



**Foundation Investigation Report**  
Highway 7  
Culvert at Station 19+538  
Belmont Township

Morrison Hershfield

W.P. 84-99-00

Geocres No. 31C-210

Project No. 122410641

February 2012

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**FOUNDATION INVESTIGATION REPORT**

For

W.P. 84-99-00

Highway 7 – Culvert at Station 19+538

Belmont Township

## **1.0 Introduction**

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Stantec Consulting Ltd. (Stantec) was retained by Morrison Hershfield, on behalf of the Ministry of Transportation, Ontario (MTO), to undertake the investigation of the existing conditions at the culvert located at Station 19+538 on Highway 7 in Belmont Township, Ontario.

This Foundation Investigation Report has been prepared specifically and solely for the culvert which is part of Project W.P. 84-99-00. The culvert site is located on Highway 7 approximately 20 m west of Preneveau Road (County Road 50).

## **2.0 Site Description and Geology**

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### Site Location

The site is located on Highway 7, at approximate Station 19+538, shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. At the project site, Highway 7 runs east/west with chainage increasing from west to east. The axis of the existing culvert is nearly perpendicular to the Highway 7 centreline.

### General Site Description

At the culvert location Highway 7 has one lane in each direction with a taper for a right-turn lane onto County Road 50. The paved portion of Highway 7 at this location is approximately 11 m wide.

### Existing Culvert

The existing culvert consists of a 914 mm diameter Corrugated Steel Pipe (CSP) section with a length of approximately 24.1 m.

### Physiographic Description

The site is located within the physiographic region known as the Dummer Moraines. The region predominantly contains moraines and drumlinized till plain overlying limestone bedrock.

The terrain generally slopes gently southwards.

At the investigation site, Highway 7 crosses a swamp which includes cattails on both sides of the road. See photographs in Appendix A.

### **3.0 Investigation Procedures**

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#### **3.1 FIELD INVESTIGATION**

The foundation field investigation carried out at the culvert site consisted of two boreholes within the driving lanes of Highway 7; one on either side of the culvert. The boreholes were designated as BH11-1 and BH11-2. Borehole locations are shown on the Borehole Location Plan, Drawing No.1 in Appendix A.

Prior to carrying out the investigation, Stantec contacted the public utility authorities to clear the borehole locations of both private and public utilities.

The field drilling program was carried out on July 18 and 19, 2011. The boreholes were advanced using a CME-75 truck mount drill rig equipped with continuous flight hollow-stem augers and NQ-size rock coring equipment. Standard Penetration Tests (SPT) were performed at regular intervals in both boreholes while collecting soil samples in accordance with ASTM (1999). Continuous rock coring was carried out in both boreholes over approximate lengths of 7 and 5.9 m.

The subsurface stratigraphy encountered in each borehole was recorded in the field by Stantec field personnel. All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing.

Boreholes were backfilled with auger cuttings and bentonite layers to match observed stratigraphy in accordance with MOE requirements. The holes were topped with cold patch asphalt.

#### **3.2 LOCATION AND ELEVATION SURVEY**

Borehole locations were established in the field by Stantec personnel relative to the centerline of the existing highway alignment and the existing culvert. The ground surface elevation at each borehole location was surveyed by Stantec personnel with reference to a Geodetic Benchmark. The benchmark used was the centerline of top of pavement at Station 19+538. This benchmark has a geodetic elevation of 196.3 m. Borehole location information is summarized in Table 3.1.

**Table 3.1: Borehole Summary**

	<b>Boreholes</b>	
	<b>BH11-1</b>	<b>BH11-2</b>
MTM Zone 9 Coordinates		
Northing	4922884	4922890
Easting	200022	200029

	Boreholes	
	BH11-1	BH11-2
Station	19+534	19+542
Offset	2.5 Rt CL	2.0 Lt CL
Ground Surface Elevation, m	196.4	196.3
Total Depth Drilled, m	19.2	19.8
End of Borehole Elevation, m	177.2	176.5
Depth Augered, m	12.2	13.9
Number of Soil Samples	13 <sup>1</sup>	16 <sup>2</sup>
Depth Cored, m	7.0	5.9

Notes: (1) Two of the 15 attempted samples were not recovered.

(2) Two of the 18 attempted samples were not recovered.

### 3.3 LABORATORY TESTING

All samples were taken to Stantec's Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer. Selected soil samples were submitted for plasticity testing (4 samples), gradation analysis (14 samples), moisture content testing (29 samples), and organic content (3 samples).

It is noted that a nominal size of 0.002 mm has been utilized to distinguish between silt and clay size particles.

Unconfined compressive strength tests were conducted on three bedrock samples.

Samples remaining after testing will be placed in storage for a period of one year after issuance of the final report. It is noted that sample conditions will change over time. After the storage period, the samples will be discarded unless we are directed otherwise by MTO.

## 4.0 Subsurface Conditions

### 4.1 GENERAL

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

In general, the subsurface stratigraphy encountered during the field investigation consisted of asphalt pavement over roadway and embankment fill material over organic material (peat and marl) over sand and silt deposits over till over limestone bedrock.

Descriptions of these strata are given below. A Borehole Location Plan and a Stratigraphic Section showing the soils encountered within the boreholes are provided on Drawing No. 1 in Appendix A.

## **4.2 OVERBURDEN**

### **4.2.1 Pavement Structure and Embankment Fill**

The pavement structure was observed in both boreholes and consisted of approximately 150 to 190 mm of asphalt overlying approximately 1.7 to 1.8 m of granular base/subbase and embankment fill. The fill layer extended to approximate elevation of 194.3 to 194.6 m.

Standard Penetration Test (STP) blow count (N-values) within the base/subbase and embankment fill material ranged from 8 to 41 blows per 0.3 m penetration suggesting a loose to dense state.

Grain size analysis and moisture content testing carried out on samples of the fill material yielded the following results:

Gravel:	14 to 29%
Sand:	54 to 62%
Fines (silt & clay):	17 to 27%
Moisture Content:	6 to 11%

This material can be classified as silty sand (SM) to silty sand with gravel (SM). The grain size distribution curves are shown on Figure 1 in Appendix C.

### **4.2.2 Peat**

A layer of soft brown peat was encountered in both boreholes immediately beneath the fill material. The thickness of the peat layer was approximately 0.9 and 1.4 m; extending down to an elevation of approximately 193.7 and 192.9 m.

The STP N-values within the peat layer was less than 4 blows per 0.3 m suggesting a very loose or soft state.

No sample was retrieved during the course this investigation; however, previous pavement investigation carried out in the immediate vicinity of the current location indicated a moisture content of 313% for the peat layer.

### **4.2.3 Marl**

Marl was observed in both boreholes immediately beneath the peat layer. The marl layer had a thickness of approximately 0.5 m and extended to approximate elevation of 193.2 and 192.4 m. The STP N-values within the marl layer were less than 3 blows per 0.3 m suggesting a very loose state. The moisture content of this layer was approximately 106%. The organic content of a sample retrieved from the marl layer was approximately 10%.

#### **4.2.4 Silty Sand**

This deposit was encountered in both boreholes immediately beneath the marl layer. The thickness of the layer was approximately 3.5 and 3.6 m and extended to elevations of approximately 189.7 and 188.8 m.

This deposit consisted predominantly of silty sand with variable amounts of gravel. The SPT N-values for this deposit ranged from 6 to 22 blows per 0.3 m indicating a loose to compact state.

Index tests carried out on representative samples from this deposit yielded the following results:

Gravel:	0 to 13%
Sand:	66 to 90%
Fines (silt & clay):	10 to 23%
Moisture Content:	15 to 25%
Organic Content:	1 to 2%

The material of this deposit can be classified generally as silty sand (SM). The upper portion of this layer in Borehole BH11-2 contained slightly less fines and can be classified as a poorly graded sand with silt (SP-SM). The lower portions in both boreholes contained more gravel and one tested sample can be classified as well-graded sand with silt (SW-SM). The grain size distribution plots of representative samples obtained from this deposit are shown in Figures 2a and 2b in Appendix C.

#### **4.2.5 Silt**

A silt deposit was encountered in both boreholes immediately beneath the silty sand layer. The thickness of this deposit was 3.8 and 4.5 m; extending to an approximate elevation of 185.9 and 184.3 m.

The SPT N-values for this deposit ranged from 1 to 10 blows per 0.3 m indicating a very loose to loose state.

Index tests carried out on representative samples from this deposit yielded the following results:

Gravel:	0%
Sand:	0 to 9%
Silt:	78 to 84%
Clay:	9 to 20%
Moisture Content:	20 to 33%

The grain size distribution plots of representative samples obtained from this deposit are shown in Figure 3.

Four Atterberg Limits tests were carried out on representative samples from this deposit. Three samples were non-plastic while one sample had low plasticity (plasticity index = 6%). The plasticity chart is provided in Figure 4 in Appendix C.

The material of this deposit can be classified as silt (ML).

#### **4.2.6 Till**

This deposit was encountered in both boreholes immediately beneath the silt layer. The approximate thickness of the till layer was 1.7 and 1.9 m; extending to an approximate elevation of 184.2 and 182.4 m.

The till deposit consisted predominantly of silty sand with variable amounts of gravel. The SPT N-values for this deposit ranged from 46 to greater than 100 blows per 0.3 m suggesting a dense to very dense state.

Index tests carried out on representative samples from this deposit yielded the following results:

Gravel:	23 and 33%
Sand:	39 and 41%
Fines (silt & clay)	28 and 36%
Moisture Content:	6 to 8%

The material of this deposit can be classified as silty sand with gravel (SM). The grain size distribution plots of representative samples obtained from this deposit are shown in Figure 5.

### **4.3 BEDROCK**

Grey limestone bedrock was encountered in both boreholes. Bedrock was confirmed by coring approximately 7.0 and 5.9 m into the bedrock using NQ-size coring equipment. Bedrock was encountered at elevations of 184.2 and 182.4 m (approximately 12.2 and 13.9 m below existing ground surface).

The total core recovery (TCR) of the rock ranged between 14 and 52% (with average of 29%). The rock quality designation (RQD) ranged between 3 and 44% (with average of 15%), indicating a very poor to poor rock mass quality. The bedrock was friable to slightly weathered with joint spacing ranging from close to moderate and joint orientation predominantly flat. A detailed description of the rock core is provided in Field Core Logs along with rock core photographs in Appendix B.

Unconfined compressive strength tests were carried out on a total of three samples from both boreholes. The results of these tests are summarized in Table 4.1.

**Table 4.1: Unconfined Compressive Strength of Rock Cores**

Borehole	Ground Surface Elevation (m)	Test Elevation (m)	Unconfined Compressive Strength (MPa)
BH11-1	196.4	180.2 to 180.1	227
		177.9 to 177.8	183
BH11-2	196.3	176.6 to 176.5	184



#### **4.4 GROUNDWATER**

Groundwater was observed during drilling in both boreholes. Groundwater was observed approximately 1.5 m below existing ground surface (corresponding to approximate elevation of 194.8 and 194.9 m).

Fluctuations in the groundwater and culvert water levels should be anticipated due to seasonal variations or in response to a particular precipitation event.

#### **5.0 Miscellaneous**

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The field work was carried out under the supervision of Ms. Katurah Firdawsi, B.Sc., under the direction of Mr. Paul Carnaffan, P.Eng., Senior Geotechnical Engineer.

The drilling equipment was supplied and operated by OGS Inc. of Almonte, Ontario.

Geotechnical laboratory testing was carried out at the Stantec Ottawa laboratory.

This report was prepared by Simon Gudina, and reviewed by Fred Griffiths and Raymond Haché.

## 6.0 Closure

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectively Submitted;

**STANTEC CONSULTING LTD.**

Simon Gudina, Ph.D., P.Eng.  
Geotechnical Engineer



Fred J. Griffiths, Ph.D., P.Eng.  
Principal



Raymond Haché, M.Sc., P.Eng.  
Designated Principal MTO Foundation Contact



## **7.0 References**

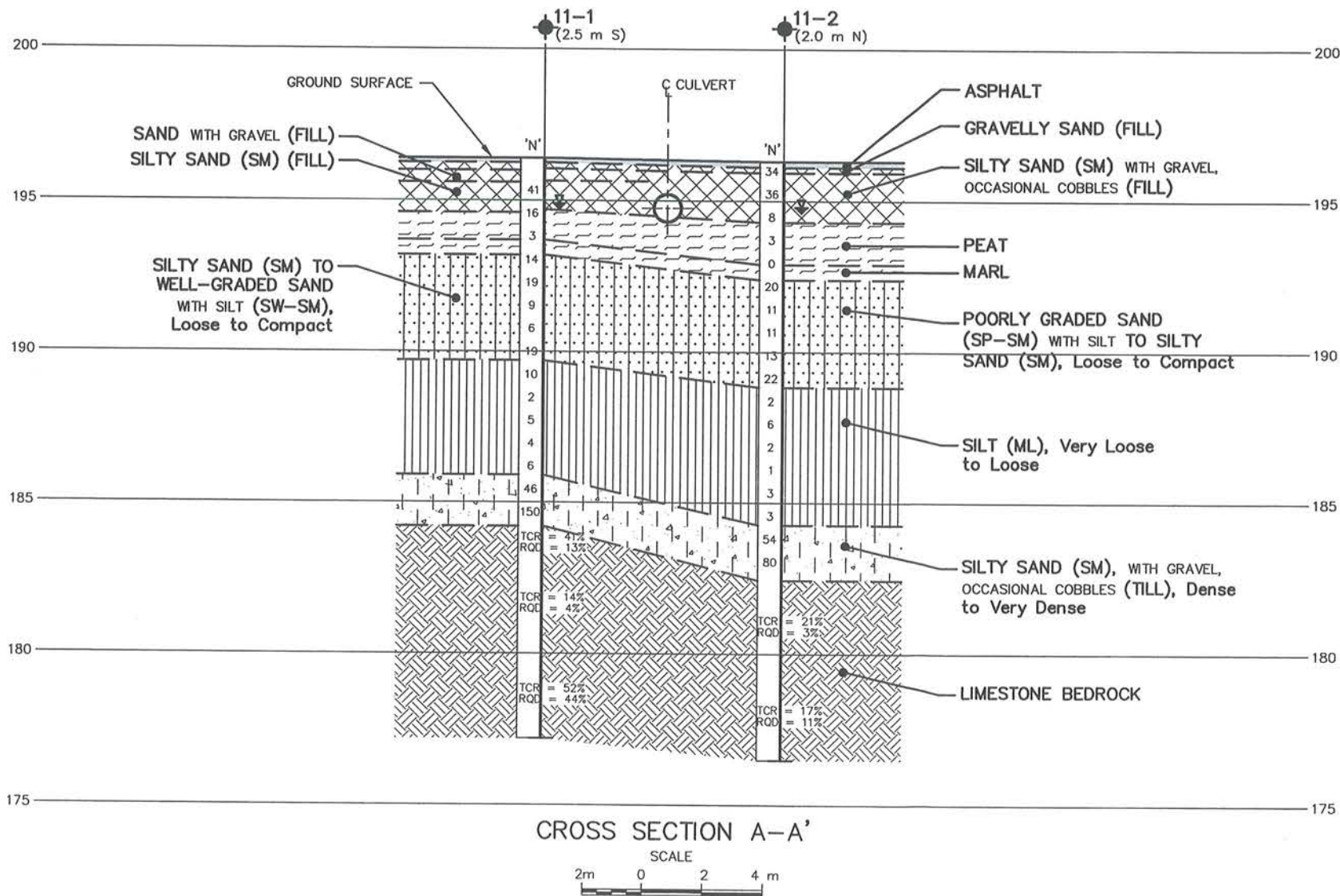
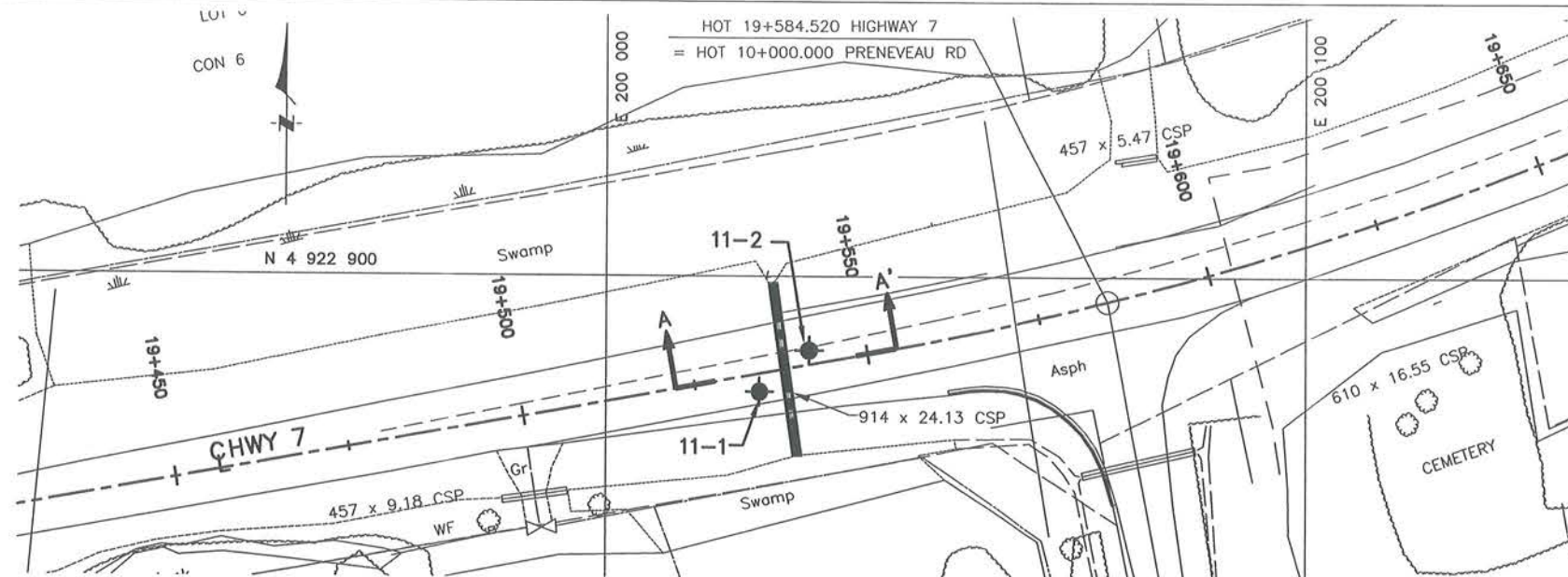
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ASTM. 1999. Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D 1586). ASTM International, West Conshohocken, PA.

Chapman, L.J., and Putnam, D.F. 1984. The physiography of southern Ontario; Ontario Geological Survey, Special Volume 2. Ontario Research Foundation, Ontario Geological Survey, Toronto.

## **APPENDIX A**

Drawing No. 1 – Borehole Location Plan and Soil Strata  
Site Photographs

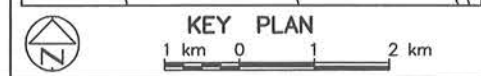


METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



PLATE No  
CONT  
WP 84-99-00

HIGHWAY 7  
CULVERT AT STA 19+538  
BOREHOLE LOCATIONS & SOIL STRATA



#### LEGEND

- Bore Hole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at time of investigation (July 2011)
- (2.5 m S) Offset from cross section line in meters

No	ELEVATION	MTM ZONE 9 COORDINATES NORTH	EAST
11-1	196.4	4 922 883.8	200 022.2
11-2	196.3	4 922 889.6	200 029.2

#### NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REVISIONS	DATE	BY	DESCRIPTION

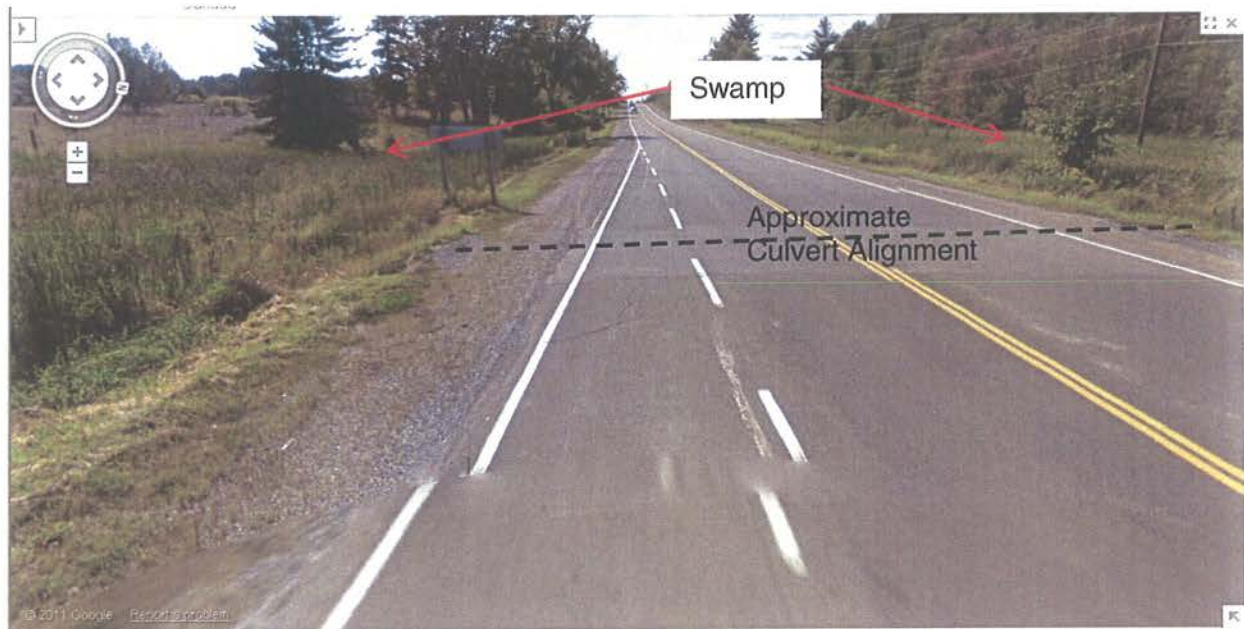
GEOCRES No 31C-210

HWY No 7	CHECKED	DATE 2011-08-31	DIST
SUBM'D SG	CHECKED	DATE 2011-08-31	SITE
DRAWN GBB	CHECKED	DATE 2011-08-31	DWG 1





**Photo No. 1: Looking east along Highway 7 at culvert site**



**Photo No. 2: Looking west along Highway 7 at culvert site**

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## **APPENDIX B**

Symbols and Terms Used on Borehole Records

Borehole Records

Field Rock Core Records

Rock Core Photographs

## SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

### SOIL DESCRIPTION

#### Terminology describing common soil genesis:

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

#### Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization 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 in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 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:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 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
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>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
<i>Very Soft</i>	<0.25	<12.5
<i>Soft</i>	0.25 - 0.5	12.5 - 25
<i>Firm</i>	0.5 - 1.0	25 - 50
<i>Stiff</i>	1.0 - 2.0	50 - 100
<i>Very Stiff</i>	2.0 - 4.0	100 - 200
<i>Hard</i>	>4.0	>200





## ROCK DESCRIPTION

### Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	<i>Very Poor</i>
25-50	<i>Poor</i>
50-75	<i>Fair</i>
75-90	<i>Good</i>
90-100	<i>Excellent</i>

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	<i>Extremely Wide</i>	-
2000-6000	<i>Very Wide</i>	<i>Very Thick</i>
600-2000	<i>Wide</i>	<i>Thick</i>
200-600	<i>Moderate</i>	<i>Medium</i>
60-200	<i>Close</i>	<i>Thin</i>
20-60	<i>Very Close</i>	<i>Very Thin</i>
<20	<i>Extremely Close</i>	<i>Laminated</i>
<6	-	<i>Thinly Laminated</i>

### Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
<i>Extremely Weak</i>	< 1
<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 rock weathering:

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


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
$\gamma$	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



# RECORD OF BOREHOLE No BH11-1

1 OF 2

METRIC

W.P. 84-99-00 LOCATION Culvert at Sta. 19+538, Belmont N: 4 922 884 E: 200 022 ORIGINATED BY KF  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler, Rock Core COMPILED BY KF  
 DATUM Geodetic DATE 2011 07 18 - 2011 07 18 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
196.4	Asphalt						20	40	60	80	100							
196.0	150 mm ASPHALT																	
196.2	Gravelly sand, brown, FILL																	
196.1	Sand with gravel, brown, FILL																	
195.6	Silty sand (SM), brown, FILL		1	SS	41													
194.6	PEAT		2	SS	16													
1.8	Brown																	
	- No recovery SS-3																	
193.7	MARL		3	SS	3													
2.7																		
193.2	SILTY SAND (SM)		4	SS	14													
	Loose to compact																	
	Grey																	
	- trace woody organics		5	SS	19													
			6	SS	9													
	- No recovery SS-7		7	SS	6													
	- well-graded sand with silt (SW-SM) below 6 m		8	SS	19													
189.7	SILT (ML)																	
6.7	Very loose to loose		9	SS	10													
	Grey																	
			10	SS	2													
			11	SS	5													
	- @ 9.5 m: SILTY CLAY (CL-ML)		12	SS	4													
			13	SS	6													
</																		

Continued Next Page

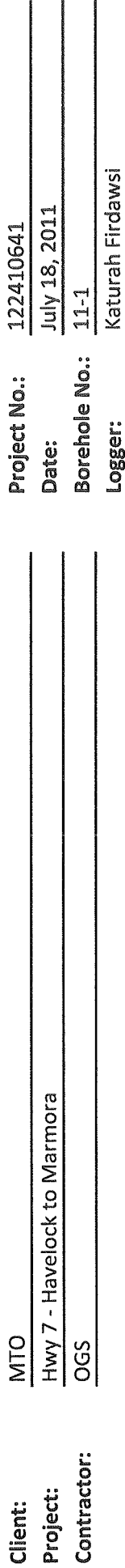
×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

○ 3% STRAIN AT FAILURE









DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO (m)	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES						OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE		
12.2	NQ 16	41	13	13.2	Grey limestone				B	F-D	C	RP		T	
13.2	NQ 17	14	3.6	16.2	Grey limestone	VS			B	F-D	C-M	RP		T	
16.2	NQ 18	100	73	19.2	Grey limestone	VS			B	F-D	C	RP		T	

**STRENGTH (MPa)**

EH = Extremely Strong = > 250  
VS = Very Strong = 100-250  
S = Strong = 50-100  
MS = Medium Strong = 25-50  
W = Weak = 5 - 25

**DISCONTINUITY TYPE**

B = Bedding Joint  
J = Cross Joint  
F = Fault  
S = Shear Plane

**ORIENTATION**

F = Flat = 0-20°  
D = Dipping = 20-50°  
V = n-Vertical = >50°

**FILLING**

T = Tight, Hard  
O = Oxidized  
SA = Slightly Altered, Clay Free  
S = Sandy, Clay Free  
SI = Sandy, Silty, Minor Clay  
NC = Non-softening Clay  
SC = Swelling, Soft Clay

**WEATHERING**

U = Unweathered = No Signs  
S = Slightly = Oxidized  
M = Moderately = Discoloured  
H = Highly = Friable  
C = Completely = Soil-like

**SPACING**

VW = Very Wide = >3m  
W = Wide = 1-3 m  
M = Moderate = 0.3-1 m  
C = Close = 5-30 cm  
VC = Very Close = <5 cm

**ROUGHNESS**

RU = Rough Undulating  
RP = Rough Planar  
SU = Smooth Undulating  
SP = Smooth Planar  
LU = Slickensided Undulating  
LP = Slickensided Planar



Stantec

# Field Core Log

Client: MTO Project: Hwy 7 - Havelock to Marmora Contractor: OGS  
Project No.: 122410641 Date: July 19, 2011  
Borehole No.: 11-2 Logger: Katurah Firdawsi

DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% ROD	DEPTH TO (m)	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES						OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING	
13.9	NQ 19	21	3.4	16.8	Grey limestone				B	F	M	SP		T	
16.8	NQ 20	17	11	19.8	Grey limestone	VS			B	F	C	SP		T	

**STRENGTH (MPa)**  
EH = Extremely Strong = > 250  
VS = Very Strong = 100-250  
S = Strong = 50-100  
MS = Medium Strong = 25-50  
W = Weak = 5 - 25  
VW = Very Weak = 1-5  
EW = Extremely Weak = < 1

**DISCONTINUITY TYPE**  
B = Bedding Joint  
J = Cross Joint  
F = Fault  
S = Shear Plane

**SPACING**  
VW = Very Wide = >3m  
W = Wide = 1-3 m  
M = Moderate = 0.3-1 m  
C = Close = 5-30 cm  
VC = Very Close = <5 cm

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SP = Smooth Planar  
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**FILLING**  
T = Tight, Hard  
O = Oxidized  
SA = Slightly Altered, Clay Free  
S = Sandy, Clay Free  
Si = Sandy, Silty, Minor Clay  
NC = Non-softening Clay  
SC = Swelling, Soft Clay





Project No.: 122410641

Project Name: Highway 7 – Culvert at  
Station 19+538

Rock Core  
Photographs



Photo No.: 1

Borehole: BH11-1

Depth: 12.2 to 19.2 m



Photo No.: 2

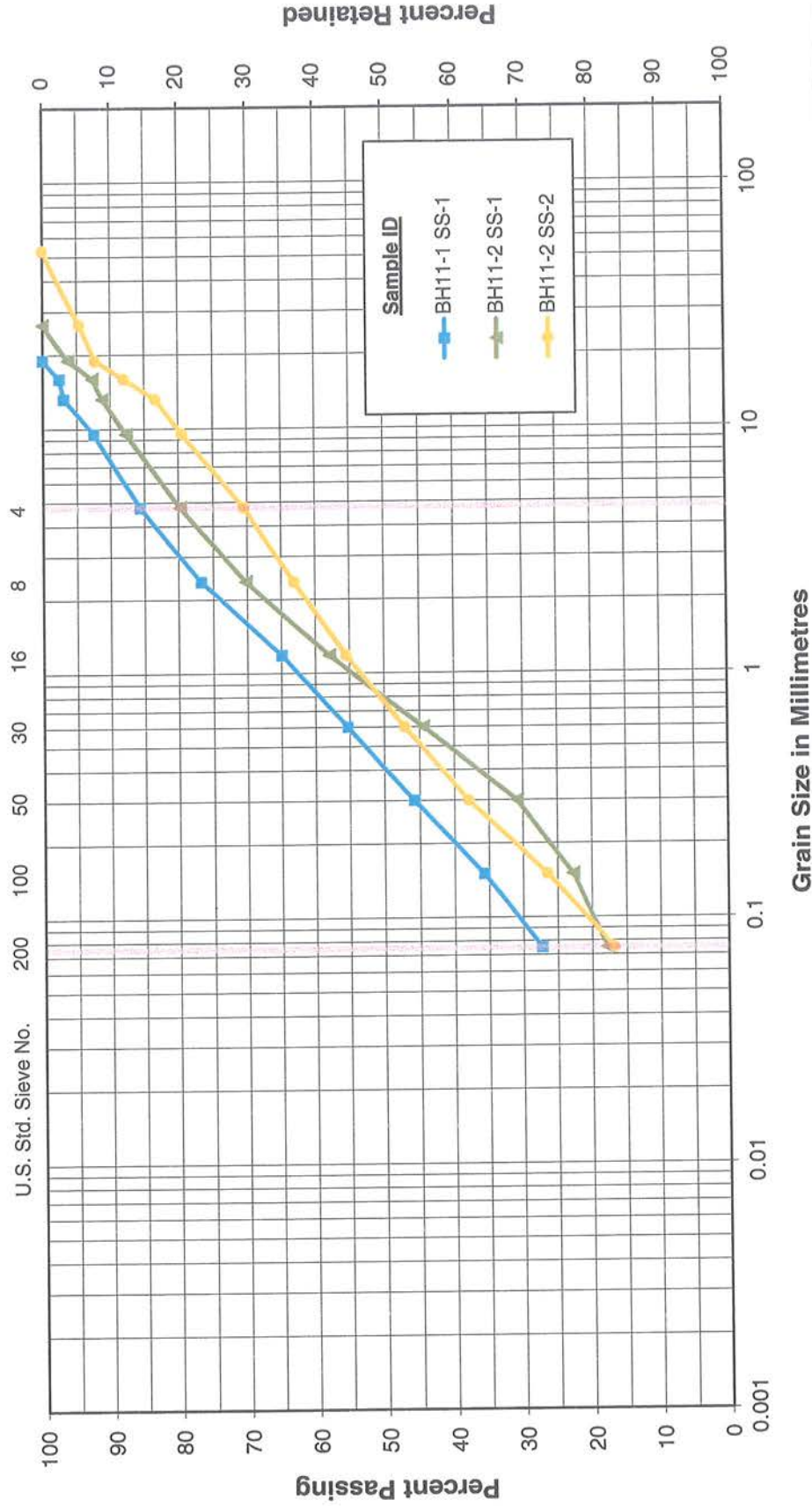
Borehole: BH11-2

Depth: 13.9 to 19.8 m

## **APPENDIX C**

### **Laboratory Test Results**

		SAND			Gravel	
		Fine	Medium	Coarse	Fine	Coarse
CLAY & SILT						



# GRAIN SIZE DISTRIBUTION

Project No. 122410641





# Unified Soil Classification System

CLAY & SILT	SAND				Gravel	
	Fine	Medium	Coarse	Fine	Coarse	

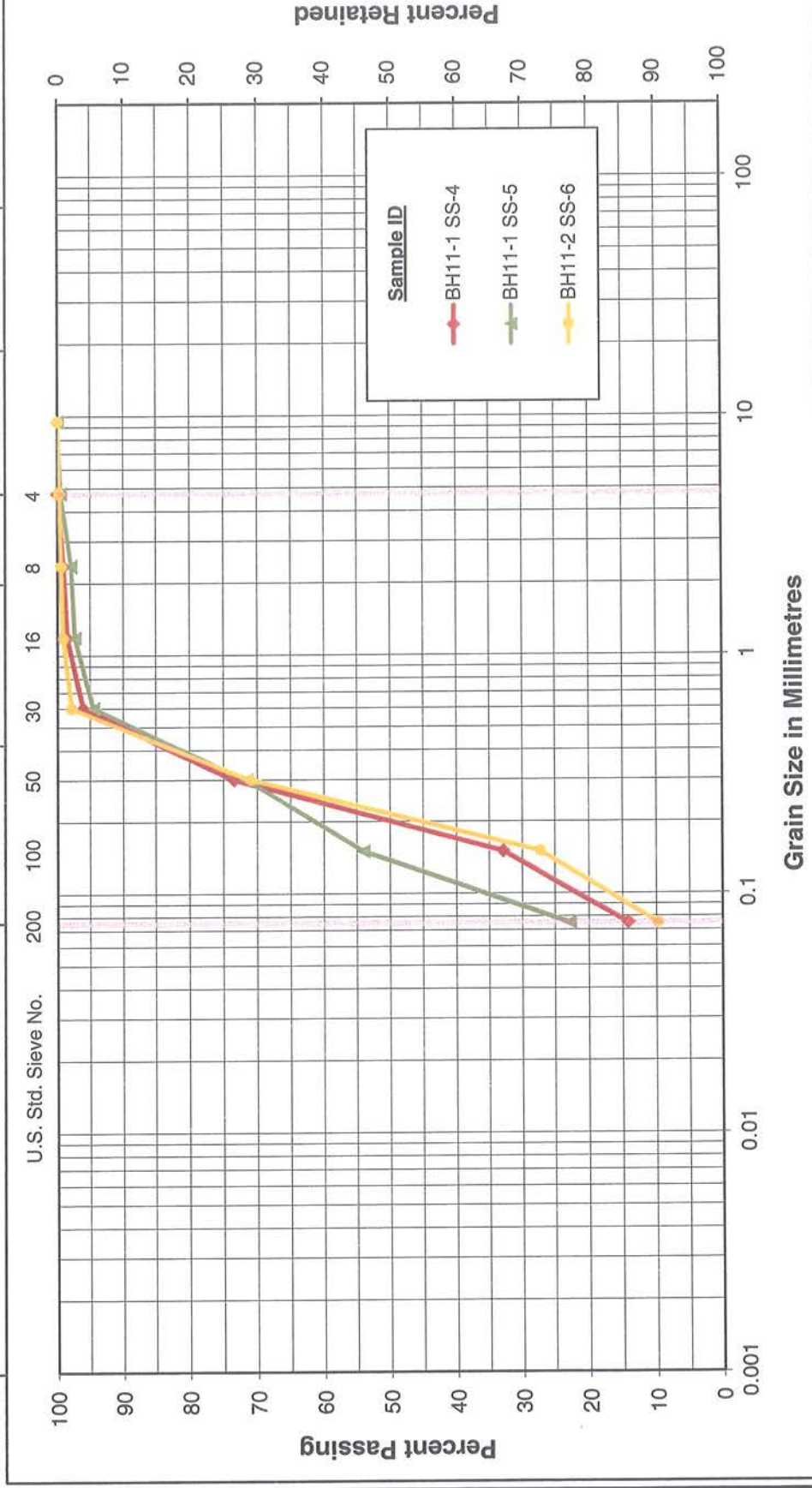


Figure No. 2a

Project No. 122410641

## GRAIN SIZE DISTRIBUTION

Silty Sand (SM) to Poorly Graded Sand with Silt (SP-SM)



Stantec



# Unified Soil Classification System

SAND				Gravel	
CLAY & SILT		Fine	Medium	Coarse	Coarse

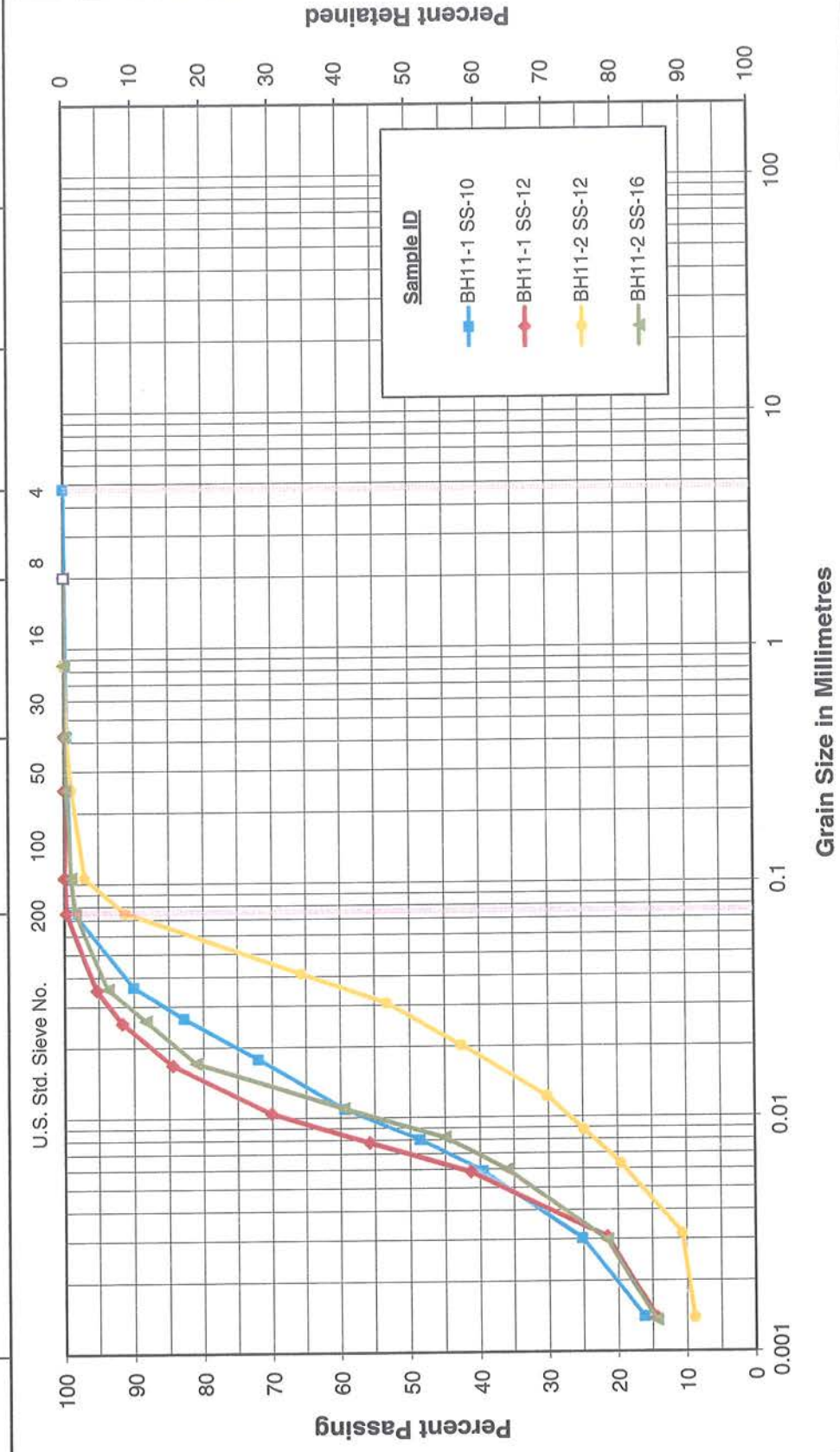


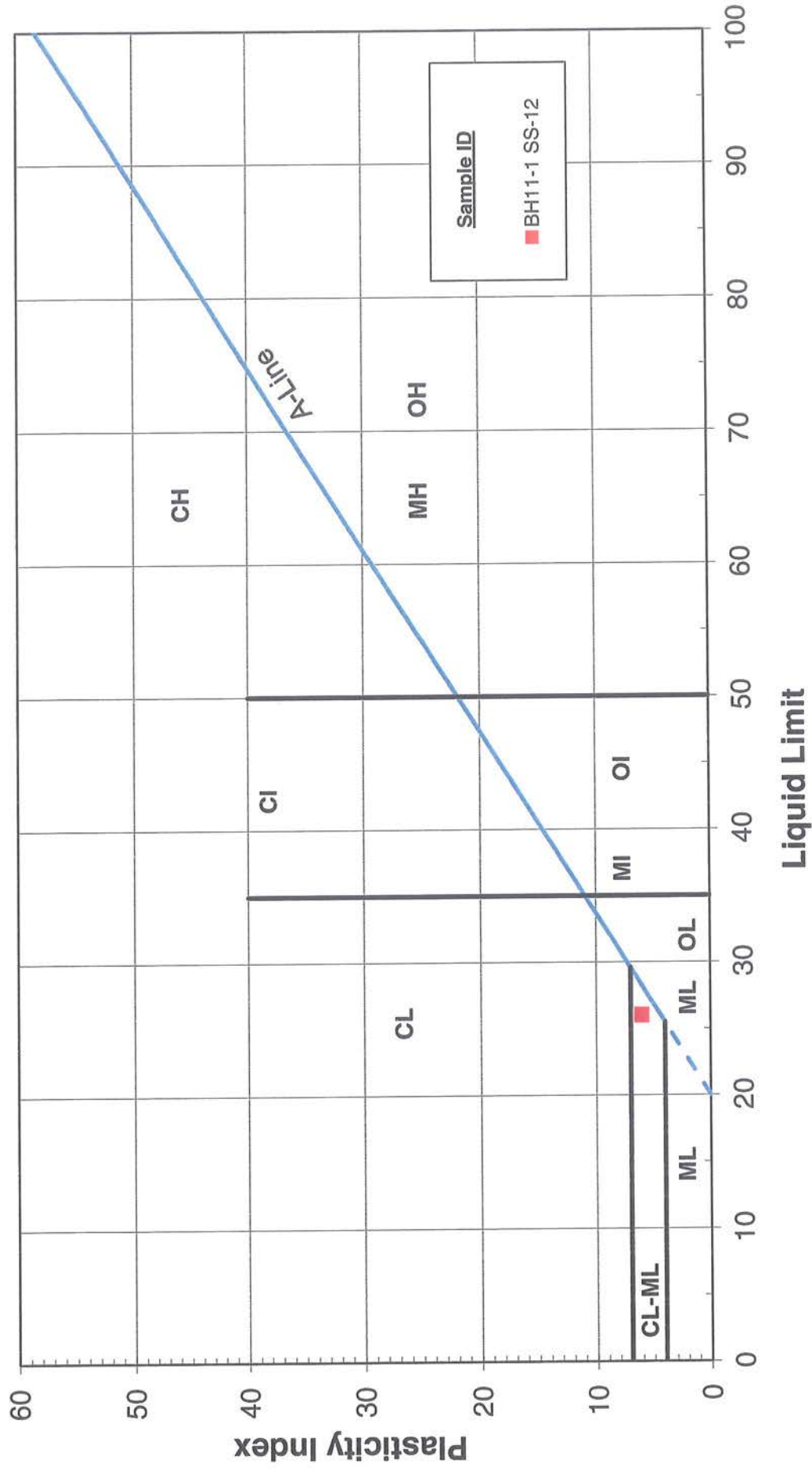
Figure No. 3

**GRAIN SIZE DISTRIBUTION**  
Silt (ML) to Silty Clay (CL-ML)

Project No. 122410641



Stantec



# PLASTICITY CHART

Figure No. 4

Project No. 122410641



# Unified Soil Classification System

	SAND			Gravel	
	CLAY & SILT			Fine	Coarse
	Fine	Medium	Coarse	Fine	Coarse

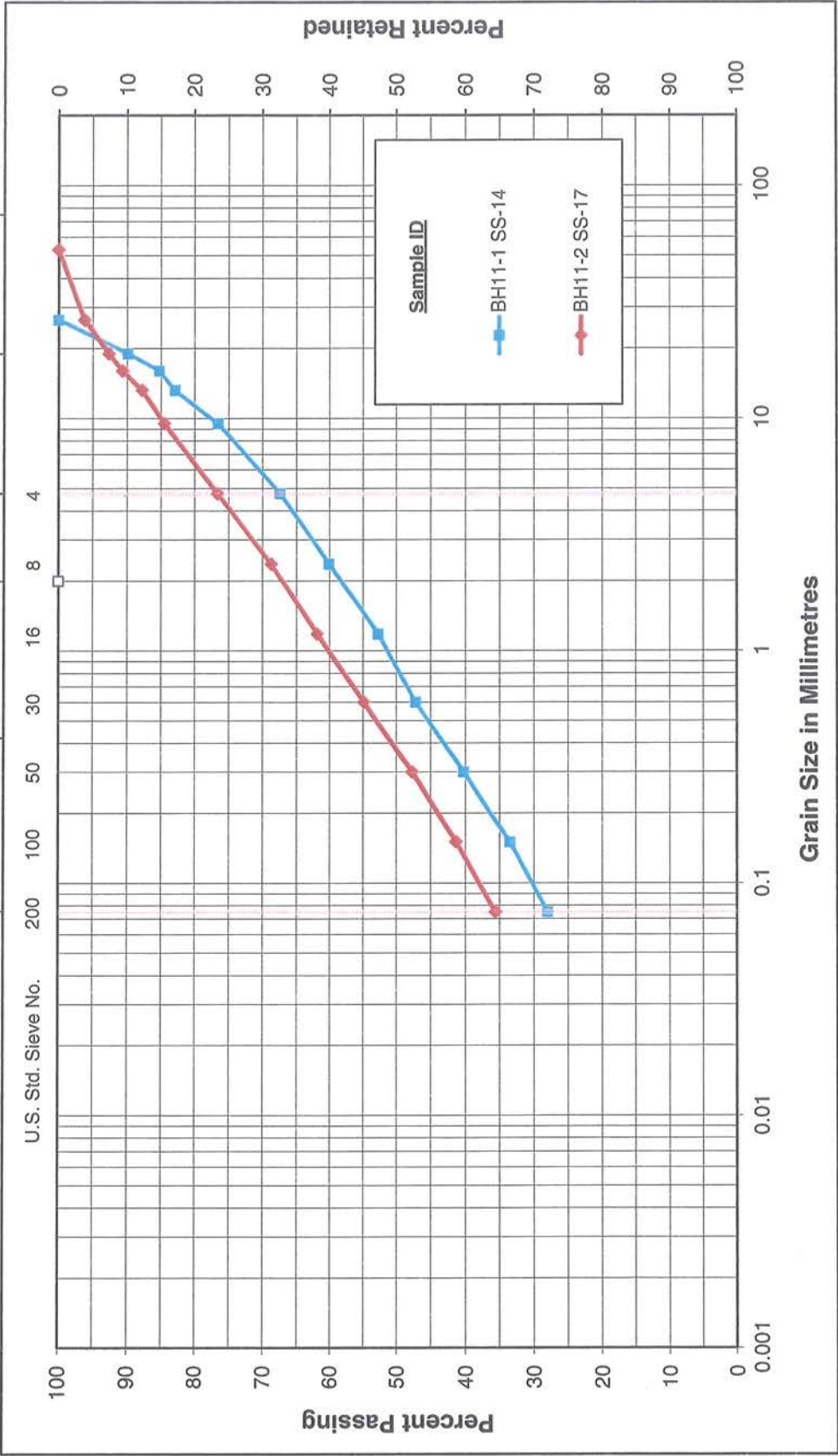


Figure No. 5

**GRAIN SIZE DISTRIBUTION**  
Silty Sand with Gravel (SM), TILL

Project No. 122410641

