APPENDIX B

Geotechnical Reports

Geotechnical Investigation

Rocky Barachois Bridge Replacement,
Gros Morne National Park, NL

File No: 163545

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1.0 INTRODUCTION

Acting on the request and authorization of Harbourside Engineering Consultants (HEC), on behalf of Parks Canada Agency, Harbourside Geotechnical Consultants (HGC) have completed a geotechnical investigation for the proposed replacement of the Rocky Barachois Bridge in Gros Morne National Park, Newfoundland and Labrador.

The existing Rocky Barachois Bridge is a two-lane, single-span concrete girder bridge with a reinforced concrete deck. The structure carries Newfoundland and Labrador Route 430 over Rocky Barachois Brook.

The purpose of this geotechnical investigation was to determine the subsurface soil and rock conditions at the site and to provide geotechnical recommendations to aid with replacement of the Rocky Barachois Bridge.

The scope of work completed for this project includes the following:

- Completion of a geotechnical field investigation, completed in three phases and consisting of seven boreholes, eight test pits, and a series of push probes;
- A laboratory testing program; and
- Preparation of this report detailing the findings of the field investigation and laboratory analyses, as well as discussion and recommendations to aid with site earthworks and foundation design.

This report has been prepared specifically and solely for the project described herein and contains all of the findings of this investigation.

2.0 SITE DESCRIPTION AND GEOLOGY

Rocky Barachois Bridge, located between Rocky Harbour and Deer Lake, carries Newfoundland and Labrador Route 430 over Rocky Barachois Brook along the East Arm of Bonne Bay. At the bridge, Rocky Barachois Brook flows in a westerly direction from the Long Range Mountains into the East Arm. The immediate north approach to the bridge is relatively flat and appears to have been constructed in the water to shorten the span of the existing structure. The south approach has a long, sweeping, left-turning horizontal curve (looking from the bridge) on the immediate approach to the bridge with the road gradient rising to the south, away from the bridge. An unpaved road providing access to a pit or quarry is located on the east side of the north approach, approximately 300 m from the bridge.

The location of the existing bridge is shown on Sketch G1, Borehole Location Plan and Sketch G2, Test Pit and Push Probe Location Plan in Appendix C.

Surficial geologic mapping near the bridge indicates that the principal overburden soils consist of glaciofluvial deposits of fine-grained sand to coarse-grained cobbly gravel. Bedrock geology at the site is mapped as Paleozoic sedimentary rocks of the Labrador Group (Hawke Bay Formation and Forteau Formation) including quartzose sandstone (quartz arenite), sandstone, carbonate, and shale.

3.0 INVESTIGATIVE PROCEDURES

3.1 GENERAL

The first phase of the geotechnical investigation, comprised of two boreholes, was conducted between September 17 and 22, 2016. The second phase, which consisted of five boreholes, four test pits, and a series of push probes was conducted between November 25 and December 5, 2016. The third phase, which consisted of four test pits, was conducted on May 28, 2017. Samples of the soil and bedrock were recovered from the test locations, classified in the field, and taken to our geotechnical laboratory for final classification and testing. A detailed summary of the soil and bedrock conditions encountered, as well as the sampling and testing carried out, is presented on the borehole records and test pit records in Appendix A. A document entitled “Symbols and Terms used on Borehole and Test Pit Records”, which clarifies terms used through this report and symbols used on the borehole and test pit records, is also included in Appendix A.

3.2 BOREHOLES

To support construction of the new Rocky Barachois Bridge, three boreholes were advanced in the vicinity of the north abutment of the existing structure (BH01, BH06, and BH07), three in the vicinity of the south abutment (BH02, BH04 and BH05), and one east of the south approach (BH03). Conditions at each test location were observed and logged by experienced geotechnical personnel. Boreholes were drilled to depths ranging from 16.8 to 36.1 m below the ground surface. Upon completion of drilling, standpipe was installed in five boreholes (BH01, and BH03-BH06). Water levels were measured on December 4, 2016 as indicated on the borehole records in Appendix A, however, at the time of measuring, the standpipe was blocked in three of the boreholes (BH03, BH04, and BH06).

Boreholes were advanced using a combination of 100-mm flight augers, HW-sized casing, and NW-sized casing. Soil sampling was carried out at regular intervals using conventional 50-mm diameter split spoon samplers while performing standard penetration testing as described in *ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. The standard penetration test (SPT) “N-value” is the number of blows required to advance a 50-mm outer-diameter split-spoon sampler a distance of 300 mm into the soil using a standardized drop height and weight. N-values generally provide an indication of soil consistency or compactness and may also be used to aid in estimation of other soil parameters. Occasionally, a 76-mm split-spoon sampler was used to retrieve samples with relatively large particle sizes. A record of the sampling is included on the borehole records in Appendix A.

Bedrock was cored using HQ- and NQ-sized diamond coring bits. The recovery and rock quality designation (RQD) of each run of core was recorded.

3.3 TEST PITS

Four test pits were advanced east of the existing north approach (TP01, TP02, TP03, and TP04), and four test pits were advanced east of the existing south approach (TP06, TP07, TP08, and TP09) near the maximum (most eastern) extents of the alignments for the design options being considered. Test pits were excavated to depths ranging from 0.9 to 4.6 m below the ground surface using a track-mounted excavator. The subsurface conditions were visually observed with compactness/consistency inferred based on excavator performance. Soil samples were taken from select locations of the various strata encountered.

3.4 PUSH PROBES

A series of four push probes were put down east of the existing south approach to the bridge. These were advanced while visually inspecting the area in the vicinity of the most eastern extents of the proposed alignments. The depths of the probes may be used to estimate the thickness of loose or soft surficial materials, however, these probes do not provide any information on the type or extent of material below the depth of refusal.

3.5 LABORATORY TESTING

All soil samples recovered from the test locations were stored in water-tight containers and taken to our geotechnical laboratory for final classification and testing. Laboratory testing on select soil samples included water content determinations (*ASTM D2216 Standard Test Methods for Laboratory Determination of Water Content of Soil and Rock by Mass*), and particle-size analyses (*ASTM D6913 Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis*).

Samples of bedrock were stored in core boxes and returned to our geotechnical laboratory. Testing was performed on select samples of rock core to determine the unconfined compressive strength (*ASTM D7012-14 Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures*).

A summary of the testing performed is presented on the borehole records and test pit records in Appendix A and in separate figures in Appendix B. Soil descriptions used throughout this report are in general accordance with the Unified Soil Classification System (*ASTM D2487 Standard Practice for Classification of Soils for Engineering purposes / ASTM D2488 Standard Practice for Description and Identification of Soils*).

3.6 SURVEYING

The locations and ground surface elevations for each borehole were surveyed by Yates and Woods LTD. Elevations are referenced to the Canadian Geodetic Vertical Datum of 1928 (CGVD28).

4.0 SUBSURFACE CONDITIONS

4.1 BRIDGE ABUTMENTS (BOREHOLES BH01 TO BH07)

The subsurface conditions encountered near the existing abutments generally consisted of the following sequence:

- Asphalt
- Fill
- Original rootmat and topsoil
- Sand and gravel
- Silty sand/silty gravel
- Bedrock

Not all strata were encountered at all test locations. The subsurface conditions observed in the boreholes are summarized in Table 1 and the following paragraphs and are described in additional detail on the borehole records in Appendix A.

Table 1 Summary of Subsurface Conditions Near Abutments

Location	Ground Elevation[a] (m)	Thickness						Bedrock		Groundwater		Total Depth (m)
		Asphalt (m)	Fill (m)	Original Rootmat / Topsoil (m)	Sand and Gravel (m)	Silty Sand / Silty Gravel (m)	Depth to Surface (m)	Surface Elevation[a] (m)	Depth (m)	Elevation[a] (m)	
BH01	6.86	0.13	5.97	-	9.34	-	> 21.41	< -14.55	6.8	0.1	21.41
BH02	7.70	0.13	7.44	-	> 9.19	-	> 16.76	< -9.06	-	-	16.76
BH03	2.17	-	1.22	-	9.19	2.59	17.98	-15.81	> 2.1	< 0.1	20.50
BH04	7.61	0.15	8.23	0.25	12.61	0.66	29.31	-21.70	> 0.5	< 7.1	31.98
BH05	7.53	0.18	8.45	-	12.95	4.07	28.99	-21.46	7.2	0.3	36.07
BH06	6.85	0.15	7.32	-	10.07	-	26.54	-19.69	> 6.0	< 0.9	29.59
BH07	6.88	0.15	7.93	-	9.45	3.88	27.68	-20.80	-	-	34.54

(a) Elevations are referenced to CGVD28.

4.1.1 Asphalt

A layer of asphalt was encountered at the surface of all boreholes advanced through the existing road embankment (boreholes BH01, BH02, and BH04-BH07)

Where encountered, the asphalt was approximately 130 to 180 mm thick.

4.1.2 Fill

Fill was encountered at the surface of borehole BH03 (where it was placed to construct a temporary access pad) and below the asphalt in the six boreholes advanced through the existing roadway. Generally, the fill encountered in the boreholes can be divided into three groups: access pad, base gravel, and sand and gravel.

Access Pad

Brown silty sand fill, approximately 1.2 m thick, was encountered at the surface of BH03. This fill consisted of material placed when constructing a temporary access pad out of local material. Based on our field classification, the fill may be described as silty sand with gravel.

Base Gravel

A layer comprised of grey to greyish-brown sand and gravel was encountered below the asphalt in the six boreholes advanced through the existing embankment. This layer forms part of the pavement structure and, where encountered, ranged from 0.8 to 1.8 m in thickness.

The results of particle-size analyses on three samples of the base gravel is presented in Table 2. Based on our field classification and laboratory testing, the base gravel may be described as silty sand with gravel to gravel with silt and sand.

The water content of three samples from this layer were 4, 4, and 5 percent.

Table 2 Particle-Size Analyses – Fill: Base Gravel (Bridge Abutments)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[(a)]	Material Composition by Weight (percent)		
				Gravel	Sand	Fines[(b)]
BH02	SS1	0.3 to 0.9	Silty Sand with Gravel	35	51	14
BH04	SS1	0.3 to 0.9	Well-Graded Sand with Silt and Gravel	39	48	12
BH06	SS1	0.3 to 0.9	Well-Graded Sand with Silt and Gravel	32	55	12

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

Sand and Gravel

Brown to grey fill comprised of sand, gravel, and silt was encountered below the base gravel in all boreholes advanced through the existing road embankment. At the borehole locations, the thickness of this fill ranged from 5.2 to 7.3 m.

The results of particle-size analyses on three samples from the sand and gravel fill is presented in Table 3. Based on our field classification, visual-manual inspection, and laboratory testing, the sand and gravel fill may be described as silty sand with gravel to gravel with sand. Occasional wood fragments were noted in borehole BH02 at depths of approximately 8.5 m. Frequent cobbles and boulders were encountered in several boreholes and are anticipated to occur throughout the layer.

The water content of eleven samples of the sand and gravel fill from the boreholes ranged from 1 to 11 percent with an average of 8 percent.

Table 3 Particle-Size Analyses – Fill: Sand and Gravel (Bridge Abutments)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[(a)]	Material Composition by Weight (%)		
				Gravel	Sand	Fines[(b)]
BH01	SS2	0.9 to 1.5	Well-Graded Sand with Silt and Gravel	34	57	9
BH05	SS2	2.0 to 2.6	Well-Graded Sand with Silt and Gravel	30	56	13
BH05	SS6	5.8 to 6.5	Poorly Graded Gravel with Silt and Sand	55	35	11

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.1.3 Original Rootmat and Topsoil

A layer of brown to black silty sand with some organic material was encountered below the fill in BH04. This layer was the rootmat and topsoil at the ground surface before placement of the overlying fill. The layer contained roots and decaying vegetable matter.

4.1.4 Sand and Gravel

A layer of sand and gravel was encountered below the rootmat and topsoil in BH04 and below the fill in the other six boreholes. On the north side of the brook, in boreholes that were advanced through this layer, the thickness ranged from 15.7 m (BH07) to 19.1 m (BH06). South of the brook the thickness ranged from 9.2 m (BH05) to 20.0 m (BH04).

Occasional wood fragments were noted in BH02; frequent cobbles and boulders were encountered in most boreholes and are anticipated to occur throughout the deposit. The results of particle-size analyses of nineteen samples from the sand and gravel materials are presented in Table 4, below. Based on our field classification, visual-manual inspection, and laboratory testing soil classifications on retrieved samples ranged from silty sand to gravel with sand, however, the layer can generally be described as sand with silt and gravel to gravel with silt and sand.

The natural water contents of thirty-five samples tested from this layer ranged from 3 to 18 percent with an average of 10 percent.

Within this layer, SPT N-values ranged from 10 to sampler refusal. However, many N-values were elevated due to gravel and cobbles obstructing the advancement of the split-spoon sampler during testing and the layer can generally be described as compact to dense.

Table 4 Particle-Size Analyses – Sand and Gravel (Bridge Abutments)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[a]	Material Composition by Weight (%)		
				Gravel	Sand	Fines[b]
BH01	SS10	6.1 to 6.7	Well-Graded Sand with Silt and Gravel	45	49	6
BH01	SS16	9.9 to 10.5	Well-Graded Gravel with Sand	60	38	3
BH01	SS24	15.4 to 16.1	Silty Sand	6	80	14
BH01	SS28	18.4 to 19.0	Well-Graded Sand with Silt and Gravel	41	54	6
BH02	SS9	8.2 to 8.8	Well-Graded Sand with Silt and Gravel	35	55	11
BH02	SS10	9.1 to 9.7	Well-Graded Gravel with Silt and Sand	48	42	10
BH03	SS5	3.7 to 4.3	Well-Graded Sand with Silt and Gravel	28	64	8
BH03	SS10	7.2 to 7.9	Silty Sand	0	87	13
BH04	SS14	9.6 to 10.2	Well-Graded Gravel with Silt and Sand	49	44	7
BH04	SS25	27.7 to 23.3	Well-Graded Sand with Silt and Gravel	29	63	9
BH05	SS11	9.0 to 9.7	Well-Graded Sand with Silt and Gravel	34	54	11
BH05	SS16	14.9 to 15.5	Well-Graded Sand with Silt and Gravel	19	71	10
BH05	SS18	18.0 to 18.6	Well-Graded Gravel with Sand	61	36	3
BH05	SS21	22.5 to 23.1	Poorly Graded Sand with Silt and Gravel	19	76	5
BH06	SS11	7.4 to 8.0	Poorly Graded Sand with Silt and Gravel	47	49	5
BH06	SS22	15.7 to 16.3	Well-Graded Sand with Silt and Gravel	36	57	7
BH06	SS26	19.5 to 20.1	Well-Graded Sand with Silt and Gravel	43	49	8
BH07	SS11	8.1 to 8.7	Well-Graded Sand with Silt and Gravel	36	52	12
BH07	SS24	20.1 to 20.7	Well-Graded Sand with Silt and Gravel	42	51	7

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.1.5 Silty Sand/Silty Gravel

A layer of silty gravel to silty sand was encountered below the sand and gravel layer in four of the seven boreholes (BH03-BH05, BH07). Boreholes BH01 and BH02 were terminated in the overlying layers and the silty sand to silty gravel layer was not encountered in BH06 but its presence may have been obfuscated by poor drilling recovery. Where encountered, the thickness of this layer ranged from 0.7 m (BH04) to 4.1 m (BH05).

The results of particle-size analyses of three samples of this layer are presented in Table 5. Based on our field classification, visual-manual inspection, and the laboratory testing the layer can generally be described as silty sand to silty gravel with sand.

The natural water contents of two samples from this layer were 9 and 17 percent. Based on SPT N-values, this layer may generally be described as dense to very dense.

Table 5 Particle-Size Analyses – Silty Sand (Bridge Abutments)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[(a)]	Material Composition by Weight (%)		
				Gravel	Sand	Fines[(b)]
BH03	SS18	16.7 to 17.4	Silty Sand	13	52	35
BH05	SS23	25.3 to 25.9	Silty Gravel with Sand	31	27	41
BH07	SS30	25.5 to 26.1	Silty Sand with Gravel	38	49	14

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.1.6 Bedrock

Bedrock was encountered and cored in five of the seven boreholes advanced as part of this investigation.

North of the brook, in boreholes BH06 and BH07, the bedrock surface was encountered at elevations of -19.7 and -20.8 m, respectively. South of the brook and near the existing abutment, in boreholes BH04 and BH05, the bedrock surface was encountered at elevations of - 21.7 and - 21.5 m, respectively. At borehole BH03, which was advanced south of the brook and east of the existing abutment, bedrock was encountered at an elevation of -15.8 m.

Bedrock was primarily pink to light purple quartzose sandstone (quartz arenite). At the bottom of BH04, conglomeratic quartzose sandstone was encountered in which secondary voids have developed due to the dissolution and chemical leaching of soluble minerals (e.g. carbonate pebbles). The colour of the bedrock varied from the pink and light purple most commonly observed to white in BH04, light brown in BH05, and grey to purplish-grey in BH06.

Based on the RQD of the recovered core, the bedrock may generally be classified as very poor to poor quality with portions that may be classified as fair to good quality (more commonly on the north side of the brook).

Four unconfined compressive strength tests were performed on samples of the quartzose sandstone and one on the conglomeratic quartzose sandstone. Results of the tests ranged from 13 MPa (with failure occurring along an existing fracture) to 146 MPa. Based on these tests and field testing, the quartz arenite may generally be classified as strong to very strong and the conglomeratic quartzose sandstone as weak. The results of the unconfined compressive strength tests are provided in Table 6, below.

Table 6 Unconfined Compressive Strength Test Results

Borehole	Depth (m)	Rock Type	Unconfined Compressive Strength (MPa)
BH04	31.5	Conglomeratic Quartzose Sandstone	13[(a)]
BH05	32.0	Quartzose Sandstone	24
BH06	29.0	Quartzose Sandstone	146
BH07	32.0	Quartzose Sandstone	93

(a) Sample failed along existing fracture.

4.1.7 Groundwater

The groundwater level in Rocky Barachois Brook at the location of the investigation is influenced by the ocean and its tides.

Groundwater levels were measured in boreholes BH01 and BH05 on September 22 and December 4, 2016, respectively. Near the north abutment (BH01) the water level was 6.8 m below the ground surface (el. 0.1 m) and near the south abutment (BH05) the water level was 7.2 m below the ground surface (el. 0.3 m). Standpipes were also installed in boreholes BH03, BH04, and BH06 but the standpipes were blocked at depths of 2.1, 0.5, and 6.0 m, respectively.

Water levels may fluctuate with tides, brook level, construction activity, precipitation events, as well as individual weather events and climatic and seasonal weather trends.

4.2 NORTH BRIDGE APPROACH (TEST PITS TP01 TO TP04)

The subsurface conditions encountered in the test pits near the north approach generally consisted of the following sequence:

- Rootmat and topsoil
- Fill
- Sand and gravel

The subsurface conditions observed are summarized in Table 7 and the following paragraphs and are described in additional detail on the test pit records in Appendix A.

Table 7 Summary of Subsurface Conditions near North Approach

Location	Ground Elevation[a] (m)	Thickness			Bedrock		Groundwater		Total Depth (m)
		Rootmat/ Topsoil (m)	Fill (m)	Sand and Gravel (m)	Depth to Surface (m)	Surface Elevation [a] (m)	Depth (m)	Elevation[a] (m)	
TP01	4.8	0.1	3.6	-	> 3.7	< 1.1	> 3.7	< 1.1	3.7
TP02	4.2	0.1	2.8	-	> 2.9	< 1.3	> 2.9	< 1.3	2.9
TP03	5.5	0.1	3.1	-	> 3.2	< 2.3	> 3.2	< 2.3	3.2
TP04	1.8	0.2	-	2.1	> 2.3	< -0.5	1.1	0.7	2.3

(a) Elevations are referenced to CGVD28.

4.2.1 Surficial Layer

A surficial layer of rootmat and topsoil was encountered in all four test pits advanced near the north approach. At the test locations this layer was 0.1 to 0.2 m thick.

4.2.2 Fill: Sand and Gravel

Brown to grey fill was encountered below the surficial layer in test pits TP01 to TP03. Due to the limits of the excavator reach and the limits of practical excavation due to cave-in of the granular material, the test pits were not advanced through the full extents of this layer, which was in excess of 2.9 to 3.6 m thick. Occasional to frequent cobbles and boulders were encountered throughout the layer.

The results of particle-size analyses on three samples from the fill materials are presented in Table 8, below. Based on our field classification and the particle-size analyses the layer may be described as gravel with sand.

The in-situ water content of three samples of the fill were 3, 3, and 4 percent.

Table 8 Particle-Size Analyses – Fill: Sand and Gravel (North Bridge Approach)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[(a)]	Material Composition by Weight (%)		
				Gravel	Sand	Fines[(b)]
TP01	GB1	1.8 to 2.1	Poorly Graded Gravel with Sand	58	39	3
TP02	GB1	2.4 to 2.7	Poorly Graded Gravel with Sand	55	42	2
TP03	GB1	1.8 to 2.1	Well-Graded Gravel with Sand	64	33	3

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.2.3 Sand and Gravel

A layer of greyish-brown gravel with silt and sand was encountered below the surficial layer in TP04. The test pit extended 2.1 m into this layer and was terminated within it.

Based on field observations, including excavator performance, this layer may be described as compact.

4.2.4 Bedrock

Bedrock was not encountered in any test pits advanced along the north approach. However, bedrock outcrops were observed along the road about 600 m north of the bridge.

4.2.5 Groundwater

Groundwater was noted in TP04 at a depth of 1.1 m below grade (el. 0.7 m). No water infiltration was noted in the other test pits while the excavations were open.

4.3 SOUTH BRIDGE APPROACH (TEST PITS TP06 TO TP09 AND PUSH PROBES PP05 TO PP08)

The subsurface conditions encountered at the south approach generally consisted of the following sequence:

- Rootmat and topsoil
- Fill
- Original rootmat and topsoil
- Clay
- Sand and gravel
- Clay
- Bedrock

Not all strata were encountered at all test locations. The subsurface conditions observed in the test pits are summarized in Table 9 and the following paragraphs and are described in additional detail on the test pit records in Appendix A.

Table 9 Summary of Subsurface Conditions near South Approach

Location	Ground Elevation[a] (m)	Thickness						Bedrock		Groundwater		Total Depth (m)
		Rootmat/ Topsoil (m)	Fill (m)	Original Rootmat / Topsoil (m)	Clay (m)	Gravel (m)	Clay (m)	Depth to Surface (m)	Surface Elevation[a] (m)	Depth (m)	Elevation[a] (m)	
TP06	6.0	0.3	-	-	-	4.3	-	>4.6	<1.4	3.0	3.0	4.6
TP07	14.2	0.2	-	-	-	0.7	-	0.9	13.3	>0.9	<13.3	0.9
TP08	17.1	0.2	-	-	1.0	0.8	-	2.0	15.1	>2.0	<15.1	2.0
TP09	23.3	0.2	1.6	0.3	-	0.9	1.3	4.3	19.0	>4.3	<19.0	4.3

(a) Elevations are referenced to CCVD28.

4.3.1 Rootmat and Topsoil

A layer of rootmat and topsoil was encountered at the surface of all four test pits advanced on the south approach. At the test locations, this layer was 0.2 to 0.3 m thick.

4.3.2 Fill

Fill was encountered below the rootmat and topsoil in test pit TP09. The fill consisted of a layer of brown sandy clay overlying brown silty gravel with sand. The total thickness of the fill at this location was 1.6 m.

4.3.3 Original Rootmat and Topsoil

A Layer of brown to black silty sand with some organic material was encountered below the fill in test pit TP09. This layer was the rootmat and topsoil of the ground surface before placement of the overlying fill. The layer contained roots, rootlets, and decaying vegetable matter. Based on field observations including excavator performance, the compactness of this layer may be described as loose.

4.3.4 Gravel

A layer of brown to grey gravel with sand was encountered below the surficial layer in test pits TP06 and TP07, below the clay layer in test pit TP08 and below the original rootmat and topsoil in test pit TP09. Where encountered, the thickness of this layer ranged from 0.7 to 4.3 m. Based on field observations including excavator performance, the compactness of this layer may be described as loose to dense. Occasional cobbles and boulders were encountered throughout the layer.

The results of particle-size analyses on three samples of the gravel are presented in Table 10. Based on our field classification and the particle-size analyses, the layer may be described as silty gravel with sand to gravel with sand and silt.

The natural water content of three samples of the gravel were 6, 8, and 8 percent.

Table 10 Particle-Size Analyses – Gravel (South Bridge Approach)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[a]	Material Composition by Weight (%)		
				Gravel	Sand	Fines[b]
TP06	GB1	1.2 to 1.5	Well-Graded Gravel with Sand	75	23	2
TP06	GB2	4.3 to 4.6	Poorly Graded Gravel with Sand	51	48	1
TP08	GB2	1.5 to 1.8	Silty Gravel with Sand	48	34	18

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.3.5 Clay

A layer of brown lean clay was encountered below the surficial layer in test pit TP08 and below the gravel layer in test pit TP09. At these two locations, the clay was 1.0 to 1.3 m thick. The results of particle-size analyses and Atterberg limit testing on two samples of the clay are presented in

Table 11. Based on our field classification, the particle-size analysis, and the Atterberg limits, this deposit may be classified as lean clay.

Field observations including minivane, torvane, and pocket penetrometer testing indicate that the clay may generally be described as stiff.

The natural water content of two samples of the clay were 16 and 24 percent.

Table 11 Particle-Size Analyses and Atterberg Limits – Lean Clay (South Bridge Approach)

Location	Sample No.	Sample Depth (m)	ASTM Soil Classification[(a)]	Material Composition by Weight (%)			Atterberg Limits		
				Gravel	Sand	Fines[(b)]	PL	LL	PI
TP08	GB1	0.9 to 1.2	Lean Clay	0	8	91	15	30	15
TP09	GB2	3.9 to 4.3	Lean Clay	0	6	94	16	30	14

(a) See ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
(b) For particle-size analyses performed by sieve, the percent of silt- and clay-sized particles are reported collectively as the percent fines.

4.3.6 Bedrock

Bedrock was inferred based on excavator refusal in three of the four test pits (TP07, TP08, and TP09). In these test pits, bedrock was encountered at depths ranging from 0.9 to 4.3 m. Test pit TP06 was advanced to a depth of 4.6 m and bedrock was not encountered.

Bedrock outcrops were observed along the road about 200 m south of the bridge. The location of one bedrock outcrop south of the bridge was recorded and its position (N 5 480 789, E 446 972) is shown on Sketch G2 in Appendix C.

4.3.7 Groundwater

Water infiltration was observed in TP06 at a depth of 3.1 m below grade (el. 3.0 m). No water infiltration was noted in the other test pits along the south approach.

4.3.8 Push Probes

The depth of penetration of the push probes advanced as part of this investigation ranged from 0.05 m to 0.75 m and are summarized in Table 12, below. The depths of the probes may be used to estimate the thickness of very loose and soft surficial materials however these probes do not determine any information on the type or consistency of material below the depth of refusal.

Table 12 Push Probe Locations and Penetration Depth

Probe Location	Probe Depth (mm)	Description/Observations	Northing	Easting
PP05	750	• Probe on low-lying wet area at base of slope • Frequent cobbles and boulders visible at ground surface in vicinity of probe	5 480 880	446 890
PP06	100	• Probe on forest bottom	5 480 848	446 926
PP07	200	• Probe on forest bottom • Occasional cobbles visible at ground surface in vicinity of probe	5 480 820	446 967
PP08	50	• Probe on forest bottom • Occasional boulders visible at ground surface in vicinity of probe	5 480 798	447 013

5.0 DISCUSSION AND RECOMMENDATIONS

We understand that the preferred design of the new bridge is a 42-m single-span structure. The new alignment will be skewed to the existing alignment and offset to the east by about 14.0 m at mid-span. The new structure will be constructed will traffic remains on the existing structure. Once the new structure is complete, traffic will be diverted on to the new structure and the existing bridge will be demolished.

As part of this work, both the north and south approach will be realigned to the east of the current road. This work will require infilling adjacent to the existing embankments and potential reworking of the existing fills. To reach the proposed grade, we have estimated that fills up to about 5 to 7 m above the existing grade may be required.

The following subsections provide geotechnical recommendations to support site preparation and foundation design based on our geotechnical investigation and our understanding of the proposed design options.

5.1 SITE PREPARATION

All rootmat, topsoil, and other deleterious materials (e.g. soft or loose soils, or soils containing a significant proportion of organic material) should be removed from below the footprint of the pile caps, structural fills, and new approach fills to expose the in-situ sand gravel fill or native sand and gravel. The push probes encountered soft or very loose surficial soils up to 0.75 m thick, and the thicknesses of these soils likely exceed this value at some untested locations. Where fills are being placed over the existing approach embankments, organic materials and loose or soft soils should be removed to expose the existing fill and, as a minimum, the existing fill should be removed to the new subgrade level.

After removal of the required materials, the exposed soil surface should be re-graded, compacted, and tested (proof rolled) with a loaded tandem truck or large vibratory roller under the supervision of qualified geotechnical personnel prior to fill placement. Any soft areas or yielding material within the subgrade should be removed and replaced with approved fill.

Lean clay was encountered in test pits TP08 and TP09, at the south end of the proposed realignment. At locations where the subgrade is comprised of clay, or where the presence of clay below the subgrade is thought to be influencing the subgrade performance based on the results of a proof roll, the subgrade should be over-excavated by 450 mm and reinstated using engineered rock fill or structural fill. A geotextile filter fabric will be required where coarse-grained fill is placed over fine-grained material.

5.2 EXCAVATIONS IN SOIL

The depths of excavations required depend on the existing grades on the site and the final elevation of the foundation elements (e.g. pile caps). As the pile caps are expected to be founded above the level of the brook, open excavations will be possible. Relatively shallow excavations below the ordinary high-water mark (elev. +1.03 m) may be required to allow placement of the armour stone as shown on the conceptual drawing package provided by HEC

During temporary excavations, side slopes should be no steeper than 1.5H:1V, should follow all applicable safety regulations, and should be frequently monitored for any indication of instability.

5.3 EXCAVATIONS IN ROCK

Shallow bedrock was encountered in test pits TP07 to TP09 which were advanced along the south approach. Bedrock outcrops are frequent in this area and there is an existing rock cut east of the road. As the road is being re-aligned to the east, additional rock cuts will be required to meet the design grades. The existing cut is supported by rock anchors. Rock excavation should proceed with consideration given to the anchors and the bedrock supported by the anchors. Anchors should be removed in a sequence that does not result in uncontrolled rock falls.

Based on a review of the outcropping, the bedrock has a prominent set of joints that have a strike roughly parallel with the road and a dip of approximately 45 degrees. Excavation into this rock should follow the fracturing in the rock so that this set of joints does not “daylight” on the face of the cut slopes. Therefore, without additional support (e.g. rock anchors) the cut slopes should be about 1H:1V but will depend on the specifics of the jointing. The slopes should be assessed by qualified geotechnical or geological personnel during construction to determine if additional excavation or anchoring is appropriate.

A rockfall catchment area should be designed to prevent or limit rockfall originating from the slope above the highway from reaching the highway lanes. Design of catchment area should include the ditch height and width and take into consideration the height of the slope, the steepness of the slope, the type and quality of the bedrock, as well as any other slope stabilization measures used.

If steeper slopes than those dictated by the joint orientation are preferred, the excavation can be supported by a series of rock anchors

Care should be taken during blasting operations to limit the amount of overbreak as the excavated slope should follow intact rock along the existing joints. If blasting damages the rock below the intended surface, additional excavation may be required to ensure the rock cut is stable.

5.4 WATER CONTROL

Good construction practices include diverting surface water away from excavations. This may be accomplished through the use of ditches and swales. The base of excavations should be shaped to drain to one or more sumps and pumped, as required. Any water discharged from site should meet all applicable regulatory requirements including those related to erosion and sedimentation control.

A plan for water control should be developed prior to the start of construction and the plan should be reviewed and adapted, as required, during all stages of construction. Given the proposed design and our understanding of the likely construction phasing, steel sheet pile cofferdams will likely not be required but sand bags or other water diversion techniques may be used to control relatively shallow water and allow for shallow excavations near or below the river level, where required.

5.5 STRUCTURAL FILL

Structural fill should be used below the pile caps to achieve the proposed subgrade elevations. Structural fill should consist of well-graded rock fill with a maximum particle size of 200 mm and a fines content less than 12 percent. Granular “B” or Granular “C” as specified by the Government of Newfoundland and Labrador's Department of Transportation and Works Specifications Book are examples of suitable materials.

Where placed, structural fill should extend through the full extent of the fills in front of and transversely from the pile cap. Structural fill should extend behind the abutments a distance beyond the outside edge to include a structural splay of 1H:1V (the extents of the zone of influence beneath the pile cap). If fill is placed below the pile caps before the approach fills are placed, shallower slopes will be required to ensure stable slopes during construction (i.e. 1H:1V slopes will not have a sufficient factor of safety against slope instability).

Structural fill should be compacted to 100 percent of the standard Proctor maximum dry density as determined by *ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort*. For Materials where Proctor densities are not applicable, such as coarse rock fills, material should be compacted to a relative density of at least 80 percent. All structural fill should be placed at a water content that allows compaction to the specified density.

Appropriate lift thicknesses for structural fill will vary with the compaction equipment and material used. Typically, a rolling pattern of about six slow passes with a 10-ton vibrating roller would be required for a 300 to 500 mm lift. Placement of structural fill should be monitored by experienced geotechnical personnel to ensure that the required density is achieved.

5.6 APPROACH FILL

Portions of the site soils (inorganic material from above the groundwater level at a water content that allows for compaction to the requirements below) or imported select granular fill would be a suitable option to construct the approach fills. All, approach fill should be compacted to at least 95 percent of the standard Proctor maximum dry density and the upper 1.5 m below the subgrade should be compacted to a minimum of 100 percent. To ensure compaction through the entire depth of the lift, fill should be placed in lifts compatible with the compaction equipment used.

Due to realignment and widening of the approaches, the finished grade will be raised above the existing ground surface at some locations. Settlement analyses were completed assuming that that the new embankments would be constructed of well-compacted granular borrow to heights of 5 to 7 m above existing grades. It is anticipated that the underlying native soil deposits will settle approximately 50 to 75 mm due to construction of these embankments. The majority of the induced settlement would occur during and immediately following placement of the fills. It is not anticipated that substantial long-term settlements due to consolidation or creep of the underlying soils would occur at this site.

Armour stone shall be placed in areas where fills will be subject to flowing water from the brook or wave-action from the East Arm. This armour stone should be designed to withstand the velocities anticipated in the brook during high flow periods and the most aggressive anticipated conditions in the East Arm.

5.7 SLOPE STABILITY

Slope stability analyses were performed based on the conditions encountered in the investigation to assess the stability of the proposed embankments. It was assumed that new embankments would be constructed of well compacted granular borrow to heights of 5 to 7 meters above existing grades. In order to achieve the required factors of safety for global stability the embankment slopes should be constructed no steeper than 2H:1V.

Where steeper slopes are required, permanent slopes as step as 1.5H:1V may be practical provided an appropriately-sized thickness of angular well-graded rock fill or other stabilization measures are used.

5.8 FOUNDATIONS

Based on our geotechnical investigation and our understanding of the proposed design, we are providing recommendations for both driven and drilled piles founded in bedrock. However, due to the presence of numerous cobbles and boulders in the site soils, which may interfere with installation of driven piles, piles drilled into bedrock and driven to refusal are the recommended option to support the bridge abutments.

5.8.1 General

The design depth of frost penetration should be taken as 1.8 m. The bottom of footings in frost susceptible soils should be located below this depth to prevent heave under frost action. Where this depth is not maintained, an equivalent combination of soil and insulation, or other measures such as excavation and replacement with non-frost susceptible soil, may be used to protect the structure from frost action.

Base preparation for the pile cap should include removal of all rootmat, topsoil, and other deleterious materials (soft soils, organic material, etc.) down to the existing fill layer or native undisturbed soil.

5.8.2 Driven Pile Foundations

Steel H-Piles or open-ended pipe piles driven to practical refusal in bedrock are another option to support the bridge abutments. However, cobbles and boulders noted through the site soils may provide obstacles complicating their installation. The presence of cobbles and boulders can result in problems with shallow refusal, problems driving the piles plumb and on the correct alignment, problems achieving ‘fixity’, and damage during pile driving. If driven piles are to be used, consideration should be given to pre-drilling the pile locations to remove the obstructions and then seating the piles to the refusal criteria.

Notwithstanding the above, driven piles founded in bedrock may be designed using a ULS geotechnical axial compressive resistance of 80 MPa based on the cross-sectional area of the steel. The factored compressive axial resistances of several H-pile sections are provided in Table 13; we would be pleased to review other sections upon your request. In accordance with the Canadian Highway Bridge Design Code (CAN/CSA S6-14, 2014) Clause 6.9.1 this includes a resistance factor of 0.4.

Table 13 Factored Axial Resistance at ULS for Driven Piles

Pile Type	Factored Axial Resistance (Compression)
406 x 12.7 Steel Pipe Pile	1255 kN
HP 310 x 110	1120 kN
HP 360 x 152	1550 kN

The resistance will be achieved through a combination of end-bearing and shaft resistance. To achieve this resistance, the piles should penetrate the overburden and may also penetrate approximately to 1 to 3 m into bedrock. Precise estimates of pile penetration are not possible; the above estimate is based on our past experience for sites with similar subsurface conditions under typical driving conditions.

The resistance of pile groups may be calculated as the sum of the individual pile capacities provided that the centre-to-centre spacing of the piles is at least three pile diameters. The expected settlement of piles driven to refusal on or in bedrock at the serviceability limit state (SLS) loads is negligible.

Piles should be driven with a hammer having a minimum rated energy of 450 Joules/cm^2 of steel cross-sectional area. Practical refusal in bedrock should be taken as a pile penetration of less than 25 mm for 15 blows at the rated energy for four consecutive 25-mm increments. The contractor should provide full details on the method of installation and equipment to the geotechnical engineer prior to starting the work.

If piles are obstructed by cobbles or boulders before reaching bedrock, remedial measures (e.g. excavating the obstruction, removing the pile and driving at a modified location, pre-drilling the pile locations, or using drilled piles) may be required. Alternatively, dynamic pile monitoring can be performed to assess the pile resistance and the piles analyzed by the structural and geotechnical engineers to assess if the pile group will meet other performance requirements (e.g. performance under lateral loads or in tension).

For driven piles, dynamic pile monitoring (e.g. using Pile Driving Analyzer System) should be carried out on the initial pile installations to verify that overstressing does not occur, that the hammer is operating within normal efficiencies, and that the estimated resistance provided for design is achieved at the set criteria. As a minimum, dynamic pile monitoring should be performed on 10 percent of the piles at end of initial drive and at the beginning of re-strike at each abutment. Full-time inspection by qualified geotechnical personnel is recommended during pile installation.

To further evaluate the potential for relaxation to occur following initial driving, at least two piles at each abutment should be re-tapped a minimum of 24 hours after initial driving refusal. If relaxation occurs, all piles should be re-driven to the refusal criteria and the cycle repeated until the refusal criteria is maintained during subsequent re-taps. If significant relaxation continues to occur, dynamic pile monitoring could be used to determine if the required load capacity is being developed.

5.8.3 Drilled Pile Foundations

Rock-socketed piles rely on the bond between the grout and the rock to develop their capacity. Design of rock-socketed piles should be based on the factored resistance of the socket which is a function of the socket diameter, socket length, bond stress, and installation method. Based on the types and quality of bedrock encountered at the site during our investigation, the following factored bond stresses are recommended for use in design of gravity-grouted rock sockets:

- Axial Compression 600 kPa
- Axial Tension 450 kPa

These values include a resistance factor of 0.4 for piles in compression and 0.3 for piles in tension in accordance with the Canadian Highway Bridge Design (CAN/CSA S6-14, 2014). The design bond length should begin below the highly-fractured or weak bedrock that occurs near the bedrock surface. For this site, we recommend that the design bond length not include the upper 1.5 m of bedrock. Steel casing should be extended to the top of the bonded zone. Socket lengths should generally be kept between 3.0 m and 8.0 m.

As indicated above, rock-socketed piles provide capacity in tension that can be used to resist uplift forces. The uplift resistance should also consider pulling a cone or wedge of rock and soil. For design, the cone can be taken as a 60-degree apex from the base of the socket. If a series of piles are used, the uplift may mobilize a wedge of rock and soil which splays outwards from the base of the piles at 30 degrees. Submerged unit weights should be used for soils and rock below the groundwater table. A resistance factor of 0.8 is typically applied to the submerged unit weight.

For drilled piles socketed into bedrock, the factored geotechnical axial compressive resistance at ultimate limit states (ULS) is presented below in Table 14 for varying socket diameters and lengths. Group capacities for piles can be taken as the sum of the individual pile capacities provided that the centre-to-centre spacing between the bond zones of adjacent piles is at least three pile diameters. The settlement at the serviceability limit state (SLS) of socketed piles installed as described herein is expected to be negligible.

Table 14 Factored Socket Resistance at ULS for Drilled Piles in Bedrock

Socket Length	Pile Diameter			
	203 mm	254 mm	305 mm	457 mm
	Factored Axial Resistance, kN (Compression)			
5 m	1910	2390	2870	4300
6 m	2290	2870	3440	5170
7 m	2680	3350	4020	6030
8 m	3060	3830	4590	6890

Grouting should be performed promptly after drilling of the pile socket is complete. Installation of the piles should be closely monitored by personnel having experience with rock-socketed piles. Comparison of bedrock elevations should be carried out on an ongoing basis to check that the socket length is as designed. Compressive strength testing of grout used in the socket and pile shaft should also be completed.

In order to confirm the bond stress and the contractor's installation methods, we recommend verification testing be performed on at least one pile at each foundation location. Verification testing may be either carried out on a sacrificial pile installed specifically for the test or on a production pile. The test load should be at least two times the design load. If verification testing is performed on a production pile, the pile should be designed with a structural capacity at least 1.25 times the maximum test load and it should not be failed or overloaded during testing. Good practice dictates that a plan should be developed prior to testing to replace the pile in the case that it does fail during testing.

5.8.4 Lateral Pile Behaviour

For consideration of lateral loads, the depth to fixity for three piles types through newly placed approach, structural fill, or existing sand and gravel materials are provided below in Table 15.

Table 15 Depth to Fixity

Pile Type	Depth to Fixity (m)	
	Strong Axis (X-X)	Weak Axis (Y-Y)
406 x 12.7 Steel Pipe Pile	2.6	
HP 310 x 110	2.5	2.0
HP 360 x 152	2.8	2.3

5.9 BACKFILL

The abutments for the new bridge and retaining walls should be backfilled with a non-frost susceptible, non-expansive, non-corrosive, free-draining, well-graded material such as Granular ‘C’. The extent of the granular backfill should be in accordance with the wall design requirements.

It is important that retaining walls are designed to ensure thorough drainage of the backfill material. This may be accomplished with a drainage system such as a longitudinal drain pipe discharging to a positive outlet. When backfilling behind a retaining wall, fill should be placed in lifts and compacted as a minimum to 95 percent of the standard Proctor maximum dry density. Where wall backfill acts as the road subgrade the compaction requirements for the approach fill may govern (i.e. the upper 1.5 m should be compacted to 100 percent of the standard Proctor maximum dry density). Care should be taken not to damage walls when performing backfilling and compaction operations. To limit compaction-induced stresses, compaction within 1.5 m of retaining structures should be performed with a walk-behind vibratory plate tamper or other lightweight compaction equipment in lieu of a vibratory drum roller.

All drainage materials, including backfill and drainage blankets, must be designed to limit loss of soil according to filter criteria.

The values for the soil parameters presented in the following section may be used for design of retaining walls. The earth pressure coefficients used for design should be selected or adjusted based on the appropriate finished back-slope angle. Walls that can tolerate little or no movement should be designed for at-rest lateral earth pressures.

5.10 PAVEMENT DESIGN

Based on the existing soil conditions, proposed approach fills, and expected traffic loadings, the following pavement structure is recommended:

Table 16 Pavement Structure

Materials	Pavement Structure
Asphalt Top	50 mm
Asphalt Base	60 mm
Granular “A”	150 mm
Granular “B”	450 mm

The pavement design is based on the subgrade soils being in a stable condition at the time the granular materials are placed. The subgrade soils may become soft and constructability can be a problem. As discussed above, where the subgrade is comprised of clay or where the presence of clay below the subgrade is influencing the subgrade performance, the subgrade should be over-excavated by 400 mm and reinstated using engineered rock fill or structural fill.

The physical properties and placing of the asphaltic courses, granular 'A', and granular 'B' should be in accordance with the most recent version of Newfoundland and Labrador Department of Transportation and Works Specifications Book.

5.11 GEOTECHNICAL PARAMETERS

The following unfactored values (Table 16) for the indicated parameters may be used for design purposes:

Table 17 Unfactored Geotechnical Parameters

Parameter	Value			
	In-Situ or Compacted Site Sand and Gravel	Compacted Granular "C" (a) (b)	In-Situ Silty Sand /Silty Gravel	Quartzose Sandstone Bedrock
Effective Angle of Internal Friction, degrees	34	36	32	-
Effective Cohesion, kPa	0	0	0	-
Total Unit Weight, kN/m^3	20.5	22	21.5	25.5
Submerged Unit Weight(c), kN/m^3	10.5	12	11.5	15.5
Coefficient of Active Earth Pressure(d)	0.28	0.26	0.31	-
Coefficient of Passive Earth Pressure(d)	3.54	3.85	3.25	-
Coefficient of At-Rest Earth Pressure(d)	0.44	0.41	0.47	-
Friction Factor, Soil/Concrete Interface(e)	0.45	0.50	0.38	-

(a) Compacted material shall be placed in lifts and suitably compacted as described above.
(b) As per Government of Newfoundland and Labrador Department of Transportation and Works Specifications Book (2011).
(c) For uplift design the groundwater table should be assumed at the ground surface and submerged unit weights should be used.
(d) Coefficients of earth pressure presented in the table assume a frictionless wall with a vertical back face and a horizontal back slope.
(e) For mass concrete or masonry, lower values will be required for formed or pre-cast concrete.

5.12 WINTER WEATHER CONDITIONS

Where practical, earthwork during freezing temperatures should be avoided. In the event of winter construction, special measures will be required to ensure that fills and foundations are not placed on frozen ground and that the soils are protected from freezing after placement. Even following careful procedures and precautions experience has shown that earthworks in these types of soils often become impractical at temperatures below approximately -5°C.

5.13 SEISMIC SITE CLASSIFICATION

Based on the findings at the test locations, the site classification for seismic site response in accordance with Clause 4.4.3.2 of the Canadian Highway Bridge Design Code (CAN/CSA-S6-14, 2014) is Seismic Site Class D (stiff soil).

6.0 CLOSURE

This report has been prepared to assist in the design and construction of the proposed Rocky Barachois Bridge. This report has been prepared for the sole benefit of Harbourside Engineering consultants and their agents. Any use which a third party makes of this report is the responsibility of such third party.

The recommendations made in this report are in accordance with our present understanding of your project. If any details are included in the final design of the proposed structure that differ from the assumptions outlined in this report, the geotechnical engineer should be consulted.

This report is based on the site conditions encountered by Harbourside Geotechnical Consultants at the time of the work at the specific sampling locations, and can only be extrapolated to a limited extent around these locations. Should any conditions differ from those detailed on the borehole records, the engineer should be notified to allow reassessment of any design assumptions.

If you have any questions or require any additional information, please do not hesitate to contact the undersigned at your convenience.

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEG Newfoundland and Labrador
PERMIT HOLDER
This Permit Allows
HARBOURSIDE GEOTECHNICAL CONSULTANTS LIMITED
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0849
which is valid for the year 2017

Harbourside Geotechnical Consultants

Kind Regards,

LICENSED PROFESSIONAL ENGINEER
08406
William Menzies
SIGNATURE
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APPENDIX A

Symbols and Terms Used on Borehole and Test Pit Records

Borehole Records BH01 to BH07

Test Pit Records TP01 to TP04 and TP06 to TP09

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:

USCS SOIL CLASSIFICATION SYMBOLS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN 75 µm SIEVE SIZE	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON 4.75 mm SIEVE	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES. LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL – SAND – SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL – SAND – CLAY MIXTURES
	SANDS MORE THAN 50% OF COARSE FRACTION PASSING THE 4.75 mm SIEVE	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND – SILT MIXTURES
				SC	CLAYEY SANDS, SAND – CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN 75 µm SIEZE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

OTHER COMMONLY USED SYMBOLS

GLACIAL TILL		UNSTRATIFIED GLACIAL DEPOSIT RANGING FROM CLAY TO BOULDERS
BEDROCK		IGNEOUS BEDROCK
		METAMORPHIC BEDROCK
		SEDIMENTARY BEDROCK
MATERIALS PLACED BY HUMANS		FILL: SUBSURFACE MATERIALS IDENTIFIED AS PLACED BY HUMANS
		ASPHALT
		CONCRETE

HARBOURSIDE Geotechnical Consultants

SAMPLE TYPE

SS	Split Spoon (obtained by performing SPT)
ST	Shelby Tube (Thin-Walled Tube)
BS	Bulk Sample
PS	Piston Sample
WS	Wash Sample
HQ, NQ, AQ, BQ, etc.	Rock Core Samples Obtained Using Standard Size Diamond Bits

SPT N-VALUE (N-INDEX)

The standard penetration test (SPT) provides a qualitative evaluation of compactness and a qualitative comparison of subsoil stratification. The SPT is performed in in the bottom of a borehole where a split-barrel sampler having an outside diameter of 50.8 mm is impacted using a hammer weighing 623 N falling 0.76 m for each hammer blow. The SPT N-value is the blow count representation of the penetration resistance of the soil. In accordance with ASTM D1586, the N-value, reported in blows per 300 mm, equals the sum of the number of blows (N) required to drive the sampler over the depth interval of 150 to 450 mm. However, when a 600 mm sampler is used the number of blows (N) required to drive the sampler over the interval of 300 to 600 mm may be reported if this value is lower. For samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in mm (e.g. 50/120). Although some methods make use of N-values corrected for various factors (for equipment used, overburden stress, length of drill rod, etc.) no corrections have been applied to the N-values presented on the logs.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests (DCPT) are performed using a standard 60-degree apex cone connected to ‘A’ size drill rods with the same standard fall height and weight as the SPT test. The DCPT value is the number of blows of the hammer required to drive the cone 300 mm. The DCPT provides a qualitative evaluation of compactness and allows for a qualitative comparison of subsurface stratification.

RECOVERY

For soil samples, recovery is recorded as the total length of the soil sample recovered. For rock core, recovery is expressed as a percentage of the total length drilled on a per run basis.

OTHER TESTS

S	Sieve Analysis	CD	Consolidated-Drained Triaxial	C	Consolidation
H	Hydrometer Analysis	CU	Consolidated-Undrained Triaxial	Q_u	Unconfined Compression
γ	Unit Weight	UU	Unconsolidated Undrained Triaxial	I_p	Point Load Index, Ip(50)
G_s	Specific Gravity of Soil Particles	DS	Direct Shear	k	Laboratory Permeability

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	Vegetation, roots, and moss with organic matter and topsoil typically forming a mattress at the ground surface.
Topsoil	Mixture of soil and humus capable of supporting vegetative growth.
Peat	A soil composed of vegetable tissue in various stages of decomposition usually with an organic odor, a dark-brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.
Till	Non-stratified glacial deposit which may range from clay to boulders
Fill	Artificial (man-made) deposits transported and placed on the natural surface of soil or rock.

Terminology describing soil structure:

Homogeneous	The lack of visible bedding and the same appearance and colour throughout
Desiccated	Having visible signs of weathering by oxidation of clay minerals, shrinking cracks, etc.
Fissured	Having cracks and hence a blocky structure
Stratified	Composed of regular alternating successions of different soil types
Varved	Comprised of regular alternating successions of silt and clay which were transported into freshwater lakes by melt water
Layer	> 75 mm
Seam	2 mm to 75 mm
Parting	< 2 mm
Pocket	Small erratic deposit, usually less than 300 mm
Lens	Lenticular deposit

Terminology describing soil types:
Soils are described in accordance with the Unified Soil Classification System (USCS) as described in ASTM D2487 and ASTM D2488. This system classifies soil into categories representing the results of laboratory tests to determine the particle-size characteristics, the liquid limit, and the plasticity index. Using this system, soils are assigned a group name (e.g. silty sand) and symbol (e.g. SM). The various groupings of this classification system have been devised to correlate in a general way with the engineering behavior of soils. Laboratory tests are performed on the portion of the sample passing the 75 mm sieve.

When laboratory test results indicate that that the soil is close to another classification group, the borderline condition can be indicated with two symbols separated by a slash (e.g. CL/CH).

Terminology describing cobbles, boulders, and non-matrix materials:
Materials outside of the USCS (e.g. particles larger than 75 mm, organic matter, construction debris) are described based on the proportion of these materials by weight using the following terminology:

Trace, or occasional	< 10%
Some	10% to 20%
Frequent	> 20%

Terminology describing the compactness condition of cohesionless soils:
A qualitative term describing the compactness condition of a cohesionless soil is interpreted from the SPT N-value (also known as the N-index). The relationship between the SPT N-value and the compactness condition is shown in the following table.

Compactness Condition	**SPT N-Value (blows per 0.3 m)**
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

Terminology describing the compactness condition of cohesive soils:
Cohesive soils can be classified in relation to undrained strength. Undrained strength can be determined by a number of tests including: unconfined compression tests, field and laboratory vane tests, laboratory fall-cone tests, shear-box tests, and triaxial tests. The consistency and undrained shear strength may also be approximately related the SPT N-Value. The relationship between the consistency and the undrained shear strength, as well as a rough correlation with SPT N-Value as shown in the following table.

Consistency	Undrained Shear Strength (kPa)	SPT N-Value (blows per 0.3 m)
Very Soft	< 12	< 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

ROCK DESCRIPTION

Rock is a natural aggregate of minerals that cannot be readily broken by hand and that will not disintegrate on a first wetting and drying cycle. A rockmass comprises blocks of intact rock that are separated by discontinuities such as cleavage, bedding planes, joints, shears and faults.

Terminology Describing Geological Classification of Rock:

Rock is classified with respect to its geological origin or lithology as follows:

Igneous Rocks	Rocks such as granite, diorite, and basalt, which are formed by the solidification of molten material.
Sedimentary Rocks	Rocks such as sandstone, limestone and shale, which are formed by the lithification of sedimentary soils.
Metamorphic Rocks	Rocks such as quartzite, schist, and gneiss, which have been altered by the application of intense heat and/or pressure.

Terminology Describing the Strength of Intact Rock:

Strength is the maximum stress level that can be carried by a specimen. Rocks may be classified based on their intact strength as shown in the following table.

Term	Unconfined Compressive Strength (MPa)
Extremely Weak	0.25 to 1
Very Weak	1 to 5
Weak	5 to 25
Medium Strong	25 to 50
Strong	50 to 100
Very Strong	100 to 250
Extremely Strong	> 250

Terminology Describing Discontinuity Spacing

The structural integrity of a rockmass will be affected by the presence of discontinuities. The spacing of discontinuities can vary from extremely wide to extremely close as indicated in the table below.

Term	Spacing Width (m)
Extremely Close	< 0.02
Very Close	0.02 to 0.06
Close	0.06 to 0.20
Moderately Close	0.20 to 0.6
Wide	0.6 to 2.0
Very Wide	2.0 to 6.0
Extremely Wide	> 6.0

Rock Quality Designation (RQD)

RQD is an indirect measure of the number of fractures within a rockmass. The method provides a quick and objective technique to estimate rockmass quality during diamond drill core logging. All pieces of intact and sound rock greater than 100 mm long are summed and divided by the total length of the core run in accordance with ASTM D6032.

RQD Classification	RQD (%)
Very Poor Quality	0 to 25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Terminology to Describe Rock Weathering

The state of weathering significantly alters the geotechnical behaviour of rocks and rockmasses. Weathering of the rockmass may be classified as shown in the following table.

Term	Description
Fresh	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces.
Slightly Weathered	Discolouration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discoloured by weathering and may be somewhat weaker than its fresh condition.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones
Highly Weathered	More than a half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

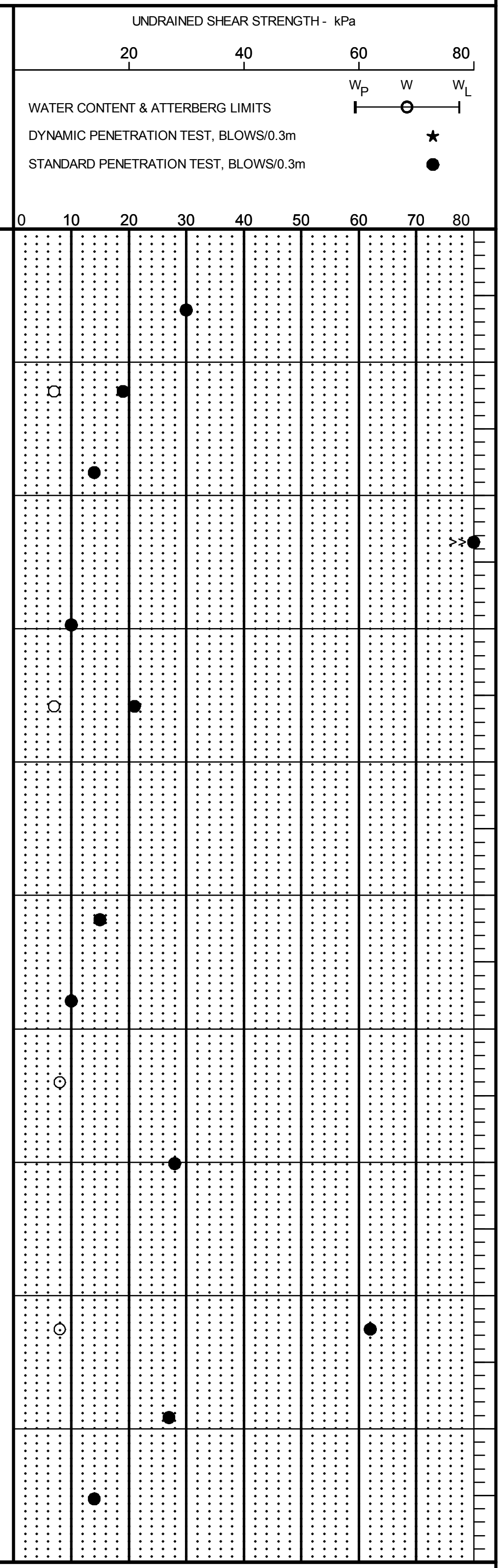
HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 01

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	**PROJECT No.**	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	**DATUM**	CGVD28
DATES: BORING	17/09/2016 TO 20/09/2016 — **WATER LEVEL** 22/09/2016	**BH SIZE**	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm)	BLOWS / 150 mm (N VALUE)	OTHER TESTS
	6.86								
	6.73	ASPHALT							
		FILL: grey gravel with silt and sand to sand with silt and gravel			SS	1	450	17-20-17-13 (30)	
	5.95	FILL: brown to grey sand with silt and gravel - with occasional cobbles and boulders			SS	2	300	12-10-9-10 (19)	S
					SS	3	150	5-8-7-7 (14)	
					SS	4	150	17-17-50 / 125 mm	
					SS	5	0	13-9-4-6 (10)	
					SS	6	75	7-12-12-9 (21)	
					SS	7	200	76-mm Spoon	
					SS	8	75	10-8-7-8 (15)	
					SS	9	75	7-5-5-9 (10)	
6	0.76	Compact to very dense brown to grey SAND with silt and gravel to GRAVEL with silt and sand (Alluvium) - with occasional cobbles and boulders			SS	10	175	76-mm Spoon	S
				▼	SS	11	200	12-15-13-19 (28)	
					SS	12	200	76-mm Spoon	
					SS	13	175	17-37-25-44 (62)	
					SS	14	0	20-28-15-12 (27)	
					SS	15	125	12-11-6-8 (14)	



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BH 01

HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	**PROJECT No.**	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	**DATUM**	CGVD28
DATES: BORING	17/09/2016 TO 20/09/2016 — **WATER LEVEL** 22/09/2016	**BH SIZE**	HW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

(0, 10, 20, 30, 40, 50, 60, 70, 80)

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm)	BLOWS / 150 mm (N VALUE)	OTHER TESTS
		Compact to very dense brown to grey SAND with silt and gravel to GRAVEL with silt and sand (Alluvium) - with occasional cobbles and boulders *(continued)*	SS	16	200	20-14-14-12 (26)	S
			SS	17	150	11-17-19-23 (36)	
11			SS	18	100	37-55-50 / 75 mm	
12		- 450 mm boulder	SS	19	75	20-43-50 / 50 mm	
			SS	20	100	21-15-17-8 (25)	
13			SS	21	250	20-19-20-23 (39)	
14			SS	22	150	12-16-34-27 (50)	
15			SS	23	50	20-28-26-28 (54)	
	-8.58	Compact brown silty SAND	SS	24	300	12-13-13-12 (25)	S
16			SS	25	0	12-15-14-15 (29)	
17	-10.13	Compact to dense brown to grey well graded SAND with silt and gravel to GRAVEL with silt and sand - with occasional cobbles and boulders	SS	26	150	15-19-22-29 (41)	
18			SS	27	0	40-17-18-21 (35)	
			SS	28	300	17-21-15-13 (28)	S
19						22-20-19-	

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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 01

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	17/09/2016 TO 20/09/2016 — WATER LEVEL 22/09/2016	BH SIZE	HW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)
WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm)	BLOWS / 150 mm (N VALUE)	OTHER TESTS
		Compact to dense brown to grey well graded SAND with silt and gravel to GRAVEL with silt and sand - with occasional cobbles and boulders *(continued)*			SS	29	50	18 (37)	
21					SS	30	50	19-43-18-33 (51)	
	-14.55	End of borehole - 25-mm diameter standpipe installed							
22									
23									
24									
25									
26									
27									
28									
29									

0 10 20 30 40 50 60 70 80

HARBOURSIDE Geotechnical Consultants

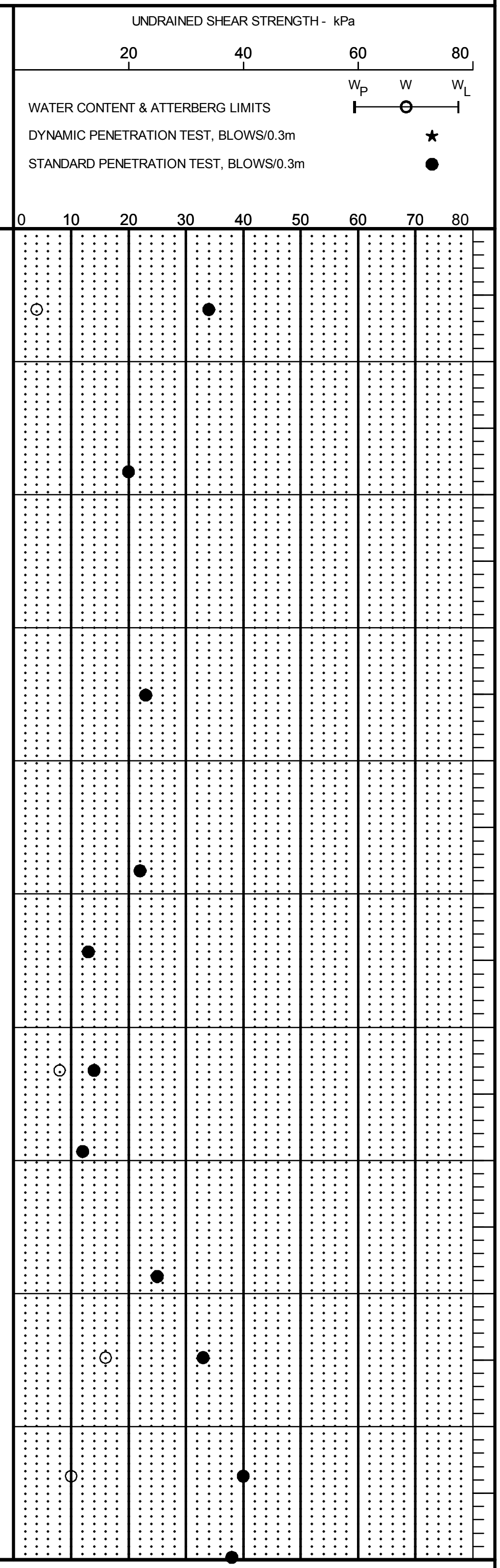
BOREHOLE RECORD

BH 02

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	21/09/2016 TO 22/09/2016 — WATER LEVEL N/A	BH SIZE	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION
0.00	7.70	
	7.57	ASPHALT
		FILL: brownish-grey silty sand with gravel
	6.48	FILL: brown to grey silty sand with gravel - with occasional cobbles and boulders
	0.13	Compact to dense grey to brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders - occasional wood fragments at a depth of 8.5 m

TYPE	NUMBER	REC. SOIL (mm)	BLOWS / 150 mm (N VALUE)	OTHER TESTS
SS	1	350	22-18-16-22 (34)	S
SS	2	175	8-4-16-17 (20)	
SS	3	150	9-15-8-17 (23)	
SS	4	0	7-8-16-6 (22)	
SS	5	50	7-6-7-6 (13)	
SS	6	75	4-6-8-6 (14)	
SS	7	75	27-6-6-7 (12)	
SS	8	0	6-10-15-11 (25)	
SS	9	200	9-11-22-27 (33)	S
SS	10	200	20-32-18-22 (40)	S
			15-26-18-	



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BOREHOLE RECORD

BH 02

CLIENT HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No. 163545
LOCATION ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM CGVD28
DATES: BORING 21/09/2016 TO 22/09/2016 **WATER LEVEL** N/A
BH SIZE HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm)	BLOWS / 150 mm (N VALUE)	OTHER TESTS
		Compact to dense grey to brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders *(continued)*	SS	11	250	20 (38)	
			SS	12	25	34-50 / 25 mm	
11			SS	13	150	8-14-11-12 (23)	
12			SS	14	100	31-20-14-10 (24)	
13							
14			SS	15	75	17-26-60 / 125 mm	
15							
16			SS	16	0	50 / 25 mm	
	-9.06	End of borehole					
17							
18							
19							

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

0 10 20 30 40 50 60 70 80

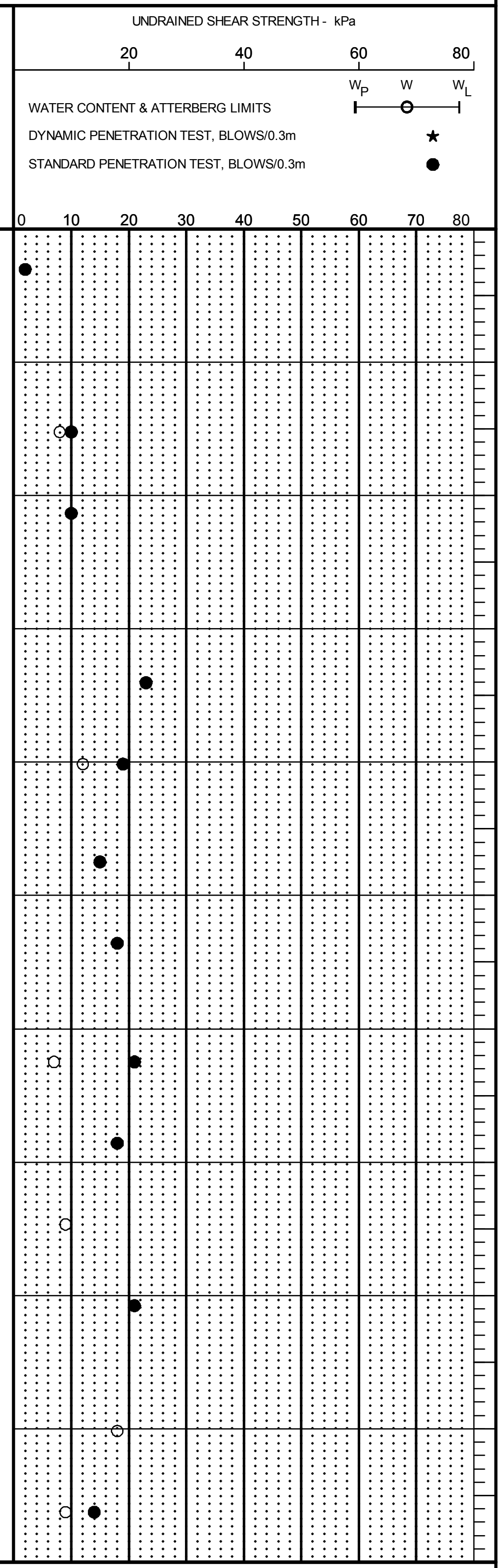
HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 03

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	27/11/2016 TO 28/11/2016 — WATER LEVEL *04/12/2016	BH SIZE	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	2.17	FILL: brown silty sand with gravel (drill access pad) - with frequent grubbings			SS	1	50	1-1-1-2 (2)	
1	0.95	Compact grey to brown GRAVEL with silt and sand (Alluvium)			SS	2	175	9-6-5-5 (10)	
2					SS	3	50	6-7-4-6 (10)	
3	-0.88	- 325 mm boulder Compact brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium)			SS	4	175	10-15-11-12 (23)	
4					SS	5	200	14-12-9-10 (19)	S
					SS	6	50	5-5-10-6 (15)	
5					SS	7	100	6-6-12-14 (18)	
6	-3.62	Compact brown to grey SILTY SAND to GRAVEL with silt and sand (Alluvium)			SS	8	100	8-15-11-10 (21)	
7					SS	9	0	14-14-10-8 (18)	
					SS	10	150	76-mm Spoon	S
8					SS	11	50	9-10-11-12 (21)	
9					SS	12	75	76-mm Spoon	
					SS	13	150	9-9-7-7 (14)	



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BH 03

HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	27/11/2016 TO 28/11/2016 — WATER LEVEL *04/12/2016	BH SIZE	HW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

(0 10 20 30 40 50 60 70 80)

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	-8.24	Compact brown to grey SILTY SAND to GRAVEL with silt and sand (Alluvium) *(continued)*					
		Dense brown to grey GRAVEL with silt and sand - with frequent cobbles and boulders	SS	14	150	16-13-22-21 (35)	
11							
12			SS	15	175	10-7-50 / 125 mm	
13		- 800 mm boulder	SS	16	200	22-26-23-50 / 50 mm	
14		- 425 mm boulder					
15	-13.22		SS	17	200	19-25-33-19 (52)	
		Dense yellowish-brown to light grey SILTY SAND - partially cemented					
16							
17			SS	18	375	21-26-19-25 (44)	S
	-15.81		GB	19	550	N/A	
18		Very poor quality white to light purple QUARTZOSE SANDSTONE - strong to very strong - slightly to moderately weathered	SS	20	150	44-50 / 0 mm	
			HQ	21	100%	0%	
19			HQ	22	100%	0%	

HARBOURSIDE GEOTECHNICAL CONSULTANTS, BOREHOLE RECORD 29/09/17

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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 03

CLIENT HARBOURSIDE ENGINEERING CONSULTANTS **PROJECT No.** 163545
LOCATION ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL **DATUM** CGVD28
DATES: BORING 27/11/2016 TO 28/11/2016 **WATER LEVEL** *04/12/2016 **BH SIZE** HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	-18.33				HQ	23	97%	16%	
21		End of borehole *25-mm diameter standpipe blocked at 2.1 m depth							
22									
23									
24									
25									
26									
27									
28									
29									

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
0 10 20 30 40 50 60 70 80

HARBOURSIDE Geotechnical Consultants

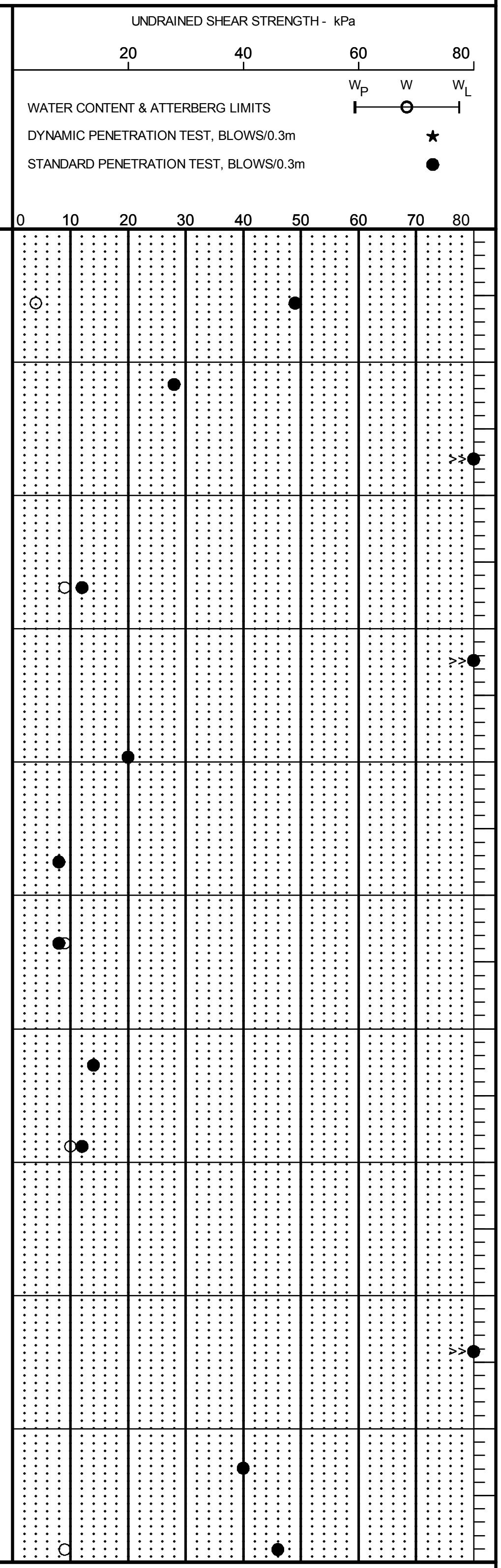
BOREHOLE RECORD

BH 04

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	28/11/2016 TO 30/11/2016	BH SIZE	HW/NW
WATER LEVEL	*04/12/2016		

ELEVATION (m)	SOIL/BEDROCK DESCRIPTION
7.61	
7.46	ASPHALT
	FILL: greyish-brown sand with silt and gravel
6.11	FILL: brown sand with silt and gravel - with frequent cobbles and boulders - 350 mm boulder
4.59	FILL: grey gravel with sand - with occasional wood fragments
4.03	FILL: brown gravel with silt and sand to sand with silt and gravel - with frequent cobbles and boulders
-0.77	ROOTMAT/TOPSOIL (Loose to compact brown to black silty sand with some organic material, roots, and rootlets)
-1.02	Compact to dense grey to brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders

TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
SS	1	300	23-31-22-27 (49)	S
SS	2	175	25-47-16-12 (28)	
SS	3	200	23-33-50 / 100 mm	
SS	4	200	11-13-5-7 (12)	
SS	5	75	7-8-50 / 75 mm	
SS	6	75	6-8-14-6 (20)	
SS	7	25	8-6-4-4 (8)	
SS	8	75	5-4-4-4 (8)	
SS	9	50	4-4-10-8 (14)	
SS	10	100	5-5-7-8 (12)	
SS	11	25	76-mm Spoon	
SS	12	100	12-13-38-50 / 75 mm	
SS	13	63	23-20-21-19 (40)	
SS	14	350	13-37-24-22	S



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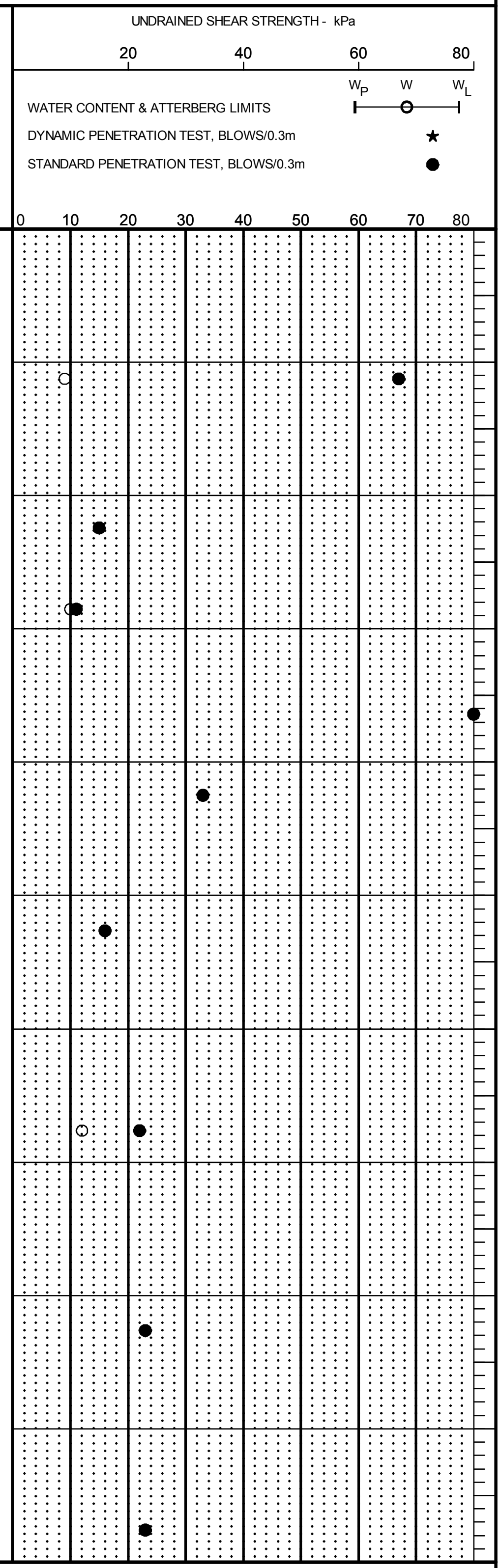
BOREHOLE RECORD

BH 04

HARBOURSIDE Geotechnical Consultants

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS			PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL			DATUM	CGVD28
DATES: BORING	28/11/2016 TO 30/11/2016	WATER LEVEL	*04/12/2016	BH SIZE	HW/NW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to dense grey to brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders *(continued)*						(46)	
11					SS	15	200	25-32-35-36 (67)	
12					SS	16	25	14-8-7-8 (15)	
					SS	17	100	6-8-5-6 (11)	
13					SS	18	100	42-52-28-52 (80)	
14					SS	19	75	51-26-14-19 (33)	
15					SS	20	75	10-9-8-8 (16)	
16									
					SS	21	75	18-18-10-12 (22)	
17									
18					SS	22	75	22-15-11-12 (23)	
19									
					SS	23	150	7-10-13-10 (23)	



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BOREHOLE RECORD

BH 04

HARBOURSIDE Geotechnical Consultants

CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATES: BORING 28/11/2016 TO 30/11/2016
WATER LEVEL: *04/12/2016
PROJECT No.: 163545
DATUM: CGVD28
BH SIZE: HW/NW

UNDRAINED SHEAR STRENGTH - kPa: 20 40 60 80
WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
0 10 20 30 40 50 60 70 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to dense grey to brown GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders *(continued)*					
21	-13.63	Compact to dense grey GRAVEL with silt and sand to SILTY SAND with gravel - with frequent cobbles and boulders	SS	24	225	7-10-7-7 (14)	
22–23			SS	25	300	24-18-19-14 (33)	S
24		- 250 mm boulder	SS	26	200	34-48-125 / 125 mm	
25–26			SS	27	50	37-47-50 / 25 mm	
28	-21.04	Dense to very dense yellowish-brown SILTY SAND					
29	-21.70	Poor quality pink to light purple QUARTZOSE SANDSTONE - strong - moderately weathered	SS	28	125	50 / 125 mm	
			NQ	29	89%	40%	

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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 04

CLIENT	**HARBOURSIDE ENGINEERING CONSULTANTS**	**PROJECT No.**	**163545**
LOCATION	**ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL**	**DATUM**	**CGVD28**
DATES: BORING	**28/11/2016 TO 30/11/2016** — **WATER LEVEL** ***04/12/2016**	**BH SIZE**	**HW/NW**

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80
WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
0 10 20 30 40 50 60 70 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
31		Poor quality pink to light purple QUARTZOSE SANDSTONE - strong - moderately weathered *(continued)*			NQ	30	100%	30%	Qu
	-23.88	Poor quality CONGLOMERATIC QUARTZOSE SANDSTONE - weak to medium strong - with secondary voids due to dissolution of carbonate minerals							
32	-24.37	End of borehole *25-mm diameter standpipe blocked at 0.5 m depth							
33									
34									
35									
36									
37									
38									
39									

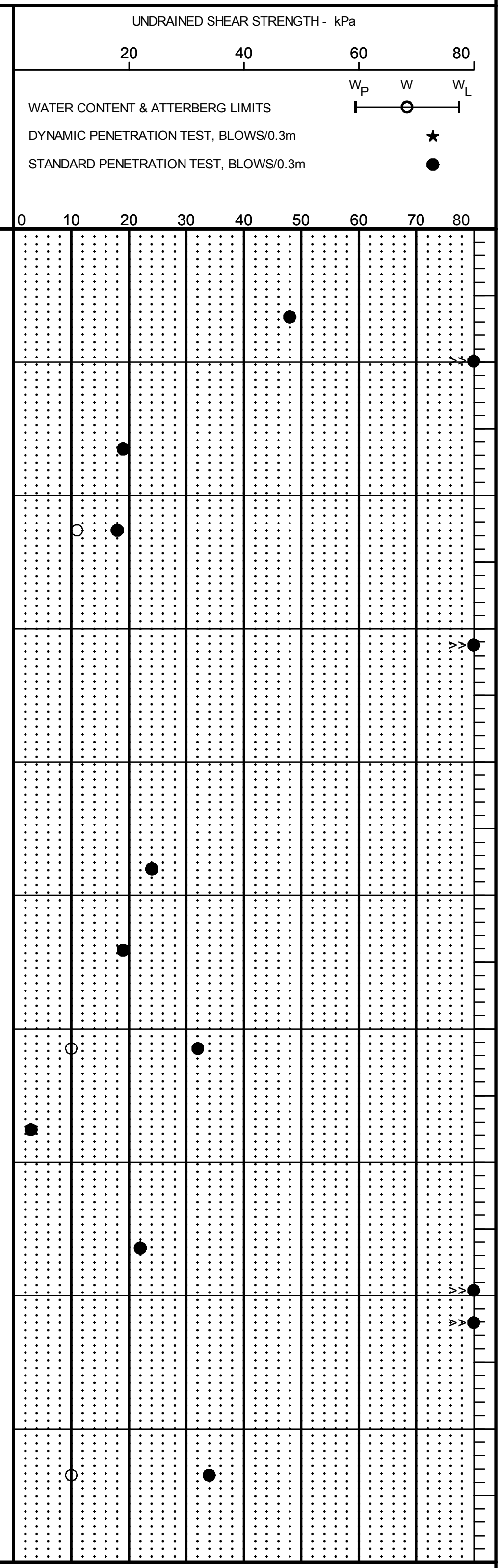
BOREHOLE RECORD

BH 05

HARBOURSIDE Geotechnical Consultants

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	30/11/2016 TO 02/12/2016 — WATER LEVEL 04/12/2016	BH SIZE	HW/NW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	7.53								
	7.35	ASPHALT							
		FILL: dense greyish-brown sand with silt and gravel to silty sand with gravel			SS	A1	300	9-23-25-29 (48)	
1		- 250 mm boulder			SS	A2	50	50 / 50 mm	
	6.16	FILL: brown gravel with silt and sand to sand with silt and gravel - with frequent cobbles and boulders			SS	B1	75	7-7-12-19 (19)	
2					SS	B2	150	9-11-7-12 (18)	S
3					SS	3	125	14-11-17-50 / 100 mm	
4									
5					SS	4	50	7-5-19-10 (24)	
					SS	5	50	6-9-10-11 (19)	
6	1.74	FILL: grey to brown gravel with silt and sand - with frequent cobbles and boulders			SS	6	100	12-36-23-9 (32)	S
					SS	7	0	7-1-2-9 (3)	
7				▼					
					SS	8	0	10-14-8-26 (22)	
8					SS	9	0	50 / 25 mm	
					SS	10	25	50 / 50 mm	
9	-1.10	Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders			SS	11	200	17-22-20-14 (34)	S



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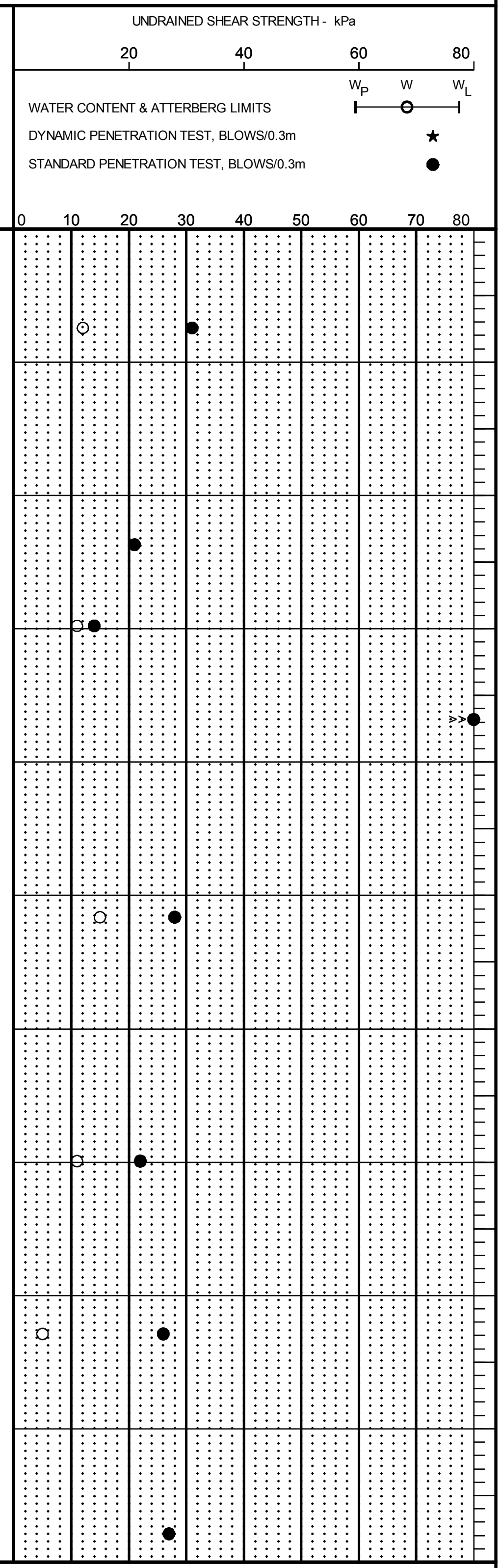
BH 05

HARBOURSIDE
Geotechnical Consultants

BOREHOLE RECORD

CLIENT HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No. 163545
LOCATION ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM CGVD28
DATES: BORING 30/11/2016 TO 02/12/2016
WATER LEVEL 04/12/2016
BH SIZE HW/NW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders *(continued)*					
			SS	12	175	8-16-16-15 (31)	
11							
12			SS	13	125	17-17-11-10 (21)	
13			SS	14	150	6-7-7-9 (14)	
		- 200 mm boulder	SS	15	25	50 / 125 mm	
14	-6.77	Compact brown SILTY SAND with gravel (Alluvium) - with frequent cobbles and boulders - 480 mm boulder					
15		- soft brown clay pocket at 15.3 m depth	SS	16	325	14-15-13-25 (28)	S
16	-8.55	Compact greyish-brown to brown GRAVEL with sand to SAND with silt and gravel (Alluvium) - with occasional cobbles and boulders					
17			SS	17	100	7-10-12-10 (22)	
18			SS	18	125	21-13-13-22 (26)	S
19	-11.37	Compact brown SAND with silt to SILTY SAND (Alluvium) - with occasional gravel - with occasional cobbles and boulders					
			SS	19	0	27-13-14-18	



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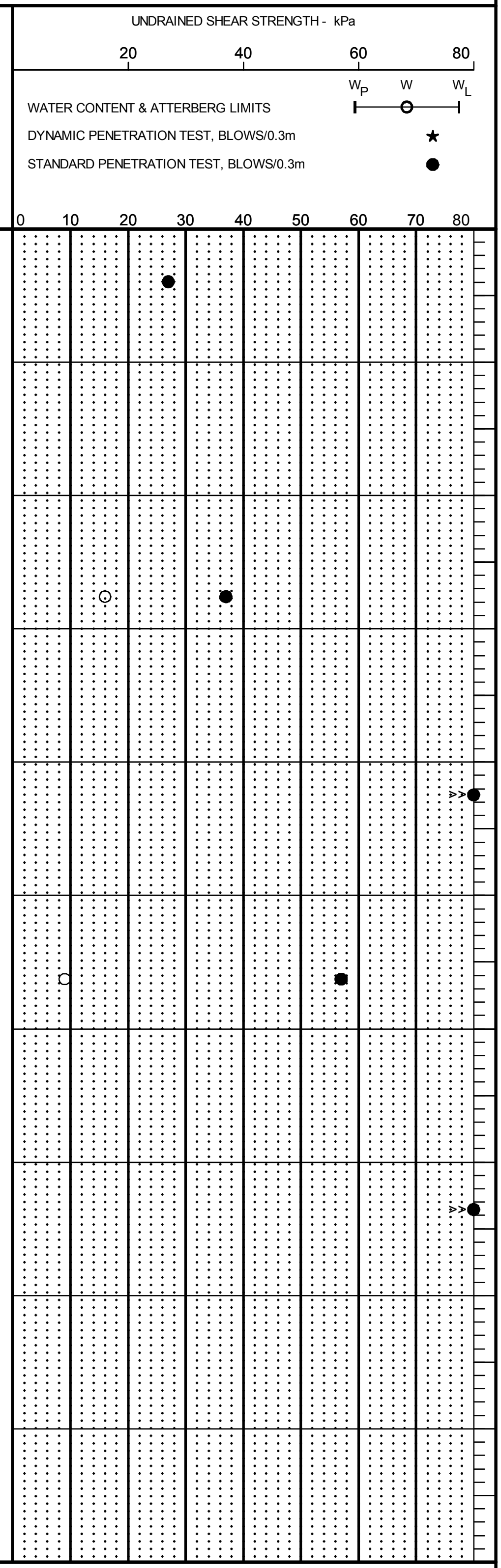
HARBOURSIDE
Geotechnical Consultants

BOREHOLE RECORD

BH 05

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	**PROJECT No.**	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	**DATUM**	CGVD28
DATES: BORING	30/11/2016 TO 02/12/2016 — **WATER LEVEL** 04/12/2016	**BH SIZE**	HW/NW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact brown SAND with silt to SILTY SAND (Alluvium) - with occasional gravel - with occasional cobbles and boulders *(continued)*				(27)	
			SS	20	325	16-17-14-13 (27)	
21							
	-14.05	Dense to very dense greyish-brown to brownish-grey GRAVEL with silt and sand to SAND with silt and gravel - with frequent cobbles and boulders					
22							
			SS	21	350	20-31-19-18 (37)	S
23							
24			SS	22	100	19-37-48-50 / 75 mm	
	-17.39	Very dense grey to greyish-brown SILTY GRAVEL with sand to SILTY SAND with gravel					
25							
			SS	23	125	21-34-26-31 (57)	S
26							
27			SS	24	125	26-52-35-57 (87)	
28							
	-21.46		SS	25	50		
29			NQ	26	85%	22%	



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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 05

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	30/11/2016 TO 02/12/2016 — WATER LEVEL 04/12/2016	BH SIZE	HW/NW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)
WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
(0, 10, 20, 30, 40, 50, 60, 70, 80)

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
31		Very poor to very good quality quality light purple to light brown QUARTZOSE SANDSTONE - slightly to moderately weathered - weak to medium strong - occasional secondary voids due to dissolution of minerals - staining on fractures *(continued)*			NQ	27	100%	34%	Qu
32		- strong to very strong below 32.0 m depth			NQ	28	100%	88%	
33	-25.54	Poor quality light purple to pink QUARTZOSE SANDSTONE - slightly to moderately weathered - medium strong - staining on fractures			NQ	29	100%	25%	
34		- clay seam at 34.3 m depth							
35					NQ	30	100%	30%	
36	-28.54	End of borehole - 25-mm diameter standpipe installed							
37									
38									
39									

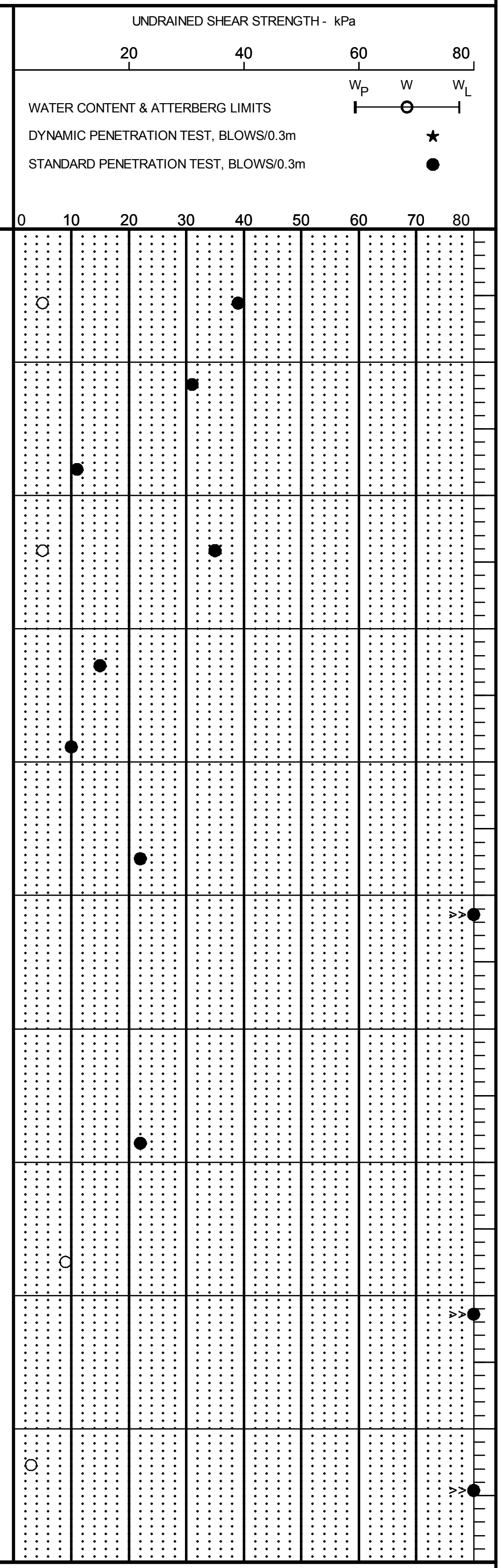
BOREHOLE RECORD

BH 06

HARBOURSIDE Geotechnical Consultants

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS			**PROJECT No.**	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL			**DATUM**	CGVD28
DATES: BORING	25/11/2016 TO 27/11/2016	**WATER LEVEL**	*04/12/2016	**BH SIZE**	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	6.85								
	6.70	ASPHALT							
		FILL: grey gravel with silt and sand			SS	1	300	31-25-22-17 (39)	S
1					SS	2	150	19-13-18-14 (31)	
	5.35	FILL: greyish-brown to brown gravel with silt and sand - with frequent cobbles and boulders			SS	3	150	8-6-5-9 (11)	
2					SS	4	100	17-20-16-19 (35)	
3					SS	5	50	4-7-8-26 (15)	
4					SS	6	0	9-13-6-4 (10)	
					SS	7	25	36-44-11-11 (22)	
5					SS	8	0	26-50 / 75 mm	
6					SS	9	50	76-mm Spoon	
7					SS	10	100	9-10-12-23 (22)	
	-0.62	Compact to very dense brown to grey SAND with silt and gravel to GRAVEL with silt and sand (Alluvium) - with frequent cobbles and boulders			SS	11	200	76-mm Spoon	S
8					SS	12	150	16-50 / 25 mm	
9					SS	13	200	76-mm Spoon	
					SS	14	150	6-10-50 / 75 mm	
		- 450 mm boulder							



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BH 06

HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	25/11/2016 TO 27/11/2016 — WATER LEVEL *04/12/2016	BH SIZE	HW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to very dense brown to grey SAND with silt and gravel to GRAVEL with silt and sand (Alluvium) - with frequent cobbles and boulders *(continued)*					
			SS	15	175	76-mm Spoon	
11			SS	16	25	12-50 / 50 mm	
12			SS	17	75	15-25-14-15 (29)	
13			SS	18	175	12-14-14-11 (25)	
14			SS	19	25	48-25-29-50 / 75 mm	
			SS	20	0	48-50 / 75 mm	
15			SS	21	150	6-12-13-17 (25)	
16			SS	22	200	13-11-27-1 (28)	S
17			SS	23	100	23-21-15-16 (31)	
	-10.69	Dense to very dense grey GRAVEL with silt and sand to SAND with silt and gravel - with frequent cobbles and boulders					
18			SS	24	75	50 / 75 mm	
19			SS	25	150	25-58-46-50 / 25 mm	
			SS	26	250	35-51-26-22	S

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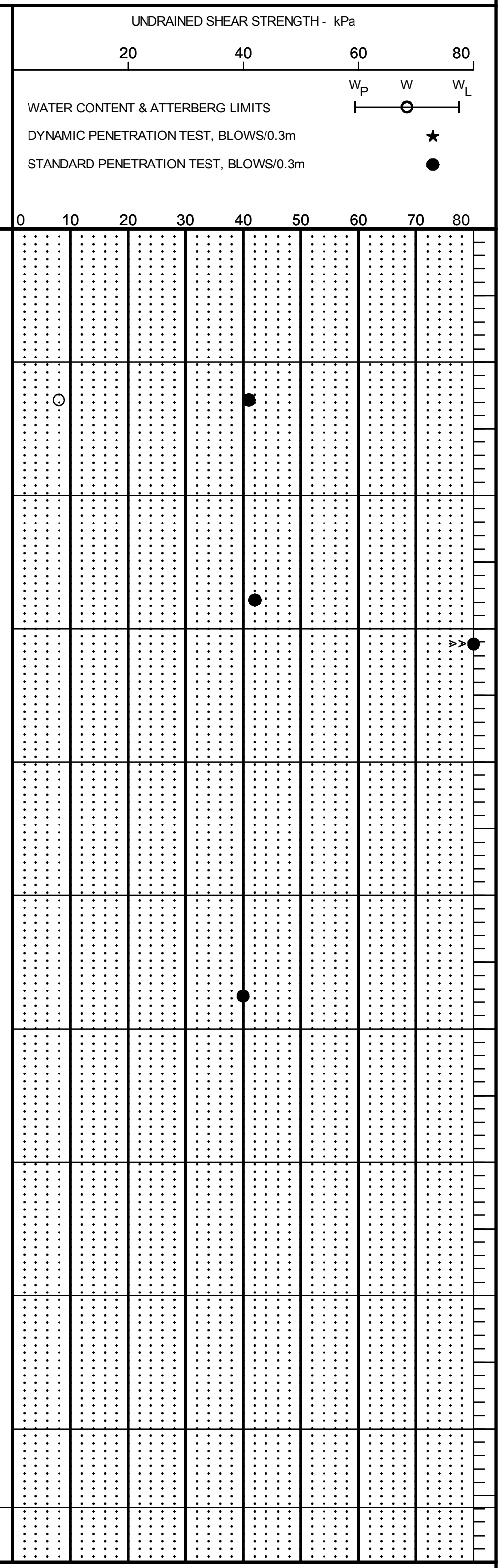
BH 06

HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	25/11/2016 TO 27/11/2016 — WATER LEVEL *04/12/2016	BH SIZE	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Dense to very dense grey GRAVEL with silt and sand to SAND with silt and gravel - with frequent cobbles and boulders *(continued)*						(48)	
21					SS	27	175	23-23-18-47 (41)	
22					SS	28	25	17-18-24-24 (42)	
23					SS	29	25	50 / 50 mm	
					HQ	30	450	N/A	
24					HQ	31	275	N/A	
25		- 675 mm boulder			HQ	32	525	N/A	
					HQ	33	75	N/A	
26					SS	34	50	18-66-22-18 (40)	
	-19.69	Very poor to fair quality purple to purplish-grey QUARTZOSE SANDSTONE - medium strong to strong - moderately weathered - with staining on fractures			HQ	35	59%	0%	
27					HQ	36	60%	50%	
					HQ	37	100%	45%	
					HQ	38	100%	57%	
					HQ	39	87%	0%	
28					HQ	40	95%	61%	
29		- slightly weathered below 28.3 m depth - clay seam at 28.4 m depth - strong to very strong below 28.5m depth			HQ	41	100%	62%	Qu
	-22.74								



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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 06

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	25/11/2016 TO 27/11/2016 — WATER LEVEL *04/12/2016	BH SIZE	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80); WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L); DYNAMIC PENETRATION TEST, BLOWS/0.3m ★; STANDARD PENETRATION TEST, BLOWS/0.3m ● (0 10 20 30 40 50 60 70 80)
		End of borehole *25-mm diameter standpipe blocked at 6.0 m depth								
31										
32										
33										
34										
35										
36										
37										
38										
39										

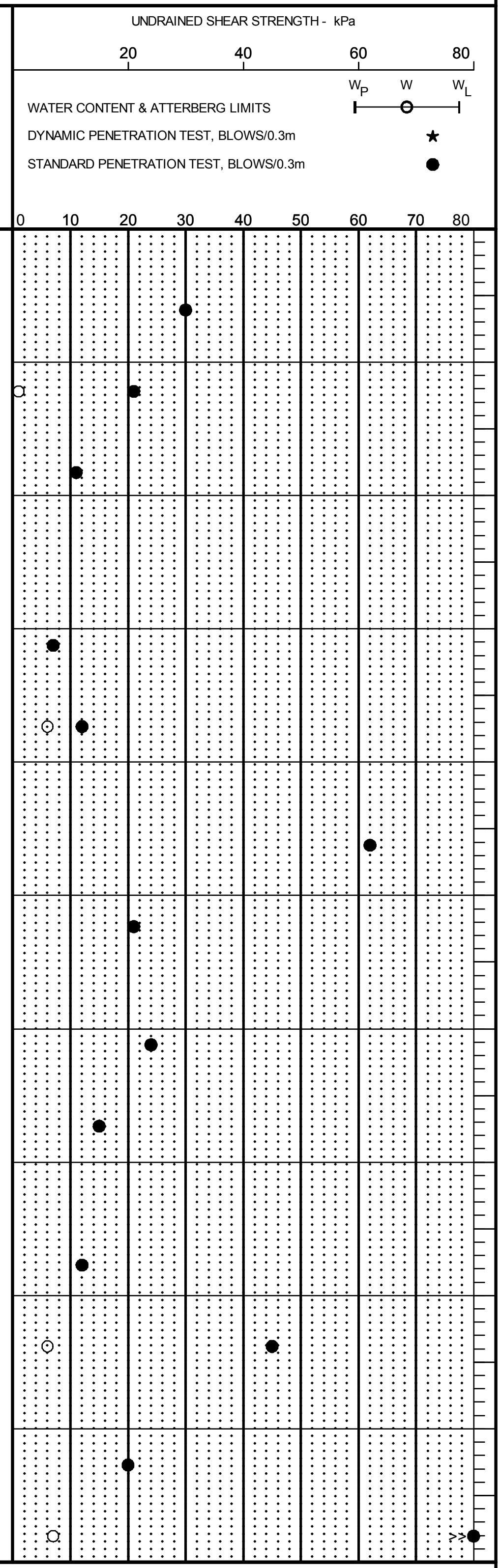
HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 07

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	**PROJECT No.**	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	**DATUM**	CGVD28
DATES: BORING	02/12/2016 TO 05/12/2016 — **WATER LEVEL** N/A	**BH SIZE**	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
	6.88								
	6.73	ASPHALT							
		FILL: grey gravel with silt and sand			SS	1	200	14-33-16-14 (30)	
1					SS	2	100	20-11-10-12 (21)	
					SS	3	300	11-6-5-6 (11)	
2	4.90	FILL: brown to grey gravel with silt and sand - with frequent cobbles and boulders							
3					SS	4	25	4-3-4-3 (7)	
					SS	5	125	3-6-6-6 (12)	
4					SS	6	100	9-45-25-37 (62)	
5					SS	7	0	19-19-14-7 (21)	
6					SS	8	0	11-11-15-9 (24)	
					SS	9	50	6-4-11-9 (15)	
7					SS	10	50	5-6-6-16 (12)	
8	-1.20	Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders			SS	11	300	27-29-23-22 (45)	S
9					SS	12	50	14-16-11-9 (20)	
					SS	13	175	6-12-51-50 / 0 mm	



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HARBOURSIDE Geotechnical Consultants

BOREHOLE RECORD

BH 07

CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No.: 163545
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM: CGVD28
DATES: BORING 02/12/2016 TO 05/12/2016
WATER LEVEL: N/A
BH SIZE: HW

UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80)
WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
(0, 10, 20, 30, 40, 50, 60, 70, 80)

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel (Alluvium) - with frequent cobbles and boulders *(continued)*	SS	14	0	14-27-50 / 75 mm	
11		- 350 mm boulder					
12			SS	15	50	43-50 / 0 mm	
			SS	16	0	50 / 25 mm	
13			SS	17	0	12-9-8-4 (12)	
14			SS	18	75	8-11-20-18 (31)	
15			SS	19	100	7-9-10-14 (19)	
16							
17			SS	20	275	19-15-18-16 (33)	
	-10.65	Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel - with occasional cobbles and boulders					
18			SS	21	250	9-15-16-15 (31)	
19			SS	22	300	13-32-10-12 (22)	
			SS	23	175	12-16-21-18	

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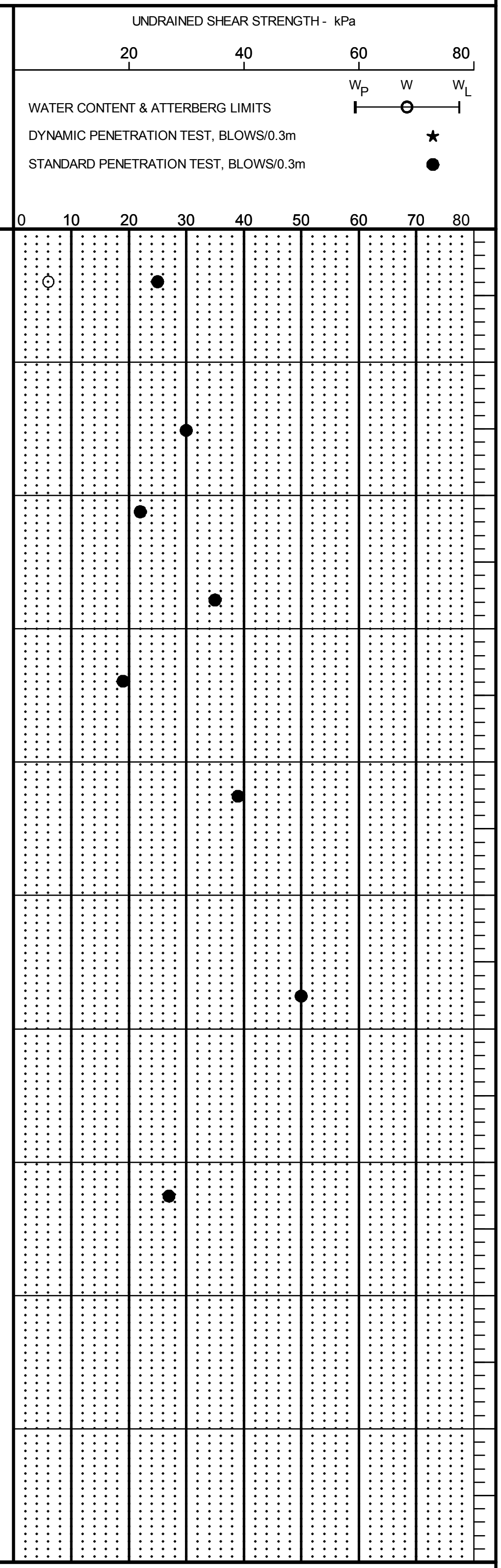
BOREHOLE RECORD

BH 07

HARBOURSIDE Geotechnical Consultants

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: BORING	02/12/2016 TO 05/12/2016 — WATER LEVEL N/A	BH SIZE	HW

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Compact to dense brown to grey GRAVEL with silt and sand to SAND with silt and gravel - with occasional cobbles and boulders *(continued)*				(37)	
			SS	24	375	15-12-13-15 (25)	S
21							
			SS	25	125	14-16-15-15 (30)	
22			SS	26	25	12-10-12-11 (22)	
			SS	27	50	12-17-18-20 (35)	
23			SS	28	25	16-16-11-8 (19)	
	-16.92	Compact to very dense grey SILTY SAND with gravel - with occasional cobbles and boulders					
24			SS	29	175	19-20-19-21 (39)	
25							
			SS	30	175	17-29-21-47 (50)	S
26							
27			SS	31	150	16-16-16-11 (27)	
	-20.80	Very poor quality purple QUARTZOSE SANDSTONE - slightly to moderately weathered - medium strong to strong - staining on fractures					
28							
			HQ	32	99%	46%	
29			HQ	33	82%	0%	
			HQ	34	60%	0%	
			HQ	35	67%	0%	
	-22.99		HQ	36	62%	0%	



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BOREHOLE RECORD

BH 07

HARBOURSIDE Geotechnical Consultants

CLIENT HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No. 163545
LOCATION ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM CGVD28
DATES: BORING 02/12/2016 TO 05/12/2016 **WATER LEVEL** N/A
BH SIZE HW

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 0, 10, 20, 30, 40, 50, 60, 70, 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	REC. SOIL (mm) REC. ROCK (%)	BLOWS / 150 mm (N VALUE) RQD %	OTHER TESTS
		Poor to good quality light purple QUARTZOSE SANDSTONE - slighly weathered - strong to very strong - staining on fractures *(continued)*			HQ	37	100%	37%	
31					HQ	38	93%	78%	
32					HQ	39	100%	61%	Qu
33–34	-27.66				HQ	40	100%	48%	
35–39		End of borehole							

TEST PIT RECORD

TP01

HARBOURSIDE Geotechnical Consultants

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: DUG	27/11/2016	WATER LEVEL	*27/11/2016

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 0, 10, 20, 30, 40, 50, 60, 70, 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS
	4.80						
	4.7	ROOTMAT/TOPSOIL					
		FILL: brown gravel with silt and sand - abandoned steel culvert at 0.5 m depth					
	4.0	FILL: greyish-brown gravel with sand - with trace silt - with frequent cobbles and occasional boulders					
2					GB	1	S
	1.1	End of test pit * no water infiltration observed while test pit was open					

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

TEST PIT RECORD

TP02

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CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: DUG	27/11/2016	WATER LEVEL	*27/11/2016

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 0, 10, 20, 30, 40, 50, 60, 70, 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS
	4.20						
	4.1	ROOTMAT/TOPSOIL					
		FILL: greyish-brown gravel with sand - with trace silt and occasional cobbles and boulders					
					GB	1	S
	1.3	End of test pit - practical limit of excavation * no water infiltration observed while test pit was open					

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TEST PIT RECORD

TP03

CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS — PROJECT No. 163545
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL — DATUM: CGVD28
DATES: DUG 27/11/2016 — WATER LEVEL *27/11/2016

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	OTHER TESTS
	5.50				
	5.4	ROOTMAT/TOPSOIL			
	5.3	FILL: brown silty sand - with trace silt			
		FILL: light brown gravel with sand - with trace silt and occasional cobbles and boulders			
2			GB	1	S
	2.3	End of test pit - practical limit of excavation * no water infiltration observed while test pit was open			

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

0 10 20 30 40 50 60 70 80

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Geotechnical Consultants

TEST PIT RECORD

TP04

CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No.: 163545
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM: CGVD28
DATES: DUG 27/11/2016
WATER LEVEL 27/11/2016

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS
	1.80						
	1.6	ROOTMAT/TOPSOIL					
		Compact greyish-brown GRAVEL with silt and sand (Alluvium)		▽ (1.0)			
	-0.5	End of test pit - practical limit of excavation					

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 0 10 20 30 40 50 60 70 80

Depth scale: 1 2 3 4 5 6 7 8 9

TEST PIT RECORD

TP06

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CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No.: 163545
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM: CGVD28
DATES: DUG 28/05/2017
WATER LEVEL 28/05/2017

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 0 10 20 30 40 50 60 70 80

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS
	6.00						
	5.7	ROOTMAT/TOPSOIL					
	3.6	Compact brown GRAVEL with sand - with occasional cobbles and boulders			GB	1	S
	1.4	Loose grey well to poorly-graded GRAVEL with sand - wet		▽	GB	2	S
		End of test pit - practical limit of excavator reach					

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

HARBOURSIDE Geotechnical Consultants

TEST PIT RECORD

TP07

CLIENT HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No. 163545
LOCATION ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM CGVD28
DATES: DUG 28/05/2017
WATER LEVEL 28/05/2017 *

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa (20, 40, 60, 80); WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L); DYNAMIC PENETRATION TEST, BLOWS/0.3m ★; STANDARD PENETRATION TEST, BLOWS/0.3m ● (0 10 20 30 40 50 60 70 80)
	14.20							
	14.0	ROOTMAT/TOPSOIL						
	13.3	Compact to dense grey to brown GRAVEL with silt and sand - with occasional boulders						
1		End of test pit - practical refusal on inferred bedrock *no water infiltration observed while test pit was open						
2								
3								
4								
5								
6								
7								
8								
9								

HARBOURSIDE Geotechnical Consultants

TEST PIT RECORD

TP08

CLIENT	HARBOURSIDE ENGINEERING CONSULTANTS	PROJECT No.	163545
LOCATION	ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL	DATUM	CGVD28
DATES: DUG	28/05/2017	WATER LEVEL	28/05/2017 *

DEPTH (m)	ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	GRAPHIC LOG	WATER LEVEL	TYPE	NUMBER	OTHER TESTS
	17.10						
	16.9	ROOTMAT/TOPSOIL					
		Stiff brown lean CLAY					
1	15.9				GB	1	S
		Compact grey brown silty GRAVEL with sand - with occasional cobbles and boulders					
	15.1				GB	2	S
2		End of test pit - practical refusal on inferred bedrock *no water infiltration observed while test pit was open					

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

0 10 20 30 40 50 60 70 80

Depth scale: 1 2 3 4 5 6 7 8 9

HARBOURSIDE Geotechnical Consultants

TEST PIT RECORD

TP09

CLIENT: HARBOURSIDE ENGINEERING CONSULTANTS
PROJECT No.: 163545
LOCATION: ROCKY BARACHOIS BRIDGE, GROS MORNE NATIONAL PARK, NL
DATUM: CGVD28
DATES: DUG 28/05/2017
WATER LEVEL: 28/05/2017 *

ELEVATION (m)	SOIL/BEDROCK DESCRIPTION	TYPE	NUMBER	OTHER TESTS
23.30				
23.1	ROOTMAT/TOPSOIL			
	Fill: brown sandy lean clay			
22.4	Fill: brown silty gravel with sand - with occasional boulders			
21.5	ROOTMAT/TOPSOIL (very loose brown to black silty sand with some organic material, roots, and rootlets)			
21.2	Loose to compact brown silty GRAVEL with sand - with occational cobbles and boulders	GB	1	
20.3	Stiff brown lean CLAY	GB	2	S
19.0	End of test pit - practical refusal on inferred bedrock *no water infiltration observed while test pit was open			

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

UNDRAINED SHEAR STRENGTH - kPa: 20, 40, 60, 80

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

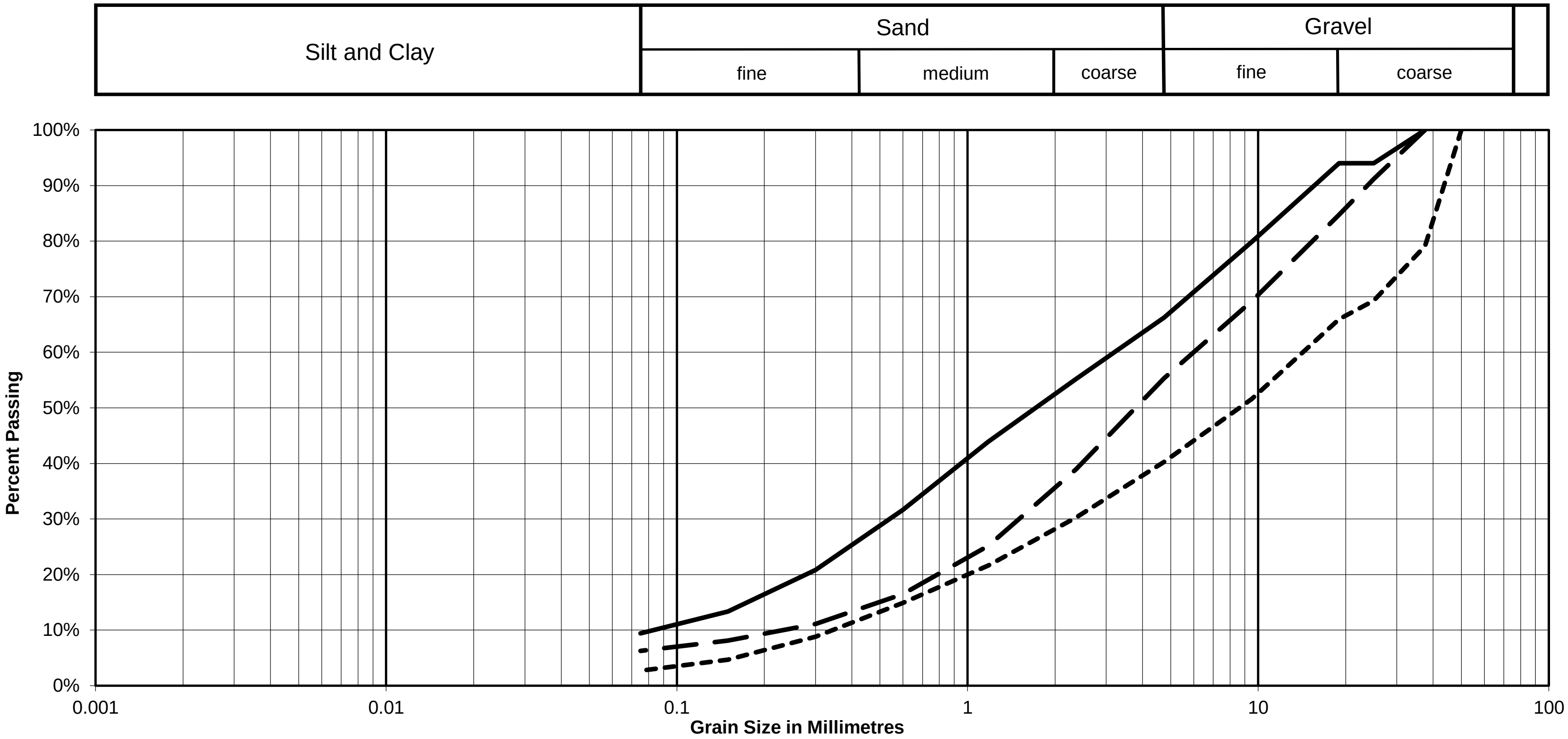
0 10 20 30 40 50 60 70 80

APPENDIX B

Particle-Size Analyses

Checked: VCG

GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH01	SS2	0.91 - 1.52	34%	57%	9%	Well-Graded Sand with Silt and Gravel
— — -	BH01	SS10	6.10 - 6.71	45%	49%	6%	Well-Graded Sand with Silt and Gravel
- - - -	BH01	SS16	9.88 - 10.49	60%	38%	3%	Well-Graded Gravel with Sand

PROJECT No.: 163545

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LOCATION: Rocky Barachois, Gros Morne National Park, NL

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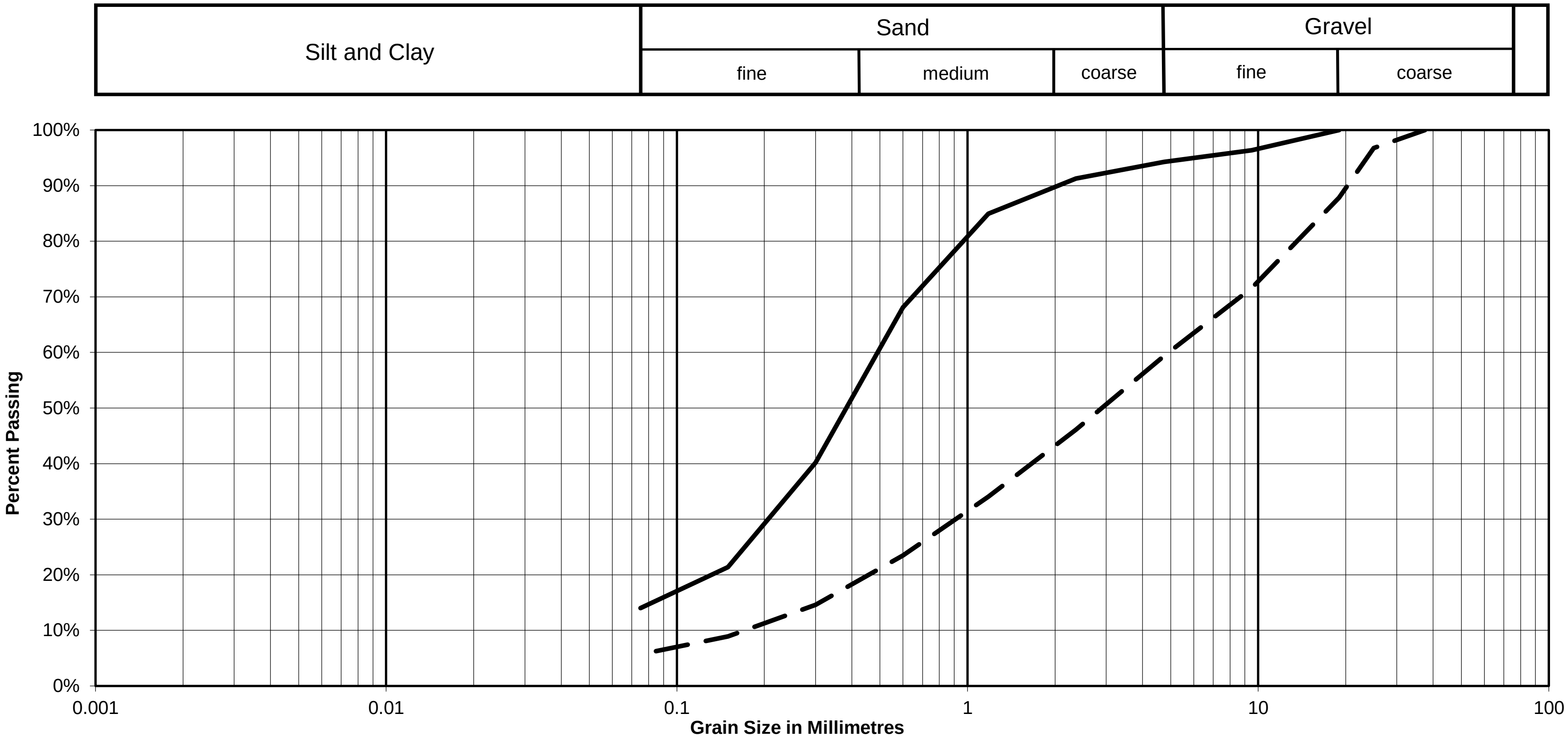
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH01	SS24	15.44 - 16.05	6%	80%	14%	Silty Sand
— — -	BH01	SS28	18.42 - 19.03	41%	54%	6%	Well-Graded Sand with Silt and Gravel

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LOCATION	Rocky Barachois, Gros Morne National Park, NL

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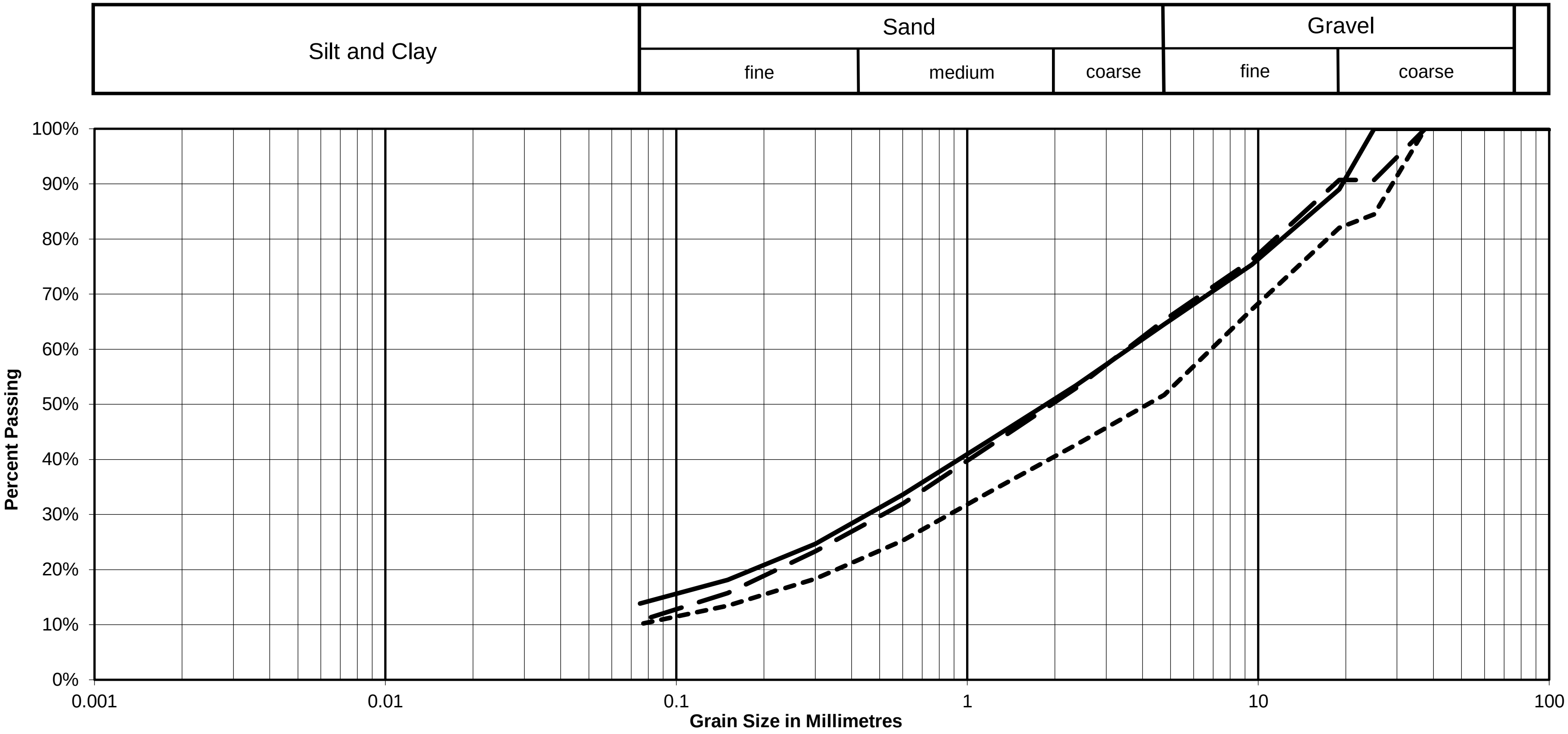
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH02	SS1	0.30 - 0.91	35%	51%	14%	Silty Sand with Gravel
— — -	BH02	SS9	8.18 - 8.79	35%	55%	11%	Well-Graded Sand with Silt and Gravel
- - - -	BH02	SS10	9.07 - 9.68	48%	42%	10%	Well-Graded Gravel with Silt and Sand

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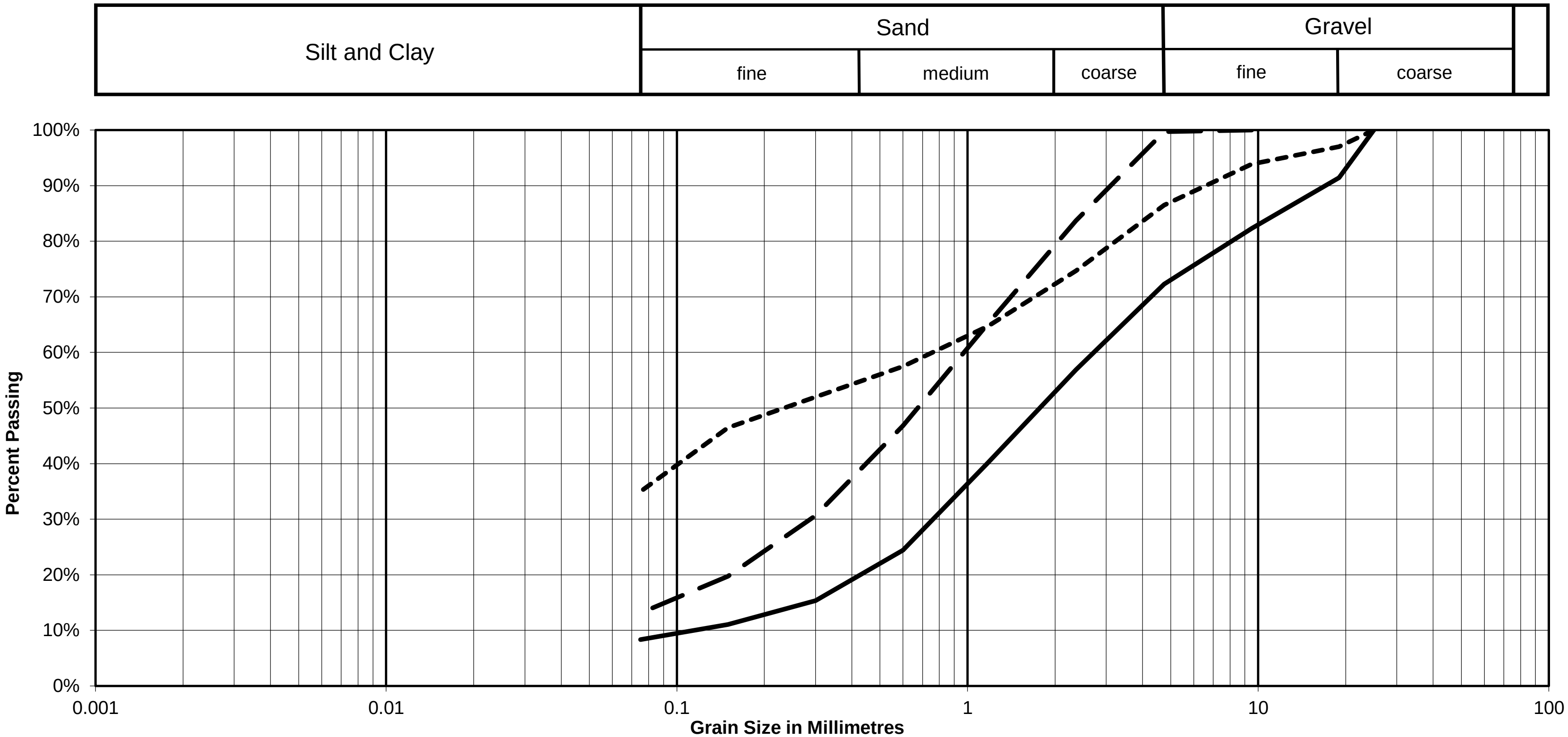
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH03	SS5	3.71 - 4.32	28%	64%	8%	Well-Graded Sand with Silt and Gravel
— — -	BH03	SS10	7.16 - 7.86	0%	87%	13%	Silty Sand
- - - -	BH03	SS18	16.74 - 17.35	13%	52%	35%	Silty Sand

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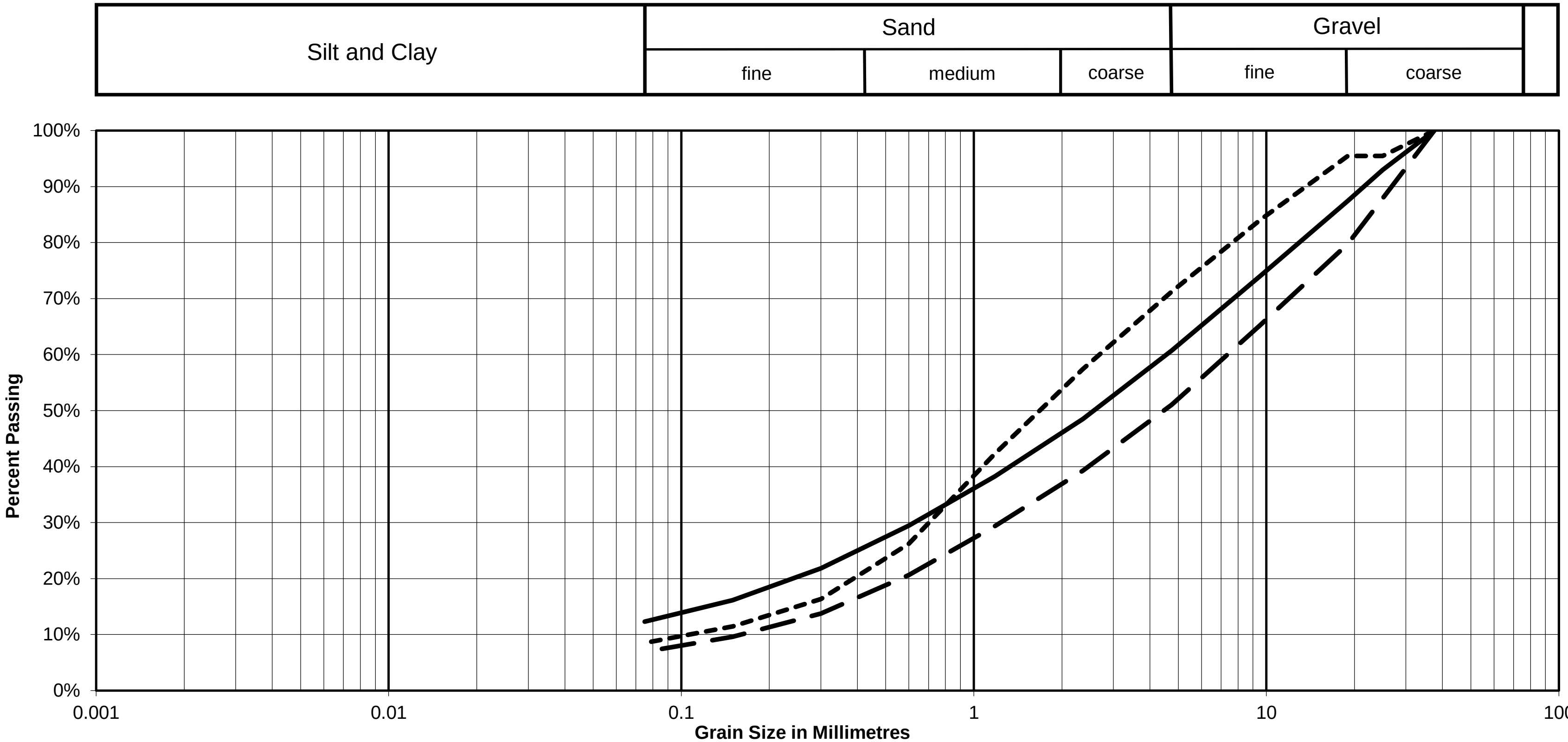
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH04	SS1	0.25 - 0.86	39%	48%	12%	Well-Graded Sand with Silt and Gravel
— — ·	BH04	SS14	9.60 - 10.21	49%	44%	7%	Well-Graded Gravel with Silt and Sand
- - - -	BH04	SS25	27.73 to 23.34	29%	63%	9%	Well-Graded Sand with Silt and Gravel

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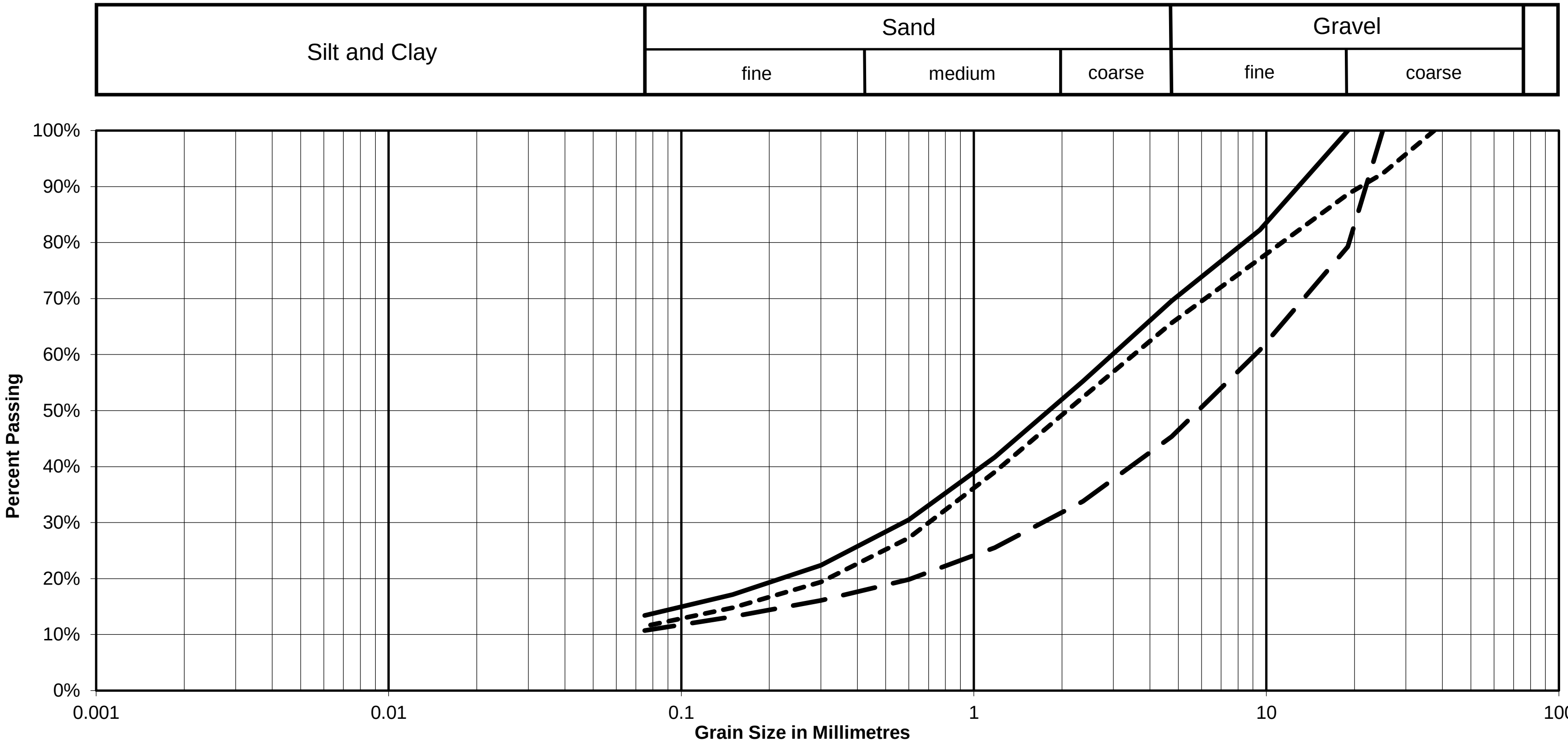

CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
——	BH05	SSB2	1.96 to 2.57	30%	56%	13%	Well-Graded Sand with Silt and Gravel
— — -	BH05	SS6	5.84 to 6.45	55%	35%	11%	Poorly Graded Gravel with Silt and Sand
- - - -	BH05	SS11	9.04 - 9.65	34%	54%	11%	Well-Graded Sand with Silt and Gravel

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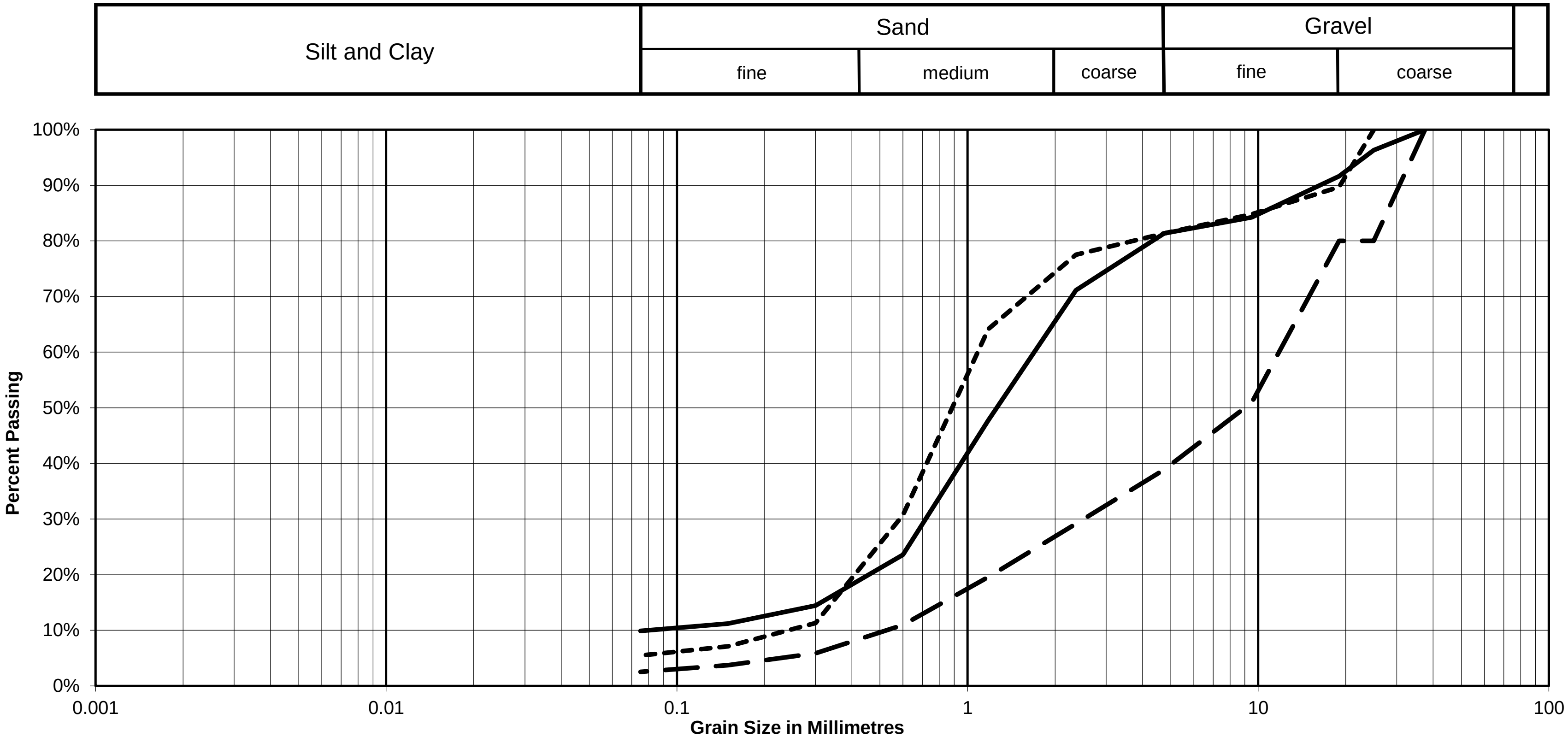

CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH05	SS16	14.86 - 15.47	19%	71%	10%	Well-Graded Sand with Silt and Gravel
— — -	BH05	SS18	17.98 - 18.59	61%	36%	3%	Well-Graded Gravel with Sand
- - - -	BH05	SS21	22.45 - 23.06	19%	76%	5%	Poorly Graded Sand with Silt and Gravel

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LOCATION: Rocky Barachois, Gros Morne National Park, NL

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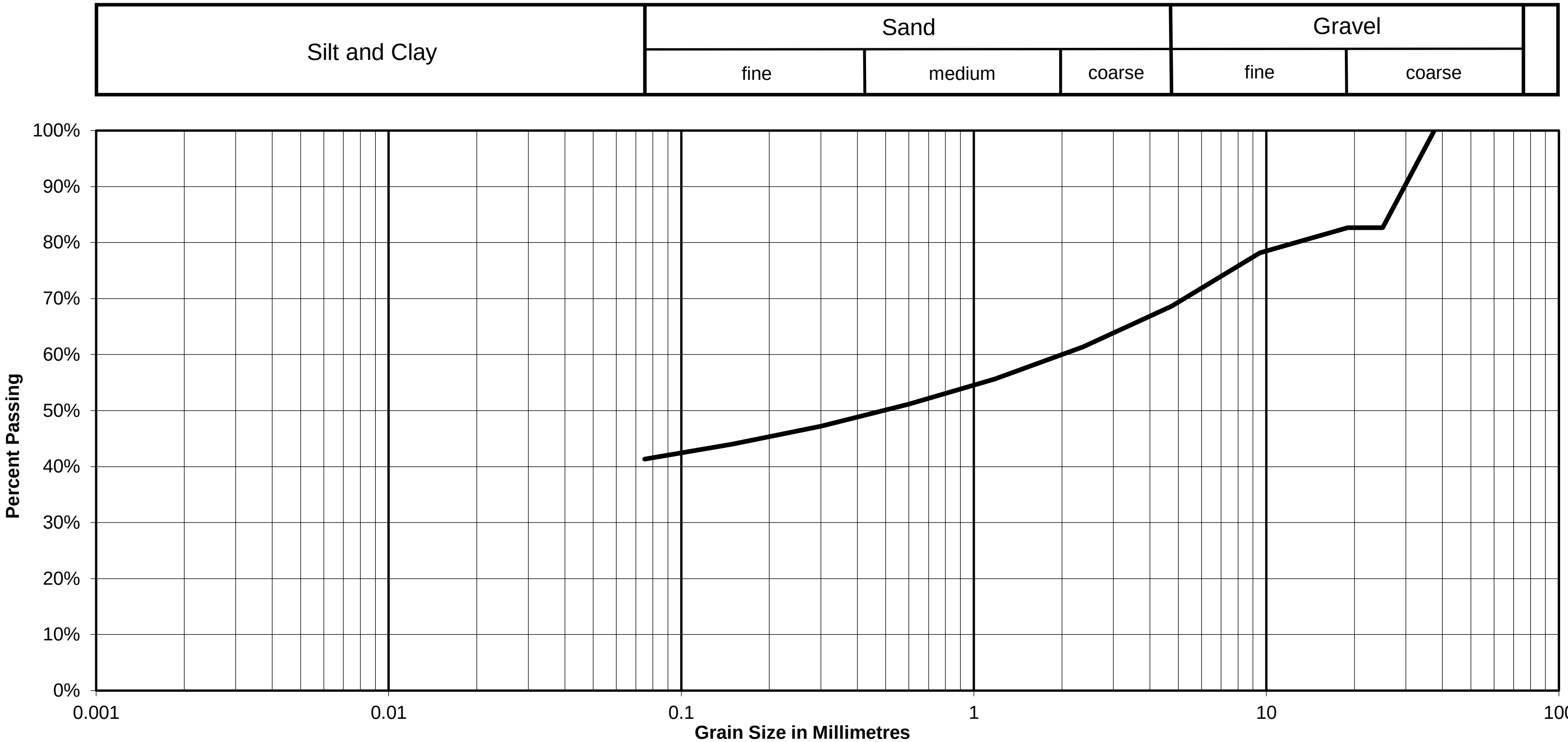
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH05	SS23	25.32 - 25.93	31%	27%	41%	Silty Gravel with Sand

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PROJECT	Rocky Barachois Bridge Replacement
LOCATION	Rocky Barachois, Gros Morne National Park, NL

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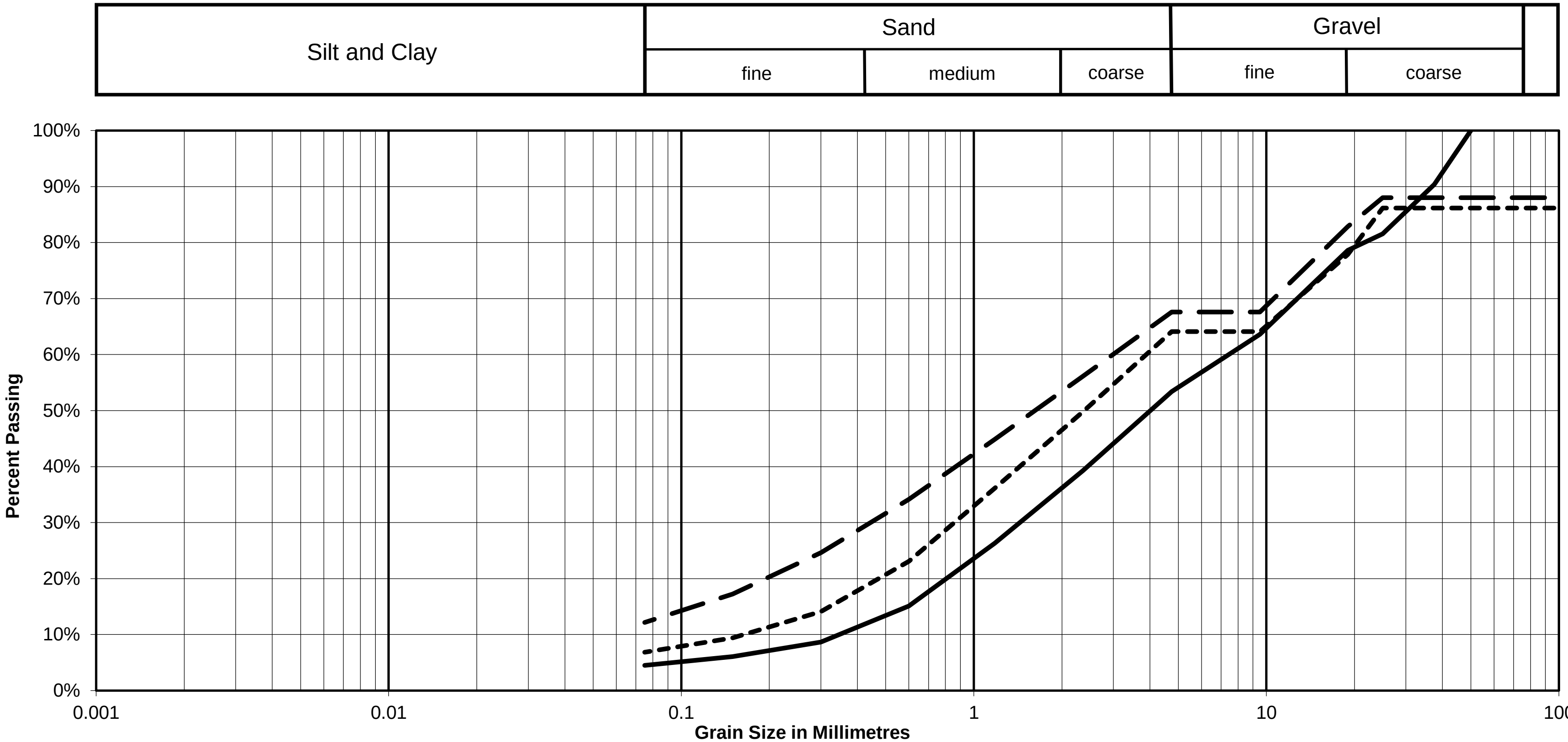
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH06	SS1	0.25 - 0.86	32%	55%	12%	Well-Graded Sand with Silt and Gravel
— — -	BH06	SS11	7.44 - 8.05	47%	49%	5%	Poorly Graded Sand with Silt and Gravel
- - - -	BH06	SS22	15.65 - 16.25	36%	57%	7%	Well-Graded Sand with Silt and Gravel

PROJECT No.: 163545

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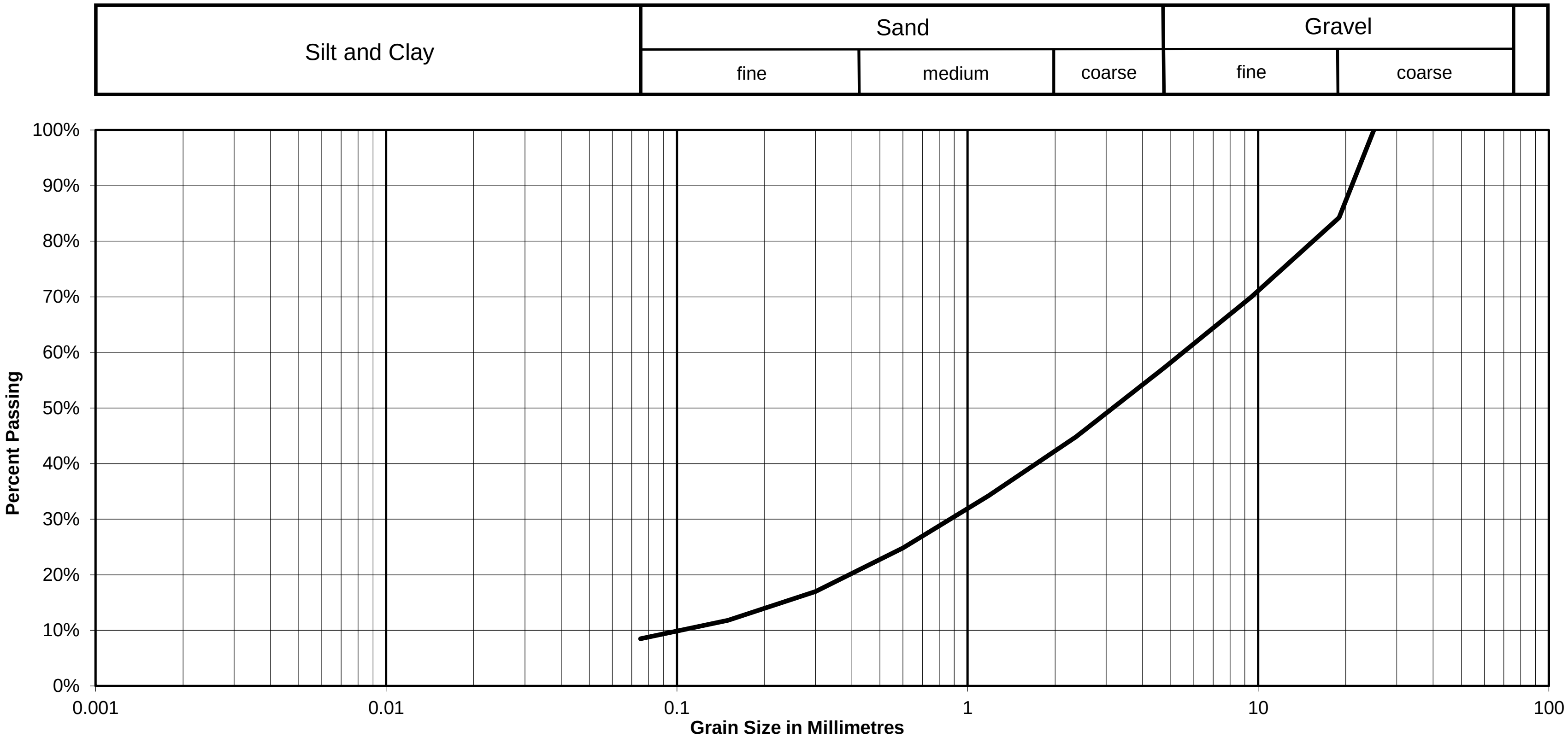
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
——	BH06	SS26	19.48 - 20.09	43%	49%	8%	Well-Graded Sand with Silt and Gravel

PROJECT No.: 163545

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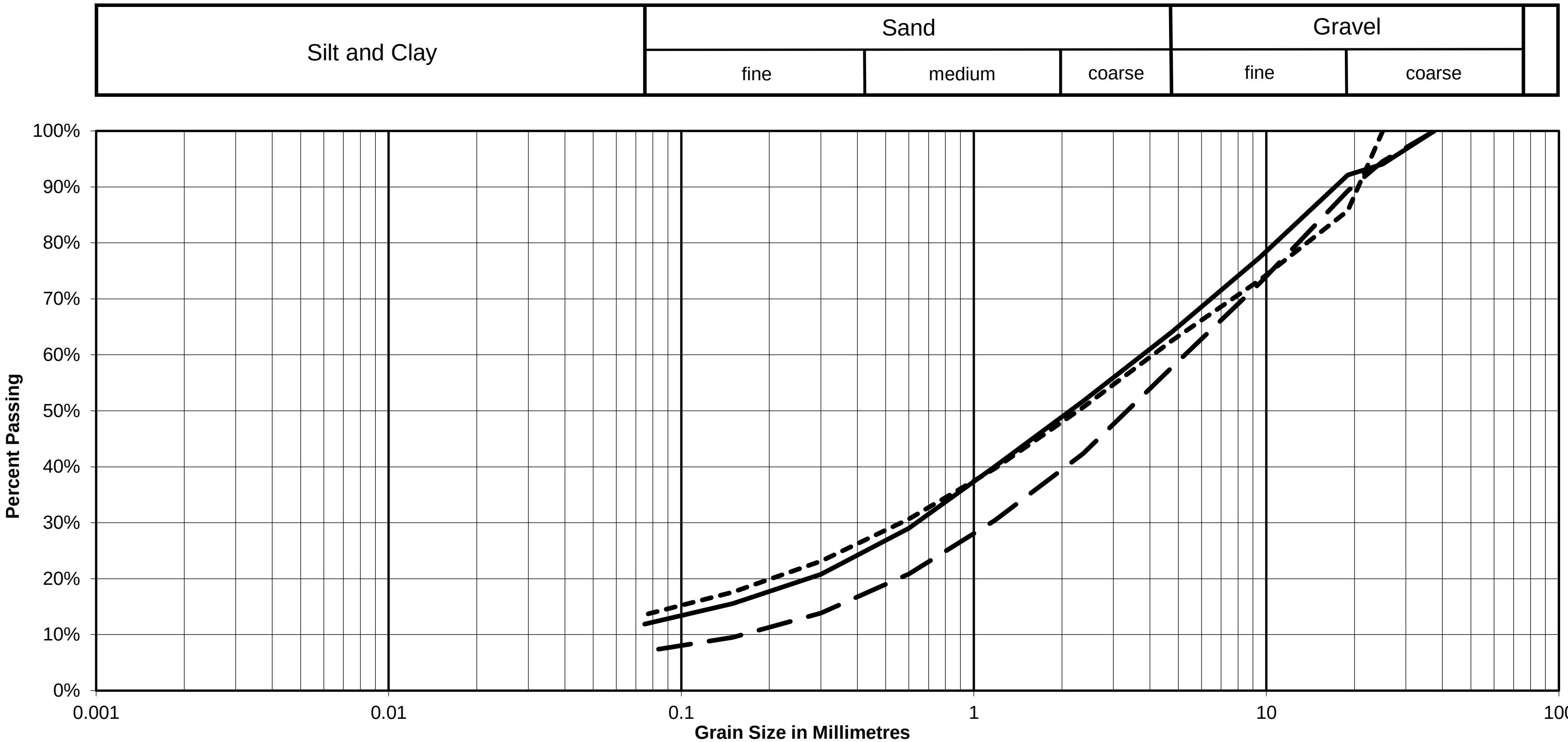
CLIENT	Harbourside Engineering Consultants
PROJECT	Rocky Barachois Bridge Replacement
LOCATION	Rocky Barachois, Gros Morne National Park, NL

Checked: VCG

GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	BH07	SS11	8.08 - 8.69	36%	52%	12%	Well-Graded Sand with Silt and Gravel
— — -	BH07	SS24	20.09 - 20.70	42%	51%	7%	Well-Graded Sand with Silt and Gravel
- - - -	BH07	SS30	25.45 - 26.06	38%	49%	14%	Silty Sand with Gravel

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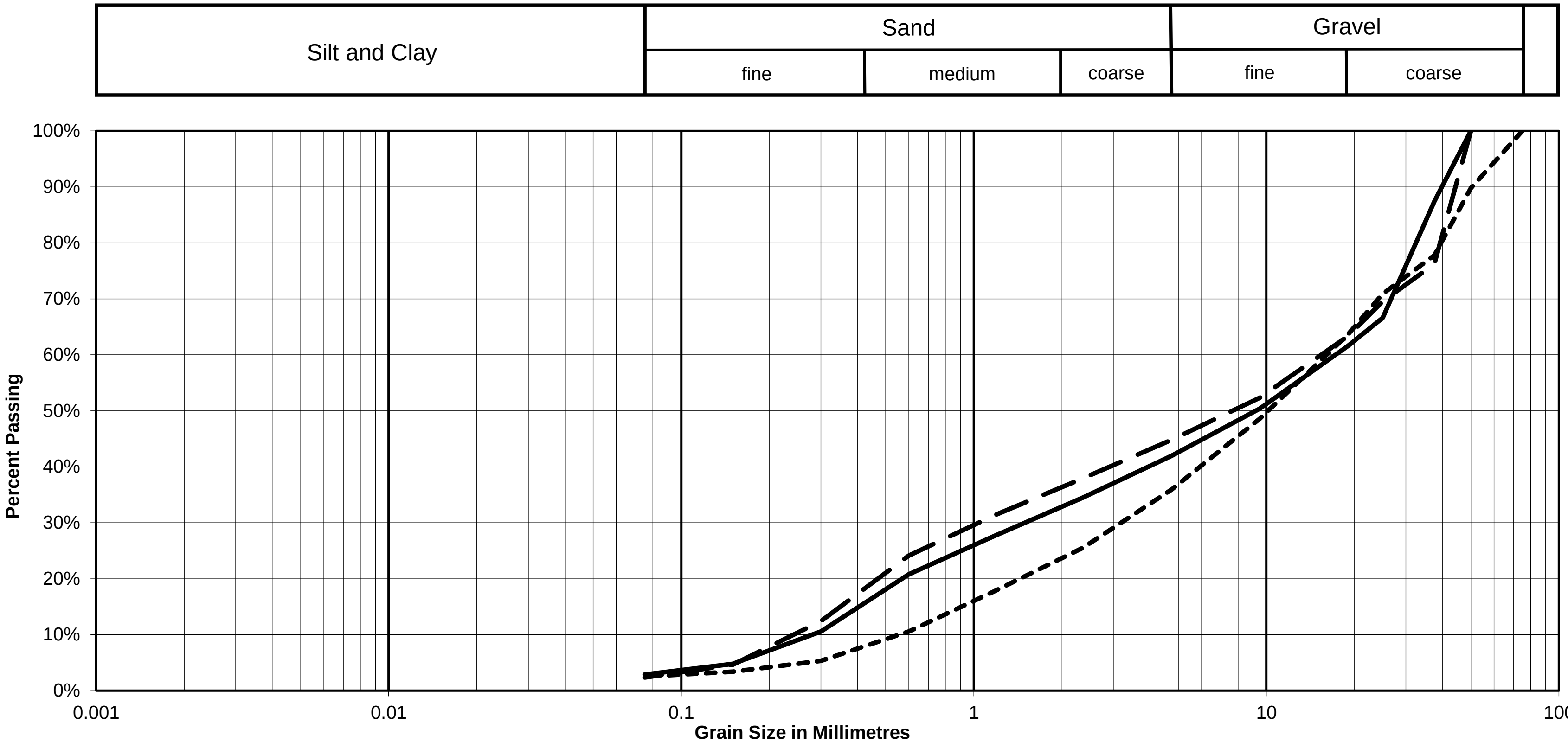
GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	TP01	GB1	1.8 - 2.1	58%	39%	3%	Poorly Graded Gravel with Sand
— — -	TP02	GB1	2.4 - 2.7	55%	42%	2%	Poorly Graded Gravel with Sand
- - - -	TP03	GB1	1.8 - 2.1	64%	33%	3%	Well-Graded Gravel with Sand

PROJECT No.: 163545

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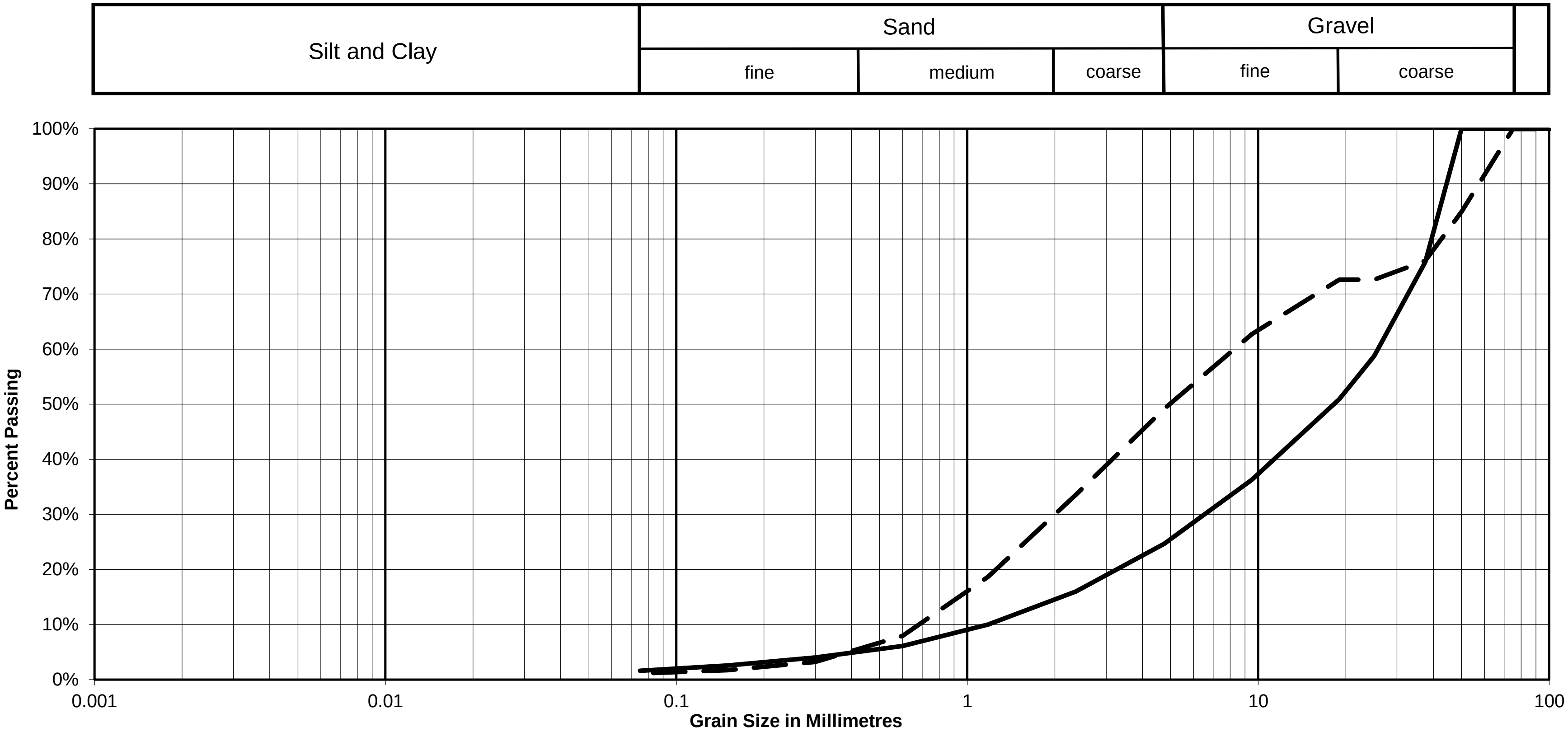
CLIENT	Harbourside Engineering Consultants
PROJECT	Rocky Barachois Bridge Replacement
LOCATION	Rocky Barachois, Gros Morne National Park, NL

Checked: VCG

GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	TP06	GB1	1.22 - 1.52	75%	23%	2%	Well-Graded Gravel with Sand
— — -	TP06	GB2	4.27 - 4.57	51%	48%	1%	Poorly Graded Gravel with Sand

PROJECT No.: 163545

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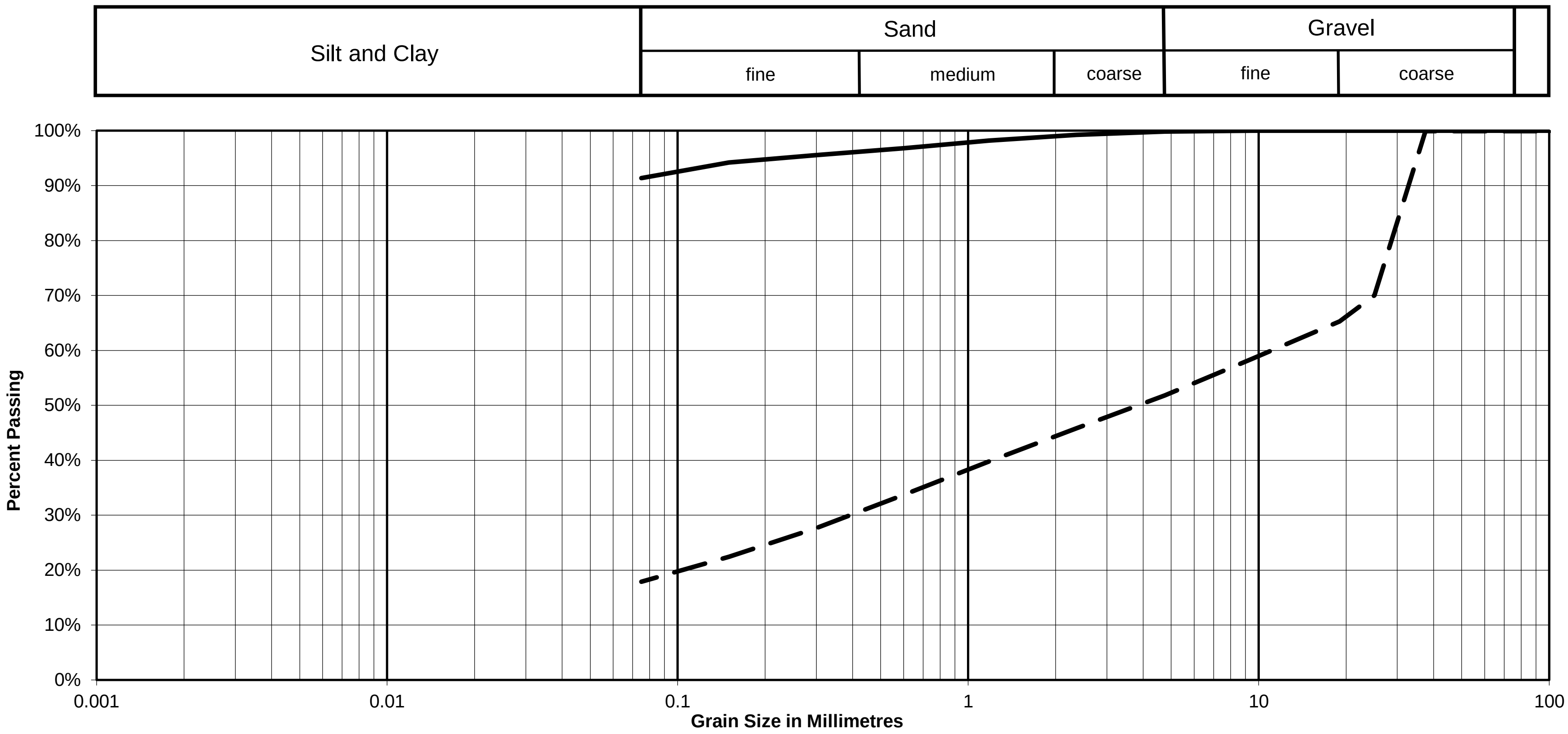
CLIENT Harbourside Engineering Consultants

PROJECT Rocky Barachois Bridge Replacement

LOCATION Rocky Barachois, Gros Morne National Park, NL

Checked: VCG

GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	TP08	GB1	0.91 - 1.22	0%	8%	91%	Lean Clay
— — -	TP08	GB2	1.52 - 1.83	48%	34%	18%	Silty Gravel with Sand

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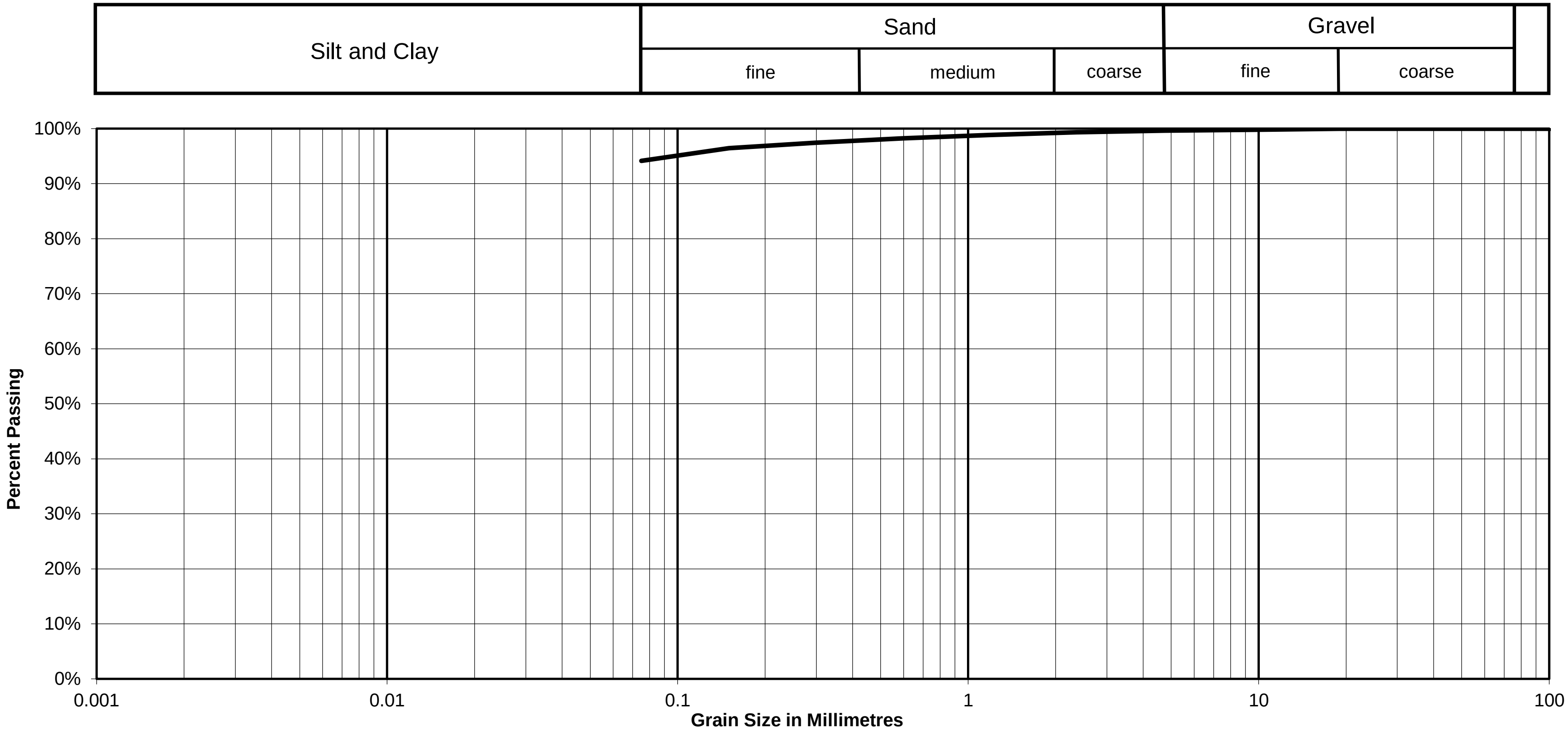
Checked: VCG

GRAIN SIZE DISTRIBUTION



CURVE	BOREHOLE / TESTPIT	SAMPLE	DEPTH (m)	SOIL FRACTION			SOIL DESCRIPITION
				GRAVEL	SAND	SILT/CLAY	
———	TP09	GB2	3.96 - 4.27	0%	6%	94%	Lean Clay

PROJECT No.: 163545

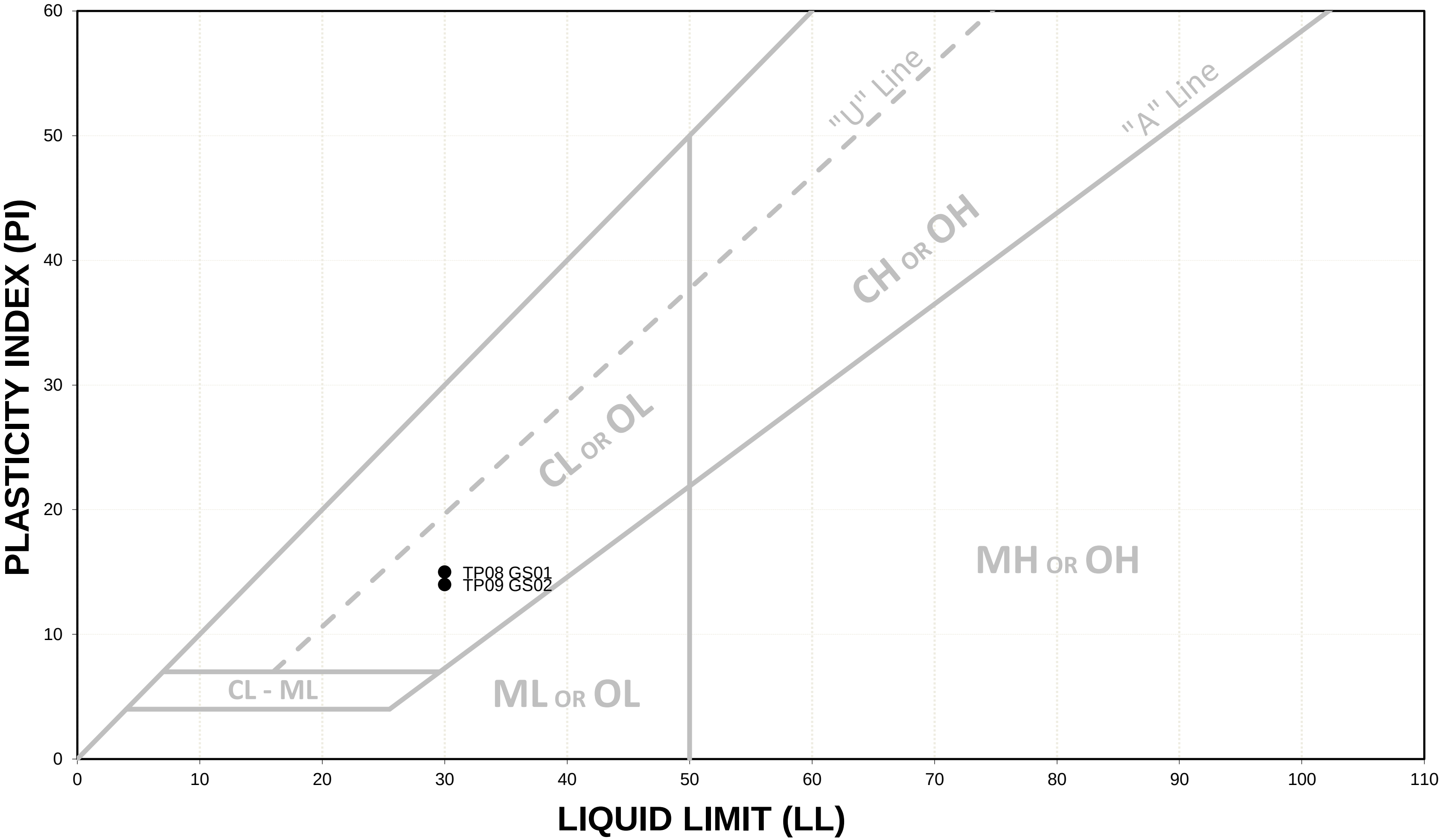
HGC

t: 1.902.405.4696 | f: 1.902.405.4693
219 Waverley Road, Suite 200
Dartmouth, NS B2X 2C3
http://harboursideengineering.ca

CLIENT	Harbourside Engineering Consultants
PROJECT	Rocky Barachois Bridge Replacement
LOCATION	Rocky Barachois, Gros Morne National Park, NL

Checked: VCG

ATTERBERG LIMITS



PROJECT No.:

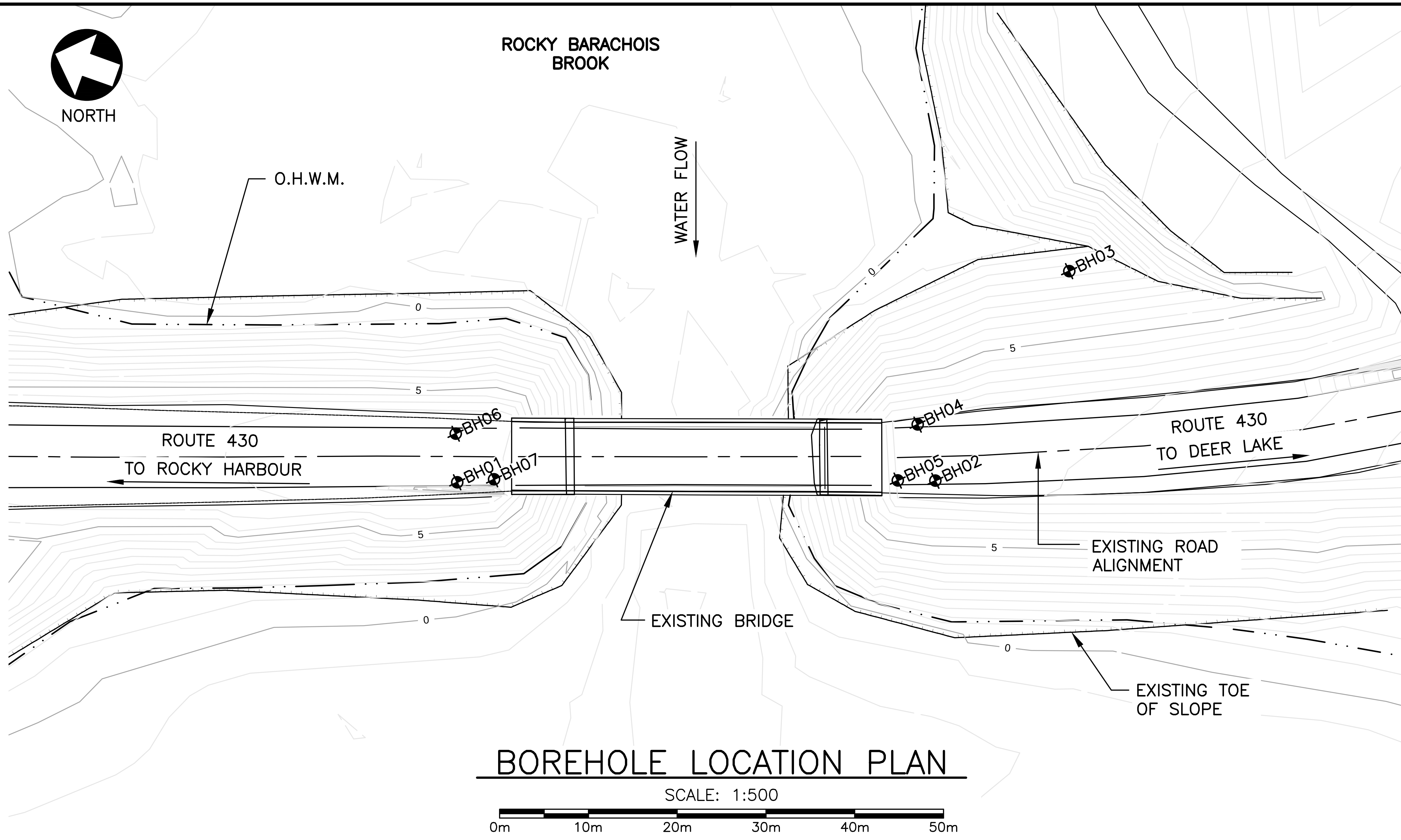
t: 1.902.405.4696 | f: 1.902.405.4693
219 Waverley Road, Suite 200
Dartmouth, NS B2X 2C3
http://harboursideengineering.ca

CLIENT	Harbourside Engineering Consultants
PROJECT	Rocky Barachois Bridge Repacement
LOCATION	Rocky Barachois, Gros Morne National Park, NL

APPENDIX C

Sketch No. G1 – Borehole Location Plan

Sketch No. G2 – Test Pit and Push Probe Location Plan



BOREHOLE LOCATION PLAN

SCALE: 1:500

0m 10m 20m 30m 40m 50m

BOREHOLE COORDINATES			
	NORTHINGS	EASTINGS	ELEVATIONS (m)
BH01	5,480,979.2	446,809.5	6.86
BH02	5,480,928.5	446,827.7	7.70
BH03	5,480,922.2	446,855.0	2.17
BH04	5,480,930.1	446,833.0	7.61
BH05	5,480,932.5	446,826.3	7.53
BH06	5,480,981.2	446,814.6	6.85
BH07	5,480,975.4	446,811.2	6.88

Scale	Date	Drawn	Designed	Checked	Approved	Contract
AS NOTED	JULY 17, 2017	D. LARADE	V. GOREHAM	T. MENZIES	T. MENZIES	163545

HARBOURSIDE Geotechnical Consultants

ROCKY BARACHOIS BRIDGE REPLACEMENT

BOREHOLE LOCATION PLAN

SKETCH No. G1

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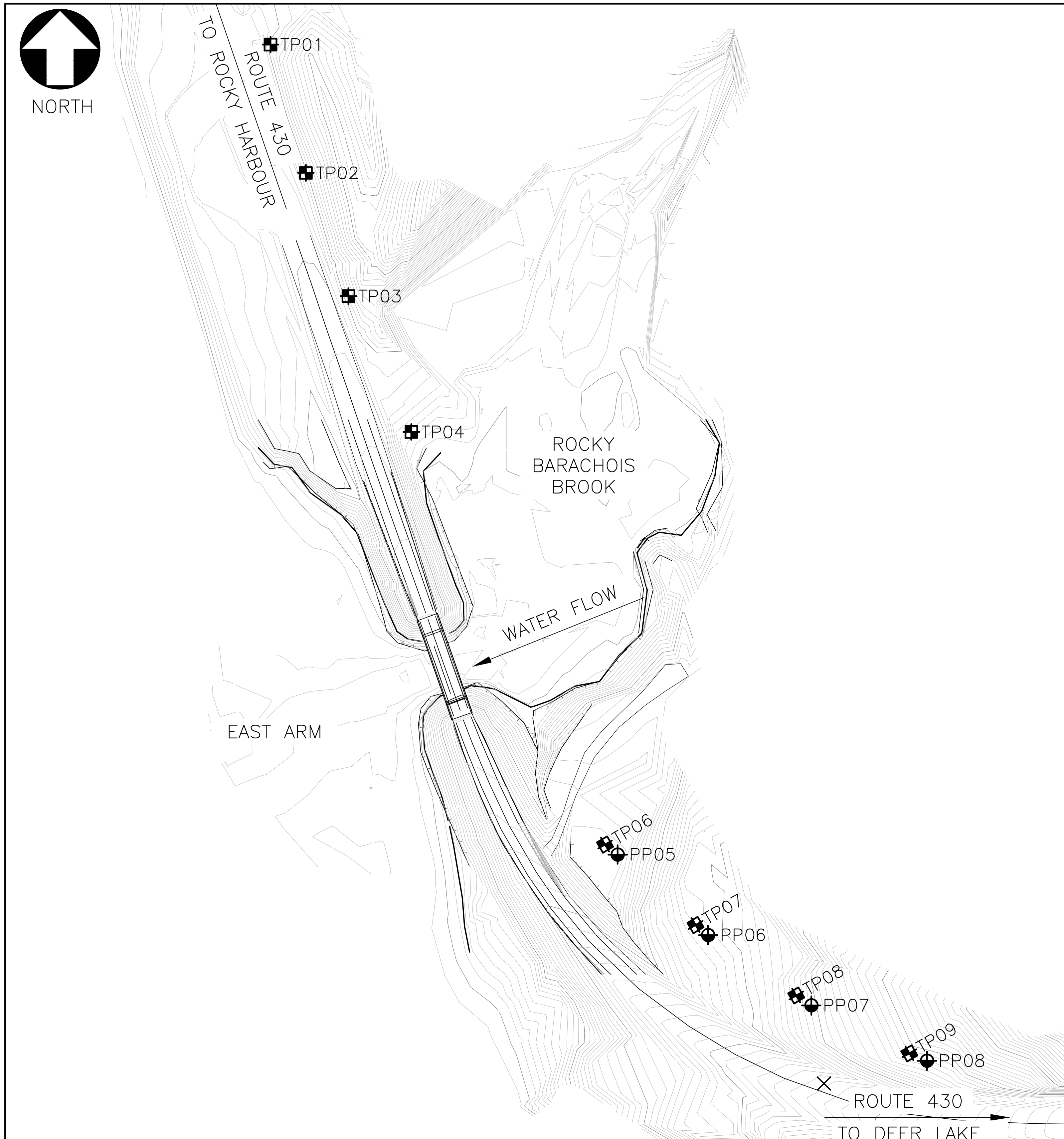

LEGEND:

- TP01 TEST PIT
- PP06 PUSH PROBE
- × BEDROCK OUTCROP

TEST PIT LOCATIONS			
	NORTHINGS	EASTINGS	ELEVATIONS (m)
TP01	5,481,202	446,752	4.8
TP02	5,481,151	446,766	4.2
TP03	5,481,102	446,783	5.5
TP04	5,481,048	446,808	1.8
TP06	5,480,884	446,885	6.0
TP07	5,480,852	446,921	14.2
TP08	5,480,824	446,961	17.1
TP09	5,480,801	447,006	23.3

PUSH PROBE LOCATIONS			
	NORTHINGS	EASTINGS	PROBE DEPTHS (m)
PP05	5,480,880	446,890	0.75
PP06	5,480,848	446,926	0.10
PP07	5,480,820	446,967	0.20
PP08	5,480,798	447,013	0.05

TEST PIT AND PUSH PROBE LOCATION PLAN

SCALE: 1:2000

0m 50m 100m 150m 200m 250m

Scale	Date	Drawn	Designed	Checked	Approved	Contract
AS NOTED	JULY 17, 2017	D. LARADE	V. GOREHAM	T. MENZIES	T. MENZIES	163545

HARBOURSIDE Geotechnical Consultants

ROCKY BARACHOIS BRIDGE REPLACEMENT

TEST PIT AND PUSH PROBE LOCATION PLAN

SKETCH No. G2

Z:\HARBOURSIDE_GEOTECHNICAL_CONSULTANTS\PROJECTS\163XXX\163545_ROCKY BARACHOIS BRIDGE\9_DRAFTING