
Appendix A

Proposed Wharf Geotechnical Investigation Factual Report



Public Works and
Government Services
Canada

Travaux publics et
Services gouvernementaux
Canada

PROPOSED WHARF GEOTECHNICAL INVESTIGATION FACTUAL REPORT

UPPER PORT LA TOUR, NS

APRIL 28, 2017

PROPOSED WHARF GEOTECHNICAL INVESTIGATION FACTUAL REPORT

UPPER PORT LA TOUR, NS



Public Works and
Government Services
Canada

Travaux publics et
Services gouvernementaux
Canada

Draft Geotechnical Investigation Report

Project No : 171-00222

Date : April 28, 2017

WSP Canada Inc.

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Dartmouth, NS B3B 1X7

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171-00222

April 28, 2017

Sylvia MacDonald

Environmental Officer
Public Services and Procurement Canada
1713 Bedford Row
Halifax, NS, B3J 3C9
(email: Sylvia.macdonald@pwgsc-tpsgc.gc.ca)

Dear Ms. MacDonald,

Subject: Draft Geotechnical Investigation Factual Report – Proposed Wharf Structure – Upper Port La Tour, Nova Scotia

Please find enclosed our Draft Geotechnical Investigation Factual Report completed by WSP Canada Inc. for the proposed wharf in Upper Port La Tour, Nova Scotia. The report presents observations, findings and recommendations from the Geotechnical investigation and testing programs.

We trust this report meets your present requirements Please review and provide us with your comments prior to our issuance of a final report.

Yours sincerely,
WSP Canada Inc.

A handwritten signature in blue ink, appearing to read "C. Rogers".

Clayton J. Rogers. P.Eng.
Manager, Geotechnical - Dartmouth
Encl.

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REVISION HISTORY

VERSION	DATE	DESCRIPTION
1	3/15/2017	Draft Report Issued for Review
2	4/28/2017	Final Report Issued

SIGNATURES

PREPARED BY



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REVIEWED BY



Clayton J. Rogers, P.Eng.
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This report was prepared by *Taylor Elson* for the account of *WSP Canada Inc.*, in accordance with the professional services agreement. The disclosure of any information contained in this report is the sole responsibility of the intended recipient. The material in it reflects *Clayton Rogers'* best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. *WSP Canada Inc.* accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This limitations statement is considered part of this report.

The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications to be made to this document.

TABLE OF CONTENTS

1	INTRODUCTION AND BACKGROUND.....	1
2	SITE DESCRIPTION.....	2
2.1	GEOLOGY.....	2
2.2	TOPOGRAPHIC INFORMATION.....	2
3	INVESTIGATION PROCEDURE	3
3.1	BOREHOLE PROGRAM.....	3
4	SUBSURFACE CONDITIONS.....	4
4.1	SANDY SILT.....	4
4.2	TILL	4
4.3	BEDROCK.....	5
5	CLOSURE.....	6

TABLES

TABLE 2-1 - BOREHOLE COORDINATES AND ELEVATIONS.....	2
TABLE 4-1 - SUMMARY OF SUBSURFACE CONDITIONS.....	4

FIGURES

FIGURE 1	SITE PLAN SHOWING APPROXIMATE BOREHOLE LOCATIONS
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APPENDICES

APPENDIX A	BOREHOLE LOG EXPLANATION FORM
APPENDIX B	BOREHOLES LOGS AND PHOTO PLATE
APPENDIX C	LABORATORY TEST RESULTS

1 INTRODUCTION AND BACKGROUND

At the request of Public Works and Government Services Canada (PWGSC), WSP Canada Inc. (WSP) has completed a geotechnical investigation for the proposed wharf structure at in Upper Port La Tour, Nova Scotia. The purpose of this investigation was to obtain information on subsurface soil and bedrock conditions at the site and provide a factual geotechnical report detailing the field findings. Soil and bedrock samples were collected at various depths and submitted for analysis of properties such as moisture content, gradation and unconfined compressive strength (UCS) for bedrock.

Fieldwork for the subsurface investigation was conducted on February 4 and 5, 2017 and consisted of drilling four (4) boreholes at the approximate locations as shown on the attached Figure 1. This report presents the results of the field investigation and laboratory testing programs.

2 SITE DESCRIPTION

The harbour of Upper Port La Tour is located on the south-west shore of Nova Scotia in Shelburne County. It is understood that PWGSC proposes to construct an L-Shaped wharf, approximately 180m in length. It is further understood that this structure is being built to replace an existing adjacent structure and will be constructed using either pile, or timber-crib foundations.

Table 2-1 - Borehole Coordinates and Elevations

BOREHOLE	NORTHING (METERS)*	EASTING (METRES)*	ELEVATION (METRES)**
BH-01	4819904.21	300304.16	-2.0
BH-02	4819948.98	300303.96	-0.9
BH-03	4819975.39	300316.58	-0.2
BH-04	4819994.21	300327.06	+0.1

*Coordinates are referenced to Horizontal Datum NAD83, Zone 20N

**Vertical Elevation are referenced to Chart Datum.

2.1 GEOLOGY

Available geologic soil mapping of the area indicates that the site is underlain by Beaver River Till. This till can generally be described as consisting of light bluish grey, loose, sandy, angular clasts, and largely cobble sized.

Geologic mapping of the proposed development area indicates that bedrock belongs to the Goldenville Formation of the Meguma Group. This formation can be described as consisting of sandstone turbidites and slate.

2.2 TOPOGRAPHIC INFORMATION

The Upper Port La Tour harbour is situated in Shelburne County, NS along the south-west shore of the province. The harbour is seasonally active and serves the local commercial fishing operation. The site generally consist of several small buildings and fish plant along with paved and unpaved parking/loading area. The adjacent coastline appears sandy with an abundance of oversize boulders near the high tide line.

The land-side of the harbour has approximately 1.5 metres of topographic relief according to available survey information provided by PWGSC. The water side of the harbour has elevations ranging from +1.1 to -2.7 chart datum from available survey soundings.

3 INVESTIGATION PROCEDURE

3.1 BOREHOLE PROGRAM

The purpose of the geotechnical investigation was to develop an understanding of the subsurface soil, bedrock and groundwater conditions at the site. Subsurface investigation of the site was conducted on February 4 and 5, 2017 and included drilling four (4) boreholes (designated BH-01 – BH-04), at the locations shown on Figure 1. The boreholes were drilled using a barge-mounted drill rig supplied by Logan Drilling. All boreholes were terminated within bedrock.

During the borehole investigation soil samples were taken at 600-mm increments using a 50 mm outside diameter split-spoon sampler, driven in accordance with standard penetration resistance procedures (ASTM D1586). N-index values, described as the number of blows required to drive the sampler 305 mm (1 ft) into the soil were recorded for each sample location and are plotted on the borehole log. Diamond-bit core-drilling of bedrock was conducted using a 96 mm outside diameter HQ core barrel at select borehole locations.

An explanation of the symbols and terms used in this report are enclosed in Appendix A. Borehole logs and photo plate detailing the subsurface conditions are enclosed in Appendix B. Confirmatory laboratory index testing results are presented in Appendix C (laboratory testing services provided by Stantec Inc.).

3.2 LABORATORY TESTING

Basic laboratory testing and visual examinations were carried out on selected soil samples from the borehole investigation. Tests were performed in accordance with materials testing requirements and procedures outlined in the ASTM and CSA testing manuals, as applicable. All laboratory testing was carried out by Stantec Inc. at the request of WSP and laboratory results can be found in Appendix C.

4 SUBSURFACE CONDITIONS

A sandy silt layer overlying undisturbed till and bedrock was encountered in the subject boreholes. The sandy silt layer consisted of sandy silt, trace clay, trace to some organics, was saturated, very loose and greyish brown in colour. Till consisted of gravelly sand to gravel and sand, an abundance of cobbles and boulders, was saturated, compact to dense and greyish brown in colour. Quartzite bedrock was encountered at depths ranging from 5.0 to 7.7 metres below the ground surface in the boreholes.

Table 4-1 - Summary of Subsurface Conditions

TEST PIT	GROUND SURFACE ELEVATION (METRES)*	THICKNESS OF SAND LAYER (METRES)	DEPTH TO TILL (METRES)	ELEVATION OF TILL (METRES)*	DEPTH TO BEDROCK (METRES)	ELEVATION OF BEDROCK (METRES)*
BH-01	-2.0	1.2	1.2	-3.2	7.7	-9.7
BH-02	-0.9	1.2	1.2	-2.1	7.7	-8.6
BH-03	-0.2	1.2	1.2	-1.4	5.0	-5.2
BH-04	+0.1	1.2	1.2	-1.1	5.0	-4.9

*Approximate elevations are taken from survey information provided by PWGSC and reference chart datum.

4.1 SANDY SILT

A sandy silt layer was encountered at all boreholes and extended to a total depth of 1.2 metres below the ground surface. The layer generally consisted of sandy silt, trace clay, trace to some organics, and was in a saturated condition, greyish brown in colour and generally very loose in relative density.

Laboratory grain size analysis of two (2) select samples of silty sand indicated an average particle size distribution (gradation) of 0.0 percent gravel, 24 to 30 percent sand, and 70 to 76 percent silt/clay. The sandy silt samples had a moisture content ranging from 51.1 to 82.3 percent. Atterberg limit tests indicate the material is non-plastic.

4.2 TILL

Available geologic soil mapping of the area indicates that the site is underlain by Beaver River Till. This till can generally be described as consisting of light bluish grey, loose, sandy, angular clasts, and largely cobble sized.

Till was encountered beneath the sandy silt layer in the subject boreholes. The till generally consisted of sandy gravel to gravel and sand, some silt, an abundance of cobbles and boulders, was in a saturated condition, greyish brown in colour and generally compact to dense in relative density.

Laboratory grain size analysis of two (2) select samples of till indicated an average particle size distribution of 43 to 47 percent gravel, 24 to 35 percent sand and a silt/clay content of 18 to 24 percent. The till samples had a moisture contents ranging from 6.8 to 10.1 percent.

4.3 BEDROCK

Geologic mapping of the proposed development area indicates that bedrock belongs to the Goldenville Formation of the Meguma Group. This formation can be described as consisting of sandstone turbidites and slate.

Fractured and weathered quartzite bedrock was encountered in all boreholes at depths ranging from 5.0 to 7.7 metres below the ground surface. Generally, the bedrock was observed to be medium strong, highly fractured, weathered and grey in color. The Rock Quality Designation (RQD) values of the core samples ranged from 0 to 80%, indicating very poor to good quality rock.

Laboratory compressive strength testing of three (3) intact rock core samples indicated uniaxial compressive strengths (UCS) ranging from 144 MPa to 157 MPa, with one sample prematurely failing along an existing fracture at 44 MPa. Based on classification systems used in the Canadian Foundation Engineering Manual (4th Ed), Section 3.2.4.1, the quartzite bedrock is generally very strong (Grade R5). Rock core photos are included in Appendix B.

5 CLOSURE

This report has been prepared for the sole benefit of PWGSC and is not intended for use by others. This report may not be reproduced without the prior written permission of WSP and PWGSC. Contractors undertaking work must draw their own interpretations of the factual investigation results provided in this report as it affects construction costs, procedures and scheduling.

As boreholes provide a localized representation of the total study area, subsurface conditions may vary between and/or beyond the borehole locations. If conditions encountered at the site vary significantly from the reported herein, we should be notified immediately so that our interpretations and recommendations can be reviewed and revised if necessary.

We trust this report meets your present requirements. If you have any questions with the information contained in the report, please do not hesitate to contact us at your convenience.

Yours truly,

WSP Canada Inc.

A handwritten signature in blue ink, appearing to read 'C. Rogers', is positioned above the printed name.

Clayton J. Rogers. P.Eng.

Manager, Geotechnical - Dartmouth

Appendix A

BOREHOLE LOG EXPLANATION FORM

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

<u>Soil Classification*</u>		<u>Terminology</u>	<u>Proportion</u>
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace" (e.g. trace sand)	<10%
Sand	0.06 to 2 mm	"some" (e.g. some sand)	10% - 20%
Gravel	2 to 60 mm	adjective (e.g. sandy)	20% - 35%
Cobbles	60 to 200 mm	"and" (e.g. and sand)	35% - 50%
Boulders	>200 mm	noun (e.g. sand)	>50%

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

<u>COHESIONLESS SOIL</u>		<u>COHESIVE SOIL</u>	
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m
Very Loose	0 to 4	Very Soft	0 to 2
Loose	4 to 10	Soft	2 to 4
Compact	10 to 30	Firm	4 to 8
Dense	30 to 50	Stiff	8 to 15
Very Dense	Over 50	Very Stiff	15 to 30
		Hard	Over 30

The moisture conditions of cohesionless and cohesive soils are defined as follows.

COHESIONLESS SOILS

Dry
Moist
Wet
Saturated

COHESIVE SOILS











DTPL - Drier Than Plastic Limit
APL - About Plastic Limit
WTPL - Wetter Than Plastic Limit
MWTPL - Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.

	Standpipe		Geotextile Material / Liner		Granular Backfill
	Piezometer		Borehole Seal (Bentonite Grout)		Granular (Filter) Pack
	Screened Interval		Cement Seal		Native Soil Backfill / Cave / Slough
	Borehole Seal (Peltonite, Bentonite or Hole Plug)				

Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS = Split Spoon	GS = Grab Sample
ST = Thin Walled Shelby Tube	CS = Channel Sample
AS = Auger Flight Sample	WS = Wash Sample
CC = Continuous Core	RC = Rock Core

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification

RQD (%)

Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60° steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{x\text{Blows}}{\text{mm}}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

W_P - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

W_L - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

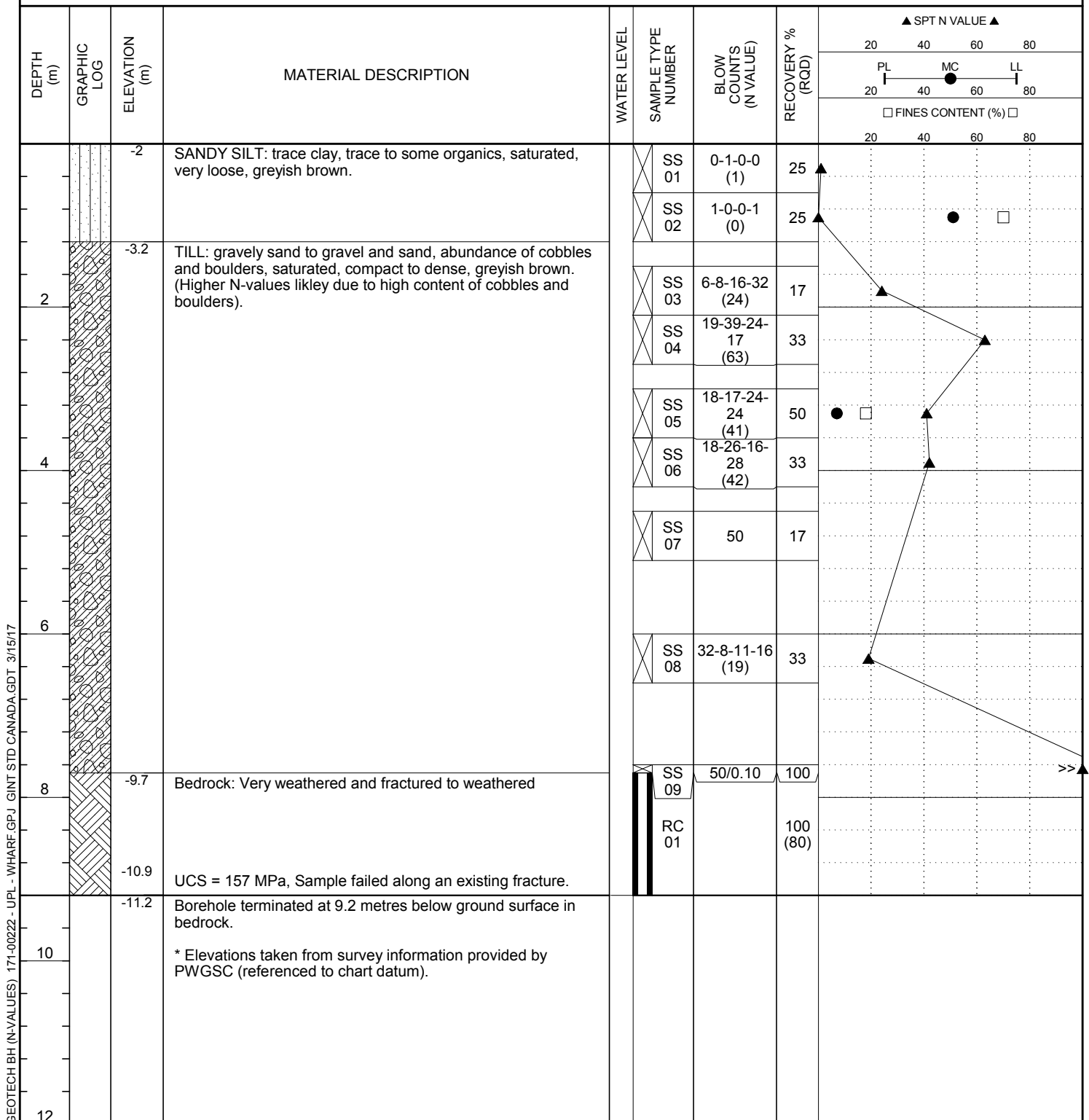
The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

Appendix B

BOREHOLES LOGS AND PHOTO PLATE

CLIENT Public Works and Government Services CanadaPROJECT NAME Proposed Wharf Geotechnical InvestigationPROJECT NUMBER 171-00222PROJECT LOCATION Upper Port La Tour, NSDATE STARTED 2/4/17 COMPLETED 2/4/17GROUND ELEVATION -2 m Chart Datum HOLE SIZE 100mmDRILLING CONTRACTOR Logan Geotech Drilling Inc.

GROUND WATER LEVELS:

DRILLING METHOD Barge Mounted Drill RigAT TIME OF DRILLING ---LOGGED BY T. Elson CHECKED BY C. RogersAT END OF DRILLING ---NOTES Proposed Wharf - Upper Port LaTourAFTER DRILLING ---

CLIENT Public Works and Government Services Canada

PROJECT NAME Proposed Wharf Geotechnical Investigation

PROJECT NUMBER 171-00222

PROJECT LOCATION Upper Port La Tour, NS

DATE STARTED 2/5/17 **COMPLETED** 2/5/17

GROUND ELEVATION -0.2 m Chart Datum **HOLE SIZE** 100mm

DRILLING CONTRACTOR Logan Geotech Drilling Inc.

GROUND WATER LEVELS:

DRILLING METHOD	Barge Mounted Drill Rig
------------------------	-------------------------

AT TIME OF DRILLING ---

LOGGED BY T. Elson **CHECKED BY** C. Rogers

AT END OF DRILLING _____

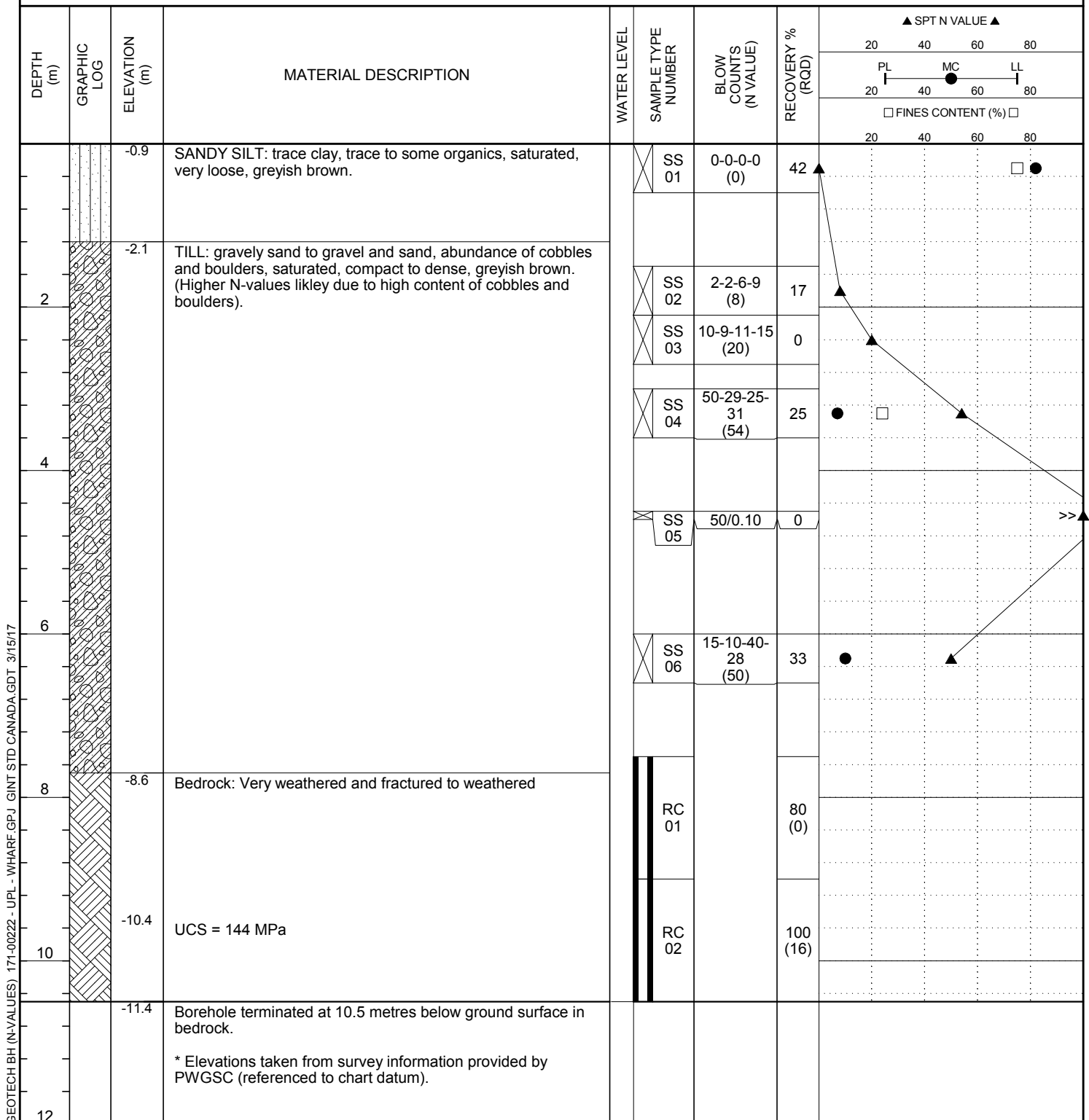
NOTES Proposed Wharf - Upper Port LaTour

AFTER DRILLING ---

[illegible]

CLIENT Public Works and Government Services CanadaPROJECT NAME Proposed Wharf Geotechnical InvestigationPROJECT NUMBER 171-00222PROJECT LOCATION Upper Port La Tour, NSDATE STARTED 2/4/17 COMPLETED 2/4/17GROUND ELEVATION -0.9 m Chart Datum HOLE SIZE 100mmDRILLING CONTRACTOR Logan Geotech Drilling Inc.

GROUND WATER LEVELS:

DRILLING METHOD Barge Mounted Drill RigAT TIME OF DRILLING ---LOGGED BY T. Elson CHECKED BY C. RogersAT END OF DRILLING ---NOTES Proposed Wharf - Upper Port LaTourAFTER DRILLING ---

CLIENT Public Works and Government Services CanadaPROJECT NAME Proposed Wharf Geotechnical InvestigationPROJECT NUMBER 171-00222PROJECT LOCATION Upper Port La Tour, NSDATE STARTED 2/5/17 COMPLETED 2/5/17GROUND ELEVATION 0.1 m Chart Datum HOLE SIZE 100mmDRILLING CONTRACTOR Logan Geotech Drilling Inc.

GROUND WATER LEVELS:

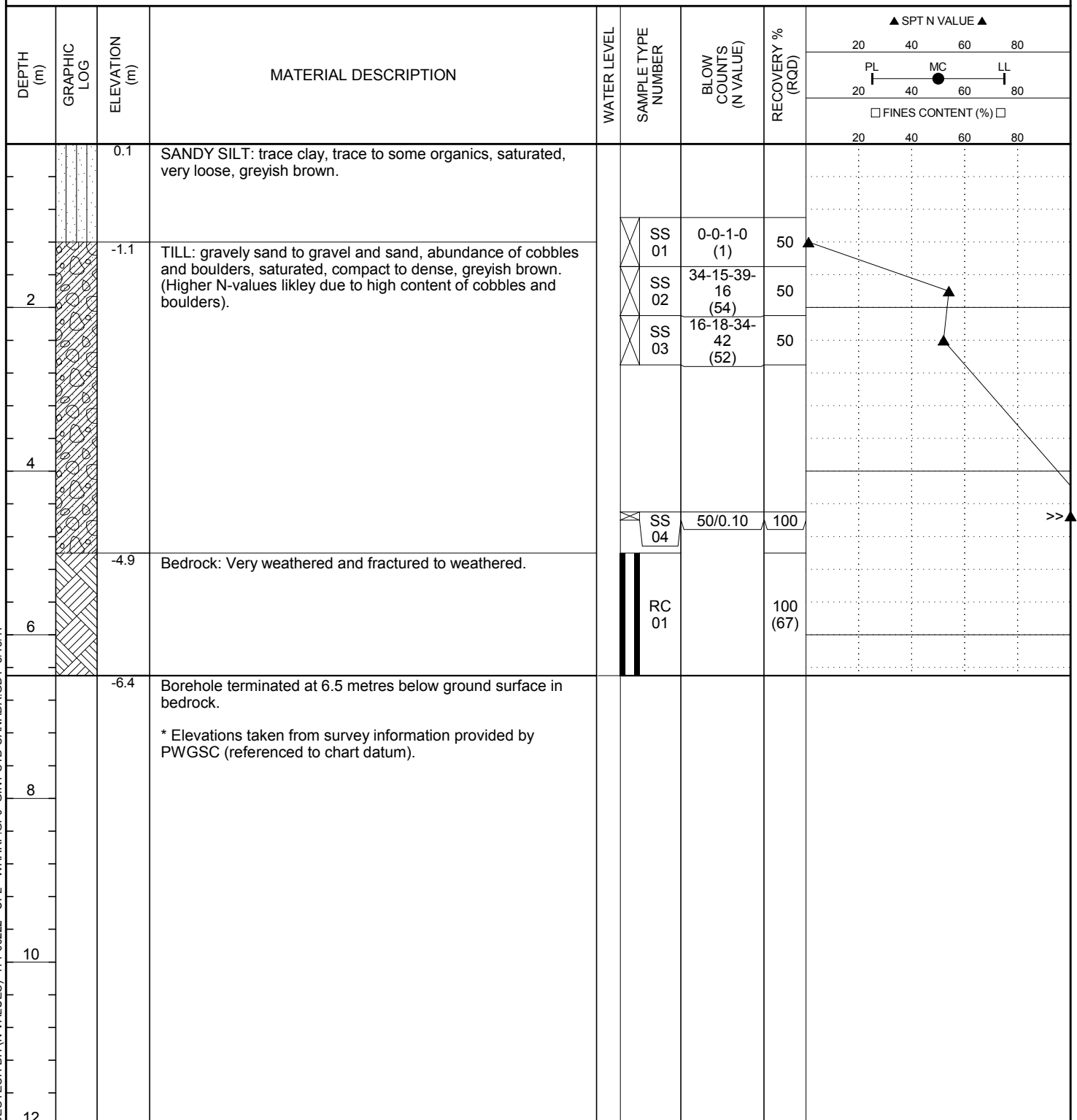
DRILLING METHOD Barge Mounted Drill RigAT TIME OF DRILLING ---LOGGED BY T. Elson CHECKED BY C. RogersAT END OF DRILLING ---NOTES Proposed Wharf - Upper Port LaTourAFTER DRILLING ---



Photo 1: Typical Sandy Silt Material



Photo 2: BH-03 Bedrock Retrieval

Appendix C

LABORATORY TEST RESULTS

Project #: 121620330

Task#: 200.115

Client: WSP Canada Inc.

Project: WSP 171-00222, Upper Port Latour Wharf

Source 1: BH02, SS01

Source 2: BH02, SS06

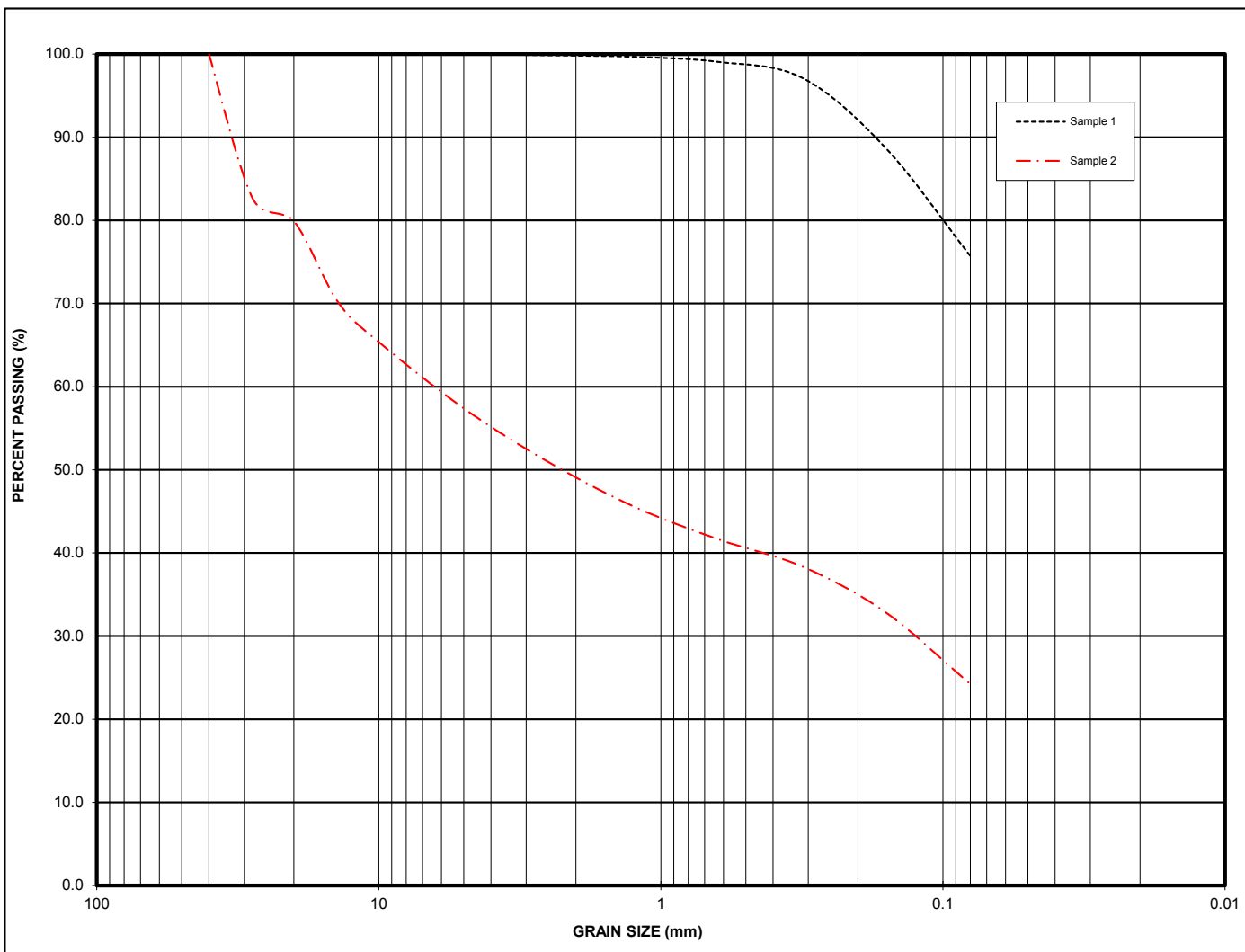
Source 3:
Material Type: N/A

Date Received: 17-Feb-17

Date Tested: 22-Feb-17

GRADING				
SAMPLE #	1	2	3	SPEC
SIEVE (mm)	% PASSING	% PASSING	% PASSING	
80				-
56				-
40		100.0		-
28		82.6		-
20		79.9		-
14		70.2		-
10		65.4		-
5	100.0	57.4		-
2.5	99.9	50.9		-
1.25	99.7	45.6		-
0.630	99.1	41.7		-
0.315	97.1	38.4		-
0.160	88.7	32.9		-
0.080	75.7	24.2		-

PHYSICAL PROPERTY TESTS			
Sample Number	1	2	
Gravel, %	0.0	42.6	
Sand, %	24.3	33.2	
Silt & Clay, %	75.7	24.2	
Classification			
Natural Moisture Content, %			
Abrasion Loss, %			
Soundness Loss, %			
Micro Deval Loss, %			
Fine Absorption, %			
Flat & Elongated Particles, %			
Coarse Absorption, %			
Coarse Spec. Gravity, kg/m ³			
Fractured Faces, %			
Liquid Limit, %			
Plastic Limit, %			
Plasticity Index, %			
Max. Dry Density: Standard			
Optimum Moisture Content %			


Technician J. Titty

Reviewed By C. Mullins

Project #: 121620330

Task#: 200.115

Client: WSP Canada Inc.

Project: WSP 171-00222, Upper Port Latour Wharf

Source 1: BH01, SS02

Source 2: BH01, SS05

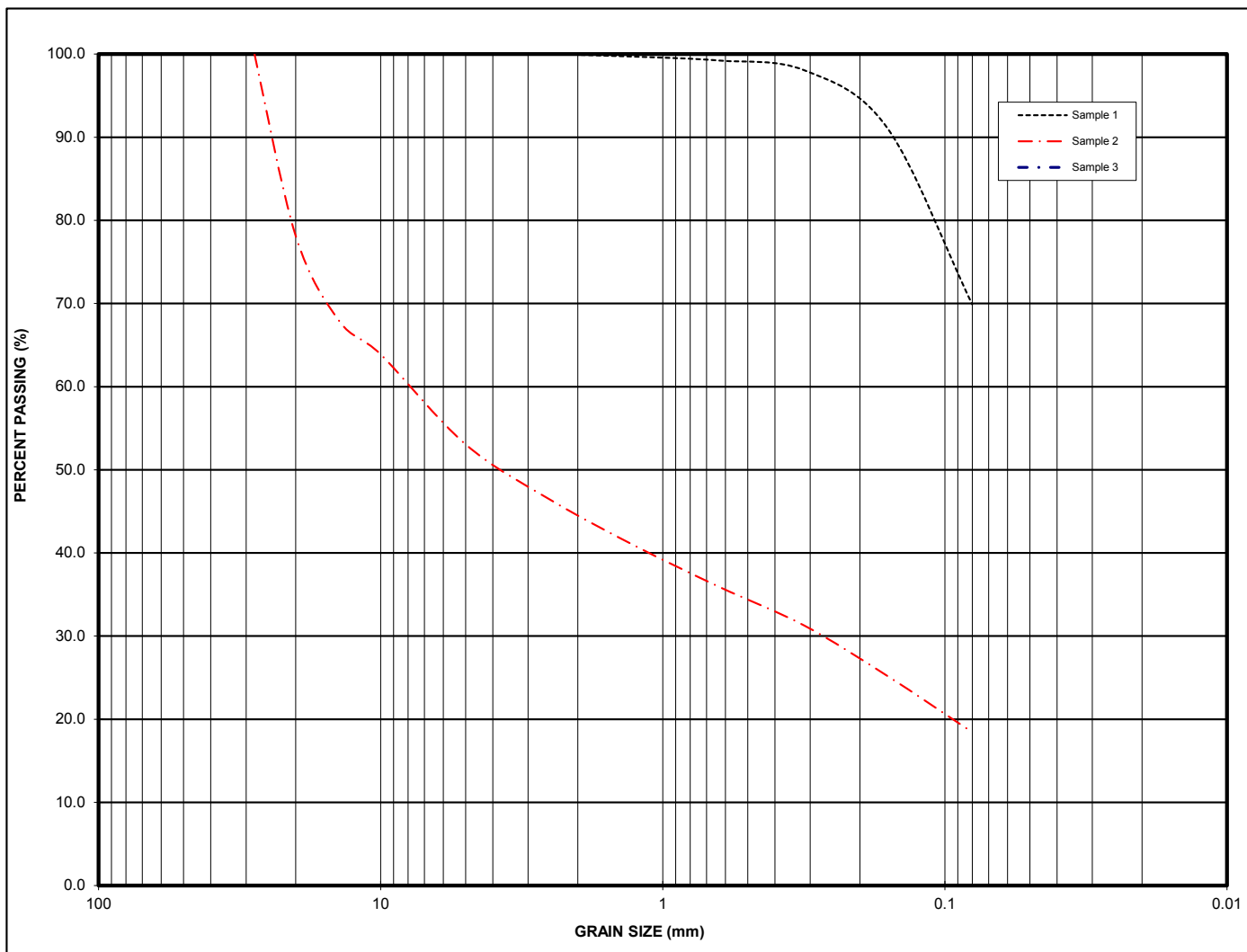
Source 3:
Material Type: N/A

Date Received: 17-Feb-17

Date Tested: 22-Feb-17

GRADING				
SAMPLE #	1	2	3	SPEC
SIEVE (mm)	% PASSING	% PASSING	% PASSING	
80				-
56				-
40				-
28		100.0		-
20		78.1		-
14		67.9		-
10		63.9		-
5		53.1		-
2.5	100.0	46.4		-
1.25	99.7	40.8		-
0.630	99.2	35.9		-
0.315	98.0	31.3		-
0.160	91.1	25.2		-
0.080	69.9	18.4		-

PHYSICAL PROPERTY TESTS			
Sample Number	1	2	
Gravel, %	0.0	46.9	
Sand, %	30.1	34.7	
Silt & Clay, %	69.9	18.4	
Classification			
Natural Moisture Content, %			
Abrasion Loss, %			
Soundness Loss, %			
Micro Deval Loss, %			
Fine Absorption, %			
Flat & Elongated Particles, %			
Coarse Absorption, %			
Coarse Spec. Gravity, kg/m ³			
Fractured Faces, %			
Liquid Limit, %			
Plastic Limit, %			
Plasticity Index, %	Non-Plastic		
Max. Dry Density: Standard			
Optimum Moisture Content %			


Technician J.Tutty

Reviewed By C.Mullins



Project Name: WSP 171-00222, Upper Port LaTour Wharf UPL-WF

Project Number: 121620330


Task: 200.115

Client: WSP Canada Inc.

[illegible]

Reviewed By: C.Mullins

Date: February 24, 2017

		Stantec Ltd. ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543							
Project Name		Upper Port Latour Wharf		Project Location	Nova Scotia			Project Number	121620330.200.115
Borehole	BH01	Sample	na	Area (mm²)	3117	L (mm)	111.00	D (mm)	63.00
Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D ₁	D ₂	D ₃	D ₄			
L ₁	0.000	0.015	0.000	0.000	0.000	0.000	D ₁ Δ	0.008	
L ₂	0.000	0.018	0.008	0.009	0.010	0.012	D ₂ Δ	0.009	
L ₃	0.000	0.020					D ₃ Δ	0.010	
							D ₄ Δ	0.012	
L ₁ Δ	0.015						L/D Ratio 1.8 L/D Out of Spec Δ Max 0.012 Δ Max / D 0.005 Perpendicularity Out of Spec		
L ₂ Δ	0.018								
L ₃ Δ	0.020								
Maximum Axial Deviation (in)									
0.02									
Axial Deviation Out of Spec									
COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012									
Load, kN	135.8	Compressive Strength, MPa			44	Unit Weight, g/cm³		2.740	
Tested By	MVG	Date			Feb.22.2017		Reviewed By		C.Mullins
Remarks	Sample failed along an existing fracture								