

GEOTECHNICAL INVESTIGATION REPORT

Vardy's Island

Channel-Port aux Basques, NL

Report to:
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Via email

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TABLE OF CONTENTS

	<i>page</i>
1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION AND GEOLOGY	1
3.0 INVESTIGATION PROCEDURE.....	2
3.1 DRILLING PROGRAM.....	2
3.2 LABORATORY TESTING.....	2
4.0 SUMMARIZED SOIL AND BEDROCK CONDITIONS.....	3
4.1 PEAT.....	3
4.2 COBBLE / BOUDLER DEPOSIT	3
4.3 RESIDUAL SOIL.....	3
4.4 BEDROCK	3
5.0 CLOSURE	6
6.0 REFERENCES	7

APPENDICES

APPENDIX A:	SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS BOREHOLE RECORDS DRAWINGS 1: BOREHOLE LOCATION PLAN
APPENDIX B:	TABLE A: SUMMARY OF FINDINGS – BOREHOLES TABLE B: UNCONFINED COMPRESSIVE STRENGTH AND BULK SPECIFIC GRAVITY TESTING RESULTS TABLE C: GEOLOGIC STRENGTH INDICES (GSI)
APPENDIX C:	SPLITTING TENSILE TEST RESULTS (STANTEC) SULPHIDE SULPHUR CONTENT TEST RESULTS (DALHOUSIE UNIVERSITY)
APPENDIX D:	ROCK CORE PHOTOGRAPHS

1.0 INTRODUCTION

We have conducted a geotechnical investigation for the proposed dredging of Vardy's Island in Channel-Port aux Basques, NL, at the request of CBCL Limited. The purpose of this investigation was to evaluate the subsurface conditions to 5 m below the proposed channel dredge elevation of -10 m (Chart Datum).

This report presents the methodology used and the factual findings of the geotechnical investigation. The factual data presented in this report includes borehole data and laboratory testing results from the investigation.

2.0 SITE DESCRIPTION AND GEOLOGY

The site, Vardy's Island, is located in Channel-Port aux Basques in Newfoundland and Labrador. The island is located within the harbour between the Marine Atlantic Terminal, Pikes Island, and the western shoreline. The island holds a number of small structures including a power line, a weather tower, and various navigational aids.

The island is generally grass covered with a relatively thin overburden layer over bedrock. Bedrock is exposed at the surface in some areas across the site but mostly along the shoreline. Marine vegetation was observed below the high water line.

The island terrain is generally rough and undulating and typically inclines towards its southeast corner. Photograph A shows a view of the drilling operations on the south side of the island.

Travelling throughout the island with equipment posed a challenge due to the rough bedrock surface and the soft surficial organic material. Photograph B shows an image of the equipment travelling over the vegetation on the island. The drill rig tracks readily cut into the surface material during transit.



Photograph A: View of the drilling operations on the south side of the island.



Photograph B: Equipment travelling over the vegetation on the island.

Surficial geologic mapping indicates the area generally consists of bedrock overlain by a thin layer of vegetation or soil (till and other sediment).

Based on J.W. Gillis, Geology of Port Aux Basques Map-Area, Paper 71-42, Map 1340A, Geological Survey of Canada, Department of Energy, Mines & Resources, 1972, bedrock of the Port aux Basques area, is comprised of two major divisions separated by the Long Range Fault. These being relative softer Carboniferous sedimentary rock to the north west of the map area, and harder metamorphic and crystalline rocks (pre-Carboniferous) in the central and eastern parts of the map area. The terrane of the latter division comprises granitic gneisses and schists of amphibolite metamorphic level. Vardy’s Island (the site) is located south of the Cape Ray Fault on the west end of a bedrock unit mapped as Ordovician to Devonian biotite-quartz-feldspar gneiss/schist locally containing minerals such as garnet, amphibole, sillimanite, and kyanite. Also, within the mapped area around the site, are quartz monzonite and pegmatite. Gillis observed that the gneisses and schists vary from place to place but were dominantly of granitic composition with amphibolite more common in the south-west regions (west of Rose Blanche).

3.0 INVESTIGATION PROCEDURE

3.1 DRILLING PROGRAM

The drilling program consisted of three (3) boreholes completed between July 13 and 15, 2020. The borehole locations are shown in Drawing 1 in Appendix A.

The borehole coordinates and elevations were provided by CBCL Limited. Borehole locations are presented throughout the report in the coordinate system NAD83, UTM Zone 21. The elevations used are with respect to Chart Datum.

The boreholes were conducted using a tracked drill rig. A Conquest geotechnical field representative was onsite to log the subsurface conditions encountered.

Bedrock cores were sampled in boreholes by continuous diamond core drilling using an HQ size triple tube core barrel. The cores were organized in wooden core boxes and transported back to our Bedford laboratory for photographing and further classification and testing.

3.2 LABORATORY TESTING

The laboratory testing program consisted of the following tests:

Bedrock Laboratory Testing

- Unconfined Compressive Strength (ASTM D7012)
 - Thirty (30) tests
- Bulk Specific Gravity (ASTM D 6473)
 - Four (4) tests
- Splitting Tensile (Brazilian) Strength (ASTM D3967)

- Nine (9) tests
- Acid Producing Potential (Sulphide Sulphur Content)
 - Seven (7) tests

4.0 SUMMARIZED SOIL AND BEDROCK CONDITIONS

The subsurface conditions encountered throughout the site are described in detail on the appended (Appendix A) Borehole Records and summarized below in the following paragraphs and Tables A, B, and C in Appendix B.

The subsurface conditions encountered throughout the site consist of the following profile:

- Peat
- Cobble / Boulder Deposit (encountered in BH2)
- Residual Soil (encountered in BH3)
- Bedrock

4.1 PEAT

A surficial layer of soft peat was encountered in all boreholes and ranged in thickness from 0.6 m to 1.1 m. The peat contained trace silt and sand particles.

Although Standard Penetration Testing was not conducted within this material, it was observed to have very little strength. A hand-held metal probe was able to be advanced through the soil with relative ease.

4.2 COBBLE / BOUDLER DEPOSIT

A cobble / small boulder deposit was encountered in BH2 below the peat at a depth of 0.6 m. The deposit was observed to be 1.7 m thick. The diameter of the largest boulder was estimated to be 0.3 m.

4.3 RESIDUAL SOIL

A layer of residual soil was encountered in BH3 below the peat at a depth of 1.1 m. The residual soil was observed to be 0.4 m thick and consist of silty gravel and cobbles with sand.

4.4 BEDROCK

Bedrock was encountered throughout the site at depths between 0.9 m and 2.3 m and generally varied between gneiss and amphibolite. A small section of schist was encountered in BH3.

Pyrite was encountered in some of the rock samples with a relatively concentrated section in BH3, between depths of approximately 17.2 m and 17.8 m.

Discontinuities dipped widely between 0 degrees and 84 degrees (with respect to the vertical core axis). Foliation within the gneiss and schist also ranged widely between 25 degrees and 80 degrees (with respect to the vertical core axis).

The rock quality designation (RQD) of the core samples varied between 39% (severely fractured) and 100% (very sound), with an average of 88% (sound).

Unconfined compressive strength testing was conducted on thirty (30) samples of selected rock core. Testing was conducted on nineteen (19) samples of gneiss, six (6) samples of amphibolite, one (1) sample of schist, and four (4) samples of that consisted of both gneiss and amphibolite. Testing showed the following ranges of unconfined compressive strengths:

- Gneiss
 - 34.6 MPa to 108.6 MPa
 - Considered medium strong to very strong
- Amphibolite
 - 109.0 MPa to 178.3 MPa
 - Considered very strong
- Schist
 - 5.3 MPa (only one sample tested)
 - Considered weak
- Gneiss/Amphibolite
 - 51.7 MPa to 171.2 MPa
 - Considered strong to very strong

Unconfined compressive strength testing results are provided in Table B in Appendix B.

Bulk specific gravity testing was conducted on four (4) samples of selected rock core. Testing was conducted on two (2) samples of gneiss and two (2) samples of amphibolite. Testing showed the following ranges of bulk specific gravity:

- Gneiss
 - 2.74 to 2.75
- Amphibolite
 - 2.97 to 3.01

Results of the bulk specific gravity testing are provided in Table B in Appendix B.

Based on the joint conditions of the rock core in conjunction with the rock mass structure, geological strength indices (GSI) were estimated. GSI values are provided in Table C in Appendix B. Where a run of core indicated intact massive rock or sparsely jointed rock, a GSI value was not assigned. This generally applied when the RQD was greater than 80%, which was the case for most of the core runs. Where assigned, GSI values ranged from 42 to 75.

Splitting Tensile (Brazilian) Strength testing was conducted on nine (9) samples of selected rock core. Testing was conducted on three (3) samples of gneiss, five (5) samples of amphibolite, and one (1) sample that consisted of both gneiss and amphibolite. Testing showed the following ranges of tensile strengths:

- Gneiss
 - 5.5 MPa to 9.0 MPa
- Amphibolite
 - 3.6 MPa to 8.7 MPa
- Gneiss/amphibolite
 - 7.0 MPa (only one sample tested)

Splitting Tensile Strength testing results are attached in Appendix C.

Seven (7) samples of bedrock were submitted to Dalhousie University for sulphide sulphur content testing (acid producing potential). Testing showed results between 0.006% and 0.732%. Results are attached in Appendix C.

Photographs of the bedrock cores are attached in Appendix D.

5.0 CLOSURE

This report has been prepared for the sole benefit of the Client. All information, documentation or other material contained in, attached to, or forming part of this report reflects Conquest's opinion and best judgment based on the information available to us at the time of preparation. Any use or reliance on this report by the Client in circumstances where there has been a change in site conditions or for any purpose not expressly intended by or delineated in this report shall be the sole responsibility of the Client and Conquest accepts no liability for such use or reliance. Any use or reliance on this report by any third party, without Conquest's prior express written consent, shall be the sole responsibility of that third party. Conquest accepts no liability whatsoever for such use or reliance.

The information and conclusions contained in this report are generally consistent with professional standards for engineering and scientific professionals providing similar services at the same time, in similar locations and under similar circumstances.

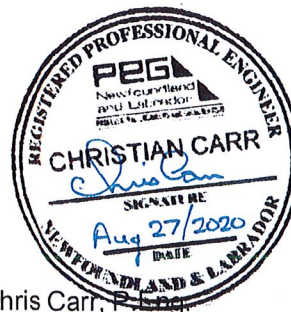
A geotechnical field investigation is a limited sampling of a site. Some variation between sampling locations should be expected. The conclusions presented in this report represent the technical judgment of Conquest, based on the data obtained from the work and on Conquest's understanding of the project. The data obtained by Conquest is specific to the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area surrounding these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. Due to the nature of the investigation and the limited data available, Conquest cannot and does not warrant that undiscovered environmental liabilities and/or undetected subsurface conditions may not arise.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we require that we be notified immediately to allow for reassessment of the conclusions provided herein. Further, if there are changes to Client's design we require that we be notified to allow for review and possible changes to our recommendations.

We trust this is the information you require at this time. We are available to discuss the contents of this report at your convenience.



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6.0 REFERENCES

- Gillis, J.W. (1972). “Geology of Port aux Basques Map-Area, Newfoundland (Report and Map 1340A)”. Geologic Survey of Canada, Department of Energy, Mines and Resources, Paper 71-42.
- Liverman, D., and Taylor, D. (1994). “Surficial Geology of the Port aux Basques Map Area (NTS 110)”. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Open File 110 (317), Map 94-234.

APPENDICES

APPENDIX A

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Topsoil</i>	surface layer with a variable mixture of mineral particles and organic matter
<i>Peat</i>	decomposing vegetative matter having a fibrous and/or amorphous structure
<i>Till</i>	unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	having cracks, and hence a blocky structure
<i>Varved</i>	composed of regular alternating layers of silt and clay
<i>Stratified</i>	composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	>75 mm
<i>Seam</i>	2 mm to 75 mm
<i>Parting</i>	< 2 mm
<i>Well Graded</i>	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
<i>Uniformly Graded</i>	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	Greater than 20%

The standard terminology to describe cohesionless soils includes the compactness as determined by laboratory test or by the Standard Penetration Test 'N' – value.

Relative Density	'N' Value	Compactness %
<i>Very Loose</i>	<4	<15
<i>Loose</i>	4-10	15-35
<i>Compact</i>	10-30	35-65
<i>Dense</i>	30-50	65-85
<i>Very Dense</i>	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength (Su)		'N' Value
	Kips/sq.ft.	KPa	
<i>Very Soft</i>	< 0.25	< 12.5	< 2
<i>Soft</i>	0.25 – 0.5	12.5 – 25	2 – 4
<i>Firm</i>	0.5 – 1.0	25 – 50	4 – 8
<i>Stiff</i>	1.0 – 2.0	50 – 100	8 – 15
<i>Very Stiff</i>	2.0 – 4.0	100 – 200	15 – 30
<i>Hard</i>	> 4.0	> 200	> 30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on N-size (45 mm) core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from in situ fractures.

RQD	ROCK QUALITY
90 – 100	Excellent, intact, very sound
75 – 90	Good, massive, moderately jointed or sound
50 – 75	Fair, blocky and seamy, fractured
25 – 50	Poor, shattered and very seamy or blocky, severely fractured
0 – 25	Very poor, crushed, very severely fractured

Total Core Recovery (TCR)

Total core recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

Solid Core Recovery (SCR)

Solid core recovery is defined as the cumulative length of all solid (at full diameter) core in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

Fracture Index (FI)

Fracture Index is defined as the number of naturally occurring fractures occurring per 1.0 m length of core. The Fracture Index is reported as a simple count of fractures. Decomposed and/or disintegrated rock and/or rubble zones are not included in the Fracture Index.

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000 – 6000	<i>Very Thick</i>	<i>Very Wide</i>
600 – 2000	<i>Thick</i>	<i>Wide</i>
200 – 600	<i>Medium</i>	<i>Moderate</i>
60 – 200	<i>Thin</i>	<i>Close</i>
20 – 60	<i>Very Thin</i>	<i>Very Close</i>
< 20	<i>Laminated</i>	<i>Extremely Close</i>
< 6	<i>Thinly Laminated</i>	

Strength Classification	Uniaxial Compressive Strength (MPa)
<i>Very Weak</i>	1 – 5
<i>Weak</i>	5 – 25
<i>Medium Strong</i>	25 – 50
<i>Strong</i>	50 – 100
<i>Very Strong</i>	100 – 250
<i>Extremely Strong</i>	> 250

Terminology describing weathering and alteration grades:

<i>W1 – Fresh</i>	- No visible sign of rock material weathering.
<i>W2 – Slightly Weathered</i>	- Discoloration indicates weathering of rock material on discontinuity surfaces.
<i>W3 – Moderately Weathered</i>	- Less than half of the rock material is decomposed and/or disintegrated into soil.
<i>W4 – Highly Weathered</i>	- More than half of the rock material is decomposed and/or disintegrated into soil.
<i>W5 – Completely Weathered</i>	- All rock material is decomposed and/or disintegrated into soil.
<i>W6 – Residual Soil</i>	- All rock material is converted to soil. The mass structure and material fabric are destroyed.

Symbols for Rock Descriptions

J	Joint	B	Bedding	SM	Smooth
F	Fault	VN	Vein	R	Rough
SH	Shear	CL	Cleavage	SL	Slickensided
		FOL	Foliation	ST	Stepped
		CON	Contact	UN	Undulating
				PL	Planar

STRATA PLOT

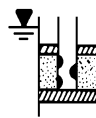
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:

Boulders Cobbles Gravel	Sand	Silt	Clay	Organics	Asphalt	Concrete	Fill	Igneous Bedrock	Metamorphic Bedrock	Sedi- mentary

WATER LEVEL MEASUREMENT



Borehole or
Standpipe



Piezometer

SAMPLE TYPE AND/OR FIELD TESTS

SS	Split Spoon Sample (obtained by performing the Standard Penetration Test)	AS	Auger Sample
		BS	Bulk Sample
		WS	Wash Sample
ST	Shelby Tube or Thin Wall Tube	HQ, NQ, BQ, etc.	Rock Core Samples (obtained with the use of standard size diamond drilling bits)
PS	Piston sample		
DC	Dynamic Cone Penetration		
FSV	Field Shear Vane		

N- VALUE

Numbers in this column are the results of the SPT (Standard Penetration Test): the number of blows of a 140 pound (64kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the abbreviation SSR (Split Spoon Refusal) will appear in place of a numerical value.

OTHER TESTS

Symbols in this column indicate that the following laboratory tests have been carried out and the results are presented separately.

S	Sieve analysis	H	Hydrometer analysis
G _s	Specific gravity of soil particles	γ	Unit weight
k	Permeability	C	Consolidation
	Single packer permeability test; test interval from depth shown to bottom of borehole	CD	Consolidated drained triaxial
	Double packer permeability test; Test interval as indicated	CU	Consolidated undrained triaxial with pore pressure measurements
	Falling head permeability test using casing	UU	Unconsolidated undrained triaxial
	Falling head permeability test using well point or piezometer	DS	Direct shear
		Q _u	Unconfined compression
		I _p	Point Load Index (I _p on Borehole Records equals I _p (50); the index corrected to a reference diameter of 50 mm)
		MSV	Laboratory Miniature Shear Vane

BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271605.9 m, E 339375.9 m

Borehole No.: BH1

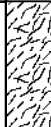
Page: 1 of 3

Start Date: July 13, 2020

End Date: July 14, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
1		Dark brown PEAT - trace silt and sand		4.1									
2													
3	1	Light blueish grey to dark blueish grey GNEISS: METAMORPHIC BEDROCK - severely fractured to very sound - strong			HQ1	65	50	46			R, UN, W2 R, UN, W1	~ 3 mm silty sand	2
4													
5													
6	2	- slightly weathered to fresh - tight to partly open apertures - discontinuities range between 10 and 58 degrees with respect to vertical core axis											
7													
8													
9									87.5		R, ST, W1 R, ST, W1		2
10	3	- rubble zones from 0.91 m to 1.47 m 5.49 m to 5.52 m 5.92 m to 5.97 m			HQ2	100	98	91			R, UN, W1 R, UN, W2 R, UN, W1	< 0.1 mm silt	4
11													
12													
13	4										R, UN/PL, W1		1
14					HQ3	100	100	93					
15													
16	5										R, PL, W1		1
17													
18													
19					HQ4	100	95	85	58.1		R, UN, W1		2
20	6												
21													
22					HQ5	100	100	78			R, UN, W1 R, UN, W1		4
23	7												
24													
25					HQ6	100	100	100	77.2		R, UN, W1 R, UN, W1 R, ST/UN, W1 R, UN, W1	< 0.1 mm silt	2
26	8												
27													
28													
29	9				HQ7	100	98	92			R, ST, W1 R, ST, W1		2

J-JOINT
F-FAULT
SH-SHEAR

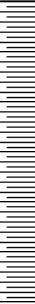
B-BEDDING
VN-VEIN
CL-CLEAVAGE
FOL-FOLIATION
CON-CONTACT

SM-SMOOTH
R-ROUGH
SL-SLICKENSIDED
ST-STEPPED
UN-UNDULATING
PL-PLANAR

W1-FRESH
W2-SLIGHTLY WEATHERED
W3-MODERATELY
W4-HIGHLY WEATHERED
W5-COMpletely WEATHERED
W6-RESIDUAL SOIL

Conquest Engineering
Experience commitment.

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data						
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m				
30	10	Light blueish grey to dark blueish grey GNEISS to blueish grey to dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - fractured to very sound - strong - slightly weathered to fresh - tight to partly open apertures - discontinuities range between 10 and 70 degrees with respect to vertical core axis - foliation (where defined) is generally around 40 degrees with respect to vertical core axis		-6.1					68.6		R, UN, W1	< 0.1 mm silt	1				
31																	
32																	
33																	
34								HQ8	93	93	92					0	
35																	
36																	
37				11													
38																	
39				12					HQ9	78	59		56				1
40																	
41																	
42																	
43	13																
44						HQ10	100	100	100					1			
45																	
46	14																
47																	
48																	
49	15																
50						HQ11	100	100	100								
51																	
52	16	Blueish grey to dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - very sound - very strong - fresh - tight apertures - discontinuities range between 2 and 31 degrees with respect to vertical core axis															
53																	
54																	
55																	
56	17																
57																	
58	18																
59						HQ13	98	98	98	138.1		R, PL, W1 R, ST, W1	< 0.1 mm silt	2			

W1-FRESH
W2-SLIGHTLY WEATHERED
W3-MODERATELY
W4-HIGHLY WEATHERED
W5-COMpletely WEATHERED
W6-RESIDUAL SOIL

BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271605.9 m, E 339375.9 m

Borehole No.: BH1

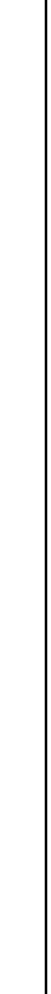
Page: 3 of 3

Start Date: July 13, 2020

End Date: July 14, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
60		Dark blueish grey to light blueish grey GNEISS to dark blueish grey to blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - very sound - strong to very strong - fresh - tight apertures - discontinuities range between 8 and 58 degrees with respect to vertical core axis - foliation (where defined) is generally around 65 degrees with respect to vertical core axis		-15.1	HQ14	100	100	100	82.5	  	R, UN, W1 R, PL, W1		3
61											R, UN, W1		
62	19												
63													
64													0
65	20	End of Borehole at 20.1 m		-15.1									
66													
67													
68													
69	21												
70													
71													
72	22												
73													
74													
75	23												
76													
77													
78	24												
79													
80													
81	25												
82													
83													
84	26												
85													
86													
87	27												
88													

J-JOINT
F-FAULT
SH-SHEAR

B-BEDDING
VN-VEIN
CL-CLEAVAGE
FOL-FOLIATION
CON-CONTACT

SM-SMOOTH
R-ROUGH
SL-SLICKENSIDED
ST-STEPPED
UN-UNDULATING
PL-PLANAR

W1-FRESH
W2-SLIGHTLY WEATHERED
W3-MODERATELY
W4-HIGHLY WEATHERED
W5-COMpletely WEATHERED
W6-RESIDUAL SOIL

BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271584.8 m, E 339320.5 m

Borehole No.: BH2

Page: 1 of 3

Start Date: July 14, 2020

End Date: July 14, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
1		Dark brown PEAT - trace silt and sand		4.6									
2		Grey COBBLES and small BOULDERS - maximum estimated particle size of 0.3 m - some gravel - trace silt and sand - subrounded to angular clasts			HQ1								
3				3.0									
4		Dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - sound - slightly weathered to fresh - tight to partly open apertures - discontinuities range between 10 and 84 degrees with respect to vertical core axis - rubble zone from 3.04 m to 3.06 m			HQ2	100	98	80			R, UN, W1 R, UN, W2 R, UN/ST, W2 R, ST, W2 R, UN, W2 R, UN, W1 R, UN, W1/W2 R, UN, W1/W2 R, UN, W1/W2 R, PL/UN, W1 R, UN/ST, W2 R, UN, W2/W1 R, PL, W1 R, UN, W1 R, UN, W2/W1 R, UN, W2 R, UN/ST, W2 R, UN/PL, W2 R, UN/ST, W2 R, ST/UN, W1	< 2 mm silty sand < 0.5 mm silt	4
5				1.6					94.1				7
6		Dark blueish grey to blueish black AMPHIBOLITE to light blueish grey to dark blueish grey GNEISS: METAMORPHIC BEDROCK - fractured to very sound - strong to very strong - slightly weathered to fresh - tight to partly open apertures - discontinuities range between 0 and 70 degrees with respect to vertical core axis - foliation (where defined) generally ranges between 45 and 70 degrees with respect to vertical core axis - rubble zone from 7.81 m to 7.82 m			HQ3	100	95	66					7
7					HQ4	100	98	95					3
8									89.3				
9					HQ5	100	92	80					6
10									108.0				
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30					HQ6	100	100	97	121.1				3

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W5-COMpletely WEATHERED
W6-RESIDUAL SOIL

BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271584.8 m, E 339320.5 m

Borehole No.: BH2

Page: 2 of 3

Start Date: July 14, 2020

End Date: July 14, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
30											R, UN, W2	< 0.1 mm silt	
31													
32											R, ST, W2/W1 R, UN, W1	< 0.1 mm silt	5
33	10										R, UN, W2 R, UN, W1 R, UN, W2		
34											R, UN/ST, W1		
35		Light blueish grey to dark blueish grey GNEISS: METAMORPHIC BEDROCK - sound to very sound - strong to very strong - slightly weathered to fresh - tight to partly open apertures - discontinuities range between 6 and 72 degrees with respect to vertical core axis - foliation is generally around 80 degrees with respect to vertical core axis		-5.3	HQ7	100	100	86	68.5				2
36	11										R, UN, W2/W1		
37													
38													
39													
40	12				HQ8	100	100	98	74.6				0
41											R, UN, W1 R, UN, W2	< 0.1 mm silt	
42													3
43	13												
44											R, UN, W1		
45					HQ9	100	100	100	108.6				1
46	14										R, ST, W2		
47													
48													
49	15	Dark blueish grey to blueish black AMPHIBOLITE: METAMORPHIC BEDROCK - sound to very sound - very strong - slightly weathered to fresh - tight to widely open apertures - discontinuities range between 0 and 48 degrees with respect to vertical core axis		-9.6	HQ10	95	81	81	64.1		R, UN/ST, W2/W1 R, UN/ST, W2/W1	< 0.1 mm silt	3
50													
51											R, UN/ST, W1/W2	< 0.1 mm silt	
52	16												2
53											R, ST, W2/W1 R, PL, W1		
54					HQ11	-	-	-	178.3		R, PL, W2/W1		1
55	17												
56													
57													
58	18					97	97	92	144.3		R, PL, W1/W2 R, UN, W1/W2	< 0.1 mm silt	2
59					HQ12								

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W5-COMpletely WEATHERED
W6-RESIDUAL SOIL

BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271584.8 m, E 339320.5 m

Borehole No.: BH2

Page: 3 of 3

Start Date: July 14, 2020

End Date: July 14, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
60									109.0				
61				-13.5						▲	R, ST, W1/W2	< 0.1 mm silt	1
62	19	Light blueish grey to dark blueish grey GNEISS to dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK											
63		- very sound											
64		- strong			HQ13	95	95	95					
65		- fresh								▲	R, UN/PL, W1		
66	20	- tight apertures											
67		- discontinuity was 60 degrees with respect to vertical core axis		-15.0					51.7				
68		- foliation (where defined) generally ranges between 55 and 60 degrees with respect to vertical core axis											
69	21	End of Borehole at 20.3 m											
70													
71													
72	22												
73													
74													
75	23												
76													
77													
78													
79	24												
80													
81													
82	25												
83													
84													
85	26												
86													
87													
88	27												

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W5-COMpletely WEATHERED
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BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271547.2 m, E 339348.2 m

Borehole No.: BH3

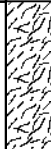
Page: 1 of 3

Start Date: July 15, 2020

End Date: July 15, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
1		Dark brown PEAT - trace silt and sand		6.7									
2													
3													
4		Dark brown to dark grey silty GRAVEL and COBBLES with sand: RESIDUAL SOIL		6.3									
5													
6		Light blueish grey to blueish grey GNEISS: METAMORPHIC BEDROCK			HQ1	95	82	39			R, UN, W2 R, UN, W2/W1 R, UN, W2	< 0.1 mm silt	
7		- severely fractured to very sound									R, UN/ST, W2/W3 R, ST, W2/W3	< 0.5 mm silt	5
8		- strong							80.5				
9		- slightly weathered to fresh			HQ2	100	100	97			R, UN/PL, W1/W2		2
10		- widely open to very tight apertures									R, UN, W1		
11		- discontinuities range between 4 and 80 degrees with respect to vertical core axis											
12		- foliation generally ranges between 55 and 80 degrees with respect to vertical core axis											
13		- rubble zones from 5.94 m to 5.99 m									R, UN/ST, W2/W3		
14		7.98 m to 8.08 m			HQ3	100	100	88	68.4		R, UN, W1/W2 R, ST, W1		4
15											R, UN, W2		
16											R, UN, W2 R, UN, W2	< 0.1 mm silt < 0.1 mm silt	5
17													
18											R, ST, W2 R, UN/ST, W2/W1 R, ST, W2/W1 R, ST/UN, W2		
19					HQ4	100	97	65			R, UN, W2 R, SM, UN, W1	< 0.1 mm silt < 0.1 mm silt	7
20											R, ST/UN, W3/W4 R, UN, W2/W4 R, UN/ST, W2		
21											R, ST, W1	< 0.1 mm silt	
22											R, PL/UN, W1		2
23					HQ5	100	92	86	53.8		R, UN, W1		
24													
25											R, UN, W1		
26											R, ST, W1 R, UN, W1/W2 SM/R, UN/PL, W1	~ 1 mm silt	5
27											SM/R, UN/PL, W1	< 0.5 mm silt	
28						100	100	100					2
29					HQ6				56.8				

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BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271547.2 m, E 339348.2 m

Borehole No.: BH3

Page: 2 of 3

Start Date: July 15, 2020

End Date: July 15, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
30											R, UN, W1		
31				-1.8							SM/R, UN, W1		
32		Light blueish grey to dark blueish grey GNEISS to blueish grey to dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - sound to very sound - medium strong to strong - slightly weathered to fresh - partly open to very tight apertures - discontinuities range between 17 and 73 degrees with respect to vertical core axis - foliation (where defined) generally ranges between 55 and 75 degrees with respect to vertical core axis - trace schist layers - rubble zone from 15.29 m to 15.47 m			HQ7	100	98	97			R, UN, W1		3
33	10										SM/R, PL/UN, W1		
34											R, UN, W1		
35											R, PL, W2/W1		4
36	11										R, UN, W2/W1		
37											R, PL, W2/W1		
38					HQ8	100	100	92	82.2		R, UN, W2		
39	12										SM/R, UN, W1		3
40											SM/R, UN, W1		
41											R, UN, W2/W1		
42											SM/R, UN, W1		
43	13				HQ9	100	100	97	94.2		R, UN, W1		3
44											SM/R, UN, W1		
45											SM, UN, W1		1
46	14										R, UN, W1		
47													
48					HQ10	59	86	78	34.6				1
49	15												
50													
51		Black SCHIST: METAMORPHIC BEDROCK - sound - weak - slightly weathered to fresh - very tight apertures - discontinuities range between 60 and 72 degrees with respect to vertical core axis - foliation generally ranges between 60 and 75 degrees with respect to vertical core axis		-7.8							SM/R, UN, W2/W4	~ 2 mm silt / weathered rock	
52	16										SM/R, UN, W1		4
53					HQ11	100	100	88	5.3		SM/R, UN, W1		
54											SM/R, UN, W4	~ 2 mm silt / weathered rock	
55											R, UN, W2/W1		
56	17			-9.1							SM/R, UN, W1		2
57													
58					HQ12	98	98	98					
59	18										R, UN, W1		1

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BOREHOLE RECORD - BEDROCK

Project Name: Vardy's Island

Project Number: 20S010.00

Client: CBCL Limited

Location: Channel-Port Aux Basques, NL

Water Level Date: --

Borehole Location: N 5271547.2 m, E 339348.2 m

Borehole No.: BH3

Page: 3 of 3

Start Date: July 15, 2020

End Date: July 15, 2020

Datum: Chart

Coord. Syst.: UTM NAD83 Zone 21

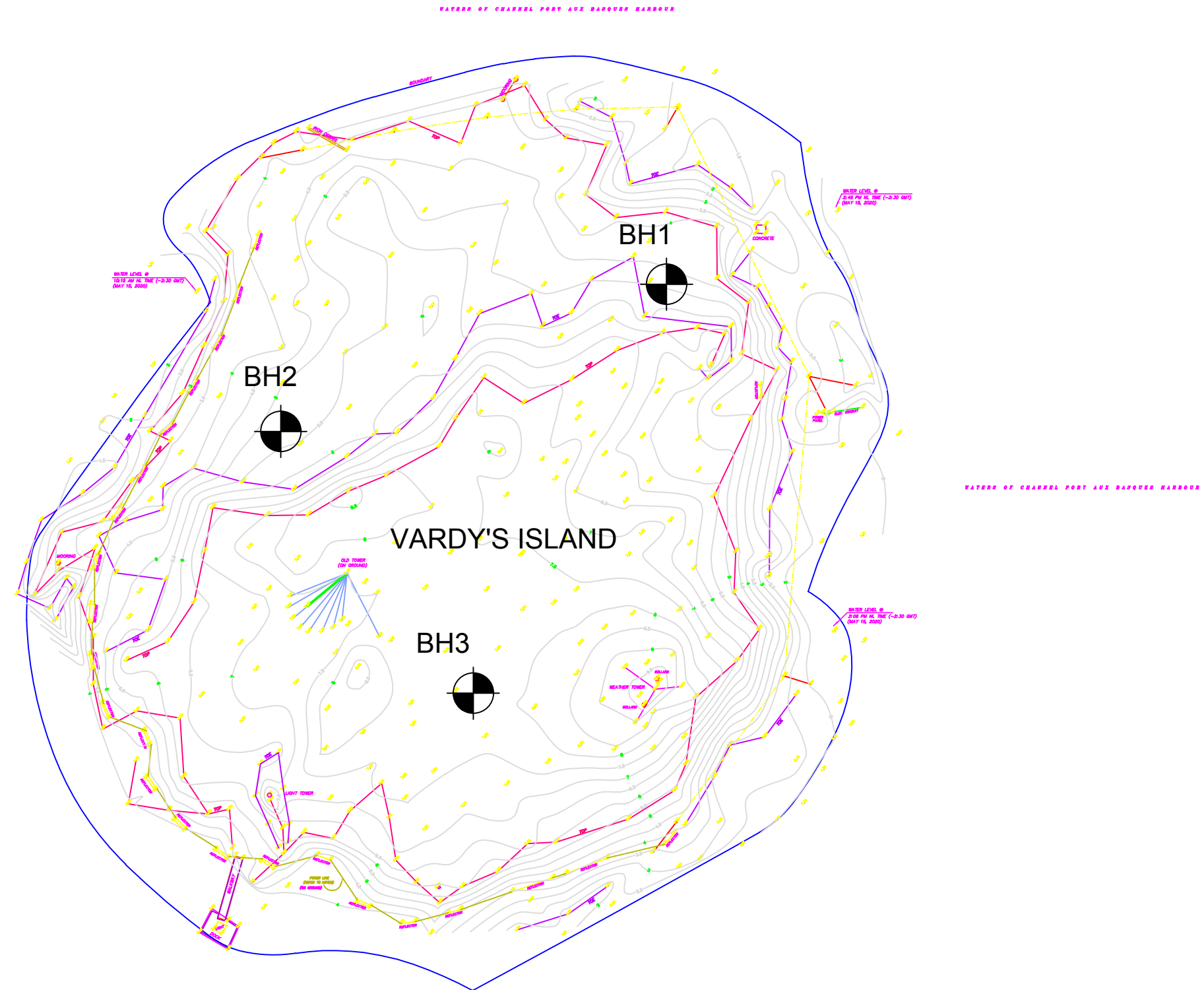
Depth (ft/m)	Water Level	DESCRIPTION	Symbols	Elevation (m)	Sample Type/No.	Recovery		RQD (%)	USC (MPa)	Dip w.r.t. Core Axis ▲ degrees ▲ 30 60	Discontinuity Data		
						Total Core Recovery (%)	SCR (%)				Description	Infill	Fracture Index per m
60		Light blueish grey to dark blueish grey GNEISS to blueish grey to dark blueish grey AMPHIBOLITE: METAMORPHIC BEDROCK - very sound - slightly weathered to fresh - very tight to partly open apertures - discontinuities range between 43 and 65 degrees with respect to vertical core axis - foliation (where defined) generally ranges between 60 and 70 degrees with respect to vertical core axis							85.8				
61										▲	R, PL/UN, W1		
62	19				HQ13	100	100	95					1
63													
64													
65	20	End of Borehole at 23.1 m		-15.3					171.2				1
66													
67					HQ14	100	100	98		▲	R, PL, W2		
68													
69	21												2
70		End of Borehole at 23.1 m		-15.3					171.2	▲	R, UN/ST, W1 R, UN, W1		
71													
72	22				HQ15	100	100	100					0
73													
74													
75	23	End of Borehole at 23.1 m		-15.3					171.2				
76													
77													
78	24												
79													
80		End of Borehole at 23.1 m		-15.3					171.2				
81													
82	25												
83													
84													
85	26	End of Borehole at 23.1 m		-15.3					171.2				
86													
87													
88	27												

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DRAWING:	1
V:	0

APPENDIX B

Table A: Summary of Findings - Boreholes

Location	Elevation (m) ¹	Coordinates (m) ²	Thickness of Peat (m)	Thickness of Cobble/Boulder Deposit (m)	Thickness of Residual Soil (m)	Depth of Bedrock (m)	Elevation of Bedrock (m) ¹	Depth of Borehole (m)
BH1	5.0	N 5271605.9 E 339375.9	0.9	--	--	0.9	4.1	20.1
BH2	5.3	N 5271584.8 E 339320.5	0.6	1.7	--	2.3	3.0	20.3
BH3	7.8	N 5271547.2 E 339348.2	1.1	--	0.4	1.5	6.3	23.1

Notes: ¹Chart Datum.
²UTM NAD83 Zone 21

Table B: Unconfined Compressive Strength and Bulk Specific Gravity Testing Results

Location	Depth (m)	Lithology	Unconfined Compressive Strength (MPa)	Bulk Specific Gravity
BH1, HQ2	2.4	GNEISS	87.5	--
BH1, HQ4	5.6	GNEISS	58.1	--
BH1, HQ6	7.7	GNEISS	77.2	--
BH1, HQ8	10.1	GNEISS	68.6	--
BH1, HQ11	14.5	GNEISS	50.3	2.75
BH1, HQ12	16.0	AMPHIBOLITE	143.4	--
BH1, HQ13	17.7	AMPHIBOLITE	138.1	--
BH1, HQ14	19.1	GNEISS	82.5	--
BH2, HQ3	4.6	GNEISS	94.1	--
BH2, HQ4	5.7	GNEISS	89.3	--
BH2, HQ5	7.2	GNEISS / AMPHIBOLITE	108.0	--
BH2, HQ6	8.8	AMPHIBOLITE	121.1	2.97
BH2, HQ7	10.7	GNEISS	68.5	--
BH2, HQ8	11.8	GNEISS	74.6	--
BH2, HQ9	13.6	GNEISS	108.6	--
BH2, HQ10	14.5	GNEISS	64.1	2.74
BH2, HQ11	16.5	AMPHIBOLITE	178.3	--
BH2, HQ12	17.5	AMPHIBOLITE	144.3	--
BH2, HQ12	18.3	AMPHIBOLITE	109.0	3.01
BH2, HQ13	20.1	GNEISS / AMPHIBOLITE	51.7	--

Location	Depth (m)	Lithology	Unconfined Compressive Strength (MPa)	Bulk Specific Gravity
BH3, HQ2	2.4	GNEISS	80.5	--
BH3, HQ3	4.3	GNEISS	68.4	--
BH3, HQ5	7.0	GNEISS	53.8	--
BH3, HQ6	9.0	GNEISS	56.8	--
BH3, HQ8	11.6	GNEISS	82.2	--
BH3, HQ9	13.7	GNEISS	94.2	--
BH3, HQ10	15.0	GNEISS	34.6	--
BH3, HQ11	16.3	SCHIST	5.3	--
BH3, HQ13	19.2	GNEISS / AMPHIBOLITE	85.8	--
BH3, HQ15	22.1	GNEISS / AMPHIBOLITE	171.2	--

Table C: Geological Strength Indices (GSI)

Location	Lithology	Geologic Strength Index (GSI)
BH1, HQ1	GNEISS	53
BH1, HQ2	GNEISS	N/A ¹
BH1, HQ3	GNEISS	N/A ¹
BH1, HQ4	GNEISS	N/A ¹
BH1, HQ5	GNEISS	75
BH1, HQ6	GNEISS	N/A ¹
BH1, HQ7	GNEISS	N/A ¹
BH1, HQ8	GNEISS	N/A ¹
BH1, HQ9	GNEISS / AMPHIBOLITE	61
BH1, HQ10	GNEISS / AMPHIBOLITE	N/A ¹
BH1, HQ11	GNEISS / AMPHIBOLITE	N/A ¹
BH1, HQ12	GNEISS / AMPHIBOLITE	N/A ¹
BH1, HQ13	GNEISS / AMPHIBOLITE	N/A ¹
BH1, HQ14	GNEISS / AMPHIBOLITE	N/A ¹
BH2, HQ2	GNEISS / AMPHIBOLITE	70
BH2, HQ3	GNEISS / AMPHIBOLITE	65
BH2, HQ4	GNEISS / AMPHIBOLITE	N/A ¹
BH2, HQ5	GNEISS / AMPHIBOLITE	72

Notes:

¹Intact/Massive, RQD>80%²Close spacing of weak schistosity

Location	Lithology	Geologic Strength Index (GSI)
BH2, HQ6	GNEISS / AMPHIBOLITE	N/A ¹
BH2, HQ7	GNEISS / AMPHIBOLITE	75
BH2, HQ8	GNEISS	N/A ¹
BH2, HQ9	GNEISS	N/A ¹
BH2, HQ10	GNEISS / AMPHIBOLITE	72
BH2, HQ11	AMPHIBOLITE	N/A ¹
BH2, HQ12	AMPHIBOLITE	N/A ¹
BH2, HQ13	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ1	GNEISS	42
BH3, HQ2	GNEISS	N/A ¹
BH3, HQ3	GNEISS	N/A ¹
BH3, HQ4	GNEISS	63
BH3, HQ5	GNEISS	N/A ¹
BH3, HQ6	GNEISS	N/A ¹
BH3, HQ7	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ8	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ9	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ10	GNEISS / AMPHIBOLITE	74
BH3, HQ11	SCHIST / GNEISS / AMPHIBOLITE	N/A ²

Notes:

¹Intact/Massive, RQD>80%

²Close spacing of weak schistosity

Location	Lithology	Geologic Strength Index (GSI)
BH3, HQ12	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ13	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ14	GNEISS / AMPHIBOLITE	N/A ¹
BH3, HQ15	GNEISS / AMPHIBOLITE	N/A ¹

Notes:

¹Intact/Massive, RQD>80%

²Close spacing of weak schistosity

APPENDIX C

Splitting Tensile Strength of Intact Rock Core Specimnes

ASTM D3967 - 16

Client:	Conquest Engineering Ltd.
Project:	Conquest Lab Testing
Project #:	121622888 - PO#205010.00
Task #:	200

Lab Sample #: S20-473
 Performed by: MG/TW
 Date Received: 29-Jul-2020
 Date Performed: 31-Jul-2020

[illegible]

Comments: Samples were prepared for testing by Client.

July 29, 2020

Conquest Engineering Ltd.
348 Bluewater Road
Bedford, NS
B4B 1J6
Attention: Devan McKenney/Wesley Smith

Re: Results of analysis on submitted samples, acid producing potential based on sulphide sulphur content if available.

Project # 20S010.00

Sample	Wt. %		kg/t
	S(Total)	S(Sulphide)	Acid Producing Potential
BH1 HQ2 2.41M	0.082	0.081	2.49
BH1 HQ13 17.52M	0.132	0.130	3.98
BH2 HQ313 4.65M	0.046	0.043	1.31
BH2 HQ8 12.72M	0.175	0.173	5.30
BH2 HQ8 12.72M Dup.	0.187		5.73
BH2 HQ12 17.47M	0.007	0.006	0.18
BH3 HQ11 16.29M	0.008	0.007	0.21
BH3 HQ12 17.22M	0.733	0.732	22.40

Reference Sample:	Wt. %
Sample	S (Total)
KZK-1 (0.80% S)	0.801



Digitally signed
by Daniel
Chevalier
Date: 2020.08.05
14:03:26 -03'00'

Daniel Chevalier, MASc
Manager, Minerals Engineering Centre

APPENDIX D

PHOTOGRAPHS OF ROCK CORE



Photograph 1: Borehole **BH1**, 0.91 m to 12.65 m. Drilled between July 13 and 14, 2020.



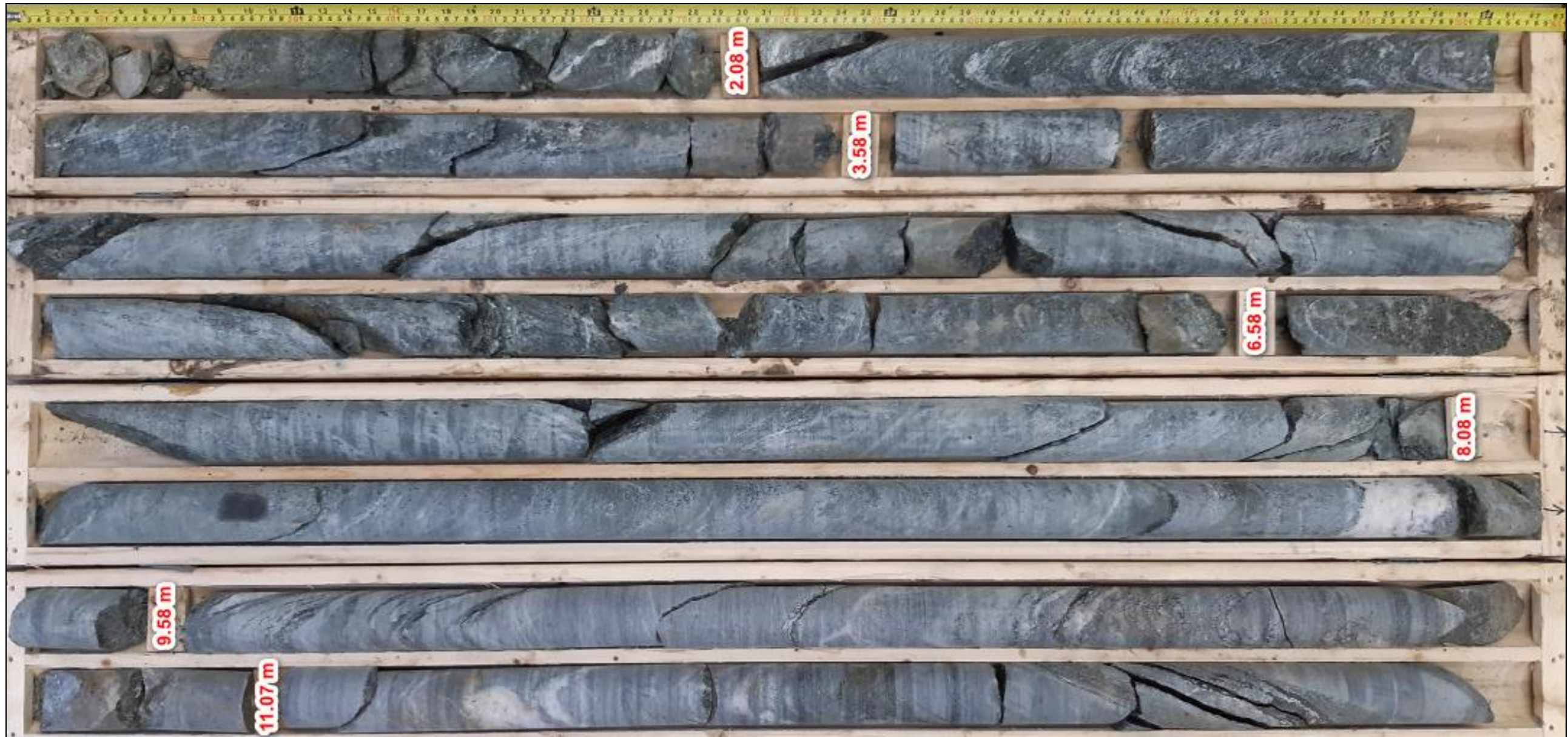
Photograph 2: Borehole **BH1**, 12.65 m to 20.14 m. Drilled between July 13 and 14, 2020.



Photograph 3: Borehole **BH2**, 0.61 m to 12.40 m. Drilled on July 14, 2020.



Photograph 4: Borehole **BH2**, 12.40 m to 20.27 m. Drilled on July 14, 2020.



Photograph 5: Borehole **BH3**, 1.52 m to 12.24 m. Drilled on July 15, 2020.



Photograph 6: Borehole **BH3**, 12.24 m to 23.06 m. Drilled on July 15, 2020.