

**Foundation Investigation  
Report  
Replacement of Kemuel Lake  
Culvert, Highway 11  
Site No. 45-270/C**

Rehabilitation/Replacement of 17  
Structures along various Highways  
in Northwestern Region

G.W.P. 6212-14-00

Geocres No. 52B-28



Prepared for:  
Ministry of Transportation Ontario

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Project No. 165000958

December 2016

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**FOUNDATION INVESTIGATION REPORT  
REPLACEMENT OF KEMUEL LAKE CULVERT, HIGHWAY 11  
SITE NO. 45-270/C  
December 2016**

**FOUNDATION INVESTIGATION REPORT**

For  
G.W.P 6212-14-00

Highway 11 – Replacement of Kemuel Lake Culvert

Site No. 45-270/C  
Unsurveyed Territory of Thunder Bay

## **1.0 INTRODUCTION**

Stantec Consulting Ltd. (Stantec) was retained by the Ministry of Transportation, Ontario (MTO), to undertake the detailed design for the proposed replacement of the Kemuel Lake Culvert. This culvert is located on Highway 11 approximately 1.7 km west of Junction Highway 11B in an unsurveyed territory of Thunder Bay.

Stantec previously completed a preliminary foundation investigation and design report for the Kemuel Creek Culvert titled “Preliminary Foundation Investigation and Design Report, Replacement of Kemuel Lake Culvert, Highway 11, Site No. 45-270/C, Geocres No. 52B-20” dated January 2015.

The purpose of this investigation was to document the subsurface conditions at the site and, to provide a borehole locations plan and soil strata drawing with a stratigraphic profile and cross-sections, records of boreholes, laboratory test results and a written description of the subsurface conditions, based on the data obtained, in accordance with MTO standards and requirements.

This Foundation Investigation Report has been prepared specifically and solely for the proposed replacement of the Kemuel Lake Culvert.

Project Number: 165000958

Project Location: Hwy 11 Kemuel Lake Culvert Replacement, 1.7 km west of Jct. Hwy 11B

G.W.P.: 6212-14-00

Agreement Number: 3014-E-0025

## 2.0 SITE DESCRIPTION AND GEOLOGY

### Site Location

The site location is shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. The existing Kemuel Lake Culvert crosses beneath Highway 11 at approximate Station 13+428, approximately 1.7 km west of Junction Highway 11B near the town of Atikokan.

### General Site Description

General site photographs showing the highway and culvert are provided in Appendix A.

Highway 11 runs approximately east-west at the project location with chainage increasing from west to east. In the vicinity of the culvert, Highway 11 has a two-lane rural cross-section with narrow shoulders (see Photograph 1 in Appendix A). The paved Highway 11 surface is approximately 7.2 m wide with approximately 2.1 m wide shoulders and guide rails. The embankment has approximate side slopes of 2H:1V. Both the inlet and outlet ends of the culverts were partially submerged at the time of the 2014 drilling investigation.

Drainage is generally north and northwest toward the Seine River. In the immediate vicinity of the site, drainage is provided via ditches leading to the culvert. The flow through the culvert is north out of Kemuel Lake.

### Existing Culvert

The existing culvert is a two-cell Timber Culvert with a total span of 4.4 m (2.2 m each cell) with a height of approximately 1.8 m. The culvert is approximately 20.0 m long and was built in 1899. The fill cover is approximately 2.0 m.

### Physiographic Description

The site is located within the Atikokan-Lumby Lake Area of northwestern Ontario. The Quaternary Geology of the area has been compiled in Map 2554 of the Ontario Geological Survey (Barnett et al. 1991). Surficial materials within this area consist predominantly of a thin, discontinuous veneer of drift (till) over bedrock. Modern fluvial deposits occupy major river valleys, such as along the Seine River. Glaciolacustrine sand, silt and clay occur locally. The generalized geology of the area indicates that the bedrock is dominated by the Marmion Lake batholith (OGS, 1999) and includes metasedimentary rocks.

## 3.0 SITE INVESTIGATION

The following sections outline the site investigation methodology.

### 3.1 DRILLING INVESTIGATION

A field investigation consisting of four boreholes was carried out by Stantec on May 12, 13 and 29, 2014, for the replacement of the proposed Kemuel Creek culvert (Site No. 45-270/C) during the preliminary design stage. The boreholes were designated BH14-1 through BH14-4 and their locations are shown on the Borehole Location Plan, Drawing No.1 in Appendix A.

During the detailed design stage one additional borehole (BH15-5) was advanced by Stantec's sub-consultant, Amec Foster Wheeler, on December 7, 2015. The borehole location is shown on the Borehole Location Plan, Drawing No.1 in Appendix A.

Prior to carrying out the investigations, Stantec and Amec Foster Wheeler contacted the public utility authorities to clear the borehole locations of public utilities. Boreholes BH14-1, BH14-2, and BH15-5 were advanced through the gravel shoulders and asphalt surface of the Highway 11 with hollow-stem augers using a truck mounted drill rig equipped for soil and bedrock sampling (HQ casing). Boreholes BH14-3 and BH14-4 were advanced near the culvert inlet and outlet using portable drilling casing (NQ casing).

The subsurface stratigraphy encountered in each borehole was recorded in the field by Stantec or Amec Foster Wheeler representatives. Split spoon samples were collected at regularly spaced intervals (typically every 760 mm) during the course of Standard Penetration Testing (ASTM D1586). Bedrock was cored with HQ size coring equipment in Boreholes BH14-1 & BH14-2 and NQ size in BH14-3 & BH14-4. All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing.

Boreholes were backfilled with auger cuttings mixed with bentonite and road holes were topped with cold patch asphalt as required. Groundwater depth was inferred from open boreholes during drilling.

### 3.2 SURVEY

The elevation and coordinates (northing and easting) of Boreholes BH14-1 through BH14-4 were determined using a Global Positioning System (GPS) apparatus, Trimble Geo XH, capable of decimeter accuracy.

The coordinates of Borehole BH15-5 were interpreted from the site plan based on off-set measurements from the existing culvert and edge of asphalt. The elevation of the borehole was surveyed relative to a temporary benchmark on the southwest corner of the culvert. The

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December 2016

temporary benchmark was determined to have an elevation of 433.85 m Geodetic by Amec Foster Wheeler.

The ground surface elevations and coordinates of the borehole locations are provided in Drawing 1 of Appendix A and on the Borehole Records included in Appendix B. Summary information pertaining to the boreholes included in this report is given in Table 3.1.

**Table 3.1: Borehole Summary**

	Boreholes				
	BH14-1	BH14-2	BH14-3	BH14-4	BH15-5
MTM Zone 16 Coordinates					
Northing	5399594	5399585	5399573	5399605	5399591
Easting	406287	406295	406284	406278	406296
Ground Surface Elevation, m	436.0	436.0	432.3	432.4	436.1
Total Depth Drilled, m	9.9	7.9	2.0	3.4	5.3
End of Borehole Elevation, m	426.1	428.1	430.3	429.0	430.8
Depth Augered, m	8.2	5.6	0.6	1.7	5.3
Number of Soil Samples	11	8	1	3	6
Depth Cored, m	1.7	2.3	1.4	1.7	-

### 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.

The geotechnical laboratory testing program for the borehole samples is summarized in Table 3.2.

**Table 3.2: Geotechnical Laboratory Testing Program**

Test Description	Number of Tests
Moisture Content	25
Atterberg Limits	3
Grain Size Distribution	7
Unconfined Compression (rocks)	2
Organic Content	3

One soil samples was tested for pH, soluble sulphate content, chloride content, and resistivity.

Samples remaining after testing will be placed in storage for a period of one year after issuance of the final report. After the storage period, the samples will be discarded.

## 4.0 SUBSURFACE CONDITIONS

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

The borehole location plan and stratigraphic section of the soils encountered within the boreholes is provided in Drawing No. 1 of Appendix A.

In general, the subsurface stratigraphy encountered at the boreholes consisted of embankment fill over a thin layer of peat followed by till (silty sand to sandy silt) overlying bedrock. A silt layer was encountered beneath the peat layer in Borehole BH14-1. Boulders are visible on embankment side slope, see photograph No. 2 in Appendix A. Bedrock outcrops are also visible to the east of the existing culvert, see photograph No. 1 in Appendix A.

### 4.1 OVERBURDEN

#### 4.1.1 Embankment Fill

Embankment fill material was encountered in Boreholes BH14-1, BH14-2, BH14-4 and BH15-5. The fill was predominantly a mixture of gravel and sand with silt. The thickness of the embankment fill was approximately 0.6 m and 4.9 m and extended to approximate base elevations of 431.1 to 431.8 m. Borehole BH15-5 was terminated in the fill at elevation 430.8 m.

The embankment fill consisted predominantly of gravel with sand and silt. Frequent cobbles and boulders were encountered throughout the fill in Boreholes BH14-1, BH14-2 and BH15-5. Auger refusal on inferred bedrock or boulder was encountered in Borehole BH15-5 at elevation 403.8 m.

Index tests carried out on representative samples of the embankment fill material indicated the following results:

Gravel:	36 and 67%
Sand:	27 and 46%
Fines (Silt & Clay):	6 and 18%
Moisture Content:	1 to 16%

A representative grain size distribution plot for the embankment fill material is provided in Figure 1 of Appendix C. According to the Unified Soil Classification System (USCS), the group symbol for the embankment fill material is GW-GM (well-graded gravel with silt and sand), SW-SM (well-graded sand with silt and gravel), GP-GM (poorly graded gravel with silt and sand) and SM (silty sand with gravel).

#### 4.1.2 Peat

Peat was encountered in Boreholes BH14-1 through BH14-4. It was encountered immediately beneath the embankment fill in Boreholes BH14-1, BH14-2 and BH14-4, and at the ground surface in BH14-3. The peat thickness varied approximately between 100 and 900 mm and extended to base elevations of 430.8 to 431.7 m.

The peat contained some wood, silty sand and gravel. The moisture content of the peat ranged between 39 and 122%. The organic matter content ranged between 14 and 58%.

#### 4.1.3 Silt

A silty layer was encountered in Borehole BH14-1 immediately beneath the peat layer. This layer is approximately 2.5 m thick and extended to an approximate base elevation of 428.5 m.

This layer was predominantly silt and contained trace amounts of sand and clay. The Standard Penetration Test (SPT) N-values for the silt layer ranged between 10 and 15 per 0.3 m suggesting a compact state. In-situ field vane tests indicate an undrained shear strength of 195 kPa and greater than 200 kPa (limit of vane). Pocket penetrometer test carried out on split spoon samples indicate an undrained shear strength of 200 kPa.

Index tests carried out on representative samples of the silt layer indicated the following results:

Gravel:	0%
Sand:	4%
Silt Size:	82%
Clay Size:	14%
Moisture Content:	17 to 21%

Atterberg limits tests carried out on a representative sample of the silt layer indicated a plasticity index of 4 (low plasticity) and liquid limit of 20. The USCS group symbol for this layer is ML (silt).

Representative grain size distribution plot and the plasticity chart for the silt layer are provided in Figure 2 and Figure 4 of Appendix C, respectively.

#### 4.1.4 TILL

A till layer was encountered immediately beneath the silt layer in Borehole BH14-1 and beneath the peat layer in Boreholes BH14-2 and BH14-4. The till consisted mainly of silty sand with gravel and sandy silt with gravel. Occasional cobbles were encountered within the till layer in BH14-1. The thickness of the till layer ranged approximately between 200 and 700 mm and extended to bottom elevation between 427.9 and 430.7 m.

The SPT N-value within the till layer was 12 to greater than 50 blows per 0.3 m, suggesting a compact to very dense state.



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Index tests carried out on representative samples of the till layer indicated the following results:

Gravel: 10 to 36%  
Sand: 39 to 48%  
Fines (Silt & Clay): 16 to 51%  
Moisture Content: 6 to 19%

Atterberg limits tests carried out on two representative samples of the till layer produced non-plastic results.

Representative grain size distribution plots for till layer are provided in Figure 3 of Appendix C while the plasticity chart is provided in Figure 5. According to the Unified Soil Classification System (USCS), the group symbol for the till layer ranges between ML (sandy silt with gravel) and SM (silty sand with gravel).

## **4.2 BEDROCK**

Grey to dark grey graphite schist bedrock was encountered in Boreholes BH14-1 to 14-4. In addition, auger refusal on inferred bedrock or boulder was encountered in BH15-5 at depth 5.3 m (base elevation 430.8 m).

The top of bedrock elevations encountered in Boreholes BH14-1 to 14-4 ranged between 427.9 and 431.7 m. The schist bedrock contained trace to significant amounts of quartz infill with occasional pyrite and mica intrusions. The bedrock was slightly weathered. The Rock Quality Designation (RQD) values were between 12% and 100%, indicating a very poor to excellent rock quality. A RQD value of 0% was estimated in borehole BH14-3, this low value is attributed to the very short core length. The Total Core Recovery (TCR) values ranged between 65 and 100%. A detailed description of the rock core is provided in Field Core Logs in Appendix B. Rock core photographs are provided in Appendix B.

Unconfined compressive strength (UCS) tests were carried out on two bedrock samples (one each from Boreholes BH14-1 and BH14-3). The results of these tests are summarized in Table 4.1.

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

Borehole No	Ground Surface Elevation (m)	Test Elevation (m)	Unconfined Compressive Strength (MPa)
BH14-1	436.0	426.8	62
BH14-3	432.3	431.4	102

Based on the rock UCS test results presented above, the tested bedrock samples may be described as strong to very strong.

### 4.3 GROUNDWATER

Groundwater was observed in the boreholes at the time of drilling, in May 2014 and December 2015 (BH15-5). The observed groundwater levels are summarized in Table 4.2 as “inferred” groundwater level.

**Table 4.2: Inferred Groundwater Levels (time of drilling)**

Borehole No	Ground Surface Elevation (m)	Groundwater	
		Depth (m)	Elevation (m)
BH14-1	436.0	3.8	432.2
BH14-2	436.0	4.4	431.6
BH14-3	432.3	0.2	432.1
BH14-4	432.4	0.4	432.0
BH15-5	436.1	4.4	431.7

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

The water level in the creek was observed (by others) at elevation 432.5 m on June 5, 2013. During drilling in May 2014, the water level in the creek was inferred to be at approximate elevation 432.3 m.

### 4.4 CHEMICAL TEST RESULTS

One sample of the native material was tested for pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are provided in Table 4.3.

**Table 4.3: Results of Chemical Analysis**

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
BH14-1	SS-8	5.33 to 5.94	6.7	9	40	52

## 5.0 MISCELLANEOUS

The field work for the Preliminary Foundation Investigation was supervised by Mr. Jason Hopwood-Jones, Geotechnical Engineering Technician, under the direction of Mr. Chris McGrath, P.Eng. The supplemental borehole drilled as part of the Detailed Foundation Investigation was supervised by Amec Foster Wheeler representative Mr. Tyler Renaud, P.Eng.

USL-1 of Ottawa, Ontario, carried out the private and public utility locates for the boreholes.

The drilling equipment used for the investigation was supplied and operated by Paddock Drilling Ltd. of Brandon, Manitoba, and TBT Engineering Limited of Thunder Bay, Ontario. The portable drilling equipment was supplied and operated by Landcore Drilling of Chelmsford, Ontario.

Location and elevation survey of Boreholes BH14-1 to 14-4 was carried out by Stantec while Borehole BH15-5 was carried out by Amec Foster Wheeler.

Geotechnical laboratory testing was carried out at Stantec's Ottawa laboratory. Chemical testing for pH, soluble sulphate, and chloride content, and resistivity was carried out by Paracel Laboratories of Ottawa.

This report was prepared by Marjan Oboudi, and reviewed by Chris McGrath 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.

Respectfully Submitted;

STANTEC CONSULTING LTD.



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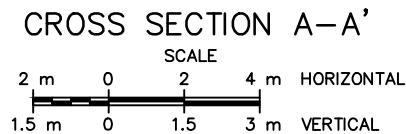
Raymond Haché, M.Sc., P.Eng.  
Designated Principal MTO Foundation Contact

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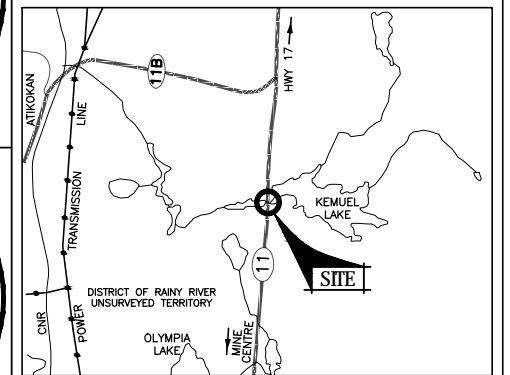
## APPENDIX A

Drawing No. 1 – Borehole Location Plan and Soil Strata Plot

Site Photos



SHEET






LEGEND


- | No   | ELEV  | MTM ZONE 16<br>NORTH | COORDINATES<br>EAST |
|------|-------|----------------------|---------------------|
| 14-1 | 436.0 | 5 399 593.8          | 406 287.4           |
| 14-2 | 436.0 | 5 399 584.5          | 406 294.7           |
| 14-3 | 432.3 | 5 399 573.2          | 406 283.6           |
| 14-4 | 432.4 | 5 399 604.7          | 406 277.6           |
| 15-5 | 436.1 | 5 399 591.4          | 406 296.4           |

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.

REVISED					
	DATE	BY		DESCRIPTION	
GEOCRES No 52B-28					
HWY No 11				DIST	
SUBM'D SG	CHECKED CM	DATE 2016-12-02	SITE	45-270C	
DRAWN CBR	CHECKED CM	APPROVED	DWG	2	



	Project No.: 165000958	GWP: 6212-14-00	Site Photographs
	Project Name: Highway 11 Replacement of Kemuel Lake Culvert, District of Rainy River, ON		
			Date: May 12-13 & 29, 2014
			
Site Photo No.: 1	Looking east at the south end of culvert (inlet). Bedrock outcrop visible to the east of the culvert.		
			
Site Photo No.: 2	Looking west at the north end of culvert (outlet). Boulders visible on embankment slope.		

	Project No.: 165000958	GWP: 6212-14-00	Site Photographs
	Project Name: Highway 11 Replacement of Kemuel Lake Culvert, District of Rainy River, ON		Date: May 12-13 & 29, 2014
			
Site Photo No.: 3	Close-up view of culvert outlet		
			
Site Photo No.: 4	Culvert Barrel		



## APPENDIX B

Symbols and Terms Used on Borehole Records

Borehole Records

Rockcore Records

Rockcore 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 BH14-1

1 OF 1

METRIC

W.P. 6212-14-00 LOCATION Highway 11 Kemuel Lake (Site 45-270/C) N: 5 399 594 E: 406 287 ORIGINATED BY JHJ  
DIST \_\_\_\_\_ HWY 11 BOREHOLE TYPE Hollow-stem Augers, Splitt spoon Sampler COMPILED BY KF  
DATUM Geodetic DATE 2014 05 12 - 2014 05 12 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>P</sub>	W	W <sub>L</sub>			WATER CONTENT (%)								
								○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE															
436.0	Granular Fill						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL
0.0	FILL: well graded sand with silt and gravel (SW-SM), brown		1	BS	-																		
			2	SS	12																		
434.5	FILL: well graded gravel with silt and sand (GW-GM), brown		3	SS	47																		
1.5	- frequent boulders and cobbles		4	SS	12																		
	Loose to dense		5	SS	23																		
			6	SS	6																		
431.1	PEAT	7	SS	10																			
434.0	Reddish Black																						
5.0	SILT (ML), trace sand		8	SS	10																		
	Compact		9	SS	15																		
	Grey		10	SS	14																		
428.5	Silty sand (SM) with gravel TILL																						
7.5	- occasional cobbles		11	SS	58																		
427.9	Grey																						
8.2	Graphite schist BEDROCK: numerous quartz intrusions, traces of pyrite; grey		12	HQ	-																		
	- very poor to fair quality - strong - slightly weathered - foliated - close joint spacing  (Refer to Field Bedrock Core Log)		13	HQ	-																		
426.1	End of Borehole																						
9.9	PP = Pocket penetrometer UCS = Unconfined compressive strength TCR = Total core recovery																						

STN13-ONTARIO MTO STANTEC 165000873 - MTO 13 STRUCTURES\_KEMUELLK.GPJ ONTARIO MOT.GDT 107/16

$\times^3, \times^3$ : Numbers refer to Sensitivity  $\circ$  3% STRAIN AT FAILURE



# RECORD OF BOREHOLE No BH14-2

1 OF 1

METRIC

W.P. 6212-14-00 LOCATION Highway 11 Kemuel Lake (Site 45-270/C) N: 5 399 585 E: 406 295 ORIGINATED BY JHJ  
 DIST HWY 11 BOREHOLE TYPE Hollow-stem Augers, Splitt spoon Sampler COMPILED BY KF  
 DATUM Geodetic DATE 2014 05 13 - 2014 05 13 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								20	40	60	80	100						WATER CONTENT (%)		
						○ UNCONFINED      ✕ FIELD VANE ● QUICK TRIAXIAL    ✕ LAB VANE														
436.0	Granular Fill																			
0.0	FILL: well graded sand with silt and gravel (SW-SM), brown		1	BS	-															
435.4																				
0.6	FILL: well-graded gravel with silt and sand (GW-GM) to poorly graded gravel with silt and sand (GP-GM), brown		2	SS	18		435													
	- frequent cobbles and boulders																			
	Compact to very dense																			
			3	SS	100/ 50 mm		434													
			4	SS	36															
			5	SS	100/ 40 mm		433													
			6	SS	41		432													
431.3	PEAT, with some wood		7	SS	16		431													
430.8	Reddish black																			
5.2	Sandy silt (ML) TILL, some gravel																			
430.4	Compact Grey		8	SS	12															
5.6	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites and mica, some mud infills; dark grey		9	HQ	-		430													
	- very poor to poor quality																			
	- strong																			
	- slightly weathered																			
	- close joint spacing																			
	(Refer to Field Bedrock Core Log)		10	HQ	-		429													
428.1	End of Borehole																			
7.9	TCR = Total core recovery																			

$\times^3, \times^3$ : Numbers refer to Sensitivity  $\circ^3$  STRAIN AT FAILURE

STN13-ONTARIO MTO STANTEC 165000873 - MTO 13 STRUCTURES, KEMUELLK.GPJ ONTARIO MOT.GDT 107/16



## RECORD OF BOREHOLE No BH14-3

1 OF 1

METRIC

W.P. 6212-14-00 LOCATION Highway 11 Kemuel Lake (Site 45-270/C) N: 5 399 573 E: 406 284 ORIGINATED BY JHJ  
DIST HWY 11 BOREHOLE TYPE Portable Drilling Equipment, Splitt spoon Sampler COMPILED BY KF  
DATUM Geodetic DATE 2014 05 29 - 2014 05 29 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
432.3	Peat		1	SS	-												
0.0	PEAT, with silty sand and gravel																
431.7	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites and mica; grey		2	NQ	-												
0.6	- very poor to excellent quality - very strong - slightly weathered - close to wide joint spacing (Refer to Field Bedrock Core Log)		3	NQ	-												
430.3			4	NQ	-												
2.0	End of Borehole																
	TCR=Total core recovery UCS = Unconfined compressive strength																



## RECORD OF BOREHOLE No BH14-4

1 OF 1

METRIC

W.P. 6212-14-00 LOCATION Highway 11 Kemuel Lake (Site 45-270/C) N: 5 399 605 E: 406 278 ORIGINATED BY JHJ  
DIST HWY 11 BOREHOLE TYPE Portable Drilling Equipment, Splitt spoon Sampler COMPILED BY KF  
DATUM Geodetic DATE 2014 05 28 - 2014 05 29 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
								20 40 60 80 100								
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w w <sub>L</sub>									
							WATER CONTENT (%)									
							○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20 40 60 80 100									
432.4	Granular Fill															
0.0	FILL: silty sand with gravel (SM), brown															
	Very loose		1	SS	2		432									
431.8	PEAT, with silty sand, some gravel															
0.6	Black		2	SS	8											
430.9	Silty sand with gravel (SM) TILL		3	SS	50/ 75 mm		431									
430.7	Very dense		4	NQ	-											
1.7	Grey		5	NQ	-		430									
	Graphite schist BEDROCK: medium to coares grained, some quartz infills; grey		6	NQ	-											
	- poor to fair quality															
	- strong															
	- slightly weathered															
	- close joint spacing															
	(Refer to Field Bedrock Core Log)															
429.0	End of Borehole						429									
3.4																

STN13-ONTARIO MTO STANTEC 165000873 - MTO 13 STRUCTURES, KEMUELLK.GPJ ONTARIO MOT.GDT 107/16





## RECORD OF BOREHOLE No BH15-5

1 OF 1

METRIC

W.P. 6212-14-00 LOCATION Highway 11 Kemuel Lake (Site 45-270/C) N: 5 399 591 E: 406 296 ORIGINATED BY JHJ  
DIST HWY 11 BOREHOLE TYPE Hollow-stem Augers, Splitt spoon Sampler COMPILED BY MO  
DATUM Geodetic DATE 2015 12 07 - 2015 12 08 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>
								○ UNCONFINED	● QUICK TRIAXIAL	✕ FIELD VANE	✕ LAB VANE									
436.1 0.0	FILL: Silty sand with gravel (SM), brown  Compact to very dense  -frequent cobbles and boulders  cobbles and boulders encountered at: -1.5 m -2.1 m -4.4 m						436									36 46 16 2				
			1	SS	48		435													
			2	SS	51		434													
			3	SS	14		433													
			4	SS	26		432													
			5	SS	55		431													
430.8 5.3	End of Borehole  Auger Refusal on Inferred Boulder or Bedrock																			

STN13-ONTARIO MTO STANTEC 165000873 - MTO 13 STRUCTURES\_KEMUELLK.GPJ ONTARIO MOT.GDT 107/16

**Client:** Ontario Ministry of Transportation  
**Project:** Replacement of Kemuel Lake Culvert (Hwy 11)  
**Contractor:** Paddock Drilling Ltd

**Project No.:** 165000958  
**Date:** May 12, 2014  
**Borehole No.:** BH14-1  
**Logger:** Simon Gudina

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	FILLING		
8.15	HQ 12	85%	22%	9.07	Graphite schist BEDROCK: numerous quartz intrusions, traces of pyrite; grey		S	1	B	D-V	C	RP		T		Hardness = 3.5 to 6.5
9.07	HQ 13	100%	56%	9.93	Graphite schist BEDROCK: numerous quartz bands, traces of pyrite; grey	S	S	1	B	D-V	C	RP		T		Hardness = 3.5 to 6.5

**STRENGTH (MPa)**

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

**WEATHERING**

U = Unweathered = No Signs  
 S = Slightly = Discolored  
 M = Moderately < 1/2 decomposed/soil-like  
 H = Highly > 1/2 decomposed/soil-like  
 C = Completely = All decomposed/soil-like

**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

**ORIENTATION**

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

**ROUGHNESS**

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

**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

**Client:** Ontario Ministry of Transportation  
**Project:** Replacement of Kemuel Lake Culvert (Hwy 11)  
**Contractor:** Paddock Drilling Ltd

**Project No.:** 165000958  
**Date:** May 13, 2014  
**Borehole No.:** BH14-2  
**Logger:** Simon Gudina

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			FILLING
5.56	HQ 9	100%	33%	6.63	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites and mica, some mud infills; dark grey		S		B	D-V	C	RP		T	Several discontinuities	Hardness = 3.5 to 6.5
6.63	HQ 10	92%	12%	7.92	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites and mica, some mud infills; dark grey		S		B	D-V	C	RP		T	Several discontinuities	Hardness = 3.5 to 6.5

**Client:** Ontario Ministry of Transportation  
**Project:** Replacement of Kemuel Lake Culvert (Hwy 11)  
**Contractor:** Landcore Drilling Ltd


**Project No.:** 165000958  
**Date:** May 29, 2014  
**Borehole No.:** BH14-3  
**Logger:** Simon Gudina

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	FILLING		
0.64	NQ 2	95%	65%	1.14	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites & mica; grey	VS	S	1	B	F	C	RP		T	Nodular features	Hardness = 3.5 to 6.5
1.14	NQ 3	75%	0%	1.37	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites & mica; grey		S	1	S	V	C	RP		T	Nodular features	Hardness = 3.5 to 6.5
1.37	NQ 4	100%	100%	2.03	Graphite schist BEDROCK: numerous quartz infills, occasional pyrites & mica; grey		S	1	B	V	W	RP		T	Nodular features	Hardness = 3.5 to 6.5
<div> <p><b>STRENGTH (MPa)</b></p> <p>EH = Extremely Strong = &gt; 250            VS = Very Strong = 100-250            S = Strong = 50-100            MS = Medium Strong = 25-50            W = Weak = 5 - 25</p> <p><b>WEATHERING</b></p> <p>U = Unweathered = No Signs            S = Slightly = Discolored            M = Moderately &lt; 1/2 decomposed/soil-like            H = Highly &gt; 1/2 decomposed/soil-like            C = Completely = All decomposed/soil-like</p> </div> <div> <p><b>DISCONTINUITY TYPE</b></p> <p>B = Bedding Joint            J = Cross Joint            F = Fault            S = Shear Plane</p> <p><b>SPACING</b></p> <p>VW = Very Wide = &gt;3m            W = Wide = 1-3 m            M = Moderate = 0.3-1 m            C = Close = 5-30 cm            VC = Very Close = &lt;5 cm</p> </div> <div> <p><b>ORIENTATION</b></p> <p>F = Flat = 0-20°            D = Dipping = 20-50°            V = n-Vertical = &gt;50°</p> <p><b>ROUGHNESS</b></p> <p>RU = Rough Undulating            RP = Rough Planar            SU = Smooth Undulating            SP = Smooth Planar            LU = Slickensided Undulating            LP = Slickensided Planar</p> </div> <div> <p><b>FILLING</b></p> <p>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</p> </div>																

**Client:** Ontario Ministry of Transportation  
**Project:** Replacement of Kemuel Lake Culvert (Hwy 11)  
**Contractor:** Landcore Drilling Ltd

**Project No.:** 165000958  
**Date:** May 29, 2014  
**Borehole No.:** BH14-4  
**Logger:** Simon Gudina

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			FILLING	
1.68	NQ 4	100%	75%	2.34	Graphite schist BEDROCK: medium to coarse grained, some quartz infill; grey		S	1		B	F-D	C	RP		T	Semi-vertical discontinuities	Hardness = 3.5 to 6.5
2.34	NQ 5	65%	38%	2.77	Graphite schist BEDROCK: coarse grained, quartz infill; grey		S	1		B	F-D	C	RP		T	Semi-vertical discontinuities	Hardness = 3.5 to 6.5
2.77	NQ 6	100%	65%	3.43	Graphite schist BEDROCK: coarse grained, quartz infill; grey		S	1		B	F-D	C	RP		T	Semi-vertical discontinuities	Hardness = 3.5 to 6.5
<div><div><div><div><div><u>STRENGTH (MPa)</u></div><div>EH = Extremely Strong = &gt; 250</div><div>VS = Very Strong = 100-250</div><div>S = Strong = 50-100</div><div>MS = Medium Strong = 25-50</div><div>W = Weak = 5 - 25</div></div><div><div><u>WEATHERING</u></div><div>U = Unweathered = No Signs</div><div>S = Slightly = Discolored</div><div>M = Moderately &lt; 1/2 decomposed/soil-like</div><div>H = Highly &gt; 1/2 decomposed/soil-like</div><div>C = Completely = All decomposed/soil-like</div></div><div><div><u>DISCONTINUITY TYPE</u></div><div>B = Bedding Joint</div><div>J = Cross Joint</div><div>F = Fault</div><div>S = Shear Plane</div></div><div><div><u>SPACING</u></div><div>VW = Very Wide = &gt;3m</div><div>W = Wide = 1-3 m</div><div>M = Moderate = 0.3-1 m</div><div>C = Close = 5-30 cm</div><div>VC = Very Close = &lt;5 cm</div></div><div><div><u>ORIENTATION</u></div><div>F = Flat = 0-20<sup>0</sup></div><div>D = Dipping = 20-50<sup>0</sup></div><div>V = n-Vertical = &gt;50<sup>0</sup></div></div><div><div><u>ROUGHNESS</u></div><div>RU = Rough Undulating</div><div>RP = Rough Planar</div><div>SU = Smooth Undulating</div><div>SP = Smooth Planar</div><div>LU = Slickensided Undulating</div><div>LP = Slickensided Planar</div></div><div><div><u>FILLING</u></div><div>T = Tight, Hard</div><div>O = Oxidized</div><div>SA = Slightly Altered, Clay Free</div><div>S = Sandy, Clay Free</div><div>Si = Sandy, Silty, Minor Clay</div><div>NC = Non-softening Clay</div><div>SC = Swelling, Soft Clay</div></div></div></div></div>																	


	Project No.: 165000958	GWP: 6212-14-00	Rockcore Photographs Date: May 12 &13, 2014
	Project Name: Rehabilitation/Replacement of 13 Structures in Northwest Region (Highway 11), Ontario		




Rock Core Photo No. 1	Borehole: BH14-1 (Site No. 45-270C, Kemuel Lake)	Depth: 8.15 to 9.93 m
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Rock Core Photo No. 2	Borehole: BH14-2 (Site No. 45-270C, Kemuel Lake)	Depth: 5.56 to 7.92 m
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	Project No.: 165000958	GWP: 6212-14-00	Rockcore Photographs Date: May 29, 2014
	Project Name: Rehabilitation/Replacement of 13 Structures in Northwest Region (Highway 11), Ontario		



165000873  
Kemuel Lake Culvert  
BH14-3  
0.64 – 2.03 m

Stantec Consulting Ltd.

165000873  
Kemuel Lake Culvert  
BH14-4  
1.68 – 3.43 m

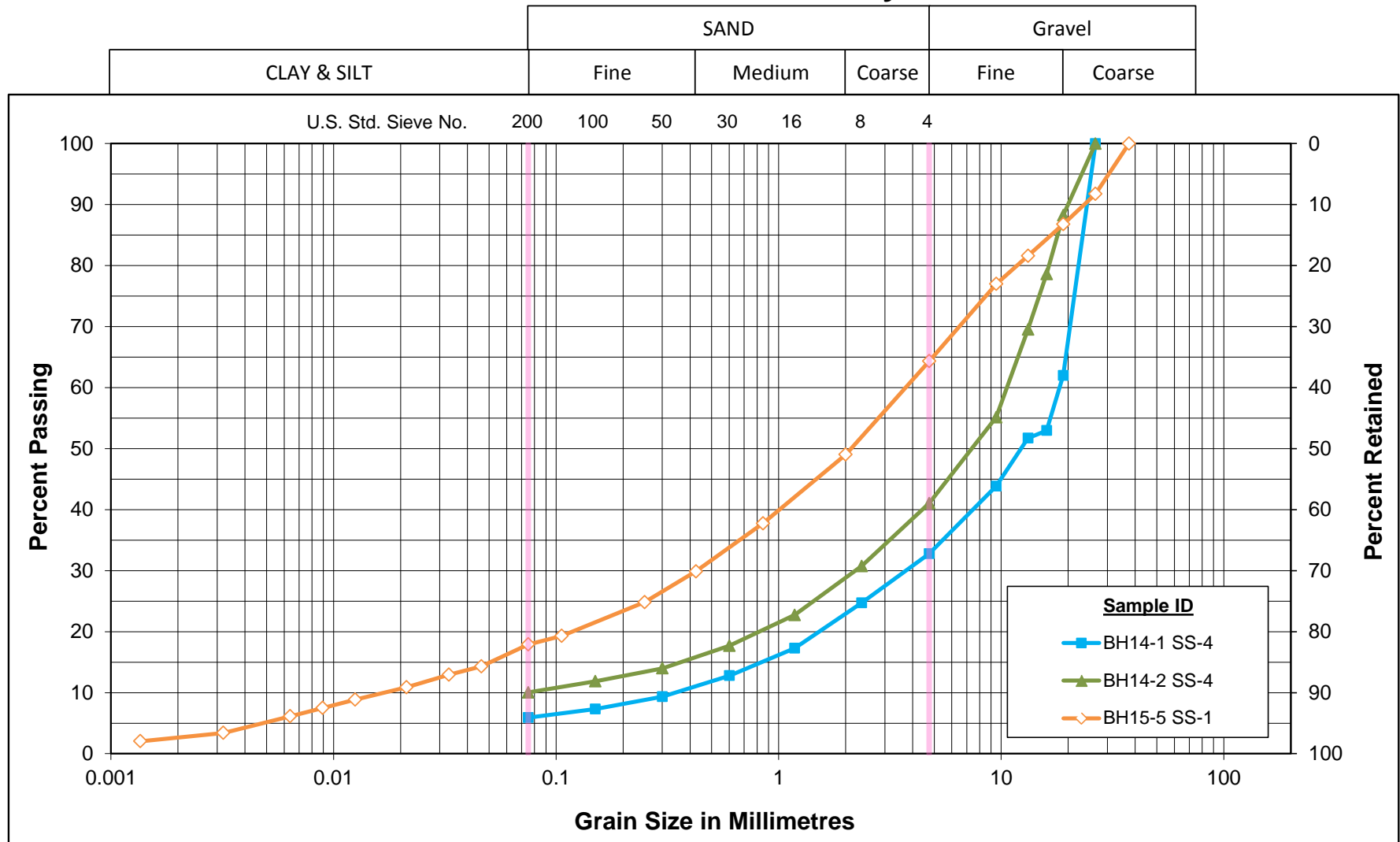
Rock Core Photo No. 2	Borehole: BH14-3 & BH14-4 (Site No. 45-270C, Kemuel Lake)	Depth: 0.64 – 2.03 m & 1.68 – 3.43 m
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## APPENDIX C

### Laboratory Test Result



# Unified Soil Classification System



## GRAIN SIZE DISTRIBUTION

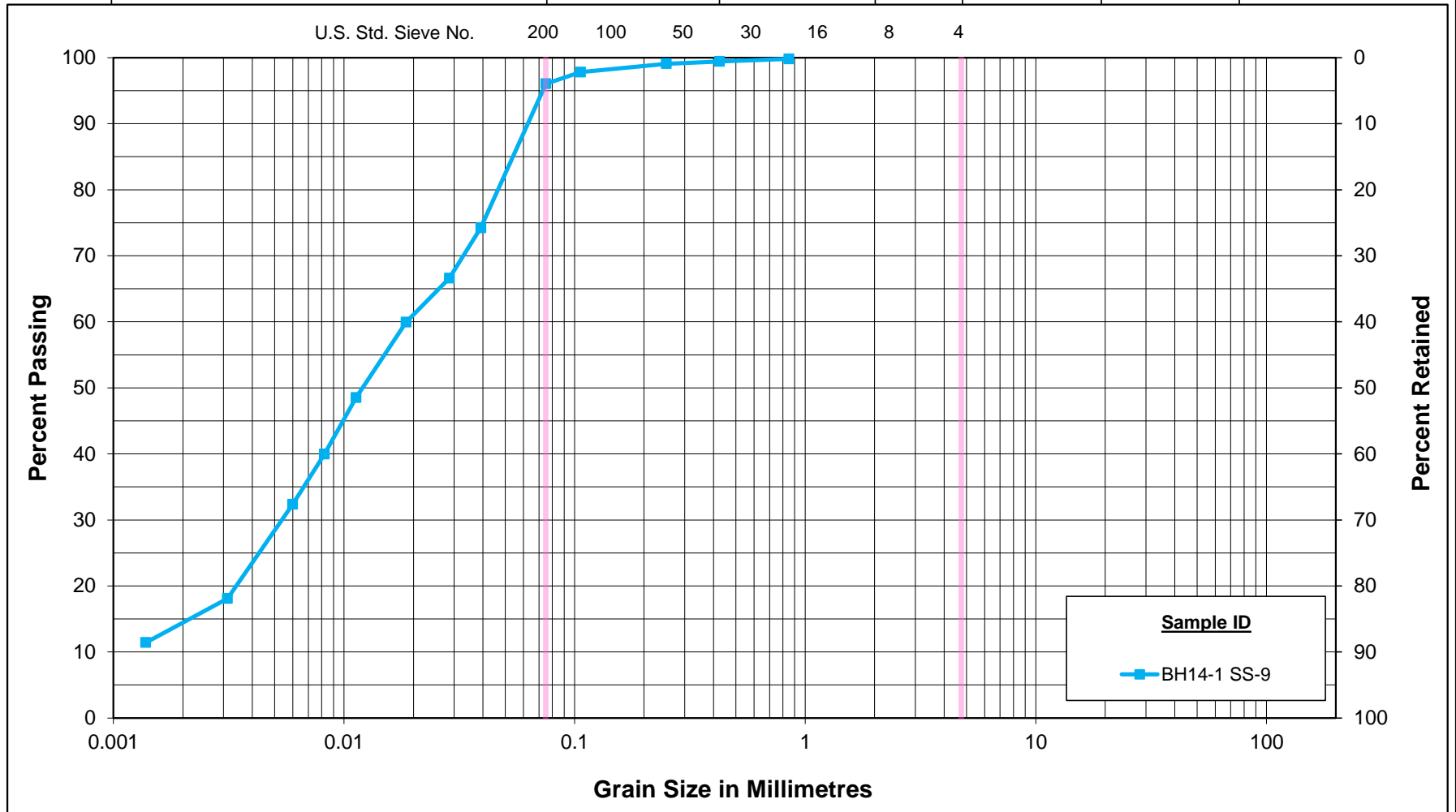
FILL: Well-graded gravel with silt and sand (GW-GM), poorly graded gravel with silt and sand (GP-GM), and silty sand with gravel (SM)

Figure No. 1

Project No. 165000958

# Unified Soil Classification System

			SAND			Gravel	
CLAY & SILT			Fine	Medium	Coarse	Fine	Coarse



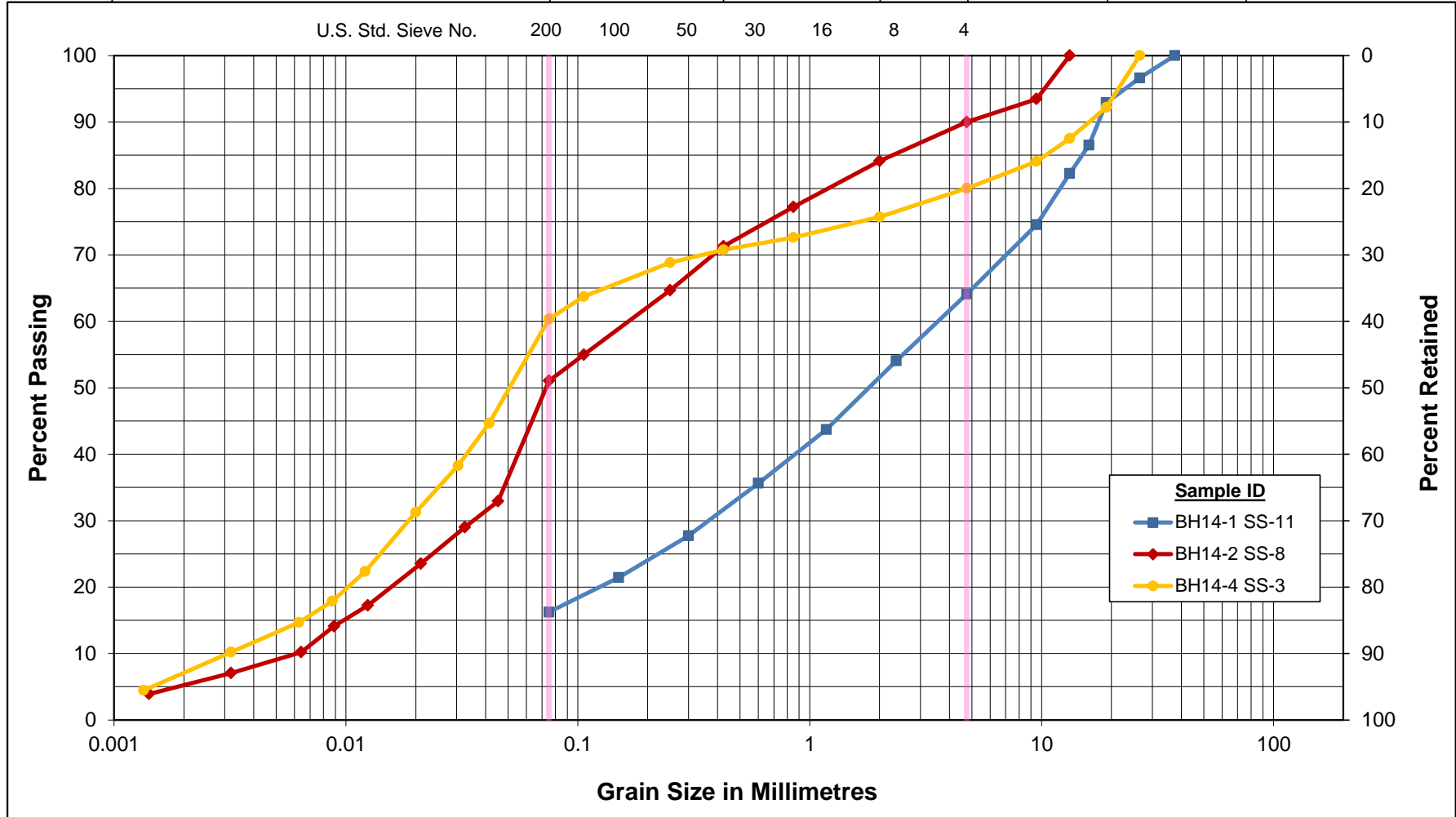
**GRAIN SIZE DISTRIBUTION**  
Silt (ML)

Figure No. 2

Project No. 165000958

# Unified Soil Classification System

			SAND			Gravel	
CLAY & SILT			Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION  
TILL: Sandy silt (ML) to silty sand (SM)

Figure No. 3

Project No. 165000958

