Subsurface Investigation
Shippagan, Gloucester County - New Brunswick

Standing Offer No. E0227 07C078/001/PWB
Call-up Against Standing Offer No. 21

Prepared For:
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Table of Contents

List of Tables

1.0 Introduction

Stantec Consulting Limited (Stantec), acting at the request of Public Works and Government Services Canada (PWGSC), has carried out a subsurface investigation along the wharf located in Shippagan Harbour in Shippagan, Gloucester County, New Brunswick. The purpose of the subsurface investigation was to obtain information on the subsurface soils and bedrock at the site.

The investigation was completed in accordance with our current Standing Offer No. E0227-07C078/001/PWB. Authorization to proceed was received via "Call-up against a Standing Offer" No. 21 from Mr. Garth Holder of PWGSC on October 8, 2009.

This factual report has been prepared specifically and solely for the project described herein. It contains all of our findings of the site investigation and laboratory testing.

2.0 Site Description

The site is located at the north end of 15^{e} Rue in Shippagan, Gloucester County, New Brunswick as shown on the Drawing No. 1 – Site Location Plan provided in Appendix D.

Boreholes were drilled from the existing wharf structure. Visually the wharf appeared to be a sheet pile structure with asphalt and concrete decking.

The site is bounded by Boulevard J.D Gauthier to the south, 16^{e} Rue to the east, Chaleur Bay to the north and Shippagan Marina to the west. 15^{e} Rue runs in an approximate northeast-southwest direction and is located immediately southwest of the site.

3.0 Field Investigation

Eight boreholes, identified as BH-01 through BH-08 were drilled at the approximate locations identified on Drawing No. 2 (Borehole Location Plan provided in Appendix D), using a track mounted drill rig provided by Boart Longyear Drilling Services Ltd. of Salisbury, New Brunswick.

The boreholes were drilled to depths ranging between 9.1 metres and 18.3 metres below the existing sea bed. The boreholes were advanced through the overburden soils mainly by rotary wash methods using NW (75 mm I.D) flush-joint casing and NQ (50 mm I.D) rods were used to prove/sample bedrock at the borehole locations. Soil samples were collected using a 50 millimeter outside diameter split spoon sampler.

Standard Penetration Test (SPT) N-values were recorded for each split spoon sample. The procedures followed were based on the standard test method ASTM D1586. The determination of soil sample compactness for granular soils, as indicated on the Borehole Records, is based on the results of the Standard Penetration Testing.

Core samples of bedrock were obtained by means of a 1.5 metre long core barrel, equipped with an NQ (50 mm I.D) – size diamond bit. Bedrock core was placed in wooded core boxes and returned to Stantec's Saint John, New Brunswick laboratory for photographing and further classification and testing.

Stantec personnel supervised the drilling activities and logged the subsurface conditions at the borehole locations. Detailed descriptions of the soils encountered and the sampling conducted are provided on the Borehole Records provided in Appendix B. Soil samples were stored in moisture-tight containers and returned to our Saint John laboratory for further classification and testing. If requested, the soil samples will be kept in storage for a period of six months from the date of the report, otherwise, the samples will be discarded after the report is approved by PWGSC..

3.1 SITE SURVEY

The approximate borehole locations are provided on the attached Drawing No. 2 – Borehole Location Plan. The locations of the boreholes were laid out in the field by Stantec personnel based on the borehole locations identified on the drawing *(not included in this report)* provided by Public Works and Government Services Canada and in relation to the existing site features and constraints of surface access. Based on the site features, several of the boreholes were relocated as shown on Drawing No. 2.

Hughes Surveys and Consultants Inc. provided the as-built coordinates and deck elevations at each of the borehole locations using global positioning system (GPS) instrumentation. All coordinates are provided with respect to the North American Datum 1983, NAD83 (CSRS), UTM Zone 20 based on New Brunswick Grid Monument MON 22118.

Elevations were obtained by Hughes Surveys and Consultants Inc., at the wharf deck surface at the borehole locations and soundings were conducted to obtain the elevation of the sea bed. Elevations are provided with reference to Chart Datum referred to CHS BM 77-B-9512 2 (Elevation 3.919 m).

The coordinates and sea bed elevation of each borehole are provided in Table 3.1.

Table 3.1 Borehole Location and Elevation Summary

Borehole ID	Northing*	Easting*	Deck Elevation (m)^{T}	Sounding (m)^{T}	Sea Bed Elevation (m)^{T}	Top of Bedrock Elevation (m)^{T}
BH-01	5289720.3	372344.1	3.84	10.03	-6.19	-12.2
BH-02	5289672.4	372387.2	3.85	10.06	-6.21	-9.3
BH-03	5289695.8	372331.4	3.80	8.71	-4.91	-7.7
BH-04	5289623.3	372245.7	3.69	10.09	-6.40	-7.0
BH-05	5289566.0	372291.9	3.71	8.51	-4.80	-6.1
BH-06	5289516.1	372340.3	3.84	8.14	-4.30	-7.9
BH-07	5289573.2	372403.3	3.95	8.79	-4.84	-5.5
BH-08	5289614.1	372396.3	4.00	7.87	-3.87	-4.9

*NAD83 (CSRS), UTM Zone 20 Based on MON 22118

T Chart Datum, CHS BM 77-B-9512 2, Elevation 3.919 m

4.0 Soil Profile

4.1 GENERAL

The soil strata encountered at the site are described in detail on the attached Borehole Records. The *Symbols and Terms used on Borehole and Test Pit Records* provide a brief explanation of the terminology and graphics used by Stantec and are provided in Appendix B.

Soil classification was based on the procedures described in ASTM D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and ASTM D2487 (Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)). In general, the principle strata encountered at the borehole locations are as follows:

- Silty GRAVEL (GM) with sand
- SILT (ML)
- Silty SAND (SM) with gravel
- Interbedded MUDSTONE, SANDSTONE, and SILTSTONE

4.1.1 Silty GRAVEL (GM) with Sand

A deposit of silty GRAVEL (GM) with sand and organics was encountered at the surface of the sea bed at borehole BH-03. The thickness of this deposit was found to be 0.6 metres at the borehole location. The material was dark brown to black in colour. One N-value from one Standard Penetration test (SPT) carried out within the deposit was 11 blows per 300 mm, indicating a relative density in the compact range.

A grain size analysis test was conducted on a sample of the material and results are summarized in Table 4.1. The results are also presented on the Gradation Curve in Appendix C.

Table 4.1 Grain Size Distribution Summary (Silty Clayey GRAVEL (GC-GM) with Sand)

Borehole ID, Sample ID.	% Gravel	% Sand	% Fines
BH-03, SS1	46.2	40.7	13.1

4.1.2 SILT (ML)

A deposit of SILT (ML) with organics to sandy SILT (ML) with organics was encountered at the surface of the sea bed at boreholes BH-01, BH-02, BH-04 and BH-05, directly below the silty GRAVEL (GM) with sand layer in borehole BH-03, and directly below the silty SAND (SM) with gravel in borehole BH-08. The thickness of this deposit was found to range from 0.6 metres to

2.5 metres at these locations. The material was found to be grey to black in colour. N-values from Standard Penetration tests (SPT) carried out within the deposit were found to be less than 2 blows per 300 mm, with the majority of SPT values being “sank” or “hammer”; meaning that no blows were required to drive the split spoon sampler a 300 mm length, indicating a relative density in the very loose range.

The natural moisture contents were determined on three selected samples from this deposit and were found to range from 38.0% to 92.1%. High water content values are attributed to the presence of organics in this layer. A grain size distribution test was conducted on a selected sample from the deposit and results are summarized in Table 4.2. Based on our visual observations of the fines portion of the material did not exhibit plasticity, the material is classified as silt. The moisture content test results are presented on the Borehole Records provided in Appendix B. The results of the grain size distribution conducted on the selected sample are presented on the Gradation Curve in Appendix C.

Table 4.2 Grain Size Distribution Summary (Sandy SILT (ML))

Borehole ID, Sample ID	% Gravel	% Sand	% Fines
BH-05, SS2	3.0	42.9	54.1

4.1.3 Silty SAND (SM) with gravel

A deposit of silty SAND (SM) with gravel and occasional siltstone cobbles and organics was encountered immediately below the SILT (ML) layer at boreholes BH-01, and BH-02 and at the surface of the sea bed surface at boreholes BH-06, BH-07 and BH-08. The thickness of this deposit was found to range from 0.6 meters to 3.6 meters at these locations. The material was found to be reddish brown to brown in colour. N-values from Standard Penetration tests (SPT) carried out within the deposit were found to range from 6 to 49 blows per 300 mm, with the SPT values in borehole BH-08 being labeled “hammer”; meaning that no blows were required to drive the split spoon sampler a 300 mm length, indicating a relative density in the very loose to dense range.

The natural moisture content determination of four selected samples from this deposit gave values ranging from 9.3% to 16.1%. One grain size distribution (sieve) test was conducted on one sample selected from the deposit and the results are summarized in Table 4.3. An Atterberg Limits test was run on the fines portion of the material and was found to be non-plastic. The moisture content test results are presented on the borehole records provided in Appendix B. The results of the grain size distribution conducted on the selected sample are presented on the Gradation Curve in Appendix C. The results of the Atterberg Limits testing are presented on the Plasticity Chart in Appendix C.

Table 4.3 Grain Size Distribution Summary (Silty clayey SAND (SC-SM) with gravel)

Borehole ID, Sample ID	% Gravel	% Sand	% Fines
BH-01, SS9	**27.8**	**54.1**	**18.1**

4.1.4 Inter-bedded MUDSTONE/SANDSTONE/SILTSTONE

An inter-bedded MUDSTONE/SANDSTONE/SILTSTONE was encountered at each borehole location; underlying the silty SAND (SM) with gravel at boreholes BH-01, BH-02, BH-06 and BH-07 and the SILT (ML) at boreholes BH-03, BH-04, BH-05 and BH-08. Each borehole was terminated within this MUDSTONE/SANDSTONE/SILTSTONE layer.

The bedrock was found to be red to purple in colour. Based on the rock quality designation, (RQD) the quality of the MUDSTONE/SANDSTONE/SILTSTONE is classified as very poor to poor.

Due to the very poor quality of the MUDSTONE bedrock, no core was available of sufficient length to satisfy the length to diameter ratio (L/D ≥ 2) for performing unconfined compressive strength tests.

The unconfined compressive strength (UCS) test data based on the point load tests conducted on two sandstone samples are summarized in Table 4.4.

Based on the average unconfined compressive strength test results, the strength of the sandstone observed at this site may be described generally as strong to very strong. **It should be noted, that the majority of the rock at the site was mudstone and therefore the unconfined compressive strength test results are not representative of the majority of the rock encountered during our subsurface investigation.**

Table 4.4 Summary of Unconfined Compressive Strength Test Results

BH-ID	Depth (m)	Average UCS (MPa)
BH- 03	11.0	126.7
BH- 05	13.2	54.8

5.0 Closure

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Public Works and Government Services Canada, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Jacques Whitford Stantec Limited should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of Care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design, or construction

This report was prepared by Lindsay MacKenzie, M.Sc.E., P.Eng., and was reviewed by Arun Valsangkar, PhD., P.Eng.

We trust that the information contained in this factual report is adequate for your present purposes. If you have questions about the contents of this factual report, or if we can be of further assistance, please do not hesitate to contact the undersigned at your convenience at (506) 634-2185.

Respectfully submitted,

JACQUES WHITFORD STANTEC LIMITED

Original Signed By

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6.0 Appendices

APPENDIX A
Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Symbols and Terms used on Borehole and Test Pit Records
Borehole Records (BH-01 through BH-08)
Rock Core Photographs

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
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:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
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, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

Rock quality classification is based on a modified core recovery percentage (RQD) 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 NW 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. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

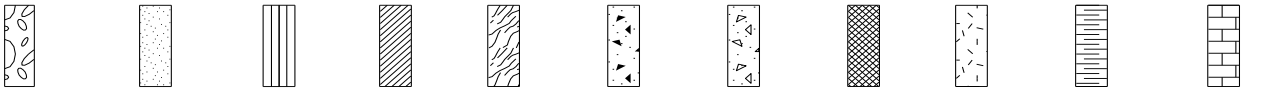
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock 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.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) 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 number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests 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 Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

Stantec

BOREHOLE RECORD

BH-01

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-01**

DATES: BORING **2009/10/27** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
6	-6.2	Sea Bed (-6.19 metres CHART DATUM)						
6		Very loose grey to black SILT (ML) with organics			SS	1	475	hammer
7					SS	2	500	hammer
8					SS	3	500	hammer
8	-8.6				SS	4	450	hammer
9		Compact to dense reddish brown silty SAND (SM) with gravel			SS	5	450	21
10					SS	6	350	32
10					SS	7	425	24
11					SS	8	175	35
11					SS	9	375	49
12	-12.2				SS	10	300	36
12		Very poor quality red MUDSTONE			SS	11	375	57
13					SS	12	350	33
14					SS	13	350	80/275
14					NQ	14	0%	0%
15					SS	15	425	0%
16					NQ	16	36%	11%
17					NQ	17	100%	0%
18					NQ	18	55%	0%
19								
20								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Continued Next Page

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BOREHOLE RECORD

BH-01

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-01**

DATES: BORING **2009/10/27** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
							mm	
20		MUDSTONE continued			NQ	19	22%	0%
21								
22					NQ	20	82%	0%
23								
24					NQ	21	100%	0%
	-24.5							
25		End of Borehole						
		Northing: 5289720.3						
26		Easting: 372344.1						
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-02

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-02**

DATES: BORING **2009/10/28** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
6	-6.2	Sea Bed (-6.21 metres CHART DATUM)						
		Very loose grey to black SILT (ML) with trace sand and black organics			SS	1	350	sank
					SS	2	550	hammer
					SS	3	NR	hammer
	-8.7				SS	4	450	hammer
9	-9.3	Loose reddish brown to brown silty SAND (SM) with gravel			SS	5	350	8
		Very poor quality red MUDSTONE			SS	6	425	40
					SS	7	500	28
					SS	8	500	57
					HQ	9	50%	0%
					SS	10	425	86
					HQ	11	62%	0%
					HQ	12	50%	0%
	-16.0							
	-16.3	Very poor quality purple SANDSTONE			HQ	13	60%	0%
	-16.9	Very poor quality red MUDSTONE						
		End of Borehole						
		Northing: 5289672.4 Easting: 372387.2						

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-03

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-03**

DATES: BORING **2009/10/26** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
	-4.9	Sea Bed (-4.91 metres CHART DATUM)						
	-5.5	Compact brown to black silty GRAVEL (GM) with sand and organics			SS	1	350	11
		Very loose grey to black SILT (ML) with organics			SS	2	150	2
					SS	3	250	2
					SS	4	200	hammer
	-7.7				SS	5	225	20
		Very poor quality red MUDSTONE			SS	6	475	68
					SS	7	425	15
					SS	8	200	85/250
	-10.7				HQ	9	40%	0%
	-11.5	Very poor quality grey SANDSTONE			HQ	10	55%	10%
		Very poor quality red MUDSTONE			HQ	11	40%	0%
					HQ	12	30%	0%
					HQ	13	12%	0%
					HQ	14	100%	0%
	-18.5							
		End of Borehole Northing: 5289695.8 Easting: 372331.4						

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-04

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-04**

DATES: BORING **2009/10/29** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
0								
1								
2								
3								
4								
5								
6	-6.4	Sea Bed (-6.4 metres CHART DATUM)						
7	-7.0	Very loose grey to black SILT (ML) with organics			SS	1	300	hammer
					SS	2	500	86
8		Very poor quality red MUDSTONE			HQ	3	43%	0%
9								
10					HQ	4	83%	0%
	-10.7							
11		Very poor quality purple SANDSTONE			HQ	5	67%	0%
12								
13					HQ	6	43%	7%
	-14.0							
14		Very poor quality red MUDSTONE			HQ	7	100%	0%
15	-15.5							
16		End of Borehole						
		Northing: 5289623.3						
17		Easting: 372245.7						
18								
19								
20								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec — BOREHOLE RECORD — BH-05

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-05**

DATES: BORING **2009/10/29** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
0								
1								
2								
3								
4								
	-4.8	Sea Bed (-4.80 metres CHART DATUM)						
5		Very loose grey to black sandy SILT (ML) with organics			SS	1	350	sank
6	-6.1				SS	2	175	hammer
	-6.3	Very poor quality red MUDSTONE			SS	3	100	50/50
7		Purple conglomerate boulder			HQ	4	20%	0%
	-7.9				SS	5	125	50/125
8		Very poor quality red MUDSTONE						
9					HQ	6	35%	0%
10					HQ	7	67%	0%
11								
12	-12.4				HQ	8	42%	0%
13		Poor quality purple SANDSTONE			HQ	9	100%	48%
	-13.9							
14		Very poor quality red MUDSTONE						
15	-15.5				HQ	10	27%	0%
16		End of Borehole						
		Northing: 5289566.0						
17		Easting: 372291.9						
18								
19								
20								

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 ●
10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-06

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-06**

DATES: BORING **2009/11/02** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
0								
1								
2								
3								
4	-4.3	Sea Bed (-4.3 metres CHART DATUM)						
5		Loose reddish brown to brown silty SAND (SM) with gravel			SS	1	350	6
					SS	2	300	10
6					SS	3	150	10
					~~SS~~	~~4~~	~~100~~	~~50/100~~
7					NQ	5	16%	0%
	-7.9							
8		Very poor quality red to green to grey MUDSTONE			SS	6	375	97/275
					NQ	7	21%	0%
9					~~SS~~	~~8~~	~~125~~	~~50/125~~
10					NQ	9	25%	0%
11					NQ	10	77%	0%
12								
13					NQ	11	97%	0%
14								
	-14.6				NQ	12	80%	15%
15		Very poor quality purple SILTSTONE						
16					NQ	13	90%	0%
	-16.8							
17		End of Borehole						
18		Northing: 5289516.1 Easting: 372340.3						
19								
20								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-07

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-07**

DATES: BORING **2009/11/03** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
	-4.8	Sea Bed (-4.84 metres CHART DATUM)						
5	-5.5	Dense brown silty SAND (SM) with gravel and siltstone cobbles			SS	1	300	38
6		Very poor quality red MUDSTONE			SS	2	400	25
					SS	3	425	42
7					SS	4	225	22
					NQ	5	62%	0%
8					NQ	6	50%	0%
9								
10					NQ	7	100%	0%
11								
12					NQ	8	87%	0%
13	-13.1							
		Poor to very poor quality purple SILTSTONE			NQ	9	100%	42%
14								
15	-15.5				NQ	10	25%	25%
16		End of Borehole						
		Northing: 5289573.2						
17		Easting: 372403.3						
18								
19								
20								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

Stantec

BOREHOLE RECORD

BH-08

CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA** PROJECT No. **1041315-968**

LOCATION **Shippagan Wharf, Shippagan, NB** BOREHOLE No. **BH-08**

DATES: BORING **2009/11/03** WATER LEVEL **Tidal** DATUM **Chart**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD
	0.00	0 metres CHART DATUM					mm	
0								
1								
2								
3								
	-3.9	Sea Bed (-3.87 metres CHART DATUM)						
4		Very loose dark brown to black silty SAND (SM) with gravel and organics			SS	1	175	hammer
	-4.9				SS	2	250	hammer
5		Very loose to loose dark grey SILT (ML)			SS	3	150	hammer
6	-6.3				SS	4	300	5
		Very poor quality purple SILTSTONE			SS	5	350	43
7					SS	6	250	25
8					SS	7	375	57
					SS	8	500	40
9					SS	9	500	77
10					NQ	10	37%	0%
					NQ	11	25%	0%
11					NQ	12	88%	27%
12								
13	-13.0				NQ	13	78%	16%
		Very poor quality red MUDSTONE						
14					NQ	14	58%	0%
15	-15.5							
16		End of Borehole						
		Northing: 5289614.1						
17		Easting: 372396.3						
18								
19								
20								

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 ●

10 20 30 40 50 60 70 80 90

Note:
"sank" - sank under self weight of rods, no blows required
"hammer" - sank under self weight of hammer, no blows required
"push" - sank with push of hammer, no blows required

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded
✖ Fall Cone

BH-01

BH-02

BH-03

BH-04

BH-05

BH-06

BH-07

BH-08

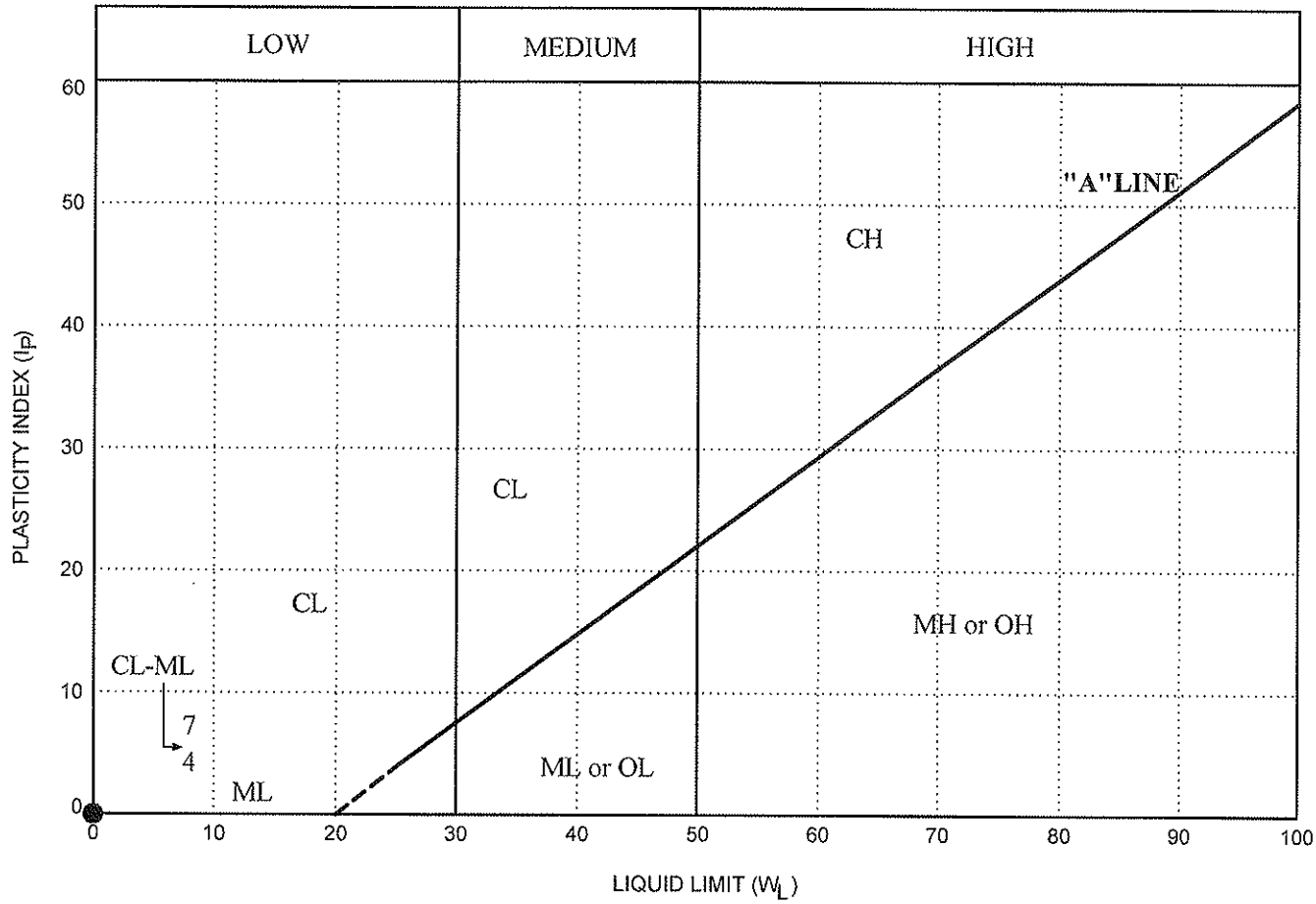
APPENDIX C
Laboratory Test Results

Stantec

Project No.: 1041315-968
Project Description: Shippagan Wharf
Location: Shippagan, New Brunswick

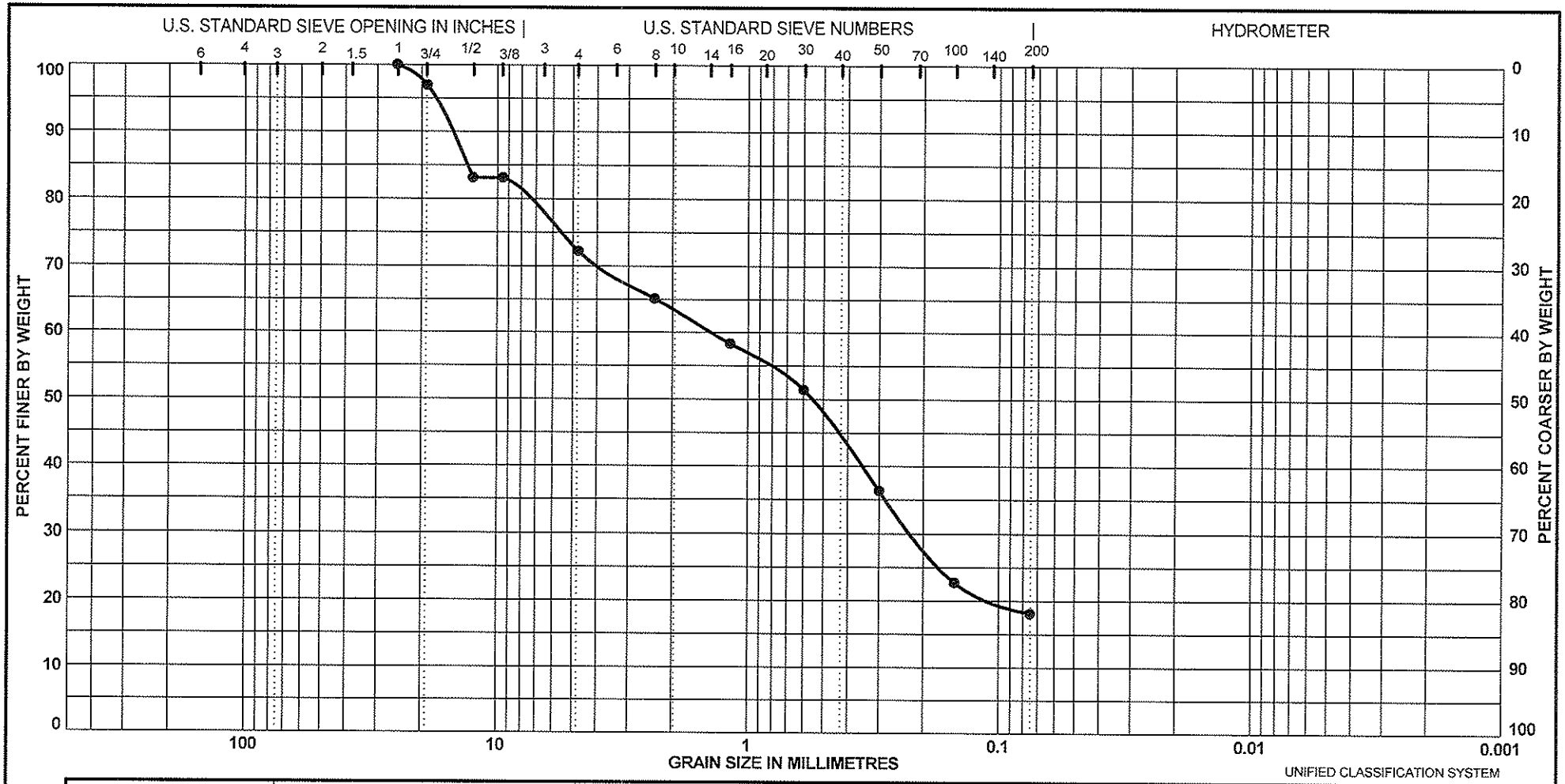
Borehole Idenfication	Depth	Diameter	Gauge Pressure	Point Load Index	Corrected Point Load Index	Corrected Unconfined Compressive Strength	Average Point Load Index	Average Unconfined Compressive Strength
	(m)	(mm)	(psi)	(MPa)	(MPa)	(MPa)	(MPa)	(MPa)
BH 03	11.0	47.2	1480	5.20	5.07	126.7	5.1	126.7
BH 05	13.2	47.2	640	2.25	2.19	54.8	2.2	54.8

PLASTICITY CHART



SYM.	SOURCE	DEPTH (m)	LL	PL	PI	W%	DESCRIPTION
●	BH-01	11.4	NP	NP	NP	9.3	Silty SAND (SM) with gravel

Project: **Shippagan Wharf,**		Location: **Shippagan, NB**
Job No.: **1041315-968**		Notes:
Date: **2009-11-13**		**SOIL PLASTICITY**

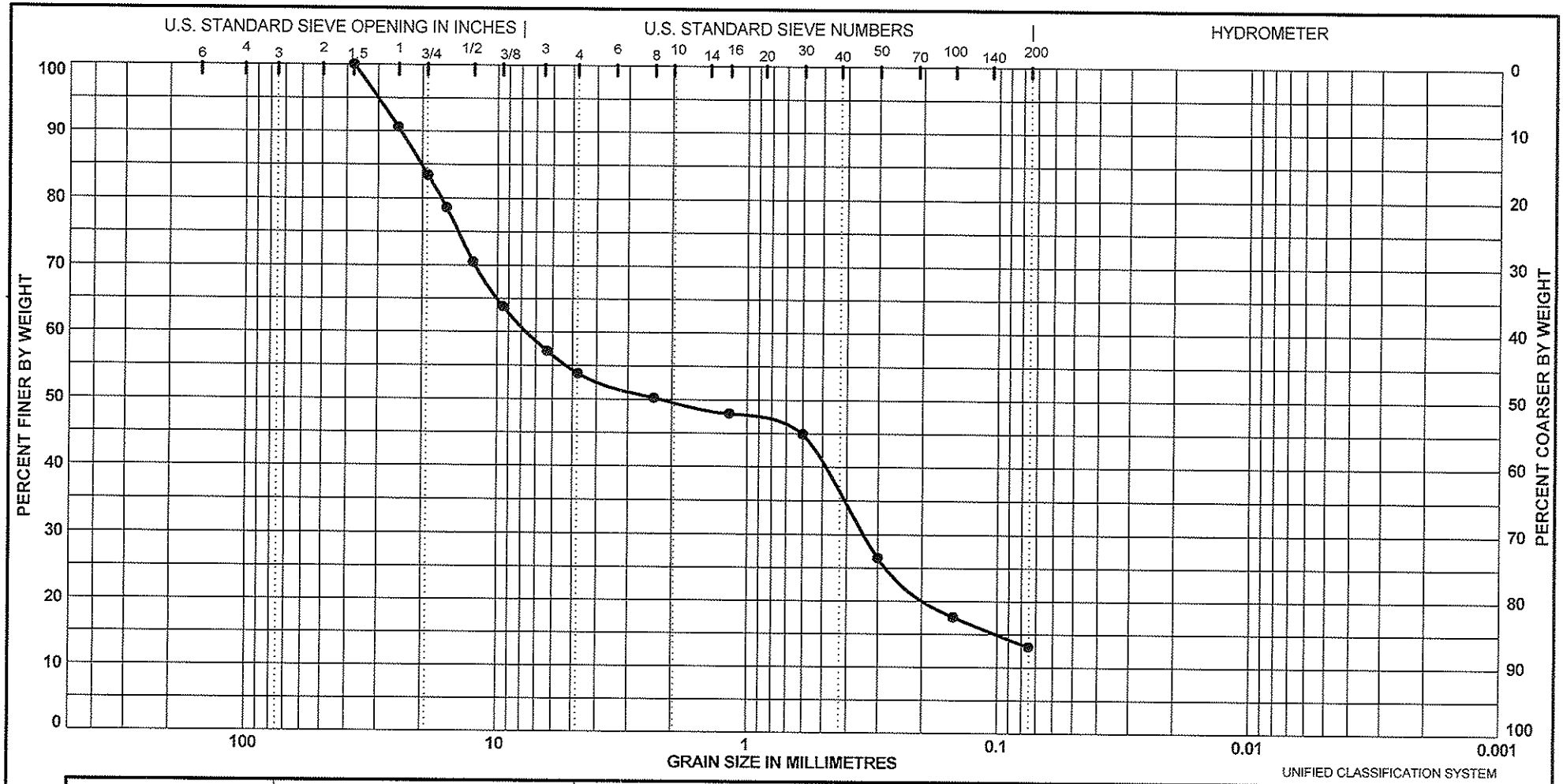


COBBLES	GRAVEL		SAND			SILT and CLAY	
	coarse	fine	coarse	medium	fine	SILT	CLAY

Source	Sample	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH-01	11	Silty SAND (SM) with gravel	9.3	NP	NP	NP	27.8	54.1	18.1	

Stantec

Project: **Shippagan Wharf,**	Location: **Shippagan, NB**
Job No.: **1041315-968**	Notes:
Date: **2009/11/13**	**GRADATION CURVES**



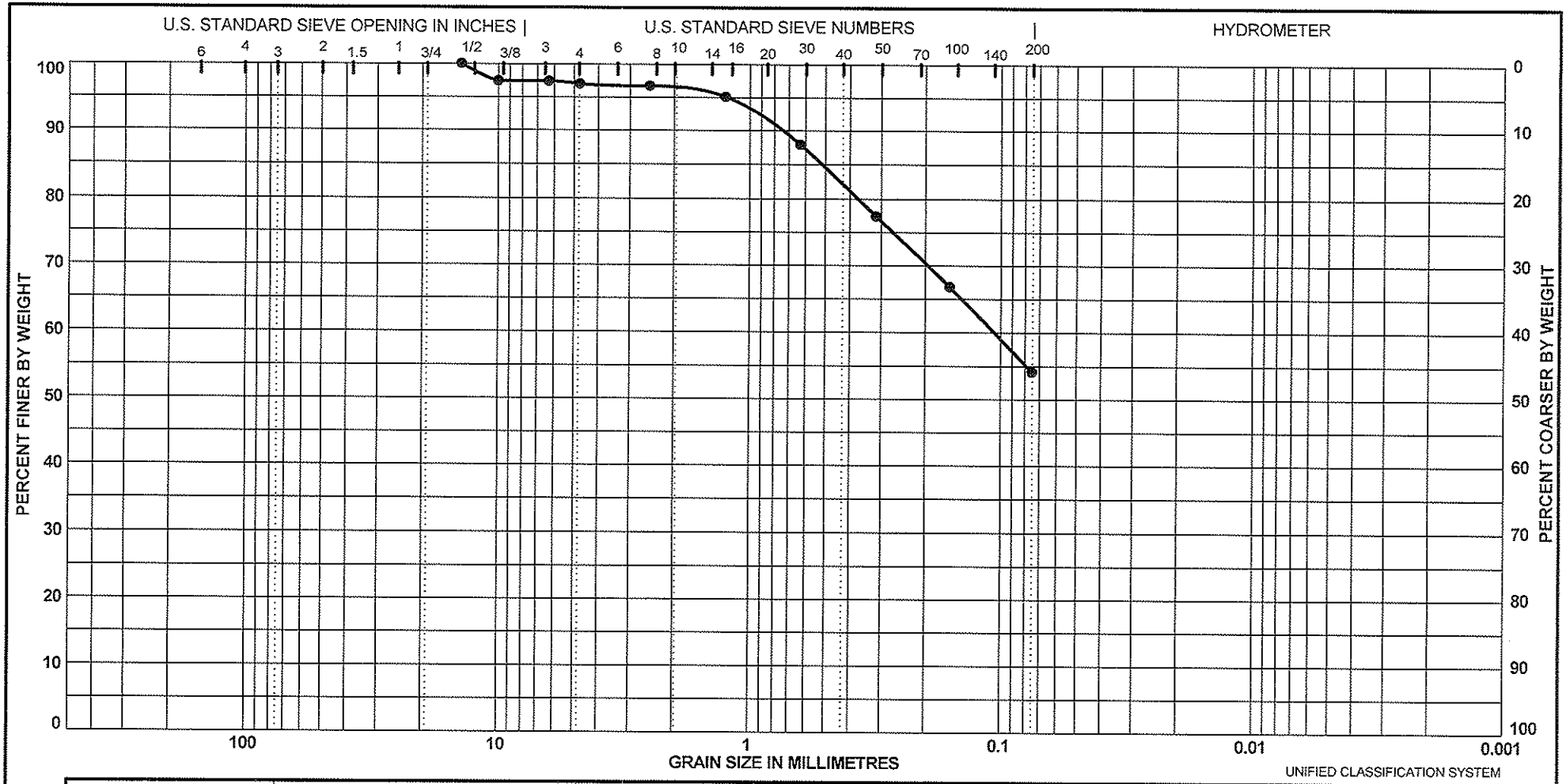
UNIFIED CLASSIFICATION SYSTEM

COBBLES	GRAVEL		SAND			SILT and CLAY	
	coarse	fine	coarse	medium	fine	SILT	CLAY

Source	Sample	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
BH-03	5	Silty GRAVEL (GM) with sand					46.2	40.7	13.1	

Stantec

Project: **Shippagan Wharf,**	Location: **Shippagan, NB**
Job No.: **1041315-968**	Notes:
Date: **2009/11/13**	**GRADATION CURVES**



COBBLES	GRAVEL		SAND			SILT and CLAY	
	coarse	fine	coarse	medium	fine	SILT	CLAY

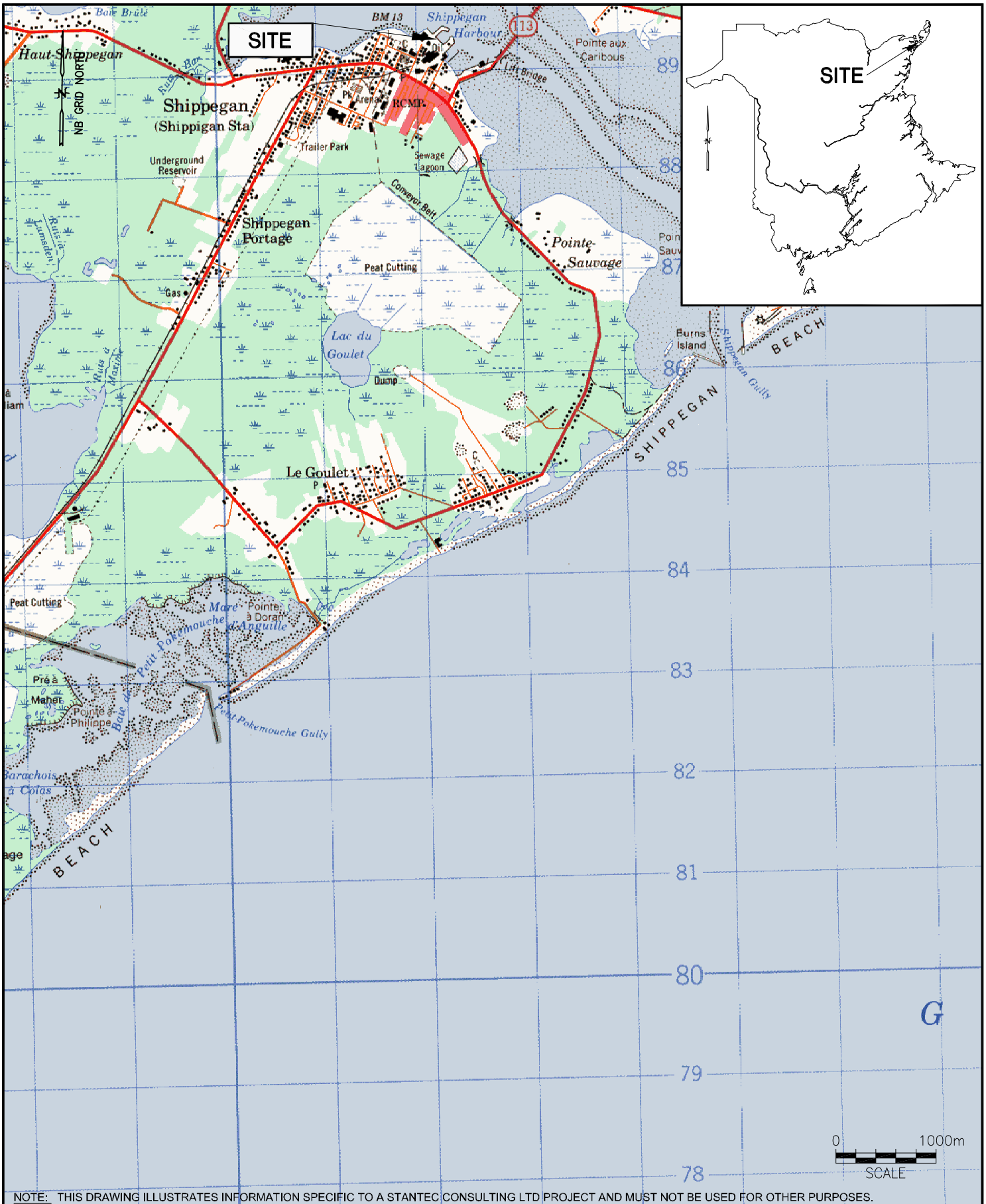
Source	Sample	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH-05	6	Sandy SILT (ML)					3.0	42.9	54.1	

Stantec

Project: **Shippagan Wharf,**	Location: **Shippagan, NB**
Job No.: **1041315-968**	Notes:
Date: **2009/11/13**	**GRADATION CURVES**

APPENDIX D

Drawing No. 1 – Site Location Plan
Drawing No. 2 – Borehole Location Plan



NOTE: THIS DRAWING ILLUSTRATES INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD PROJECT AND MUST NOT BE USED FOR OTHER PURPOSES.

SITE LOCATION PLAN

SUBSURFACE INVESTIGATION
SHIPPAGAN, NB

Client: PWGSC

Scale:	Job No.:	Dwg. No.:
1:50,000	1041315-968	01

Date:	Dwn. By:	Appd. By:
09 10 23	JCB	RB

Stantec

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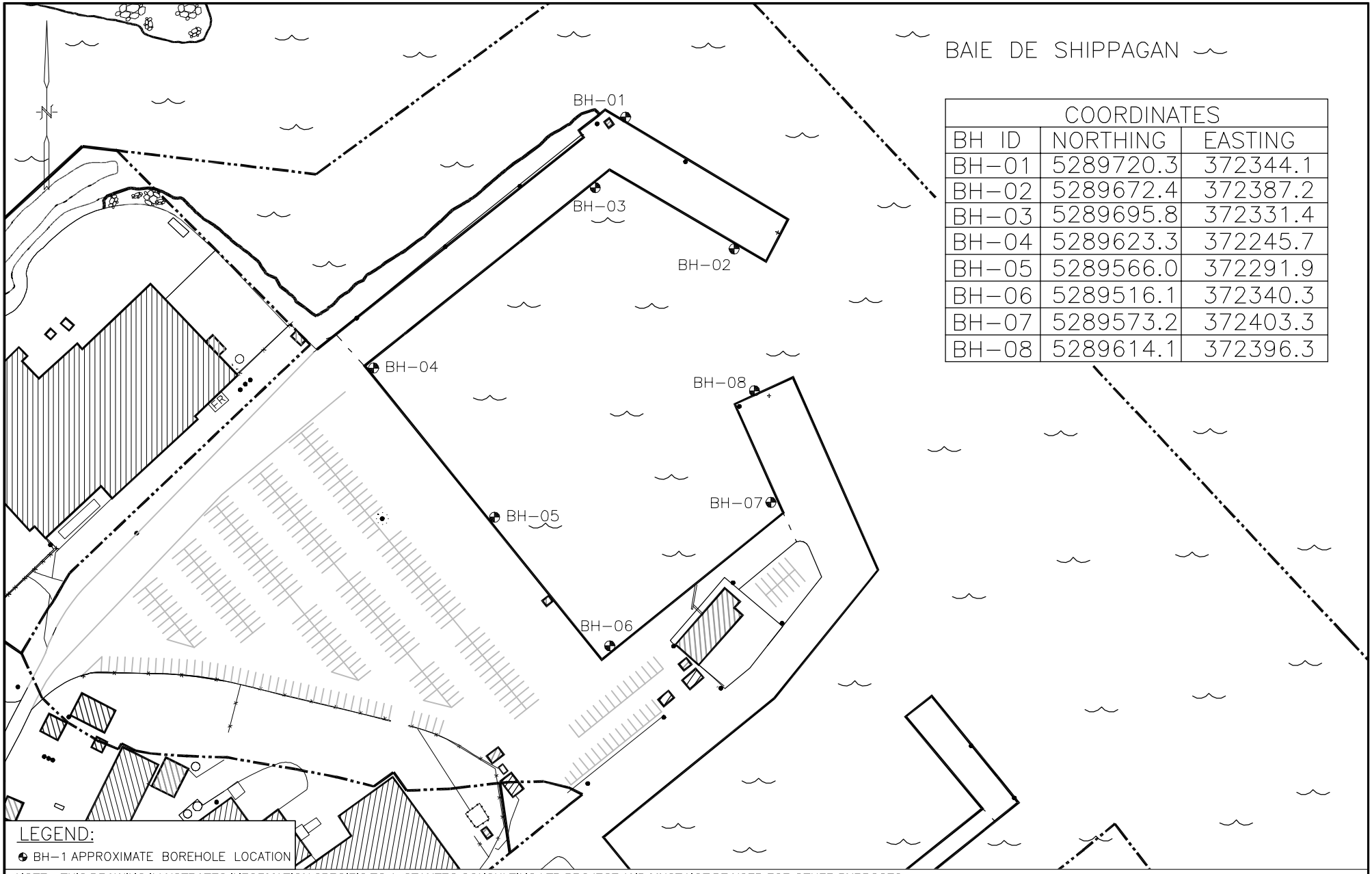

COORDINATES		
BH ID	NORTHING	EASTING
BH-01	5289720.3	372344.1
BH-02	5289672.4	372387.2
BH-03	5289695.8	372331.4
BH-04	5289623.3	372245.7
BH-05	5289566.0	372291.9
BH-06	5289516.1	372340.3
BH-07	5289573.2	372403.3
BH-08	5289614.1	372396.3

LEGEND:

◓ BH-1 APPROXIMATE BOREHOLE LOCATION

NOTE: THIS DRAWING ILLUSTRATES INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD PROJECT AND MUST NOT BE USED FOR OTHER PURPOSES.

BOREHOLE LOCATION PLAN

SUBSURFACE INVESTIGATION

SHIPPAGAN, NB

Client: PWGSC

Scale:	Job No.:	Dwg. No.:
1:2000	1041315-968	02

Date:	Dwn. By:	Appd. By:
09 10 23	JCB	RB

Stantec

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