.0
S-4	I-91 North Bound	800733.6134	1021777.8433	198.84	194.84	4.0
S-5	I-91 North Bound	800792.3372	1021825.2386	200.07	195.07	5.0
S-6	I-91 North Bound	800858.1128	1021808.4367	197.98	195.98	2.0

4.0 SUMMARIZED SUBSURFACE CONDITIONS

The subsurface conditions encountered are based on widely spaced explorations and variations in conditions should be anticipated. In general, the test borings encountered surficial layers of asphalt underlain by granular fill, glacial till, and bedrock. Subsurface conditions encountered are summarized in the following paragraphs:

4.1 BRIDGE NO. 03163 (ROUTE 160 OVER I-91 SOUTHBOUND)

4.1.1 Abutment 1 (West Abutment)

The following subsurface conditions were encountered in test borings B-1, B-2, B-3, and B-4:

4.1.1.1 Pavement

B-1 and B-2 encountered 8 inches of asphaltic pavement.

4.1.1.2 Fill Material

B-1, B-2, B-3, and B-4 encountered fill ranging in thickness from approximately 5 to 10 feet. At the location of B-1 and B-2 the fill is associated with the construction of Route 160. At the location of B-3 and B-4 the fill is associated with the construction of I-91 Southbound. The fill generally consisted of reddish-brown or brown, coarse to fine sand, little medium to fine gravel, little to trace silt. The recorded N-values ranged from 14 to 41 blows per foot (bpf), indicating a medium dense to dense consistency.

4.1.1.3 Bedrock

Two 5-foot long bedrock cores were obtained from borings B-1, B-2, B-3, and B-4. The bedrock was generally described as strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, siltstone or a strong, slightly weathered, highly fractured, light reddish brown, medium to fine grained, sandstone. The siltstone and sandstone were typically interbedded. The joints were generally horizontal with a maximum dip of less than 5 degrees. The RQD values ranged from 0 to 73 percent. The Rock Mass Rating (RMR) for the rock cores was 36 (poor rock), with the exception of boring B-3, core run C-2 which was 46 (fair rock).

4.1.2 Abutment 2 (East Abutment)

The following subsurface conditions were encountered in test borings B-5, B-6, B-7, and B-8:

4.1.2.1 Bridge Deck

Borings B-5 and B-6 were drilled through the existing bridge deck. The bridge deck consisted of 2 inches of asphaltic pavement over 6 inches of concrete. The distance from the pavement surface to the ground surface below the bridge was 15 and 16 feet at B-5 and B-6, respectively. The core holes through the bridge deck were patched with concrete upon completion of the borings.

4.1.2.2 Pavement

Borings B-7 and B-8 encountered 8 inches of asphaltic pavement.

4.1.2.3 Fill Material

Fill was encountered in borings B-5, B-6, B-7, and B-8 ranging in thickness from approximately 2.4 to 5 feet. At the location of borings B-5 and B-6 the fill is associated with the construction of I-91 Southbound. At the location of borings B-7 and B-8 the fill is associated with the construction of Route 160. The fill generally consisted of reddish brown or brown, coarse to fine sand, little medium to fine gravel, some to trace silt. The recorded N-values ranged from 3 to 35 bpf, indicating a very loose to dense consistency.

4.1.2.4 Glacial Till

Glacial till was encountered in borings B-7, and B-8 ranging in thickness from approximately 2 to 5 feet. The fill generally consisted of reddish brown, silt and fine sand, with gravel. The recorded N-value was 14 bpf, indicating a medium dense consistency.

4.1.2.5 Bedrock

Ten feet of rock core was obtained from each of the four borings B-5, B-6, B-7, and B-8. The bedrock was generally described as strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, siltstone. The joints were generally horizontal with a maximum dip of less than 5 degrees. The RQD values ranged from 20 to 61 percent. The RMR values ranged from 36 (poor rock) to 46 (fair rock).

4.2 BRIDGE NO. 03164 (ROUTE 160 OVER I-91 NORTHBOUND)

4.2.1 Abutment 1 (West Abutment)

The following subsurface conditions were encountered in test borings B-9, B-10, B-11, and B-12:

4.2.1.1 Fill Material

Fill was encountered in borings B-9, B-10, B-11, and B-12 ranging in thickness from approximately 3 to 5 feet. The fill is associated with the construction of I-91 Northbound. The fill generally consisted of reddish brown or brown, coarse to fine sand, some to little medium to fine gravel, some to trace silt. The recorded N-values ranged from 22 to 43 bpf, indicating a medium dense to dense consistency.

4.2.1.2 Bedrock

Two 5-foot long bedrock cores were obtained from each of the four borings: B-9, B-10, B-11, and B-12. The bedrock was generally described as strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, siltstone or strong, slightly weathered, highly fractured, reddish brown, fine grained, sandstone. The siltstone and sandstone were typically interbedded in some core samples. The joints were generally horizontal with a maximum dip of less than 5 degrees. The RQD values ranged from 28 to 67 percent. The RMR values ranged from 41 (fair rock) to 46 (fair rock).

4.2.2 Abutment 2 (East Abutment)

The following subsurface conditions were encountered in test borings B-13, B-14, B-15, and B-16:

4.2.2.1 Pavement

Borings B-15 and B-16 encountered 8 inches of asphaltic pavement.

4.2.2.2 Fill Material

Borings B-13, B-15, and B-16 encountered fill ranging in thickness from approximately 1.5 to 8.5 feet. At the location of B-13 the fill is associated with the construction of I-91 Northbound. At the location of B-15 and B-16 the fill is associated with the construction of Route 160. The fill generally consisted of reddish brown or brown, coarse to fine sand, little medium to fine gravel, trace silt. The recorded N-values ranged from 12 to 26 bpf, indicating a medium dense consistency.

4.2.2.3 Bedrock

Two 5-foot long bedrock cores were obtained from borings B-13, B-14, B-15, and B-16. The bedrock was generally described as strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, siltstone or strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, sandstone. The siltstone and sandstone were interbedded in some core samples. The joints were generally horizontal with a maximum dip of less than 5 degrees. The RQD values ranged from 12 to 48 percent. The RMR values ranged from 31 (poor rock) to 41 (fair rock).

4.3 SURFICIAL BEDROCK OBSERVATIONS

Based on a visual observation of the near vertical rock face below each abutment, it was noted that the rock face has not significantly deteriorated since the construction in 1965. In some areas the "half cast" from the line drilling can still be seen on the rock face. Some loose fragments of rock can be dislodged from the rock face by hand. In general, the rock face is competent with joints dipping at less than 5 degrees. Due to shallow dip the direction was difficult to evaluate, but appeared to be in a southerly direction with the strike in a roughly east-west direction.

4.4 GROUNDWATER

Groundwater was observed in boring B-4 at a depth 2 feet below the ground surface at 3.5 hours after completion of the boring. Groundwater was observed in boring S-3 at a depth of 11 feet below the ground surface 18 hours after completion of the boring. Groundwater was observed in boring B-11 at a depth of 7.6 feet below the ground surface upon completion of the boring. The remainder of the borings did not have groundwater after completion. In general, the groundwater is not expected to have significant impact on the geotechnical aspects of the project. Groundwater levels may vary over time due to seasonal changes in precipitation and temperature, snowmelt, and surrounding and on-site drainage characteristics.

4.5 LABORATORY TESTING

Laboratory tests were conducted on several representative soil samples obtained from the test borings to assist in classification and to evaluate engineering properties. Grain size distribution and moisture content tests were conducted in accordance ASTM D422 and ASTM D2216, respectively. Bulk density and unconfined compression test were conducted on two rock core samples in accordance with ASTM D7012 Method C. Soil and Rock testing was conducted by GeoTesting Express of Acton, MA. Results of the tests are included in Appendix C and summarized in the Table 2 and Table 3 below.

Table 3 – Soil Laboratory Testing Summary

Boring/ Sample No.	Depth (feet)	Soil Description	Moisture Content	General Strata	Percent Gravel	Percent Sand	Percent Fines (1)
B-1/S-2	4.0 – 6.0	c-f SAND, some silt, little f gravel	15.4	Fill	25.0	52.2	22.8
B-8/S-2	4.0 – 6.0	SILT, some c-f sand, little f gravel	12.3	Glacial Till	22.0	32.3	45.7
B-9/S-1	0 – 2.0	c-f SAND, little f gravel, little silt	7.9	Fill	30.0	47.4	22.6
S-2/S-2	5.0 – 7.0	SILT, some c-f sand, little f gravel	12.7	Glacial Till	21.0	27.9	51.1
S-5/S-2	2.0 – 4.0	c-f SAND, some silt, little f gravel	8.8	Fill	27.0	50.9	22.1

Notes: (1) Percent fines is the soil passing the #200 sieve.

Table 4 – Bedrock Laboratory Testing Summary

Boring	Core Run	Rock Type	Approximate Elevation (ft)	Bulk Density (lb/ft^3)	Compressive Strength (lb/in^2)	Failure Type
B-1	C-1	Siltstone	182	170	21,059	Intact
B-4	C-1	Sandstone	174	154	14,440	Intact
B-5	C-1	Siltstone	190	171	18,007	Intact
B-8	C-2	Sandstone/ Siltstone	196	170	17,984	Intact
B-9	C-1	Siltstone	193	172	15,944	Intact
B-12	C-2	Sandstone	189	164	22,414	Intact
B-14	C-1	Siltstone	199	171	13,957	Intact
B-15	C-2	Siltstone	210	169	18,048	Intact

5.0 DISCUSSIONS AND RECOMMENDATIONS

Based on the anticipated bearing elevations of the new footings and the elevations of the bedrock encountered in the test borings, the abutment footings will either bear on the bedrock surface or on compacted fill. The concrete footings can be cast directly on the bedrock surface or a 12 inch layer of compacted structural fill can be place to create a level working surface.

5.1 BRIDGE 03163 (ROUTE 160 OVER I-91 SOUTHBOUND)

Abutment No. 1 will be founded between the existing rock cut and the exiting bridge piers. The estimated bearing elevation of the footing is El. 175.0, which corresponds to the bearing elevation of the existing pier footing. Test borings B-3 and B-4 encountered bedrock at approximately El 174 and El 175, respectively. Therefore, the abutment footings should be founded directly on the bedrock surface. The wing walls will extend back from the face of the abutment towards the rock cut. Test borings B-1 and B-2 encountered bedrock at El. 191 and El. 197 near the ends of the wing walls. The wing wall footings should be founded on bedrock. The wing wall footings should be stepped up into bedrock to achieve the bearing elevation at the ends of the wing walls.

Abutment No. 2 will be founded at the toe of the existing rock cut. The estimated bearing elevation of the footing is El. 173.0, which corresponds to the bearing elevation of the existing pier footing. Based upon a review of the plans for the existing bridge, the existing bridge piers are founded on bedrock. Therefore, the proposed abutment footings should also be founded directly on the bedrock surface. The wing walls will extend back from the face of the abutment towards the rock cut. Test borings B-7 and B-8 encountered bedrock at approximately El. 208 and El. 206 near the ends of the wing walls. The wing wall footings should be founded on bedrock. The wing wall footings should be stepped up into bedrock to achieve the bearing elevation at the ends of the wing walls.

5.2 BRIDGE 03164 (ROUTE 160 OVER I-91 NORTHBOUND)

Abutment No. 1 will be founded approximately 85 feet in front of the rock cut in the area that was intended for the Westbound lanes of I-291 that where not constructed. The estimated bearing elevation of the abutment footings is El. 194.0. Borings B-9, B-10, B-11, and B-12 encountered bedrock at elevations ranging from approximately El. 193 to El. 195. Therefore, the abutment footings should be founded directly on the bedrock surface. A significant embankment fill will be required between the existing abutment to the proposed abutment. The embankment fill will be approximately 20 feet in height. The wing walls will extend back from the face of the proposed abutment towards the new embankment fill. The wing wall footings should be stepped up into proposed embankment. The footings should be founded on compacted Pervious Structural Backfill. The compacted Pervious Structural Backfill should be placed within the zone of influence of the footing. The zone of influence is defined as the area below a line drawn horizontally 2 feet from the lower outside edges of footing then downward on a 1H: 1V slope. The compacted Pervious Structural Backfill should extend down to a depth of 2 feet below the existing ground surface. Any existing fill not removed may remain in place provided it has been proof rolled prior to placing the compacted Pervious Structural Backfill.

Abutment No. 2 will be founded between the existing rock cut and the existing bridge piers. The estimated bearing elevation of the footing is at El. 195, which corresponds to the bearing elevation of the existing pier footings. Test borings B-13 and B-14 encountered bedrock at El 198.5 and El 201, respectively. Therefore, the abutment footings should be founded directly on the bedrock surface. The wing walls will extend back from the face of the abutment towards the rock cut. Test borings B-15 and B-16 encountered bedrock at El. 221 near the ends of the wing walls. The wing wall footings should be founded on bedrock. The wing wall footings should be stepped up into bedrock to achieve the bearing elevation at the ends of the wing walls.

5.3 BEARING RESISTANCE

The bearing resistance for the footings should be evaluated at the service limit state using the dashed red line in the figures below. The service limit state is based on a maximum settlement of 1 inch and a resistance factor (φ_b) equal to 1.0. As indicated in Section C10.6.2.1 of the AASHTO LRFD 2014, the design of footings is usually controlled by settlement at the service limit state. Therefore, it is usually advantageous to proportion spread footings at the service limit state and to check that the strength and extreme limit states are satisfied.

Once the dimensions of the footings are determined, based on the service limit state, the factored bearing resistance at the strength limit state can be determined from the solid blue line in each of the below figures. The factored bearing resistance must be greater than the applied factored vertical bearing pressure determined by the structural engineer. The strength limit state considers bearing resistance, eccentricity (overturning), sliding and reinforced concrete structural failure. The strength limit state is based on a resistance factor (φ_b) equal to 0.45. The footing widths presented in the below figures are effective widths.

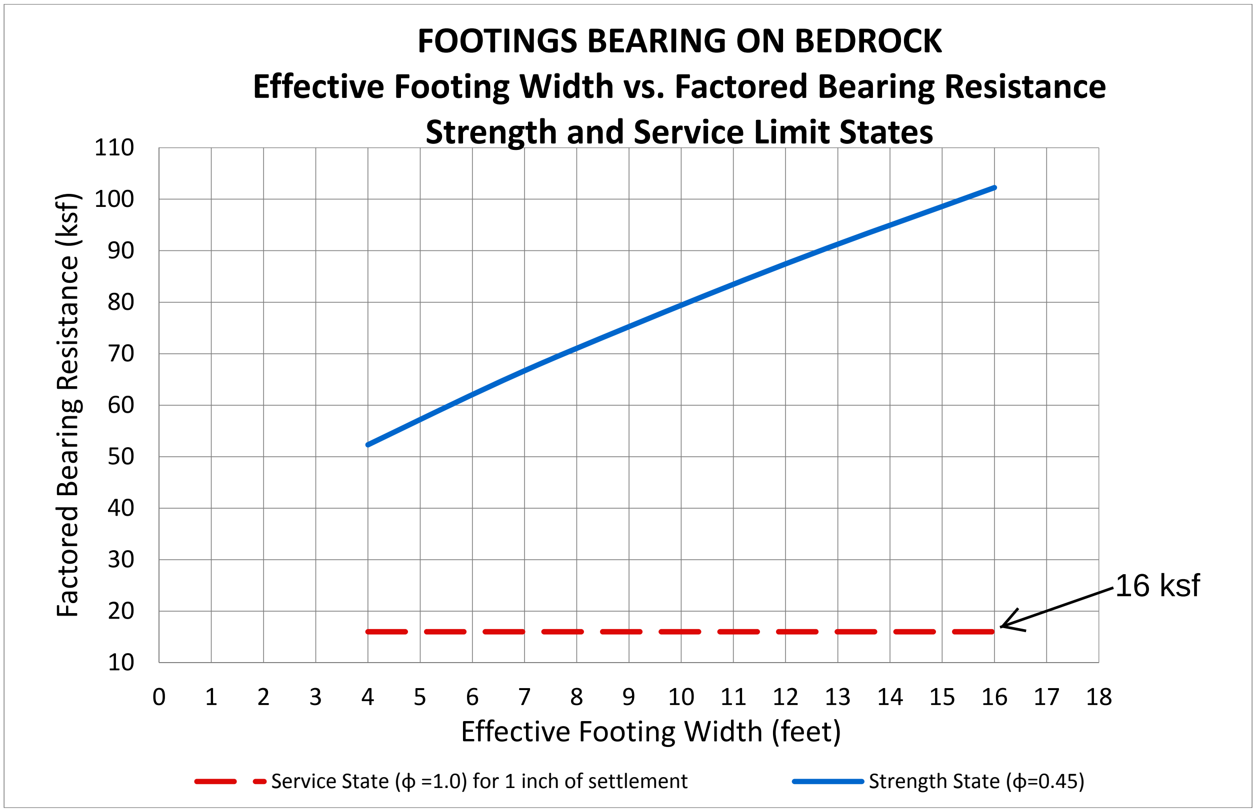
For the extreme limit state, the abutment and wing walls should be designed for bearing resistance, eccentricity, sliding and structural failure with respect to the extreme event load conditions relating to applicable events. Resistance factors, (φ), for the extreme limit state shall be taken as 1.0.

For the service limit state the abutment and wing walls should be designed for settlement, horizontal movement, bearing resistance, sliding and eccentricity. The global stability of foundations is typically evaluated at the Service I Load Combination and a resistance factor, (φ), of 0.65. However, shear failure along the joints in the rock mass below the foundations is not anticipated and a global stability evaluation is not needed for this site.

In accordance with AASHTO 10.6.3.3, for footings bearing on bedrock, the eccentricity (e) of the loading at the strength limit state shall not exceed 0.45 of the footing width or length. For footings bearing on soil, the eccentricity of the loading at the limit state shall not exceed one third of the footing width or length.

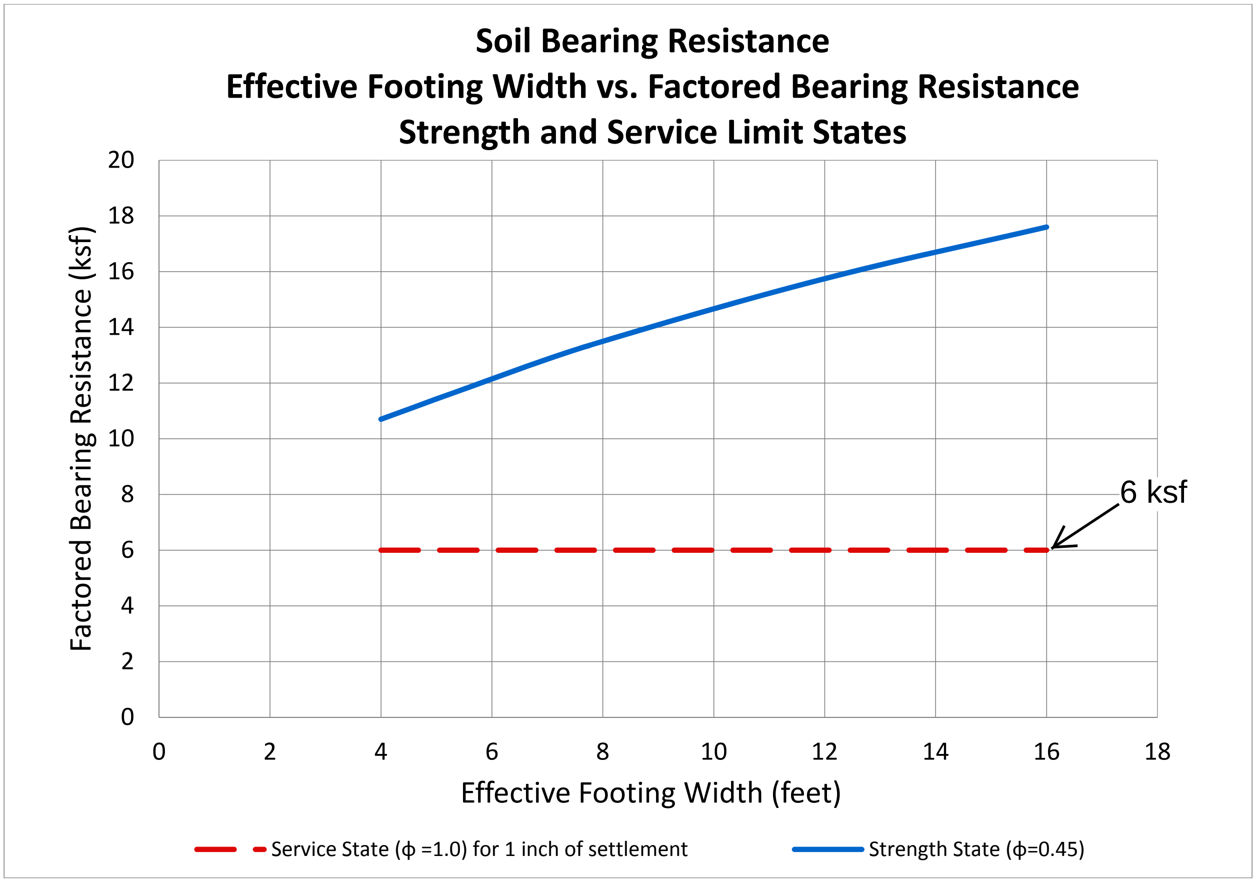
5.3.1 Bedrock bearing Resistance

The bearing resistance for footings bearing on bedrock shall be evaluated at the service limit state and strength limit state as shown by the dashed red line and solid blue line in the figure below. Footings that are expected to bear on bedrock include the wing walls and abutments for Bridge No. 03163, both abutments of Bridge No 03164 and the wing walls for Abutment No. 2 of Bridge No. 03164.



5.3.2 Soil bearing Resistance

The bearing resistance for footings bearing on compacted granular fill shall be evaluated at the service limit state and strength limit state as shown by the dashed red line and solid blue line in the figure below. Footings that are expected to bear on compacted Pervious Structural Backfill include the wing walls for Abutment No. 1 of Bridge No. 03164. A portion of the wing walls for Abutment No. 2 of Bridge No. 03164 may also bear on compacted Pervious Structural Backfill.



5.3.3 Lateral Earth Pressures

The following recommendations are for the design of the bridge abutments and wing walls. The recommendations assume the abutment and wing wall backfill will be fully drained and no hydrostatic pressure.

- Walls that are free to rotate at the top and are founded on soil should be designed based on active earth pressure (K_a) and compacted Previous Structure Backfill. Assuming level backfill, the walls should be designed using K_a equal to 0.28 and a unit weight of 125 pounds per cubic foot (pcf) for the backfill. The corresponding equivalent unit weight is 35 pcf. The equivalent earth pressures are based on Coulomb theory and an angle of internal friction equal to 34 degrees. The back face of the retaining wall was assumed to be vertical. The interface friction angle between the backfill and the concrete wall was conservatively assumed to be zero.
- Walls that are restrained against rotation at the top should be designed based on at rest earth pressure (K_o) and compacted Pervious Structure Backfill. Additionally, walls founded on bedrock should be designed based on at-rest earth pressure because the bedrock will prevent the wall from rotating. Assuming level backfill, the walls should be designed using

K_o equal to 0.45 and a unit weight of 125 pounds per cubic foot (pcf) for the backfill. The corresponding equivalent unit weight is 60 pcf. These earth pressures are based on Coulomb theory and an angle of internal friction equal to 34 degrees.

- The walls should be designed for a live load surcharge equivalent to the earth fill height summarized in AASHTO LRFD Tables 3.11.6.4-1 and 3.11.6.4-2.
- We recommend walls that retain earth be backfilled horizontally with a slope line starting at the top of the heel and extending upward at a slope of 1H:1.5V to the bottom of the roadway subbase per CTDOT Bridge Design Manual Section 5.6.2. The backfill material should be Pervious Structural Backfill meeting the requirements of CTDOT Form 817, Division III, Section M.02.06.
- In addition to the free draining Pervious Structural Backfill, weep holes should be installed in the abutment and wing walls. In accordance with the 2003 CTDOT Bridge Design Manual, weep holes should be 4 inches in diameter spaced 8 to 10 feet with a minimum slope of 1:8 (rise to run). The weep holes shall be placed approximately 12 inches above the finished grade at the front face of the wall stem. A two cubic foot area of bagged stone should be placed behind the weep holes. The bagged stone should meet the requirements of CTDOT Form 817, Division II, Section 7.25.
- For calculating nominal sliding resistance (R_n) for footings we recommend the following:

Table 5 – Coefficient of Sliding

Footing Type	Bearing Surface	Coefficient of Friction Tan(δ) Table 3.11.5.3-1	Resistance Factor (φ_τ) Table 10.5.5.2.2-1
Cast-in-place concrete	Bedrock	0.60	0.80
Cast-in-place concrete	Pervious Structural Backfill	0.55	0.80
Pre-cast concrete	Pervious Structural Backfill	0.40	0.90
Pre-cast concrete	Flowable Fill	0.50	0.90

In accordance with the 2003 CTDOT Bridge Design Manual the nominal passive resistance (R_{ep}) for soil in front of the retaining walls should be ignored.

- If the bedrock surface is observed to slope steeper then 4H:1V at the subgrade elevation, then the bedrock surface should be benched to create level steps or excavated to be completely level. Alternatively, rock dowels extending from the footings into the bedrock may be used to resist sliding forces and improve stability.

5.3.4 Approach Embankment Settlement

The 20-foot high approach embankment located at Abutment No. 1 of Bridge No. 03164 will be placed on bedrock and constructed of compacted granular fill. Settlement of the embankment fill is expected to be minimal and any settlement is expected to occur immediately after placement of the fill because it is granular.

5.3.5 Soil Embankment Slopes

Based on the available plans, the proposed embankment slopes at Bridge No. 03164 will have a grade of 2 Horizontal to 1 Vertical (2H:1V). Due to the soil and bedrock conditions encountered in the borings, we anticipate the 2H:1V slopes will be stable. The surface of the slopes can be treated with loam and seed utilizing an erosion control mat to control soil erosion.

5.3.6 Bedrock Cut Slopes

Based on the proposed plans, new bedrock cut slopes are not proposed. However, if bedrock slopes are needed for the project we recommend a maximum slope of 0.25H:1V. This is based on observations of the existing slope grades below the existing abutments.

5.3.7 Frost Depth

In accordance with Section 5.14.2 of the CTDOT Bridge Design Manual, new footings founded on soil should be founded a minimum depth of 4 feet below the surrounding grade for frost protection. In accordance with Section 5.14.3 of the CTDOT Bridge Design Manual, the is no minimum embedment depth for footings founded on competent bedrock. However, given the fractured condition of the bedrock in some areas and the porous nature of the sandstone bedrock, we recommend a minimum frost depth of 4 feet in the bedrock areas.

5.3.8 Seismic Design Parameters

Seismic design shall be in accordance with the AASHTO LRFD Bridge Design Specifications. Based on the subsurface conditions encountered in the borings, the Seismic Site Class is C – Very dense soil.

5.3.9 Liquefaction Analysis

Liquefaction is a condition when a soil undergoes continued deformation during the course of cyclic stress applications induced by an earthquake where pore water pressure becomes equal to the confining pressure (e.g. effective stress approaches zero) and large deformations occur. Significant factors influencing liquefaction include grain size distribution of sand, fines content, in-situ density, and vibration characteristics. Liquefaction generally occurs in saturated, relatively loose (N values less than 15 bpf) sandy soils with low fines content. Because the abutments and wing walls will be founded on bedrock or on compacted fill placed on bedrock the bridge sites are not considered to be susceptible to liquefaction.

5.4 STAGING AREAS

Staging areas for the construction of the new bridge decks and demolition of the existing bridge decks will be located in the nearby gore areas. For bridge no. 03163 the staging area will be located in the gore area to the north of the existing bridge. For bridge no. 03164 the staging area will be located to the south of the existing bridge. To evaluate the suitability of the soils in these areas to support heavy construction equipment and the bridge deck, three test borings were drilled in each area. The location of the borings is presented in Figures 2 and 3.

Test borings S-1 through S-3 were drilled in the staging area for bridge no. 03163. The borings encountered 3 to 6 feet of medium dense to dense granular fill over lying dense to very dense glacial till. Based on drilling refusal the bedrock was encountered between 6 to 17 feet below the ground surface, corresponding to El. 165 to El. 155.

Test borings S-4 through S-6 were drilled in the staging area for bridge no 03164. The borings encountered 2 to 5 feet of medium dense to very dense granular fill underlain by bedrock. Based on drill refusal, the bedrock surface was encountered in the range of El. 195 to El. 196.

The fill, glacial till, and bedrock are expected to provide a firm bearing surface for the heavy construction equipment and for the construction of the new bridge decks. Prior to placing temporary supports for the deck construction or demolition the ground surface should be cleared of vegetation and stripped of topsoil. Once stripped the ground surface should be proof-rolled/compacted with at least 10 passes of a 10-ton vibratory roller. Areas that are unstable should be replaced with compacted structural fill.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 TEMPORARY EARTH SUPPORT

Given the exposed/shallow bedrock at the site and the proposed construction, the need for temporary earth support on the project is expected to be limited. The design of any temporary earth support should be conducted in accordance with Section 7.16 and 1.05.02-2 of the CTDOT Form 817. The design should be conducted by a professional engineer licensed in the State of Connecticut.

6.2 CONSTRUCTION DEWATERING

Groundwater was only observed in boring S-3. Based on the anticipated footing bearing grades, groundwater will not likely be encountered during the excavation for the footings. However, the contractor should be prepared to remove groundwater from the footing excavations. It is anticipated that groundwater and surface water that enters the foundation excavations can be removed using conventional sumps and pumps. Sumps should be equipped with filter fabric to prevent the loss of fine-grained soils during pumping. Water pumped from the excavations should be discharged to silt bags to filter fine soil particles prior to discharging the water to an active drainage system. Water should be discharged in accordance with all applicable permits and regulations.

6.3 BACKFILL MATERIALS

The following materials are recommended for backfill materials for the project:

Pervious Structural Backfill – For backfill behind abutments and wing walls and as needed for cushion layer between footings and bedrock. Pervious structural backfill shall meet the requirements of CTDOT Form 817, Division II, Section 2.16 and Division III, Section M.02.05 and M.02.06, Gradation B.

Compacted Granular Fill – For backfill in areas other than area requiring pervious structural backfill. Compacted granular fill shall meet the requirements of CTDOT Form 817, Division II, Section 2.14 and Division III, Section M.02.01 and M.02.06, Gradation A.

Embankment Material – For general backfill in embankments and landscaped areas. Embankment material shall meet the requirements of CTDOT Form 817, Division II, Section 2.02.

6.4 REUSE OF EXCAVATED ON SITE SOILS

Based on the results of the test borings and laboratory test results, the excavated on-site soils will not meet the requirements of Pervious Structural Backfill or Granular Fill due to the elevated silt content. The excavated soil will be suitable for reuse as Embankment Material. Cobbles and boulders may be present within the excavated materials and will need to be removed prior to reuse.

Excavated bedrock will not be suitable for reuse as Pervious Structural Backfill or Granular Fill unless it is crushed and processed to the appropriate gradation.

6.5 PLACEMENT OF BACKFILL

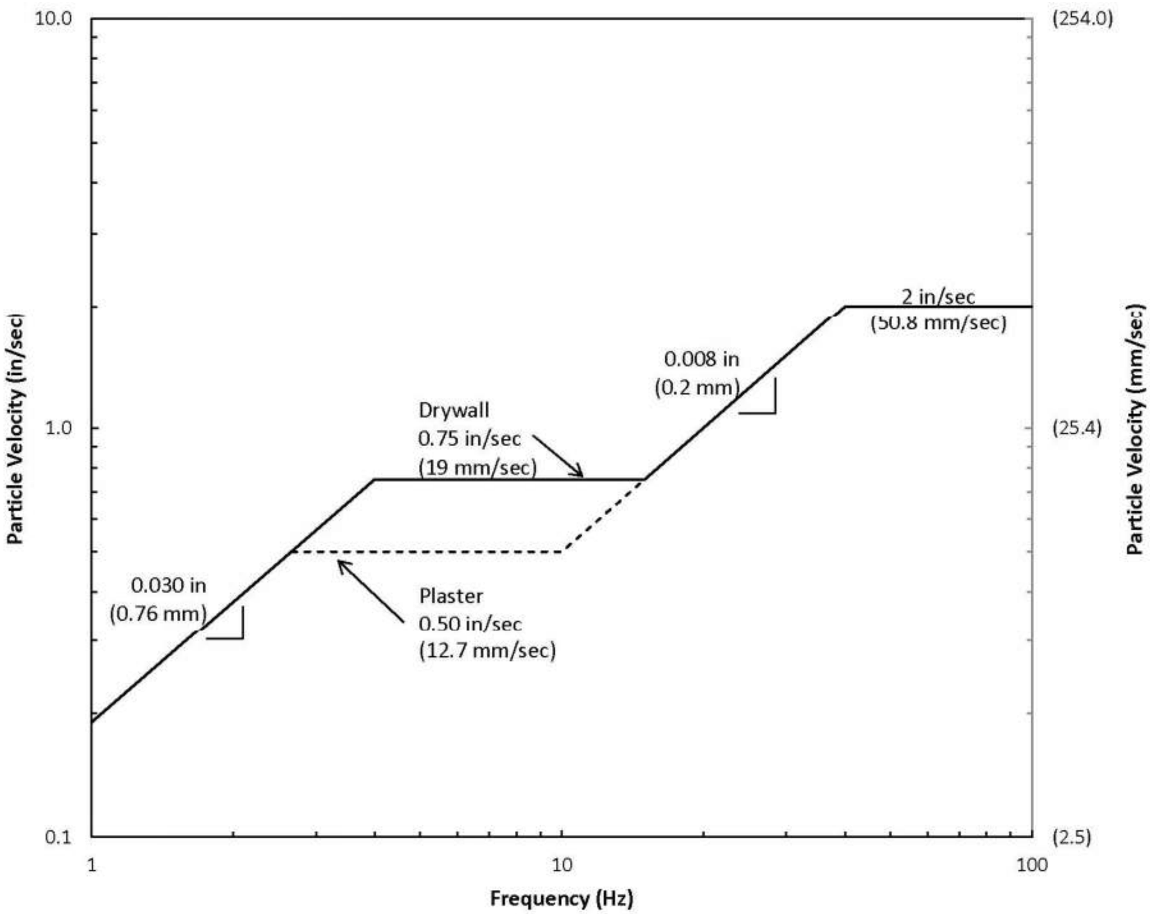
The placement and compaction of backfill should follow the requirements in CTDOT Form 817, Division II.

6.6 PROTECTION OF UTILITIES

Utilities within the area of the proposed excavations should be properly braced, temporarily re-routed and/or protected from construction activities.

6.7 BEDROCK EXCAVATION

Bedrock excavation will be required for the construction of the bridge abutment footings and wing wall footings. The bedrock could be removed by drilling and blasting techniques if permitted by the CTDOT. If blasting is not permitted bedrock should be removed by mechanical techniques such as hoe ramming and/or ripping. Other non-blasting techniques include drilling holes on a grid pattern and filling with expansive grout to fracture the rock which can then be removed by an excavator. In any case, vibrations at nearby structures and the bridge should not exceed the limits established by the United States Bureau of Mines. The peak particle velocity should be below the line shown in the figure below. Additionally, fly rock should be controlled by blasting mats and appropriate charges per delay. The blasting should be conducted in accordance with local, state regulations federal regulations and CTDOT Form 817, Division I Section 1.07.08.



6.8 BEDROCK SUBGRADE PREPARATION

In footing areas, all soil, loose rock, weathered rock, fractured rock, and erodible rock should be removed from beneath the proposed abutment footings prior to placing concrete for footing and/or Pervious Structural Backfill. The foundation subgrade should be inspected and approved by a qualified geotechnical engineer. The surface of the bedrock should be prepared as flat as possible, with all areas of the subgrade flatter than 4H: 1V. If the bedrock surface is observed to slope steeper then 4H: 1V at the subgrade elevation, then the bedrock surface should be benched to create level steps or excavated to be completely level. Alternatively, rock dowels extending from the footings into the bedrock may be used to resist sliding forces and improve stability.

7.0 LIMITATIONS

7.1 USE OF REPORT

This report has been prepared for the exclusive use of the Connecticut Department of Transportation (CT DOT) and their respective assigns and designees. This report is not intended for the use or reliance of other (third) parties, without the express consent of Stantec and CT DOT. Any use, which a third party makes of this report, or any reliance on decisions made based on this report, is the responsibility of such third parties. Further, the findings of this study apply only to the specific Site and project described herein. The findings herein are inapplicable to other Sites, and to developments of different grading, layout, loading, and performance requirements. Stantec accepts no responsibility for damages, real or perceived, suffered by parties as a result of decisions made or actions based on the unintended and/or inappropriate use of this report.

This Geotechnical Engineering Report provides recommendations, and is intended for informational use, requiring interpretation by the owner, design team, and contractor for the design and construction of the project, and interpretation of final quantities and construction costs. The Geotechnical Engineering Report is not intended, or suitable, by itself, for use as a technical specification or to determine quantities. Anticipated quantities and/or costs may be provided in the Geotechnical Report; such information is an Engineer's interpretation, and may vary dramatically from contractor bids, which are based on potentially differing interpretations, and several other variables not available or considered by the Engineer.

7.2 SUBSEQUENT INVOLVEMENT

The geotechnical process incorporates initial exploration and recommendations as summarized herein, and is followed by continuous involvement during key design and construction benchmarks. The recommendations provided herein are based on preliminary information and assumptions regarding proposed site grading, structural loading and performance requirements. It is recommended that Stantec review final foundation, grading, and other applicable plans to assess whether or not these recommendations require modification.

During construction, additional soil samples should be analyzed in the laboratory for moisture content, gradation, and moisture density relationship tests to evaluate the reuse of onsite soils (existing fill and natural sand strata) as backfill material.

Stantec should be retained to observe excavations and subgrade preparation to assess whether the intent of these recommendations is followed during construction, and whether or not other appropriate and/or cost-effective solutions may be warranted based on the actual conditions encountered. Further, a soil exploration is a random sampling of a Site. Should any conditions at the Site at any point during the project be encountered that differ from those summarized in the report, Stantec should be notified immediately in order to permit reassessment of these conditions and the recommendations contained in the report.

7.3 REPRESENTATION AND INTERPRETATION OF DATA

Surficial and subsurface information presented herein is based on field measurements obtained during the course of the exploration and site reconnaissance. The precision and accuracy of surficial data is a function of the references, benchmarks, methods and instruments employed, as summarized in the report. Subsurface data is based on measurements within the borehole or test pit using the sampling methods described on the exploration logs. The completeness, precision, and accuracy of such data is a function of the frequency and type of exploration and sampling employed, as well as the precision and accuracy of the surface location and elevation of the borehole, and may vary from actual conditions encountered during excavations. Subsurface conditions between, beyond and below explorations, may vary dramatically from the nearest exploration, due to natural geologic action, deposition and weathering, or man-made activities.

Groundwater levels were recorded during the time periods and frequencies noted on the explorations. It is important to note that groundwater levels are disrupted by the exploration, and require equilibration periods to determine actual hydrostatic levels, which exceed the duration of the measurement period. Multiple hydrostatic groundwater levels may exist, including perched or trapped water, which may not necessarily be accurately represented by one water level reading. Groundwater levels fluctuate due to seasonal variations, adjacent surface water bodies, precipitation, and on-Site and nearby land use.

Figures

Appendix A

Test Borings

Bridge No. 03163

Bridge No. 03164

Staging Areas

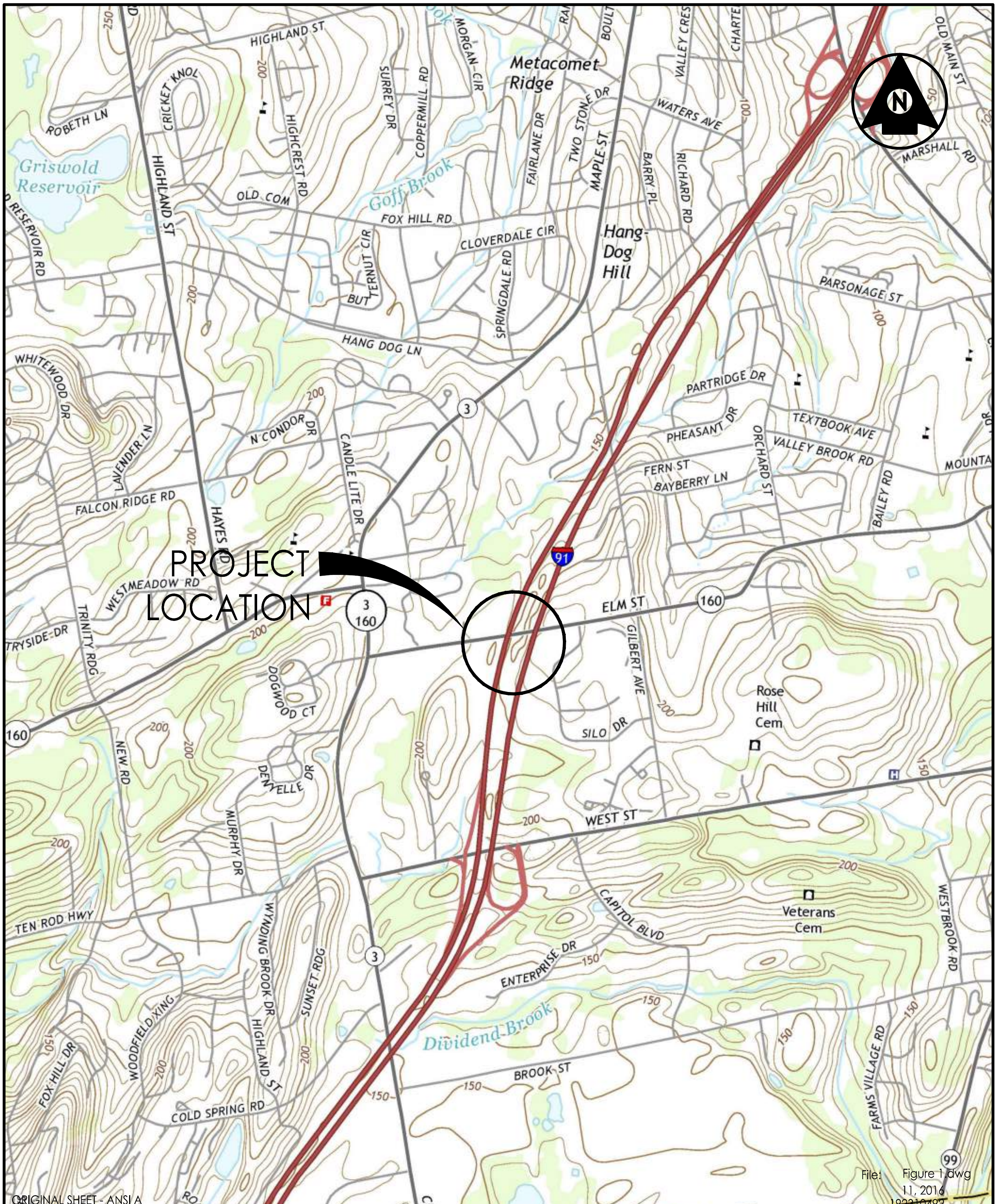
Appendix B

Rock Core Photographs

Appendix C

Laboratory Test Results

Figures



Client/Project

CTDOT BRIDGES 03163 AND 03164
ROUTE 160 OVER I-91

0 2000′ 4000′

Figure No.

1.0

Title

SITE LOCATION PLAN

Stantec

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55 CHURCH STREET, SUITE 601
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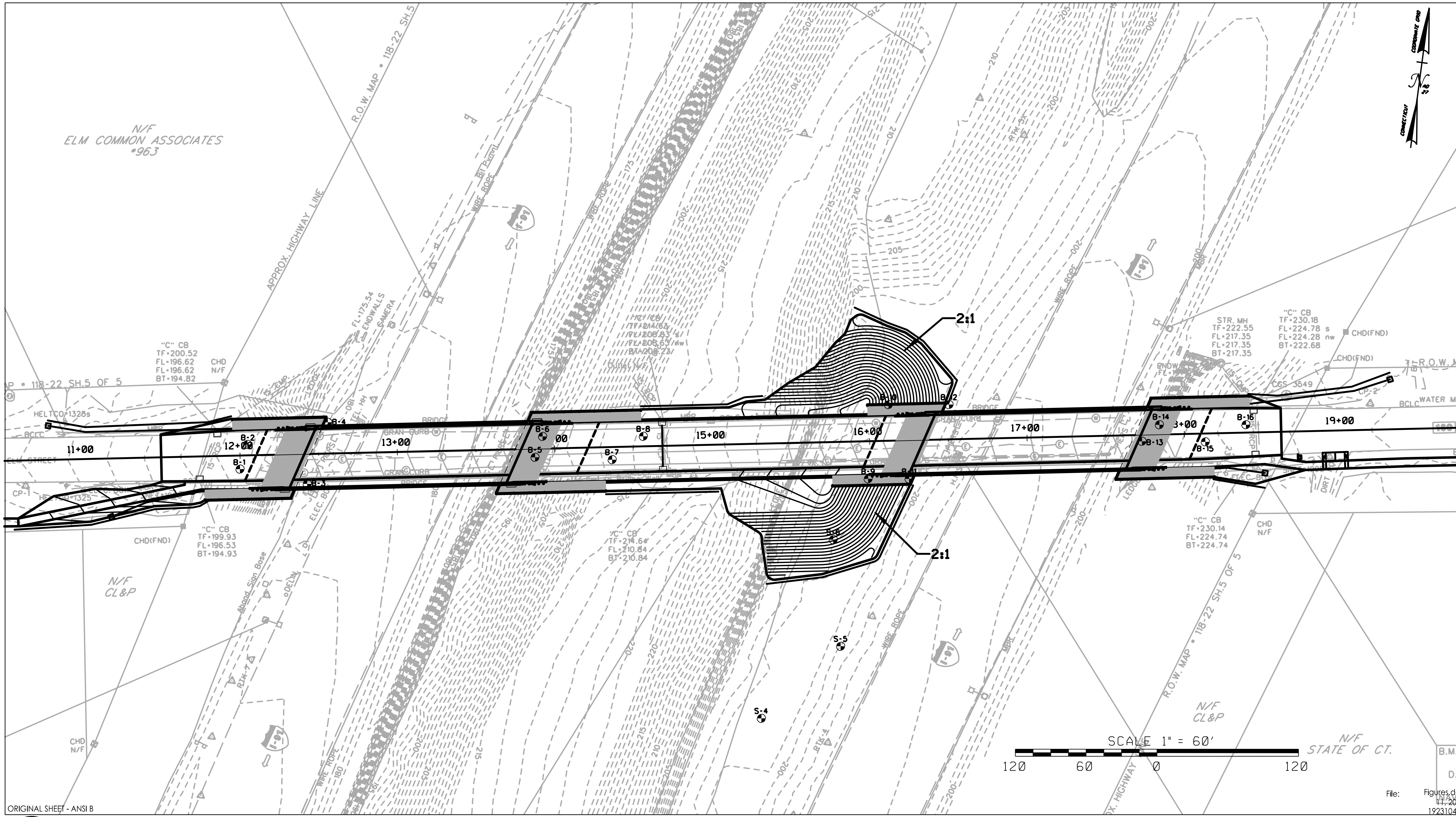

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Fax. 203.495.1652
www.stantec.com

NOTES:

1) TEST BORINGS WERE DRILLED BY NEW ENGLAND BORING OF GLASTONBURY, CONNECTICUT FROM AUGUST 29, 2016 TO SEPTEMBER 19, 2016 UNDER THE DIRECTION OF A STANTEC PERSONNEL.

2) BORING LOCATIONS WERE DETERMINED BY TAPING FROM EXISTING SITE FEATURES.

LEGEND:

B-X APPROXIMATE AS DRILLED LOCATION OF BORING

Client/Project

CTDOT BRIDGES 03163 AND 03164
ROUTE 160 OVER I-91 SB AND NB

Figure No.

2

Title

BORING LOCATION PLAN (1 OF 2)

SCALE 1'' = 60'

120 60 0 120

LEGEND:

B-X APPROXIMATE AS DRILLED LOCATION OF BORING

NOTES:

1) TEST BORINGS WERE DRILLED BY NEW ENGLAND BORING OF GLASTONBURY, CONNECTICUT FROM AUGUST 29, 2016 TO SEPTEMBER 19, 2016 UNDER THE DIRECTION OF A STANTEC PERSONNEL.

2) BORING LOCATIONS WERE DETERMINED BY TAPING FROM EXISTING SITE FEATURES.

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ORIGINAL SHEET - ANSI B

Stantec

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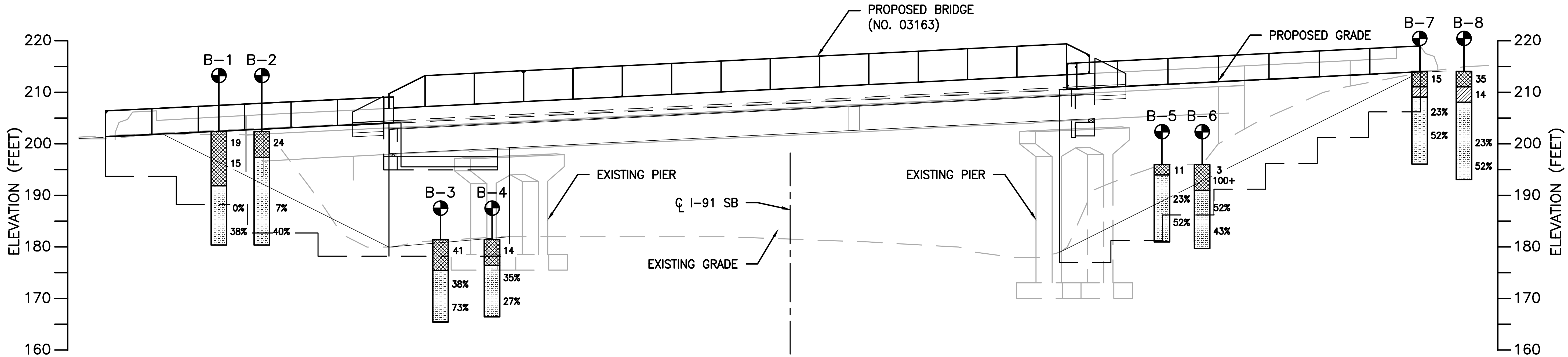
CTDOT BRIDGES 03163 AND 03164
ROUTE 160 OVER I-91 SB AND NB

Figure No.

3

Title

BORING LOCATION PLAN (2 OF 2)

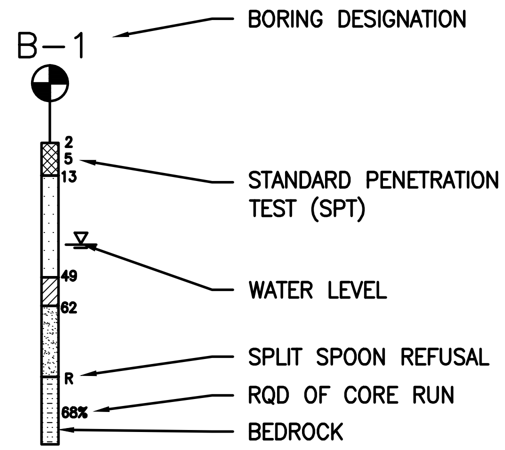


ELEVATION

Scale: 1" = 20'

BORING LEGEND

	=	FILL
	=	GLACIAL TILL
	=	BEDROCK



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Stantec

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5 Dartmouth Drive, Suite 101
Auburn NH 03032 U.S.A.
Tel. 603.669.8672
Fax. 603.669.7636

Notes

1. CONFIGURATION OF PROPOSED BRIDGE IS FROM "GENERAL PLAN" PREPARED BY STANTEC.

2. THE PROFILE SHOWS THE GENERAL SUBSURFACE CONDITIONS ALONG ELM STREET (ROUTE 160) CENTERLINE. THE STRATA LINES ARE BASED ON THE TEST BORINGS LOGS AND ARE APPROXIMATE.

Client/Project

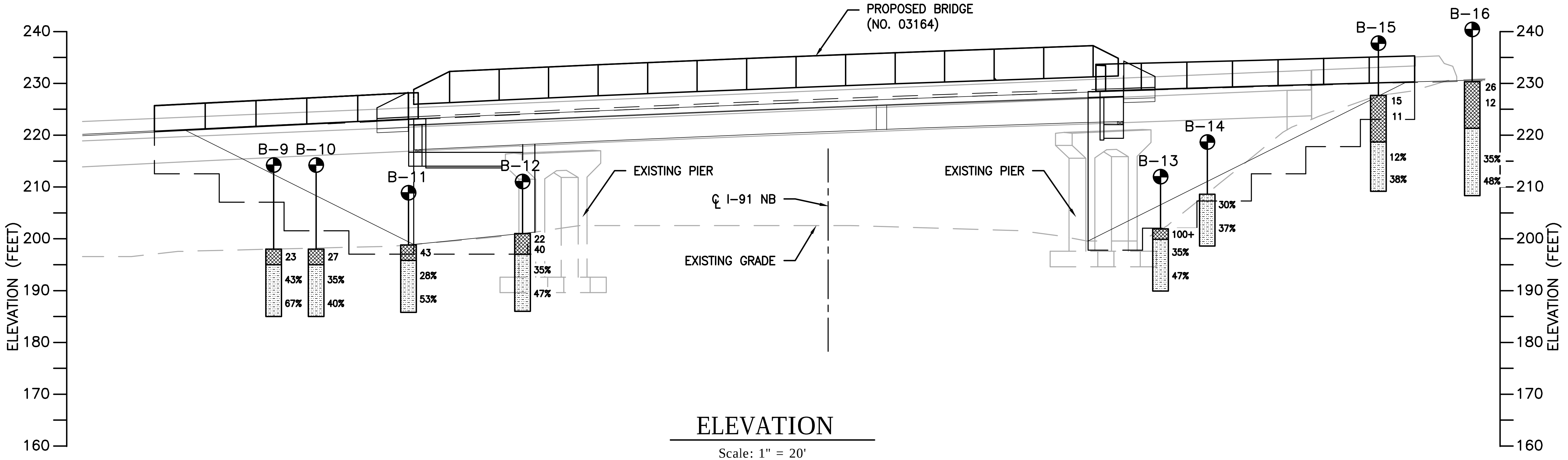
CTDOT BRIDGES 03163 AND 03164
ROUTE 160 OVER I-91 SB AND NB

Figure No.

4

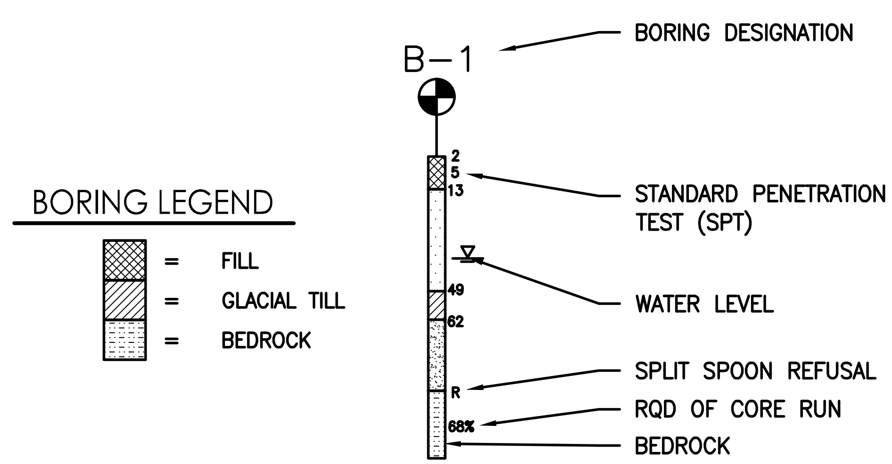
Title

BRIDGE 03163
SUBSURFACE PROFILE



ELEVATION

Scale: 1" = 20'



ORIGINAL SHEET - ANSI B

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192310492

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2. THE PROFILE SHOWS THE GENERAL SUBSURFACE CONDITIONS ALONG ELM STREET (ROUTE 160) CENTERLINE. THE STRATA LINES ARE BASED ON THE TEST BORINGS LOGS AND ARE APPROXIMATE.

Client/Project

CTDOT BRIDGES 03163 AND 03164
ROUTE 160 OVER I-91 SB AND NB

Figure No.

5

Title

BRIDGE 03164
SUBSURFACE PROFILE

Appendix A

Test Borings

Bridge No. 03163

Connecticut DOT Boring Report

Driller: T. Roe	Town: Rocky Hill, Connecticut	Hole No.: B-1
Inspector: M. Kenney	Project No.: 118-169	Stat./Offset:
Engineer: T Dykstra	Route No.: Route 160	Northing: 800849.7602
Start Date: 8-30-2016	Bridge No.: 03163	Easting: 1021423.5049
Finish Date: 8-31-2016		Surface Elevation: 201.23

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches (SAMPLES)	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT	0-0.6 Ft: ASPHALT (8 in.)		100
	S-1	10 9 10 6	24	17			FILL	Reddish brown c-f SAND, little m-f gravel, trace silt.		
5	S-2	10 9 6 7	24	7				Brown, c-f SAND, little f gravel, trace silt.		95
10	S-3	54/6"	6	2				Weathered rock with c-f SAND		90
							BEDROCK			
15	C-1		60	40	0			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		85
20	C-2		60	54	38			Medium strong, slightly weathered, intensely fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		80
								END OF BORING 22ft		
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 10.5 ft Rock: 11.5 ft		Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe			Hole No.:	B-2
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800864.4890
Start Date:	9-1-2016	Route No.:	Route 160	Easting:	1021432.5358
Finish Date:	9-1-2016	Bridge No.:	03163	Surface Elevation:	201.83

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT	0-0.6 Ft: ASPHALT (8 in.)		100
	S-1	10 12 12 15	24	13			FILL	Reddish brown c-f SAND, little m-f gravel, little silt, trace silt.		
5							FRACTURED BEDROCK			95
10							COMPETENT BEDROCK			90
15	C-1		60	52	7			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Intensely fractured from 12 to 14 feet. Joints are dipping at less than 5 degrees.		85
20	C-2		60	60	40			From 17.0 to 20.5 feet. Medium strong, fresh, intensely fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees. From 20.5 to 22 feet. Medium strong, fesh, highly fractured, light reddish brown, fine grained SANDSTONE. Joints are dipping at less than 5 degrees.		80
								BOTTOM OF BORING 22ft		
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft Rock: 17 ft		Sheet 1 of 1
No. of Soil Samples: 1 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe
Inspector:	M. Kenney
Engineer:	T Dykstra
Start Date:	9-15-2016
Finish Date:	9-15-2016
Town:	Rocky Hill, Connecticut
Project No.:	118-169
Route No.:	Route 160
Bridge No.:	03163
Hole No.:	B-3
Stat./Offset:	
Northing:	800835.4364
Easting:	1021468.9394
Surface Elevation:	179.91
Project Description:	Route 160 Over I-91 SB
Casing Size/Type:	HW/4 inch
Hammer Wt.:	300lb, Fall: 24 in
Sampler Type/Size:	Split Spoon 2 in
Hammer Wt.:	140 lbs, Fall: 30 in
Core Barrel Type:	NQ
Groundwater Observations:	Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	6 20 21 18	24	11			FILL	Brown c-f SAND, some f gravel, trace silt with fragment of rock.		
5	S-2	27 50/3"	9	9				Brown, c-f SAND, some m-f gravel, little silt.		95
	C-1		60	53	38		Bedrock	Medium strong, slightly weathered, highly fractured, reddish brown, fine to medium grained, SANDSTONE, alternating layers of fine grained, SILTSTONE from 7.5 to 10.0. Joints are dipping at less than 5 degrees.		
10										90
	C-2		60	60	73			11 - 11.5 feet reddish brown m-f grained SANDSTONE. 11.5 - 12.0 feet reddish brown, fine grained SILTSTONE. 12 - 16 feet medium strong, slightly weathered, highly fractured, reddish brown, medium to fine grained, SANDSTONE. Joints are dipping at less than 5 degrees.		
15										85
								END OF BORING 16ft		
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth:	6 ft
Rock:	10 ft
No. of Soil Samples:	2
No. of Core Runs:	2

Sheet 1 of 1

SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe			Hole No.:	B-4
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800889.5693
Start Date:	9-15-2016	Route No.:	Route 160	Easting:	1021490.4288
Finish Date:	9-15-2016	Bridge No.:	03163	Surface Elevation:	180.03

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: 2 ft after 3.5 hours

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0	S-1	4 5 9 15	24	14			FILL	Brown, c-f SAND, some m-f gravel, trace silt.		100
5	C-1		60	59	35		BEDROCK	Medium strong, slightly weathered, highly to intensely fractured, reddish brown, alternating layers m-f grained SANDSTONE and fine grained, laminated SILTSTONE. Joints are dipping at less than 5 degrees.		95
10	C-2		60	59	27			Medium strong, slightly weathered, highly to intensely fractured, reddish brown, alternating layers m-f grained SANDSTONE and fine grained, laminated SILTSTONE. Joints are dipping at less than 5 degrees.		90
15								END OF BORING 15 ft		85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft	Rock: 10 ft		Sheet 1 of 1
No. of Soil Samples: 1	No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-5
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800882.7689
Start Date:	9-12-2016	Bridge No.:	03163	Easting:	1021615.4730
Finish Date:	9-12-2016			Surface Elevation:	195.93

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	9 7 4 2	24	5			FILL	Brown, c-f SAND, little m-f gravel, trace silt.		
5	S-2	50/0"	0	0				No recovery.		95
	C-1		60	58	23		BEDROCK	Medium strong, slightly weathered, highly fractured, reddish brown, fine grained SILTSTONE, with 4 inch layer of fine grained SANDSTONE at 9.5 feet. Joints are dipping at less than 5 degrees.		
10										90
	C-2		60	58	52			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained SILTSTONE, with 3 inch layer of fine grained SANDSTONE at 12.0 feet. Joints are dipping at less than 5 degrees.		
15								END OF BORING 15 ft		85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft Rock: 10 ft	Boring was drilled througth the bridge deck. The deck consisted of 2 inches of asphalt and 6 inches of concrete. The distance from the top of deck to the grond surface was 15 feet. The bridge deck was patched upon completion.	Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-6
Inspector:	M. Kenney	Project No.:	118-16	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800889.9089
Start Date:	9-7-2016	Bridge No.:	03163	Easting:	118-169
Finish Date:	9-7-2016			Surface Elevation:	195.22

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: 195.22
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	1 1 2 3	24	5			FILL	Reddish brown, c-f SAND, trace f gravel, trace silt.		
5	S-2	18 30 86/3"	1.25	12				Reddish brown, SILT and f sand, some m-f gravel, rock fragments at bottom of spoon.		95
	C-1		60	58	52		BEDROCK	Medium strong, slightly weathered, highly fractured, reddish brown, alternating layers of medium to fine grained SANDSTONE nad fine grained SILTSTONE. Joints are dipping at less than 5 degrees.		
10										90
	C-2		60	58	43			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		
15										85
								END OF BORING 16.25 ft		
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5.25 ft Rock: 11 ft	Boring was drilled through the bridge deck. The deck consisted of 2 inches of asphalt and 6 inches of concrete. The distance from the top of deck to the grond surface was 16 feet. The bridge deck was patched upon completion.	Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-7
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800889.1885
Start Date:	8-31-2016	Bridge No.:	03163	Easting:	1021663.4641
Finish Date:	8-31-2016			Surface Elevation:	213.29

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT	0 - 0.6 ft: ASPHALT (8 inches)		100
	S-1	12 8 7 19	24	13			FILL	Reddish brown, c-f SAND, some silt, little m-f gravel. Note: bottom of sample appeared to be glacial till		
							GLACIAL TILL			
5							BEDROCK			95
10	C-1		60	53	38			Medium strong, slightly weathered, intensely fractured, reddish brown, fine grained, laminated SILTSTONE. Joints are dipping at less than 5 degrees.		90
15	C-2		60	47	20			Medium strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		85
								END OF BORING 18 ft		
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft Rock: 13 ft		Sheet 1 of 1
No. of Soil Samples: 1 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-8
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800905.1856
Start Date:	8-31-2016	Bridge No.:	03163	Easting:	1021677.3570
Finish Date:	9-1-2016			Surface Elevation:	214.01

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT	0 - 0.6 ft: ASPHALT (8 inches)		100
	S-1	8 21 14 10	24	12			FILL	Reddish brown, c-f SAND, lttle c-f gravel, little silt.		
5	S-2	12 6 8 13	24	12			GLACIAL TILL	Reddish brown, SILT and f sand, with gravel.		95
10							BEDROCK			90
	C-1		60	43	20			Medium strong, slightly weathered, intensely fractured, reddish brown, fine grained, laminated SILTSTONE. Joints are dipping at less than 5 degrees.		
15										85
	C-2		60	55	61			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		
20										80
								END OF BORING 21 ft		
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 8 ft Rock: 13 ft		Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Bridge No. 03164

Connecticut DOT Boring Report

Driller:	T. Roe	Hole No.:	B-9		
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800896.6102
Start Date:	9-14-2016	Route No.:	Route 160	Easting:	1021821.3521
Finish Date:	9-14-2016	Bridge No.:	03164	Surface Elevation:	197.52

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	11 13 20 27	24	16			FILL	Brown, c-f SAND, some m-f gravel, trace silt.		
	S-2	19 40 100/1"	12	7				Brown, c-f SAND, some m-f gravel, trace silt, with weather rock in bottom of spoon.		
5	C-1		60	60	43		BEDROCK	Medium strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated SILTSTONE. Joints are dipping at less than 5 degrees.		95
10	C-2		60	60	67			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Layer of reddishd brown, medium to fine grained, SANDSTONE at 9 feet. Joints are dipping at less than 5 degrees.		90
								END OF BORING 13 ft		
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 3 ft Rock: 10 ft		Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-10
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800948.9367
Start Date:	9-13-2016	Bridge No.:	03164	Easting:	1021836.8488
Finish Date:	9-13-2016			Surface Elevation:	197.05

Project Description: Route 160 Over I-91 NB

Casing Size/Type:	HW/4 inch	Sampler Type/Size:	Split Spoon 2 in	Core Barrel Type:	NQ
Hammer Wt.: 300lb	Fall: 24 in	Hammer Wt.: 140 lbs	Fall: 30 in		

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0	S-1	9 13 14 27	24	17			Fill	0 - 0.5 feet: Reddish brown, c-f SAND, little m-f gravel, trace silt. 0.5 - 2.0 feet: Brown, c-f SAND, some silt, little f gravel.		100
3							Bedrock			
5	C-1		60	51	35			Medium strong, slightly weathered, intensely fractured, reddish brown, fine grained, SILTSTONE with some SANDSTONE layers. Joints are dipping at less than 5 degrees.		95
10	C-2		60	38	40			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, SILTSTONE and SANDSTONE. Joints are dipping at less than 5 degrees.		90
15								END OF BORING 15 ft		85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 3.5 ft Rock: 11.5 ft

No. of Soil Samples: 1 No. of Core Runs: 2

Sheet 1 of 1

SM-001-M REV. 1/02

Driller:	T. Roe	**Connecticut DOT Boring Report**		Hole No.:	B-11
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800905.0906
Start Date:	9-14-2016	Route No.:	Route 160	Easting:	1021853.1311
Finish Date:	9-14-2016	Bridge No.:	03164	Surface Elevation:	198.60

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: 7.6 ft after completion of boring

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	10 19 24 45	24	13			FILL	Reddish brown, c-f SAND, some m-f gravel, trace silt.		
	S-1	10 13 15 120/3"	21	15				2 to 2.5 feet: Reddish brown, c-f SAND, some m-f gravel, trace silt. 2.5 to 3.75 feet: Brown, SILT, little f sand, little m-f gravel		
							BEDROCK			
5	C-1		60	59	28			Medium strong, slightly weathered, intensely fractured, reddish brown, fine grained, SILTSTONE with some layers of SANDSTONE. Joints are dipping at less than 5 degrees.		95
10	C-2		60	53	53			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE and SANDSTONE. Joints are dipping at less than 5 degrees.		90
15								End of Boring at 15 feet		85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 3.75 ft Rock: 11.25 ft		Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe			Hole No.:	B-12
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800954.2202
Start Date:	9-13-2016	Route No.:	Route 160	Easting:	1021874.7239
Finish Date:	9-13-2016	Bridge No.:	03164	Surface Elevation:	198.29

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch		Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb	Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	26 8 14 13	24	17			FILL	Brown, SILT and c-f SAND, some m-f gravel.		
	S-1	20 20 20 20	24	5				Brown, c-f SAND and silt, m-f gravel.		
5							BEDROCK			95
	C-1		60	37	35			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, SANDSTONE Joints are dipping at less than 5 degrees.		
10										90
	C-2		60	55	47			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, SANDSTONE. Joints are dipping at less than 5 degrees.		
15								End of Boring at 15 feet		85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft Rock: 10 ft		Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-13
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800947.2297
Start Date:	9-9-2016	Bridge No.:	03164	Easting:	1021995.7489
Finish Date:	9-9-2016			Surface Elevation:	200.09

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	17 36 100	18	11			FILL	Brown, c-f SAND, trace silt, with cobbles.		
5	C-1		60	58	20		BEDROCK	Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE Joints are dipping at less than 5 degrees.		95
10	C-2		60	58	33			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE Joints are dipping at less than 5 degrees.		90
								End of Boring at 12 feet		
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 1.5 ft Rock: 10.5 ft	Boring was drilled throurgth the bridge deck. The deck consisted of 2 inches of asphalt and 8 inches of concrete. The distance from the top of deck to the grond surface was 29 feet. The bridge deck was patched upon completion.	Sheet 1 of 1
No. of Soil Samples: 1 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe			Hole No.:	B-14
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800957.5620
Start Date:	9-8-2016	Route No.:	Route 160	Easting:	1022005.9317
Finish Date:	9-8-2016	Bridge No.:	03164	Surface Elevation:	201.94

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch	Sampler Type/Size: Split Spoon 2 in	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							BEDROCK			100
	C-1		60	47	30			Medium strong, slightly weathered, highly to intensely fractured, reddish brown, fine to medium grained, SANDSTONE Joints are dipping at less than 5 degrees.		
5										95
	C-2		60	58	37			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		
10										90
								End of Boring at 11 feet		
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 0 ft Rock: 11 ft	Boring was drilled throurgh the bridge deck. The deck consisted of 2 inches of asphalt and 8 inches of concrete. The distance from the top of deck to the grond surface was 28 feet. The bridge deck was patched upon completion.	Sheet 1 of 1
No. of Soil Samples: 0 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Hole No.:	B-15		
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	229.77	Northing:	800953.0100
Start Date:	8-30-2016	Route No.:	Route 160	Easting:	1022035.7169
Finish Date:	8-30-2016	Bridge No.:	03164	Surface Elevation:	220.52

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HW/4 inch		Sampler Type/Size: Split Spoon 2 in		Core Barrel Type: NQ
Hammer Wt.: 300lb	Fall: 24 in	Hammer Wt.: 140 lbs	Fall: 30 in	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT			100
	S-1	20 15 11 22	24	0			FILL	No recovery. Rock in tip of spoon. Based on drill cuttings the soil consist of brown, c-f SAND, little m gravel, trace silt.		
5	S-2	8 6 6 4	24	0				No recovery.		95
10							BEDROCK			90
	C-1		60	51	12			Medium strong, slightly weathered, highly to intensely fractured, reddish brown, fine to medium grained, SANDSTONE Joints are dipping at less than 5 degrees.		
15										85
	C-2		60	55	38			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		
20										80
								End of Boring at 21 feet		
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 9.25 ft	Rock: 11.75 ft	Sheet 1 of 1
No. of Soil Samples: 2	No. of Core Runs: 2	SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	B-16
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800966.8251
Start Date:	8-29-2016	Bridge No.:	03164	Easting:	1022059.2055
Finish Date:	8-29-2016			Surface Elevation:	230.48

Project Description: Route 160 Over I-91 NB

Casing Size/Type:	HW/4 inch	Sampler Type/Size:	Split Spoon 2 in	Core Barrel Type:	NQ
Hammer Wt.: 300lb	Fall: 24 in	Hammer Wt.: 140 lbs	Fall: 30 in		

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0							ASPHALT	0 to 0.7 feet: ASPAHLT (8 inches)		100
	S-1	20 15 11 22	24	8			FILL	Reddish brown, c-f SAND, little m-f gravel, trace silt.		
5	S-2	8 6 6 4	24	6				Brown, c-f SAND, some silt, little m-f gravel.		95
10							BEDROCK			90
15	C-1		60	50	35			Medium strong, slightly weathered, highly to intensely fractured, reddish brown, fine grained, laminated, SILTSTONE. Joints are dipping at less than 5 degrees.		85
20	C-2		60	60	48			Medium strong, slightly weathered, highly fractured, reddish brown, fine grained, laminated, SILTSTON with 4 inch SANDSTOEN layer at 18.5 feet. Joints are dipping at less than 5 degrees.		80
								End of Boring at 22 feet		
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 9 ft	Rock: 13 ft	Sheet 1 of 1
No. of Soil Samples: 2	No. of Core Runs: 2	SM-001-M REV. 1/02

Staging Areas

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	S-1
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	801686.6738
Start Date:	9-15-2016	Bridge No.:	03163	Easting:	102788.7988
Finish Date:	9-15-2016			Surface Elevation:	171.79

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HSA/4.25 inch	Sampler Type/Size: Split Spoon 2 inch	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 inches	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										0
	S-1	9 16 21 26	24	15			FILL	Reddish brown, c-f SAND, little m-f gravel, little silt.		
5										-5
	S-2	14 15 85/1"	13	12				Reddish brown c-f SAND, little m-f gravel, little silt.		
							PROBABLE BEDROCK	END OF BORING 6.1ft		
10										-10
15										-15
20										-20
25										-25

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 6.1 ft Rock: 0 ft		Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	S-2
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	801740.4450
Start Date:	9-15-2016	Bridge No.:	03163	Easting:	1021795.1234
Finish Date:	9-15-2016			Surface Elevation:	172.27

Project Description: Route 160 Over I-91 SB

Casing Size/Type: HSA/4.25 inch	Sampler Type/Size: Split Spoon 2 inch	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 inches	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	9 16 21 34	24	9			FILL	Reddish brown, c-f SAND, little f gravel, little silt.		
5	S-2	12 16 30 55	24	15			GLACIAL TILL	Brown, SILT, some m-f gravel, little f SAND.		95
10	S-3	26 75 60 55	24	18				Brown, SILT, some m-f gravel, little f SAND.		90
							PROBABLE BEDROCK	END OF BORING 13 ft		
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 13 ft Rock: 0 ft		Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe			Hole No.:	S-3
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	801820.2550
Start Date:	9-14-2016	Route No.:	Route 160	Easting:	1021807.7682
Finish Date:	9-14-2016	Bridge No.:	03163	Surface Elevation:	172.60

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HSA/4.25 inch	Sampler Type/Size: Split Spoon 2 inch	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 inches	

Groundwater Observations: 11 ft after 24 hours

Depth (ft)	Sample Type/No.	SAMPLES Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	4 9 12 50	24	18			FILL	Reddish brown, c-f SAND, little f gravel, little silt.		
								Reddish brown, c-f SAND, little f gravel, little silt.		
	S-2	21 42 60 52	24	16			GLACIAL TILL	Brown, SILT, little f gravel, little f SAND.		
5										95
	S-3	8 20 20 18	24	19				Reddish brown, c-f SAND, some silt, little m-f gravel.		
10										90
	S-4	25 44 55 65	24	24				Brown, SILT and f sand, little f gravel, little clay		
15										85
	S-5	44 59 65 80	24	20				Brown, SILT and f sand, little m-f gravel, little clay		
							PROBABLE BEDROCK	END OF BORING 17 ft		
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 17 ft Rock: 0 ft		Sheet 1 of 1
No. of Soil Samples: 5 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	S-4
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800733.6134
Start Date:	9-13-2016	Bridge No.:	03164	Easting:	1021777.8433
Finish Date:	9-13-2016			Surface Elevation:	198.84
Project Description:	Route 160 Over I-91 NB				
Casing Size/Type:	HSA/4.25 inch	Sampler Type/Size:	Split Spoon 2 inch	Core Barrel Type:	NQ
Hammer Wt.:	300lb Fall: 24 in	Hammer Wt.:	140 lbs Fall: 30 inches		
Groundwater Observations:	Not Encountered				

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	4 22 29 38	24	19			FILL	Reddish brown, c-f SAND, little m-f gravel, little silt.		
	S-2	25 63 25/1"	13	8				Reddish brown, SILT and f sand, some c-f gravel.		
5	S-3	110/5"	5	1			PROBABLE BEDROCK	Fractured Bedrock		95
								END OF BORING 5.4ft		
10										90
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 4 ft Rock: 1.4 ft		Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Connecticut DOT Boring Report		Hole No.:	S-5
Inspector:	M. Kenney	Town:	Rocky Hill, Connecticut	Stat./Offset:	
Engineer:	T Dykstra	Project No.:	118-169	Northing:	800792.3372
Start Date:	9-13-2016	Route No.:	Route 160	Easting:	1021825.2386
Finish Date:	9-13-2016	Bridge No.:	03164	Surface Elevation:	200.0

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HSA/4.25 inch	Sampler Type/Size: Split Spoon 2 inch	Core Barrel Type: NQ
Hammer Wt.: 300lb Fall: 24 in	Hammer Wt.: 140 lbs Fall: 30 inches	

Groundwater Observations: 200.07

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	11 31 37 39	24	20			FILL	Reddish brown, c-f SAND, little m-f gravel, little silt.		
	S-2	14 16 17 19	24	18				Reddish brown, c-f SAND, some m-f gravel, little silt.		
5	S-3	100/2"	2	0				No recovery		95
							PROBABLE BEDROCK	END OF BORING 5.2 ft		
10										90
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 5 ft Rock: 0.2 ft		Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Driller:	T. Roe	Town:	Rocky Hill, Connecticut	Hole No.:	S-6
Inspector:	M. Kenney	Project No.:	118-169	Stat./Offset:	
Engineer:	T Dykstra	Route No.:	Route 160	Northing:	800858.1128
Start Date:	9-13-2016	Bridge No.:	03164	Easting:	1021808.4367
Finish Date:	9-13-2016			Surface Elevation:	197.98

Project Description: Route 160 Over I-91 NB

Casing Size/Type: HSA/4.25 inch		Sampler Type/Size: Split Spoon 2 inch		Core Barrel Type: NQ
Hammer Wt.: 300lb	Fall: 24 in	Hammer Wt.: 140 lbs	Fall: 30 inches	

Groundwater Observations: Not Encountered

Depth (ft)	Sample Type/No.	SAMPLES: Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Casing Blows per 6"	Generalized Strata Description	Material Description and Notes	Well Construction	Elevation (ft)
0										100
	S-1	16 17 28 33	24	12			FILL	Brown, c-f SAND, some f gravel, little silt.		
	S-2	24 120/5"	9	4			PROBABLE BEDROCK	Fractured bedrock		
								END OF BORING 2.9 ft		
5										95
10										90
15										85
20										80
25										75

Sample type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1-10%, Little = 10-20%, Some = 20-35%, And = 35-50%

Total Penetration in Earth: 2 ft	Rock: 0.9 ft	Sheet 1 of 1
No. of Soil Samples: 2 ft	No. of Core Runs: 0	SM-001-M REV. 1/02

Appendix B

Rock Core Photographs

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-4, C-1

B-4, C-2

B-3, C-1

B-3, C-2

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-6, C-1

B-6, C-2

B-14, C-1

B-14, C-2

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-7, C-1

B-7, C-2

B-8, C-1

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-8, C-2

B-2, C-1

B-2, C-2

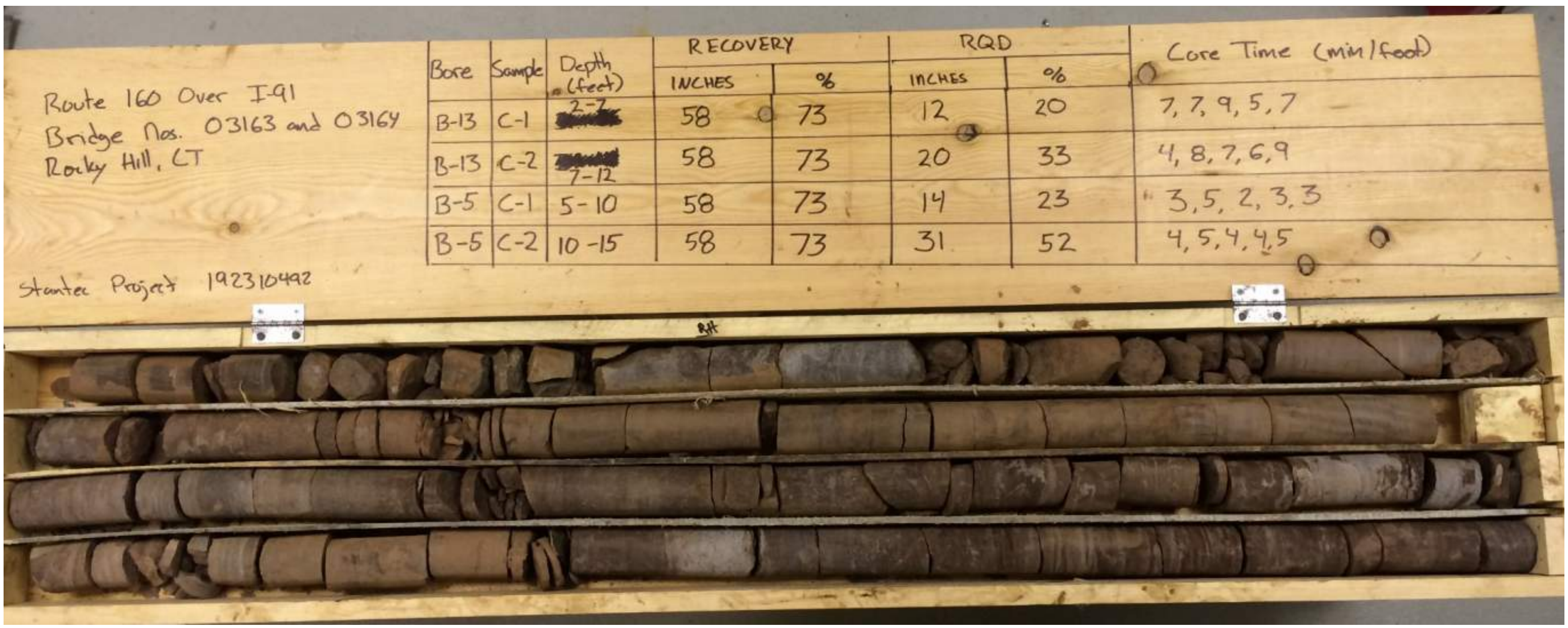
APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-10, C-1
B-10, C-2
B-12, C-1
B-12, C-2

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-11, C-1
B-11, C-2
B-9, C-1
B-9, C-2

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut



B-13, C-1

B-13, C-2

B-5, C-1

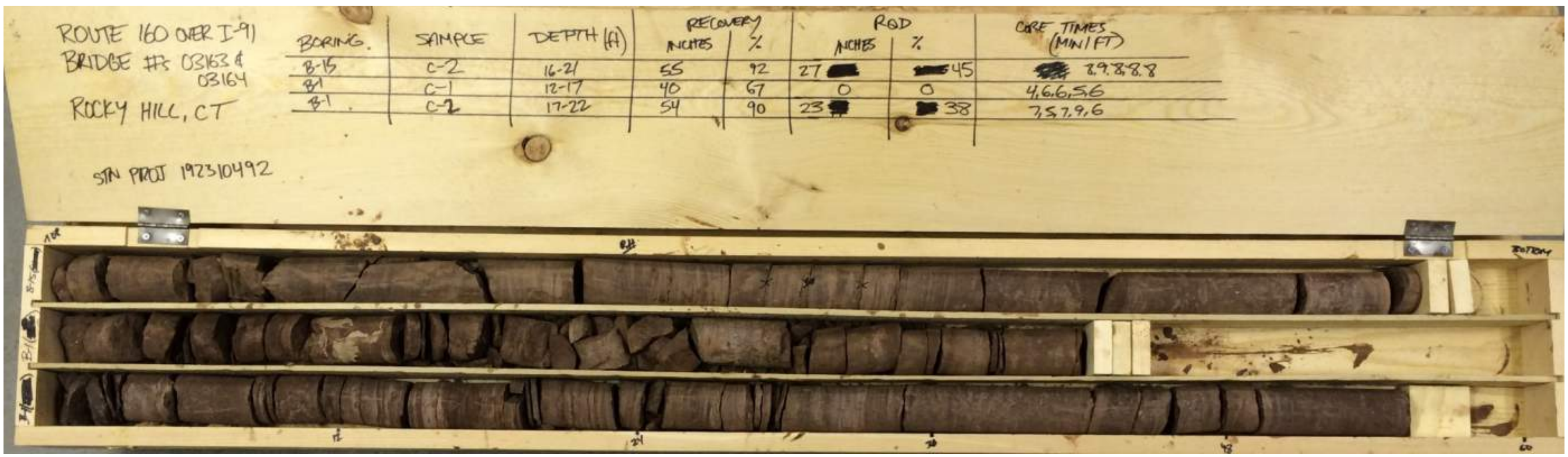
B-5, C-2

APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-15, C-2

B-1, C-1

B-1, C-2



APPENDIX B
CTDOT Project Number 118-169
Bridge Nos. 01363 and 01364
Rocky Hill, Connecticut

B-16, C-1

B-16, C-2

B-15, C-1

Appendix C

Laboratory Test Results

GeoTesting EXPRESS

Technologies to manage risk for infrastructure

Boston
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New York
www.geotesting.com

Transmittal

TO:

Trey Dykstra

Stantec Consulting Services

5 Dartmouth Drive, Suite 101

Auburn, NH 03032

DATE: 10/25/2016	GTX NO: 305410
RE: Bridge Nos. 03163 and 03164	

COPIES	DATE	DESCRIPTION
	10/25/2016	**October 2016 Laboratory Test Report**

REMARKS:

SIGNED:

Jonathan Campbell, Assistant Laboratory Manager

CC:

APPROVED BY:

Mark Dobday, P.G., Laboratory Manager

October 25, 2016

Trey Dykstra
Stantec Consulting Services
5 Dartmouth Drive, Suite 101
Auburn, NH 03032

RE: Bridge Nos. 03163 and 03164, Rocky Hill, CT (GTX-305410)

Dear Trey Dykstra:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received 13 samples from you on 10/3/2016. These samples were labeled as follows:

Boring Number	Sample Number	Depth
B-1	C-1	20.0-20.7 ft
B-1	S-2	4-6 ft
B-4	C-1	5.7-6.2 ft
B-5	C-1	6.5-7.1 ft
B-8	C-2	18.0-18.8 ft
B-8	S-2	4-6 ft
B-9	C-1	5.0-5.8 ft
B-9	S-1	0-2 ft
S-2	S-2	5-7 ft
S-5	S-2	2-4 ft
B-12	C-2	10.0-10.9 ft
B-14	C-1	2.0-2.7 ft
B-15	C-2	19.6-20.3 ft

GTX performed the following tests on these samples:

5 ASTM D2216 - Moisture Content
5 ASTM D422 - Grain Size Analysis - Sieve Only
8 ASTM D7012 Method C- Uniaxial Compressive Strength of Rock

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,

Jonathan Campbell
Assistant Laboratory Manager

GeoTesting EXPRESS

Technologies to manage risk for infrastructure

Boston
Atlanta
Chicago
Los Angeles
New York
www.geotesting.com

Geotechnical Test Report **10/25/2016**

GTX-305410

Bridge Nos. 03163 and 03164

Rocky Hill, CT

Client Project No.: 192310492.300

Prepared for:

Stantec Consulting Services

GeoTesting EXPRESS

Client:	Stantec Consulting Services				
Project:	Bridge Nos. 03163 and 03164				
Location:	Rocky Hill, CT			Project No:	GTX-305410
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	10/06/16	Checked By:	jsc
Depth :	---	Test Id:	394406		

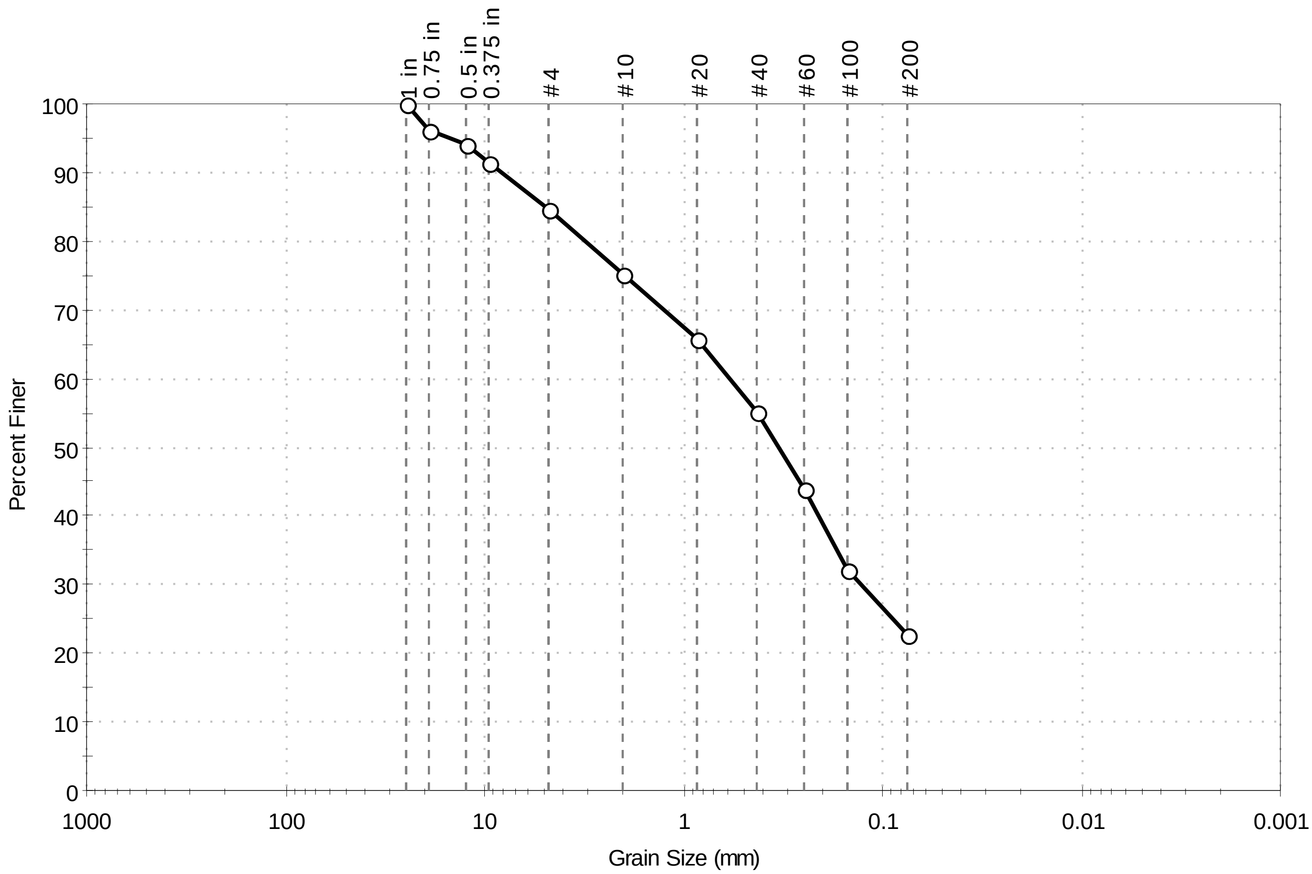
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
B-1	S- 2	4-6 ft	Moist, dark reddish brown clayey sand with gravel	15.4
B-8	S- 2	4-6 ft	Moist, dark reddish brown silty sand with gravel	12.3
B-9	S- 1	0-2 ft	Moist, dark reddish brown silty sand with gravel	7.9
S-2	S- 2	5-7 ft	Moist, dark reddish brown sandy clay	12.7
S-5	S- 2	2-4 ft	Moist, dark reddish brown silty sand	8.8

Notes: Temperature of Drying : 110º Celsius

Client:	Stantec Consulting Services		
Project:	Bridge Nos. 03163 and 03164		
Location:	Rocky Hill, CT	Project No:	GTX-305410
Boring ID: B-1	Sample Type: jar	Tested By:	jbr
Sample ID: S-2	Test Date: 10/06/16	Checked By:	jsc
Depth : 4-6 ft	Test Id: 394407		
Test Comment:	---		
Visual Description:	Moist, dark reddish brown clayey sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	15.3	61.9	22.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	96		
0.5 in	12.50	94		
0.375 in	9.50	92		
#4	4.75	85		
#10	2.00	75		
#20	0.85	66		
#40	0.42	55		
#60	0.25	44		
#100	0.15	32		
#200	0.075	23		

Coefficients

D_{85} = 4.8939 mm
D_{30} = 0.1280 mm
D_{60} = 0.5841 mm
D_{15} = N/A
D_{50} = 0.3321 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

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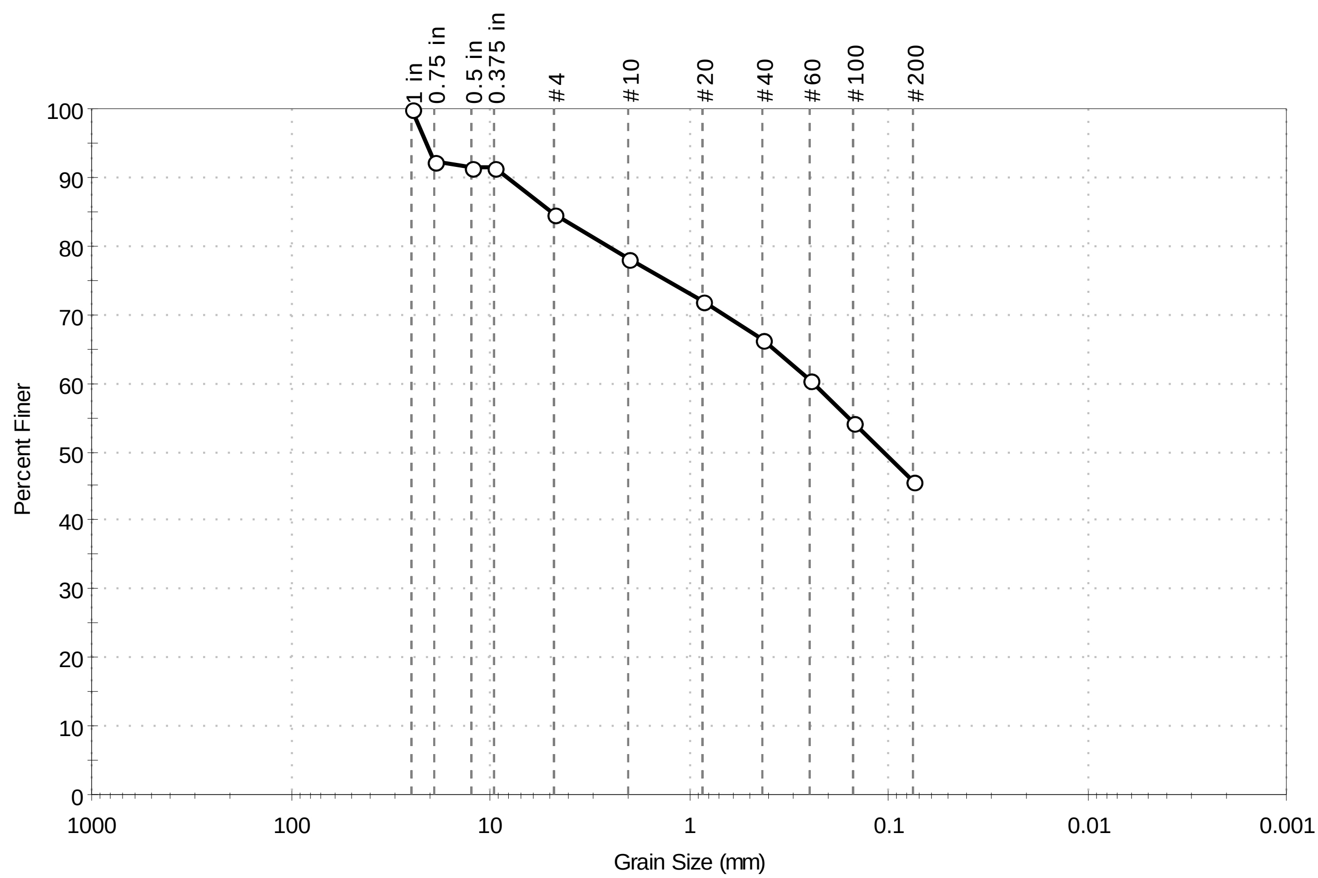
Client:	Stantec Consulting Services			
Project:	Bridge Nos. 03163 and 03164			
Location:	Rocky Hill, CT		Project No:	GTX-305410
Boring ID: B-8		Sample Type: jar	Tested By:	jbr
Sample ID: S-2		Test Date: 10/06/16	Checked By:	jsc
Depth : 4-6 ft		Test Id: 394408		
Test Comment:	---			
Visual Description:	Moist, dark reddish brown silty sand with gravel			
Sample Comment:	---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	15.3	39.0	45.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	92		
0.5 in	12.50	91		
0.375 in	9.50	91		
#4	4.75	85		
#10	2.00	78		
#20	0.85	72		
#40	0.42	66		
#60	0.25	61		
#100	0.15	54		
#200	0.075	46		

Coefficients

D_{85} = 4.9170 mm　　D_{30} = N/A

D_{60} = 0.2387 mm　　D_{15} = N/A

D_{50} = 0.1061 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

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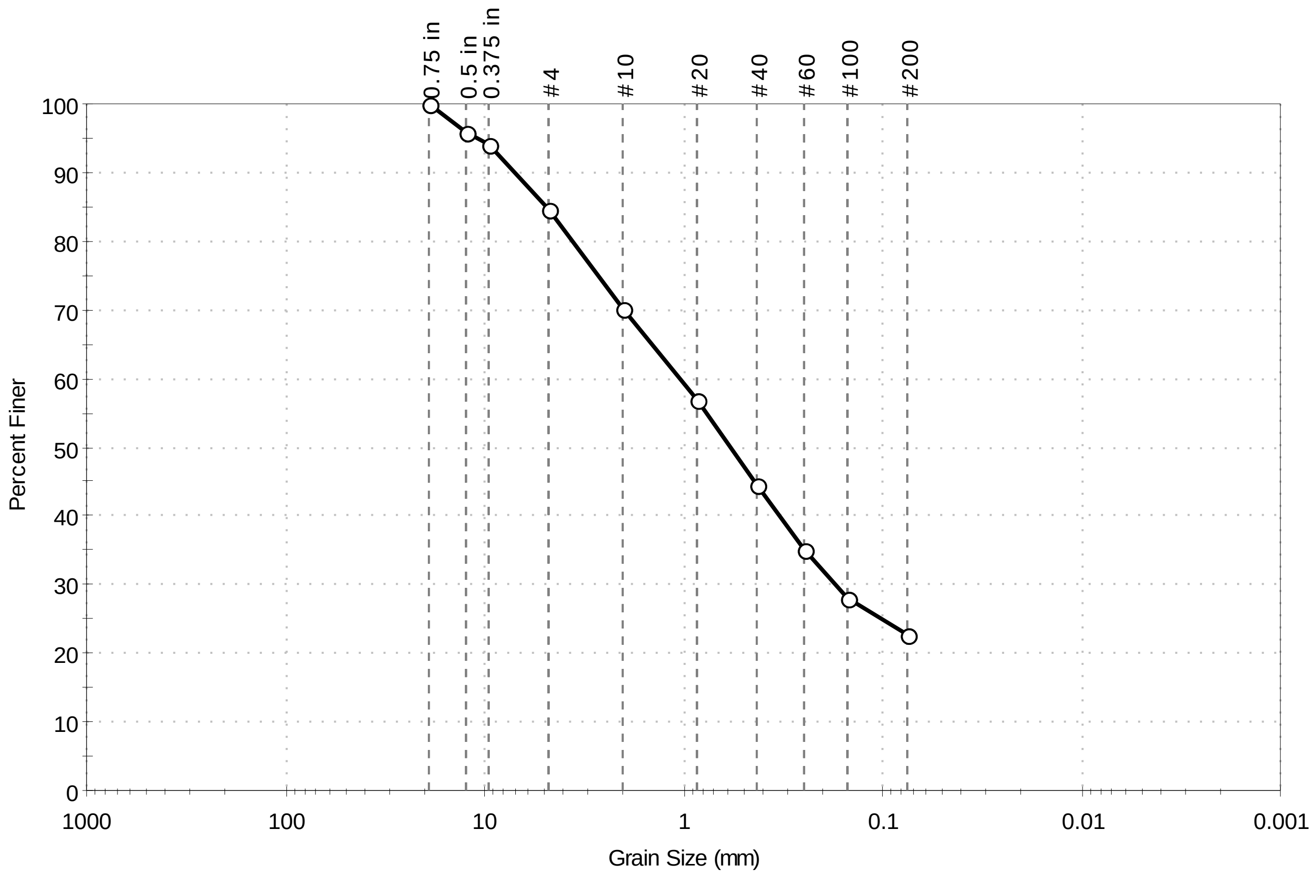
Client:	Stantec Consulting Services		
Project:	Bridge Nos. 03163 and 03164		
Location:	Rocky Hill, CT	Project No:	GTX-305410
Boring ID: B-9	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 10/06/16	Checked By:	jsc
Depth : 0-2 ft	Test Id: 394409		
Test Comment:	---		
Visual Description:	Moist, dark reddish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	15.2	62.2	22.6

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	94		
#4	4.75	85		
#10	2.00	70		
#20	0.85	57		
#40	0.42	45		
#60	0.25	35		
#100	0.15	28		
#200	0.075	23		

Coefficients

D_{85} = 4.8200 mm
D_{30} = 0.1722 mm
D_{60} = 1.0308 mm
D_{15} = N/A
D_{50} = 0.5730 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))

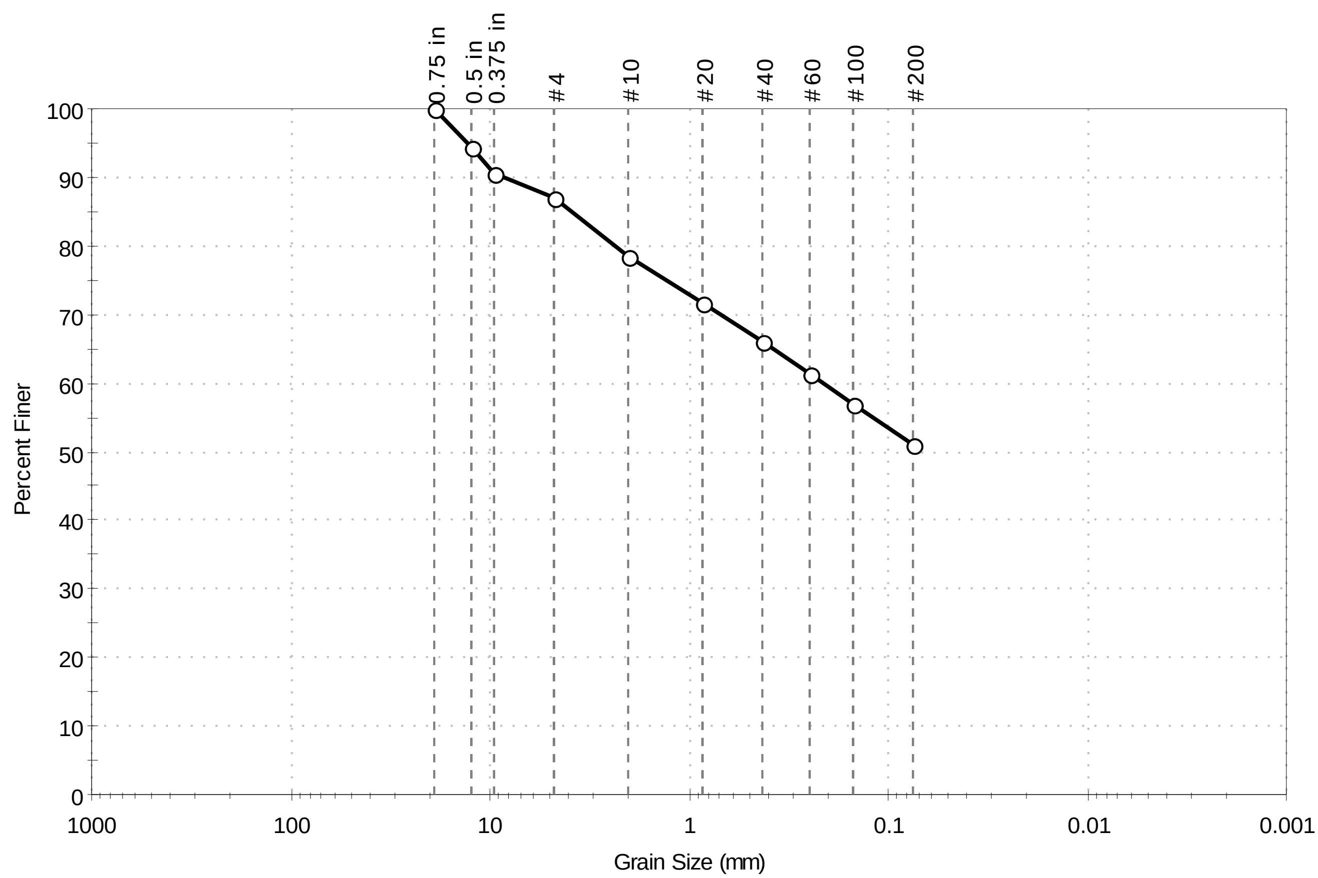
Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

Client:	Stantec Consulting Services		
Project:	Bridge Nos. 03163 and 03164		
Location:	Rocky Hill, CT	Project No:	GTX-305410
Boring ID: S-2	Sample Type: jar	Tested By:	jbr
Sample ID: S-2	Test Date: 10/06/16	Checked By:	jsc
Depth : 5-7 ft	Test Id: 394410		
Test Comment:	---		
Visual Description:	Moist, dark reddish brown sandy clay		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	13.1	35.8	51.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	91		
#4	4.75	87		
#10	2.00	79		
#20	0.85	72		
#40	0.42	66		
#60	0.25	61		
#100	0.15	57		
#200	0.075	51		

Coefficients

D_{85} = 3.8914 mm D_{30} = N/A

D_{60} = 0.2149 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 : ROUNDED

Sand/Gravel Hardness : HARD

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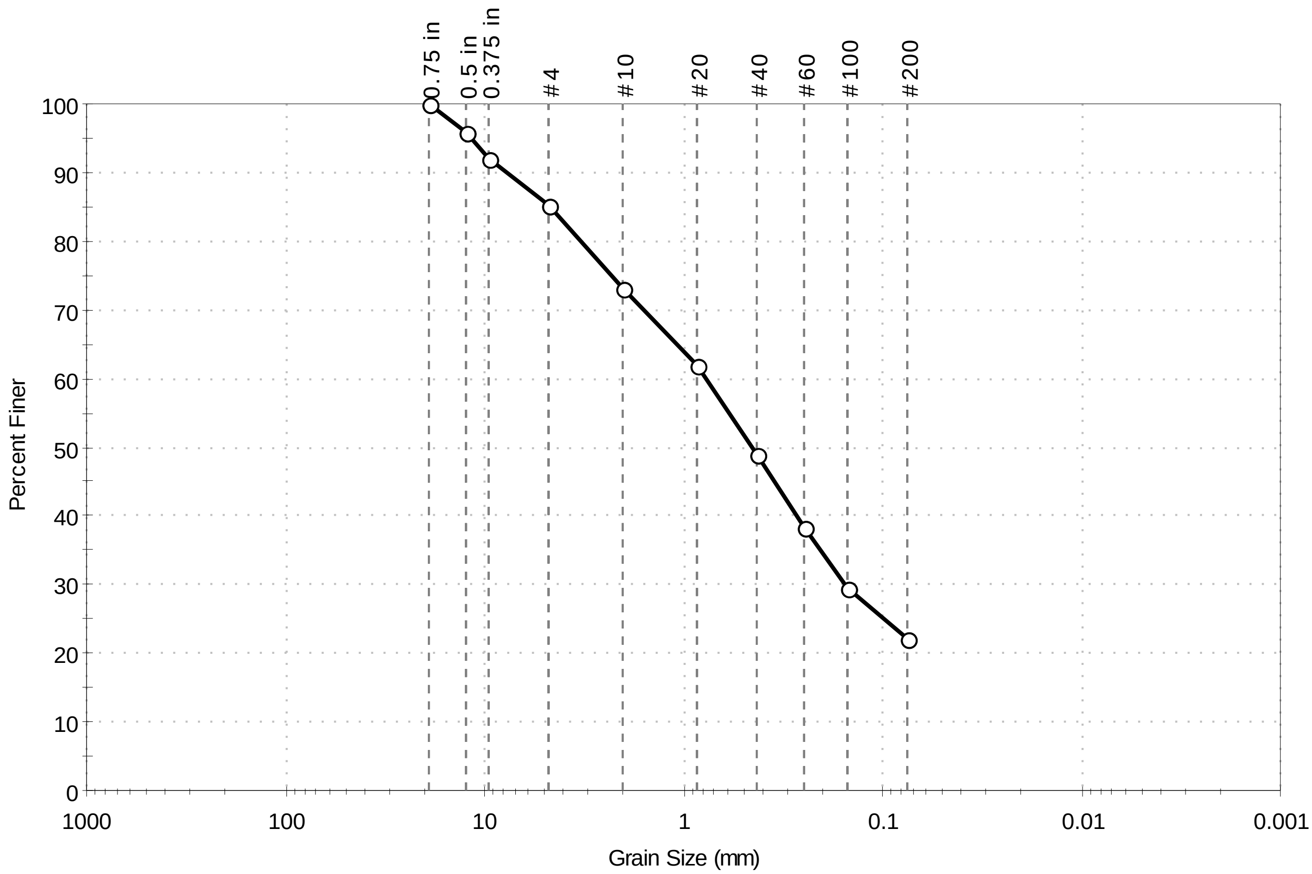
Client:	Stantec Consulting Services				
Project:	Bridge Nos. 03163 and 03164				
Location:	Rocky Hill, CT			Project No:	GTX-305410
Boring ID:	S-5	Sample Type:	jar	Tested By:	jbr
Sample ID:	S-2	Test Date:	10/06/16	Checked By:	jsc
Depth :	2-4 ft	Test Id:	394411		
Test Comment:	---				
Visual Description:	Moist, dark reddish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	14.9	63.0	22.1

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	73		
#20	0.85	62		
#40	0.42	49		
#60	0.25	38		
#100	0.15	29		
#200	0.075	22		

Coefficients

D_{85} = 4.7095 mm
D_{30} = 0.1556 mm
D_{60} = 0.7634 mm
D_{15} = N/A
D_{50} = 0.4469 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

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Client:	Stantec Consulting Services			
Project:	Bridge Nos. 03163 and 03164			
Location:	Rocky Hill, CT		Project No:	GTX-305410
Boring ID: ---		Sample Type: ---	Tested By:	daa/rlc
Sample ID: ---		Test Date: 10/10/16	Checked By:	jsc
Depth : ---		Test Id: 394399		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth, ft	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
B-1	C-1	20.0-20.7	170	21059	1	Yes	---
B-4	C-1	5.7-6.2	154	14440	1	Yes	---
B-5	C-1	6.5-7.1	171	18007	1	Yes	---
B-8	C-2	18.0-18.8	170	17984	1	Yes	---
B-9	C-1	5.0-5.8	172	15944	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure
(See attached photographs)

GeoTesting EXPRESS

Client:	Stantec Consulting Services		
Project:	Bridge Nos. 03163 and 03164		
Location:	Rocky Hill, CT	Project No:	GTX-305410

Boring ID:	---	Sample Type:	---	Tested By:	daa/rlc
Sample ID:	---	Test Date:	10/10/16	Checked By:	jsc
Depth :	---	Test Id:	394401		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth, ft	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
B-12	C-2	10.0-10.9	164	22414	1	Yes	---
B-14	C-1	2.0-2.7	171	13957	1	Yes	---
B-15	C-2	19.6-20.3	169	18048	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure
(See attached photographs)

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/RLC
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-1		
Sample ID:	C-1		
Depth:	20.0-20.7 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.55	4.55	4.55
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	634.6		
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

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

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

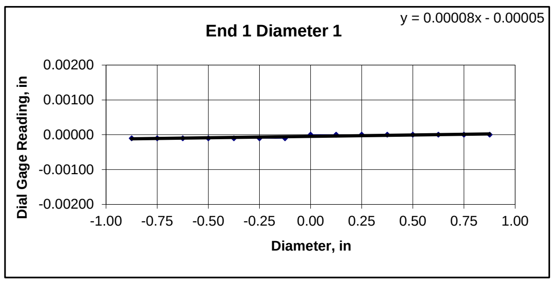
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00030

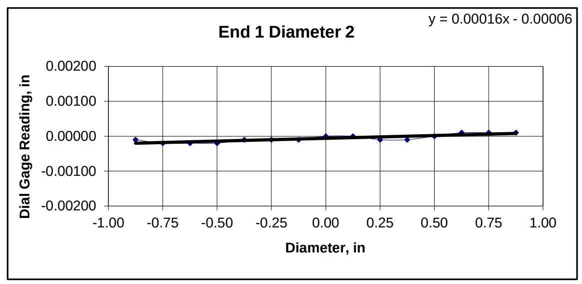
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020
Diameter 2, in (rotated 90^o)	-0.00010	-0.00010	-0.00010	0.00000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

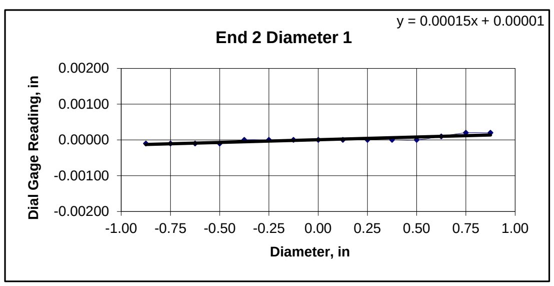
Difference between max and min readings, in:
0° = 0.0003 90° = 0.0002

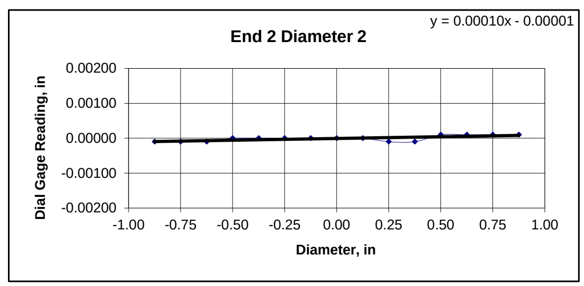
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00015

Flatness Tolerance Met? YES









DIAMETER 1

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

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00016
	Angle of Best Fit Line:	0.00917
End 2:	Slope of Best Fit Line	0.00010
	Angle of Best Fit Line:	0.00573
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? YES
Spherically Seated

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

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

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-1
Sample ID:	C-1
Depth, ft:	20.0-20.7

After cutting and grinding

After break

GeoTesting EXPRESS

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-4		
Sample ID:	C-1		
Depth:	5.7-6.2 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.53	4.53	4.53
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	570.42		
Bulk Density, lb/ft^3	154	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

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

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

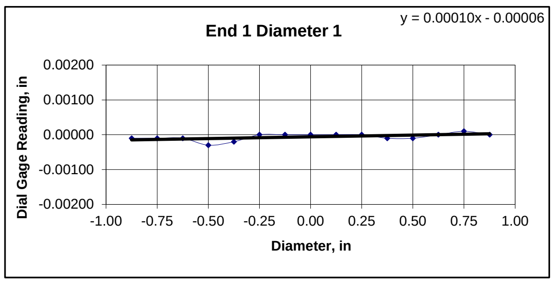
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00030

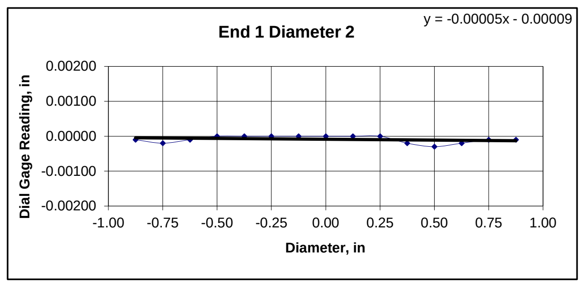
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00020	-0.00030	-0.00030	-0.00040	-0.00040	-0.00010	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00010	0.00000	-0.00010
Diameter 2, in (rotated 90^o)	-0.00010	-0.00010	-0.00010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

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

Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00020

Flatness Tolerance Met? YES





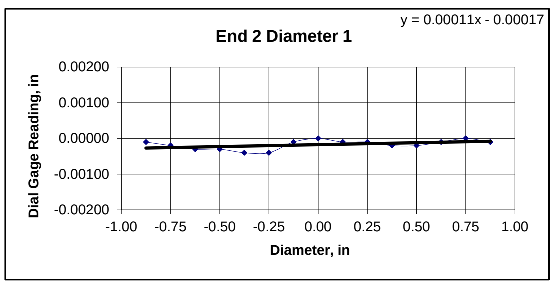
DIAMETER 1

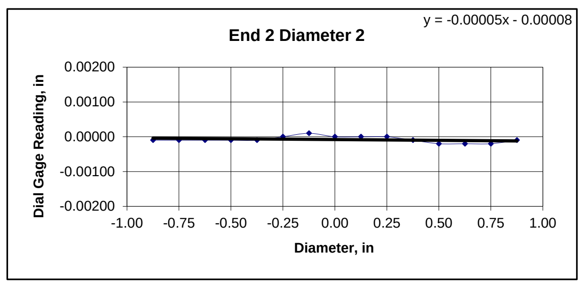
End 1:
Slope of Best Fit Line 0.00010
Angle of Best Fit Line: 0.00573

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

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line -0.00005
Angle of Best Fit Line: -0.00286

End 2:
Slope of Best Fit Line -0.00005
Angle of Best Fit Line: -0.00286

Maximum Angular Difference: 0.00000

Parallelism Tolerance Met? YES
Spherically Seated

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

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

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-4
Sample ID:	C-1
Depth, ft:	5.7-6.2

After cutting and grinding

After break

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-5		
Sample ID:	C-1		
Depth:	6.5-7.1 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.48	4.48	4.48		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	620.22				
Bulk Density, lb/ft^3	171			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\le$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00030 90° = 0.00040

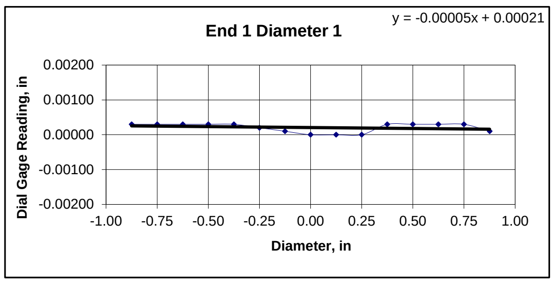
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	0.00010	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00010	0.00010	0.00010
Diameter 2, in (rotated 90^o)	-0.00030	-0.00030	-0.00030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

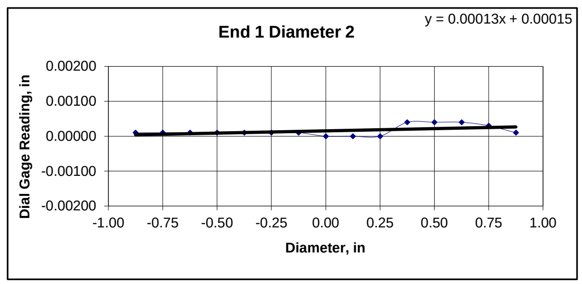
Difference between max and min readings, in:

0° = 0.0004 90° = 0.0005

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

Flatness Tolerance Met? YES





DIAMETER 1

End 1:

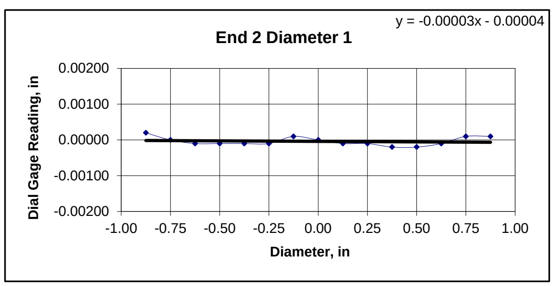
Slope of Best Fit Line	-0.00005
Angle of Best Fit Line:	-0.00286

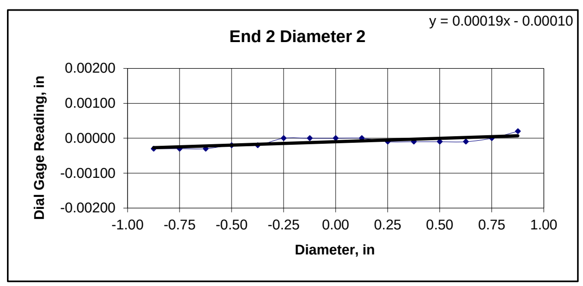
End 2:

Slope of Best Fit Line	-0.00003
Angle of Best Fit Line:	-0.00172

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	0.00013
Angle of Best Fit Line:	0.00745

End 2:

Slope of Best Fit Line	0.00019
Angle of Best Fit Line:	0.01089

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? YES
Spherically Seated

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

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.980	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00040	1.980	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00040	1.980	0.00020	0.012	YES
Diameter 2, in (rotated 90^o)	0.00050	1.980	0.00025	0.014	YES

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-5
Sample ID:	C-1
Depth, ft:	6.5-7.1

After cutting and grinding

After break

GeoTesting EXPRESS

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-8		
Sample ID:	C-2		
Depth:	18.0-18.8 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.48	4.48	4.48
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	621.79		
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00030 90° = 0.00020

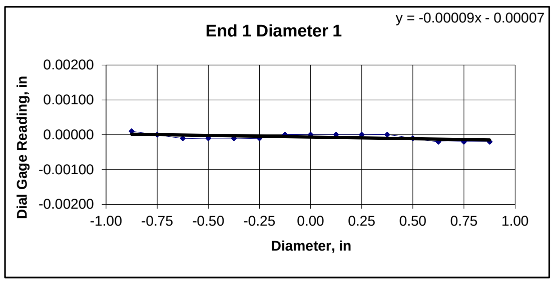
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	-0.00010	-0.00010	0.00000	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90^o)	0.00000	-0.00010	-0.00010	-0.00010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

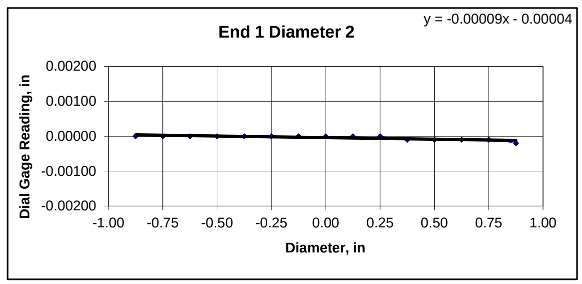
Difference between max and min readings, in:

0° = 0.0002 90° = 0.0002

Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00015

Flatness Tolerance Met? YES





DIAMETER 1

End 1:

Slope of Best Fit Line	-0.00009
Angle of Best Fit Line:	-0.00516

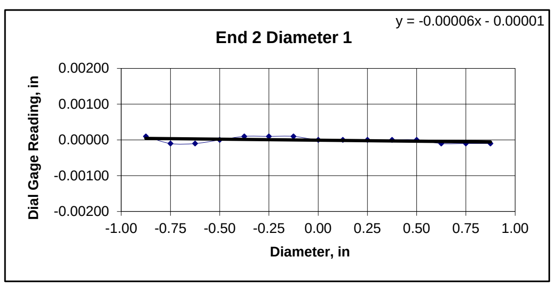
End 2:

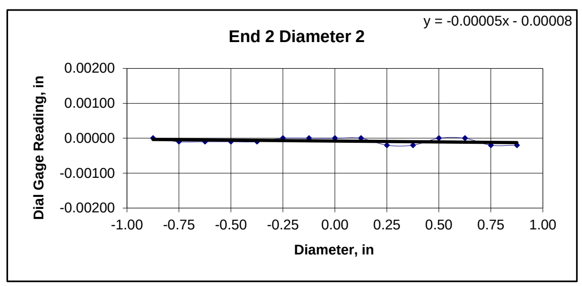
Slope of Best Fit Line	-0.00006
Angle of Best Fit Line:	-0.00344

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? YES

Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00009
Angle of Best Fit Line:	-0.00516

End 2:

Slope of Best Fit Line	-0.00005
Angle of Best Fit Line:	-0.00286

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES

Spherically Seated

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

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

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-8
Sample ID:	C-2
Depth, ft:	18.0-18.8

After cutting and grinding

After break

GeoTesting EXPRESS

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-9		
Sample ID:	C-1		
Depth:	5.0-5.8 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.48	4.48	4.48		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	629.64				
Bulk Density, lb/ft^3	172			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00060 90° = 0.00030

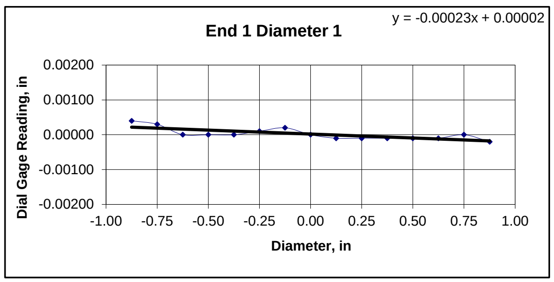
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020	-0.00020	-0.00020
Diameter 2, in (rotated 90^o)	-0.00010	-0.00010	-0.00010	-0.00010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

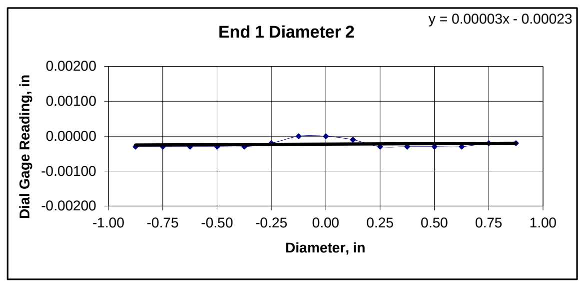
Difference between max and min readings, in:

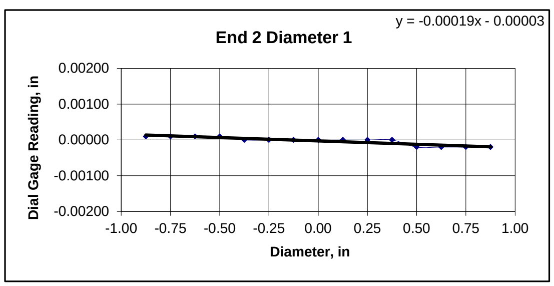
0° = 0.0003 90° = 0.0001

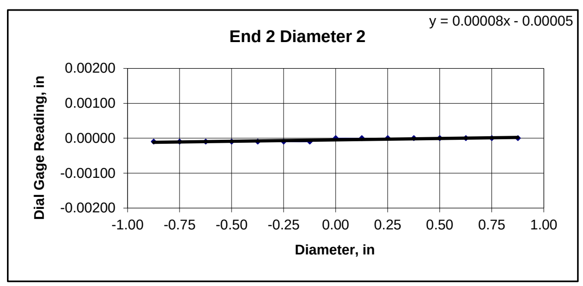
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00030

Flatness Tolerance Met? YES









DIAMETER 1

End 1:	
Slope of Best Fit Line	-0.00023
Angle of Best Fit Line:	-0.01318
End 2:	
Slope of Best Fit Line	-0.00019
Angle of Best Fit Line:	-0.01089
Maximum Angular Difference:	0.00229

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:	
Slope of Best Fit Line	0.00003
Angle of Best Fit Line:	0.00172
End 2:	
Slope of Best Fit Line	0.00008
Angle of Best Fit Line:	0.00458
Maximum Angular Difference:	0.00286

Parallelism Tolerance Met? YES

Spherically Seated

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

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	1.990	0.00030	0.017	YES
Diameter 2, in (rotated 90^o)	0.00030	1.990	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00030	1.990	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00010	1.990	0.00005	0.003	YES

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-9
Sample ID:	C-1
Depth, ft:	5.0-5.8

After cutting and grinding

After break

GeoTesting EXPRESS

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-12		
Sample ID:	C-2		
Depth:	10.0-10.9 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.47	4.47	4.47		
Specimen Diameter, in:	1.98	1.99	1.99		
Specimen Mass, g:	597.56				
Bulk Density, lb/ft^3	164			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00030 90° = 0.00010

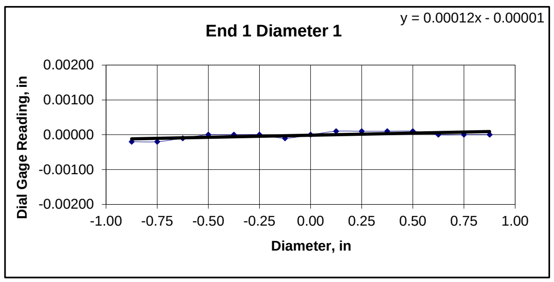
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	0.00000	0.00000	-0.00010	-0.00010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

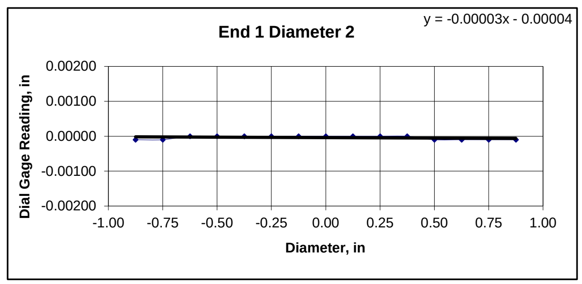
Difference between max and min readings, in:

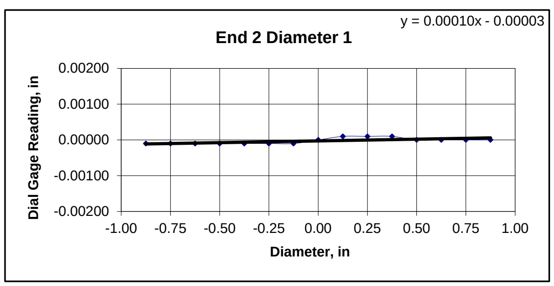
0° = 0.0002 90° = 0.0002

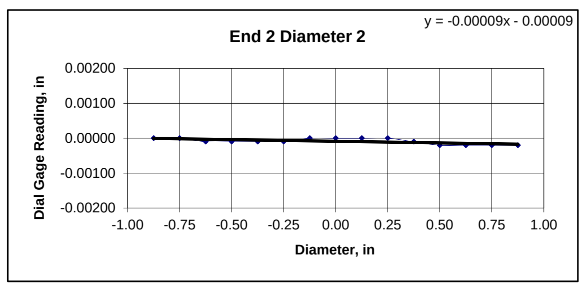
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00015

Flatness Tolerance Met? YES









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00012
	Angle of Best Fit Line:	0.00688
End 2:		
	Slope of Best Fit Line	0.00010
	Angle of Best Fit Line:	0.00573
Maximum Angular Difference:		0.00115

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	-0.00003
	Angle of Best Fit Line:	-0.00172
End 2:		
	Slope of Best Fit Line	-0.00009
	Angle of Best Fit Line:	-0.00516
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? YES

Spherically Seated

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

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.985	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00010	1.985	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00020	1.985	0.00010	0.006	YES
Diameter 2, in (rotated 90^o)	0.00020	1.985	0.00010	0.006	YES

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-12
Sample ID:	C-2
Depth, ft:	10.0-10.9

After cutting and grinding

After break

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-14		
Sample ID:	C-1		
Depth:	2.0-2.7 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.32	4.32	4.32		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	597.18				
Bulk Density, lb/ft^3	171			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00030 90° = 0.00050

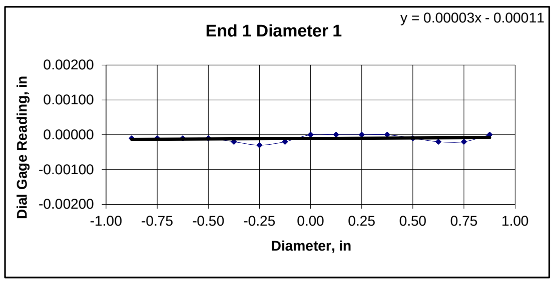
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00020	-0.00010	-0.00010	0.00010	0.00020	0.00000	0.00000	-0.00010	0.00000	0.00010	0.00030	0.00000	-0.00010
Diameter 2, in (rotated 90^o)	0.00050	0.00040	0.00040	0.00040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

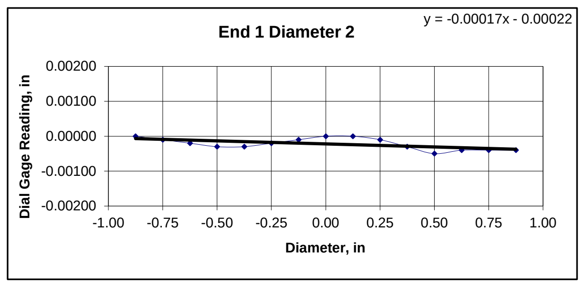
Difference between max and min readings, in:

0° = 0.0005 90° = 0.0005

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

Flatness Tolerance Met? YES





DIAMETER 1

End 1:

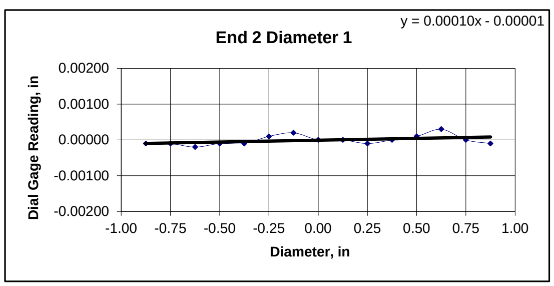
Slope of Best Fit Line	0.00003
Angle of Best Fit Line:	0.00172

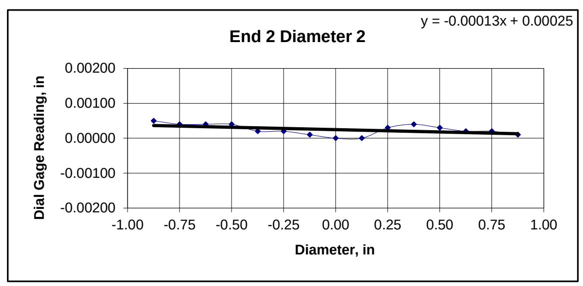
End 2:

Slope of Best Fit Line	0.00010
Angle of Best Fit Line:	0.00573

Maximum Angular Difference: 0.00401

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00017
Angle of Best Fit Line:	-0.00974

End 2:

Slope of Best Fit Line	-0.00013
Angle of Best Fit Line:	-0.00745

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES
Spherically Seated

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

Maximum angle of departure must be ≤ 0.25°

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.980	0.00015	0.009	YES
Diameter 2, in (rotated 90^o)	0.00050	1.980	0.00025	0.014	YES
END 2					
Diameter 1, in	0.00050	1.980	0.00025	0.014	YES
Diameter 2, in (rotated 90^o)	0.00050	1.980	0.00025	0.014	YES

Perpendicularity Tolerance Met? YES

GeoTesting EXPRESS

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-14
Sample ID:	C-1
Depth, ft:	2.0-2.7

After cutting and grinding

After break

Client:	Stantec Consulting Services	Test Date:	10/6/2016
Project Name:	Bridge Nos. 03163 and 03164	Tested By:	daa/rlc
Project Location:	Rocky Hill, CT	Checked By:	jsc
GTX #:	305410		
Boring ID:	B-15		
Sample ID:	C-2		
Depth:	19.6-20.3 ft		
Visual Description:	See photographs		

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

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.48	4.48	4.48		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	620.12				
Bulk Density, lb/ft^3	169			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

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

Difference between max and min readings, in:

0° = 0.00050 90° = 0.00020

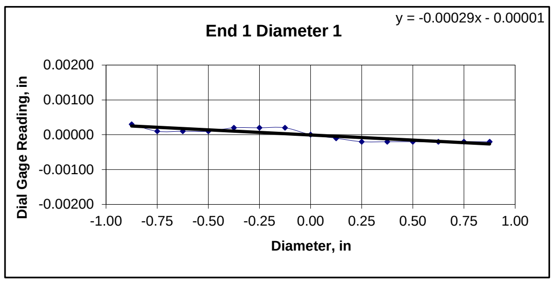
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00070	0.00070	0.00050	0.00050	0.00050	0.00040	0.00010	0.00000	0.00000	0.00010	0.00040	0.00030	0.00020	0.00010	0.00010
Diameter 2, in (rotated 90^o)	0.00030	0.00010	0.00000	-0.00010	-0.00010	-0.00010	0.00020	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00000

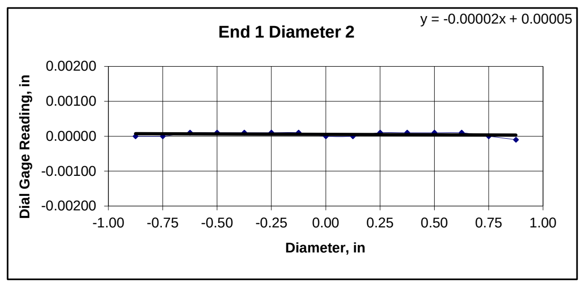
Difference between max and min readings, in:

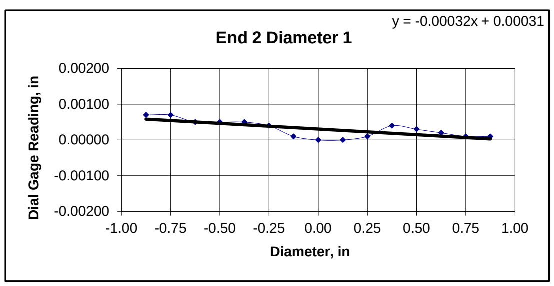
0° = 0.0007 90° = 0.0005

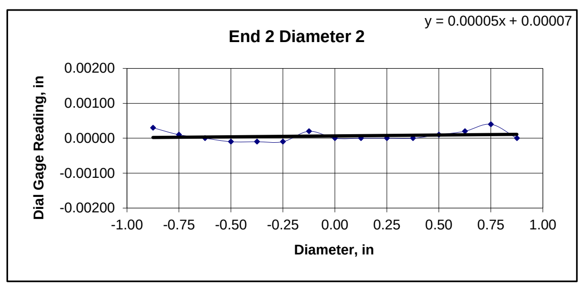
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00035

Flatness Tolerance Met? YES









DIAMETER 1

End 1:

Slope of Best Fit Line	-0.00029
Angle of Best Fit Line:	-0.01662

End 2:

Slope of Best Fit Line	-0.00032
Angle of Best Fit Line:	-0.01833
Maximum Angular Difference:	0.00172

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00002
Angle of Best Fit Line:	-0.00115

End 2:

Slope of Best Fit Line	0.00005
Angle of Best Fit Line:	0.00286
Maximum Angular Difference:	0.00401

Parallelism Tolerance Met? YES

Spherically Seated

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

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90^o)	0.00020	1.990	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00070	1.990	0.00035	0.020	YES
Diameter 2, in (rotated 90^o)	0.00050	1.990	0.00025	0.014	YES

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

Perpendicularity Tolerance Met? YES

Client:	Stantec Consulting Services
Project Name:	Bridge Nos. 03163 and 03164
Project Location:	Rocky Hill, CT
GTX #:	305410
Test Date:	10/10/2016
Tested By:	daa/rlc
Checked By:	jsc
Boring ID:	B-15
Sample ID:	C-2
Depth, ft:	19.6-20.3

After cutting and grinding

After break

GeoTesting EXPRESS

SOIL CHAIN OF CUSTODY & TEST REQUEST

GeoTesting Express, Inc.
125 Nagog Park
Acton, MA 01720
800 434 1062 Toll Free
978 635 0266 Fax

2358 Perimeter Park Drive, Suite 320
Atlanta, GA 30341
770 645 6575 Tel
770 645 6570 Fax

www.geotesting.com

CLIENT	
Company: Stantec Consutling Inc.	
Address: 5 Dartmouth Drive	
City, State, Zip: Auburn, NH	
Contact: Trey Dykstra	Phone: 603-206-7552
E-mail: trey.dykstra@stantec.com	Cell: 603-289-6068

INVOICE (complete if different from Client)	
Company:	
Address:	
City, State, Zip:	
Contact:	Phone:
E-mail: trey.dykstra@stantec.com	Cell:

PROJECT		
Project Name: Bridge Nos. 03163 and 03164	Client Project #: 192310492.300	Purchase Order#:
Project Location: Route 160 Over I-91, Rocky Hill, CT	GTX Sales Order #:	Requested Turnaround: 10/10/2016
On-site Contact:	E-mail:	Phone:

SOIL																				
Boring ID	Sample ID	Depth	Atterberg Limits (ASTM D 4318)	USCS – Classification (ASTM D 2487)	Grain Size: ASTM D 422 ☐ Sieve Only ☑ Sieve & Hydrometer ☐	Density: ASTM D 2937 ☐ ASTM D 7263 ☐	Moisture Content (ASTM D 2216)	Organic Content (ASTM D 2974)	pH (ASTM D 4972)	Specific Gravity (ASTM D 854)	Electrical Resistivity (ASTM G 57)	Proctor Compaction: Standard – ASTM D 698 ☐ Modified – ASTM D 1557 ☐	California Bearing Ratio * (ASTM D 1883)	Direct Shear* (ASTM D 3080)	Triaxial Shear* : UU – ASTM D 2850 ☐ CU – ASTM D 4767 ☐ CD – ASTM D7181 ☐	Incremental Consolidation* (ASTM D 2435)	Permeability/ Hydraulic Conductivity* : Fixed Wall – ASTM D 2434 ☐ Flexible Wall – ASTM D 5084 ☐	Unconfined Compression (ASTM D 2166)	Other:____	Other:____
B-1	S-2	4 - 6 ft			x		x													
B-8	S-2	4 -6 ft			x		x													
B-9	S-1	0 - 2 ft			x		x													
S-2	S-2	5 - 7 ft			x		x													
S-5	S-2	2 - 4			x		x													

*Specify Test Conditions (Undisturbed or Remolded, Density and moisture, Test Normal Loads, Test Confining Stresses, etc.):

AUTHORIZE BY SIGNING AND DATING:

SIGNATURE:________ PRINT NAME: Trey Dykstra DATE:________

For GTX Use Only
Incoming Sample Inspection Performed ☐
Adverse conditions:

Relinquished By:	DATE:	Received By:		DATE:	10/3/16
	TIME:			TIME:	
Relinquished By:	DATE:	Received By:		DATE:	
	TIME:			TIME:	

GeoTesting EXPRESS

ROCK CHAIN OF CUSTODY & TEST REQUEST

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CLIENT		INVOICE (complete if different from Client)	
Company: Stantec Consulting Inc.		Company:	
Address: 5 Dartmouth Drive		Address:	
City, State, Zip: Auburn, New Hampshire		City, State, Zip:	
Contact: Trey Dykstra	Phone: 603-206-7552	Contact:	Phone:
E-mail: trey.dykstra@stantec.com	Cell: 603-289-6068	E-mail:	Cell:

PROJECT		
Project Name: Bridge Nos. 03163 and 03164	Client Project #: 192310492.300	Purchase Order#:
Project Location: Route 160 Over I-91, Rocky Hill, CT	GTX Sales Order #:	Requested Turnaround: 10/10/2016
On-site Contact:	E-mail:	Phone:

ROCK

Core Run #	Sample ID	Depth	CERCHAR Abrasivity (ASTM D 7625) * 55HRC/40HRC	Direct Shear (ASTM D5607)*	Direct Tensile Strength (ASTM D 2936)	Elastic Moduli in Triaxial Compression (ASTM D 7012B)	Elastic Moduli in Uniaxial Compression (ASTM D 7012D)	Unit Weight (ISRM)	Petrographic Analysis (ISRM)	Point Load Index (ASTM D 5731)* Diametral, Axial, Lump/Block	Punch Penetration (Handewith)	Slake Durability (ASTM D 4644)	Splitting (Brazilian) Tensile Strength (ASTM D 3967)	Schmidt Hammer (ASTM D 5873)	Total Hardness (Schmidt Hammer and Taber Abrasion)	Triaxial Compression (ASTM D 7012A)	Unconfined Compression (ASTM D 7012C)	Other:	Other:
B-1/C-1		20. 0 - 20.7 ft															X		
B-4/C-1		5.7 - 6.2 ft															X		
B-5/C-1		6.5 - 7.1 ft															X		
B-8/C-2		18.0 - 18.8 ft															X		
B-12/C-2		10.0 - 10.9 ft															X		
B-9/C-1		5.0 - 5.8 ft															X		
B-14/C-1		2.0 - 2.7 ft															X		
B-15/C-2		19.6 - 20.3 ft															X		

*Specify Test Conditions (Undisturbed or Remolded, Density and Moisture, Test Normal Loads, Test Confining Stresses, etc.):

AUTHORIZE BY SIGNING AND DATING:

SIGNATURE: ____________ PRINT NAME: Trey Dykstra DATE: 10/03/16

For GTX Use Only
Incoming Sample Inspection Performed ☐
Adverse conditions:

Relinquished By:	DATE:	Received By:	DATE: 10/3/16
	TIME:		TIME:
Relinquished By:	DATE:	Received By:	DATE:
	TIME:		TIME:

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CAI	CERCHAR Abrasiveness Index
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
CSR	cyclic stress ratio
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D	damping ratio
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
H_R	Rebound Hardness number
i	gradient
I_S	Uncorrected point load strength
$I_{S(50)}$	Size corrected point load strength index
H_A	Modified Taber Abrasion
H_T	Total hardness
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation

S_r	Post cyclic undrained shear strength
T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_s	shear wave velocity
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ'_{vc}	Effective vertical consolidation stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength