



April 25, 2017

## FOUNDATION INVESTIGATION REPORT

**STRAIGHT LAKE SBL BRIDGE STRUCTURE, SITE NO. 44-461/2  
HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529  
NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 5347-08-00; WP 5146-08-01**

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REPORT





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# PART A

## FOUNDATION INVESTIGATION REPORT

STRAIGHT LAKE SBL BRIDGE, SITE NO. 44-461/2

HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529

NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5347-08-00; WP 5146-08-01



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed Highway 69 southbound lane (SBL) bridge over Straight Lake (Site No. 44-461/2) which is within the Contract 5 limits of the new Highway 69 alignment. The proposed work in Contract 5 is part of the overall four-laning of Highway 69 from 1.7 km north of Highway 529 northerly to 3.9 km north of Highway 522, for a total distance of 19.7 km, which includes: high fill embankments and embankments over swamps; the Canadian National Railway (CNR) re-alignment; the Bekanon Road and Highway 522 interchanges and structures; the Still River, Straight Lake and Key River structures; the Canadian Pacific Railway and CNR overpass structures; as well as culvert crossings. The general location of this proposed bridge along the new Highway 69 four-laning alignment is shown on the Index Plan on Drawing 1.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated December 2008. Golder's proposal (Scope of Work) for foundation engineering services associated with the Contract 5 Straight Lake bridge is contained in Section 6.8 of URS's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated April 19, 2010.

This report addresses the investigation carried out for the Straight Lake SBL bridge only. Separate reports address the foundation investigations for the related swamp crossings and high fill areas, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed bridge location, by borehole drilling, rock coring, in situ testing and laboratory testing on selected soil and rock core samples. The foundation units/limits for this investigation were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by URS. The investigation area is shown in plan on Drawing 2.

Golder completed the investigation for the SBL bridge in the following two phases:

- Phase 1 in 2013: Two boreholes and one dynamic cone penetration test were advanced within Straight Lake along the proposed SBL centreline, at two potential pier locations, following which the investigation was carried out for the high fill area immediately north of Straight Lake (High Fill Swamp 502, reported under separate cover).
- Phase 2 in 2014: The remaining boreholes for the approach embankments and for the bridge were advanced after the span arrangement and location of piers/abutments were established by URS based on preliminary input by Golder from the Phase 1 investigation.

Subsequent to completion of the Phase 2 field investigation in 2014 and a detailed assessment of the subsurface conditions, embankment stability and settlement at the north abutment and approach location, the layout of the proposed bridge piers was revised and the length of the structure extended to the north. This change to the General Arrangement was agreed upon by MTO, URS and Golder and finalized in February 2016 after detailed comparison of several options to take advantage of more suitable foundation conditions and minimize potential foundation mitigation measures that would otherwise be required for the north abutment and approach embankment. As such, select pertinent boreholes advanced along the proposed SBL centreline within High Fill Swamp 502 north of Straight Lake are also referenced in this report.

Preliminary subsurface information for this project is available and was supplied by the MTO, specifically:



- Preliminary Foundation Investigation and Design Report for Structural Areas (Foundation Investigation 2), Highway 69 Four Laning, From 3.5 km North of Highway 559 to 3.8 km North of Highway 522, GWP 5377-02-00, GEOCRE No. 41H-57, dated July 2006, by Amec Earth and Environmental.

## 2.0 SITE DESCRIPTION

The proposed Highway 69 alignment is oriented generally in a south-north direction spanning the Township of Wallbridge to the south, the Township of Henvey and the Henvey Inlet First Nation Reserve No. 2 and the Township of Mowat to the north. The Contract 5 section of the new four-lane Highway 69 alignment is also oriented generally in a south-north direction within the overall project limits, for a total distance of about 1.6 km in the Henvey Inlet First Nation Reserve No. 2. The proposed Straight Lake bridge is located approximately 1.1 km east of the existing Highway 69 alignment and 1.5 km from the northern limit of Contract 5, corresponding to approximately 9.0 km north of the junction of the existing Highway 69 and Highway 526.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely or densely treed areas and numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils. At the Straight Lake bridge site, at the south abutment and along the south approach, a bedrock outcrop protrudes from the lake surface (at about Elevation 178 m) and extends up to about Elevation 193 m, resulting in an outcrop up to about 15 m high above the lake level. At the north abutment and north approach, the ground surface in the high fill swamp area gradually increases in elevation from the north shore of the lake to the north approach at Elevation 191.0 m, about 13 m high above the lake level.

## 3.0 INVESTIGATION PROCEDURES

### 3.1 Foundation Investigation

The fieldwork for the investigation for High Fill 502 north of Straight Lake and for the Phase 1 bridge investigation (Boreholes B501-01 and B501-02), was carried out in February and March, 2013. The fieldwork for the Phase 2 bridge investigation, which includes the remaining B501-series boreholes and Dynamic Cone Penetration Tests (DCPTs), was carried out in February and March, 2014. A total of 18 boreholes and two DCPTs were advanced for the Phases 1 and 2 bridge investigation, supplemented with a total of eight boreholes and one DCPT advanced along the proposed SBL centreline and near each proposed embankment toe in High Fill 502 north of Straight Lake. A summary of the boreholes and their respective locations relative to each foundation element and approach area is presented below. The locations of the boreholes are shown in plan on Drawing 2 and the Record of Borehole/Drillhole sheets are presented in Appendix A.

Foundation Element/Approach Area	Borehole and DCPT No.
South Approach	B501-03
South Abutment	B501-04
	B501-05
	B501-06
	B501-07 and -07A
	B501-08



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Foundation Element/Approach Area	Borehole and DCPT No.
Pier 1 Area	B501-DC01
	B501-09
	B501-15
	B501-16
	B501-17
	B501-18
Pier 2 Area	B501-01, B501-10 and B501-DC10
Between Piers 2 and 3	B501-11
Pier 3 Area	B501-02
Between Piers 3 and 4	B501-12
	S502-01
Pier 4 Area	S502-03
Between Pier 4 and North Abutment	B501-13
	S502-05
	B501-14
North Abutment Area	S502-07
North Approach, including Front Slope	B501-13, B501-14, S502-05 to S502-09, S502-21, S502-DC03

The field investigation was carried out using a variety of drilling equipment as a result of the varying nature of the terrain and accessibility within the Contract 5 project limits. The details of the drilling equipment and suppliers are listed below.

Drilling Equipment	Supplied and Operated By
Skid Mounted Diedrich D-25	Landcore Drilling of Sudbury, Ontario
Skid Mounted Diedrich D-25	Walker Drilling Ltd. of Utopia, Ontario
Portable Drilling Equipment	OGS Inc. of Almonte, Ontario

The boreholes on land were advanced to depths between 0.1 m (on a bedrock outcrop) and 30.9 m and the boreholes in the lake were advanced to depths of up to 52.7 m below the ice surface, through an ice/water column between 2.1 m and 4.4 m deep.

The boreholes were advanced through the overburden using 150 mm or 127 mm outer diameter (O.D.) solid-stem augers, and 'BW' and/or 'NW' casing with wash boring techniques. In general, soil samples were taken at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler using a manual hammers (rope and cat head) on both the portable and skid-mounted equipment, and carried out in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Samples of cohesive soils were obtained at selected locations/depths using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587) for relatively undisturbed samples. Field vane shear tests were carried out in cohesive soils for assessment of undrained shear strengths (ASTM D2573) using MTO Standard 'N' size vanes. Bedrock coring was carried out using an 'NQ' core barrel. Photographs of the recovered rock core samples are provided in Appendix B.



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The groundwater conditions were observed during the drilling operations and all boreholes were backfilled upon completion in accordance with Ontario Regulation 903, Wells (as amended). A standpipe piezometer was installed in Borehole B501-06 to monitor the groundwater level at this location. The piezometer consists of 32 mm diameter PVC pipe, with slotted screen sealed within the sand and gravel strata. The borehole and annulus surrounding the piezometer pipe above the screen (and sand pack) was backfilled to near the ground surface with bentonite pellets and soil cuttings, topped with a bentonite seal at the ground surface. Piezometer installation details and water level readings are described on the Record of Borehole sheet presented in Appendix A. The water level in the piezometer was measured on March 2, 2014.

The field work was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, organic content, grain size distribution and Atterberg limits) was carried out on selected samples. Strength testing, consisting of uniaxial (unconfined) compression and point load index, was carried out on selected specimens of the rock core. The results of the laboratory testing are included in Appendix B.

For the Phase 1 investigation, the proposed centreline of the new highway alignment was staked in the field by Callon Dietz prior to drilling and the as-drilled borehole locations and ground/ice surface elevations were measured/surveyed by a member of our technical staff in reference to the centreline stakes. For the Phase 2 investigation, the boreholes were located in the field and the ground/ice surface elevations were surveyed by Callon Dietz prior to drilling. The locations given on the Record of Borehole/Drillhole sheets and shown on Drawing 2 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

Borehole No.	Location (MTM NAD 83)		Water/Ground Surface Elevation (Ice/Water Column)* (m)	Borehole Depth (m)
	Northing	Easting		
B501-01	5082991.6	223013.2	178.6*	52.7**
B501-02	5088371.8	222979.6	178.6*	40.6**
B501-03	5082862.5	223067.2	192.7	0.1
B501-04	5082877.1	223055.7	183.4	2.7
B501-05	5082880.8	223054.2	183.8	5.6**
B501-06	5082880.9	223059.5	183.4	6.2**
B501-07	5082881.0	223064.9	183.7	3.5
B501-07A	5082880.8	223064.5	183.7	8.6**
B501-08	5082884.6	223063.4	183.5	2.7
B501-09	5082927.0	223040.2	178.6*	7.8**
B501-10	5082987.0	223015.1	178.5*	52.4**
B501-11	5083046.9	222990.0	178.6*	39.8**
B501-12	5083106.9	222964.9	181.0	30.9**
B501-13	5083153.0	222945.6	185.1	16.8**



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Borehole No.	Location (MTM NAD 83)		Water/Ground Surface Elevation (Ice/Water Column)* (m)	Borehole Depth (m)
	Northing	Easting		
B501-14	5083171.5	222937.8	188.3	15.7
B501-15	5082921.3	223034.5	178.6*	5.8**
B501-16	5082926.9	223032.2	178.6*	7.4
B501-17	5082927.1	223048.3	178.6*	5.7
B501-18	5082932.7	223046.0	178.6*	13.0**
B501-DC01	5082929.8	223039.1	178.6*	23.2
B501-DC10	5082987.0	223016.9	178.5*	36.6
S502-01	5083111.4	222963.0	181.1	27.5
S502-03	5083134.5	222953.3	183.0	16.3
S502-05	5083157.5	222943.7	186.1	13.6
S502-06	5083161.2	222920.1	188.4	11.6
S502-07	5083180.6	222934.0	190.3	16.5
S502-08	5083197.7	222942.6	190.6	19.7
S502-09	5083203.6	222924.4	191.0	15.0
S502-21	5083176.3	222956.2	187.3	16.5
S502-DC03	5083183.9	222915.3	190.4	12.3

\*Ice/Water surface; Borehole Depth includes water column.

\*\*Borehole Depth includes bedrock core length between 0.8 m and 3.5 m.

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, this section of the new Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of relatively shallow deposits of sand, silt and clay underlain by metamorphic bedrock and numerous bare knobs and ridges of bedrock are present throughout the area. Localized low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, sometimes to significant depth, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of crystalline gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in *Geology of Ontario (OGS Special Volume 4)*<sup>2</sup>.

<sup>1</sup> Chapman, L.J. and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

<sup>2</sup> Ontario Geological Society, 1991. *Geology of Ontario*, Society Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

## **4.2 Subsurface Conditions**

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock core samples, are presented on the Record of Borehole and Drillhole sheets and on the laboratory test figures provided in Appendix A and Appendix B, respectively. The results of the in situ field tests (i.e., SPT 'N'-values and the undrained shear strengths obtained from the field vanes) as presented on the Record of Borehole sheets and in Sections 4.3 to 4.9 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profile and cross-sections are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. The bedrock surface has been inferred from observations made during drilling and coring and generally represents a transition from overburden to the bedrock surface and should not be inferred to represent the exact surface elevation of the bedrock. Furthermore, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawings 2 to 6 is a simplification of the subsurface conditions.

The subsurface conditions encountered at the site are characterized essentially by:

- At the south abutment/approach: deposits of organic silt, silt to sand and/or clayey silt, over granitic gneiss bedrock; and
- Within the lake and on the north side of the lake: thick deposits of organic silt or organic silty clay, clayey silt to clay, silt to sand, underlain by granitic gneiss bedrock.

The results of the unconfined compressive strength tests on the rock core samples (ASTM D7102 - Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures) are presented in Tables B1 and B2 and the results of the laboratory testing on the soil samples are presented on Figures B1 to B8, in Appendix B. Photographs of the bedrock core samples are presented on Figures B9 to B12, inclusive, in Appendix B.

The quality of the bedrock with respect to the Rock Quality Designation (RQD) value is classified in accordance with Table 3.10 in Canadian Foundation Engineering Manual (2006)<sup>3</sup>.

The degree of weathering of the bedrock samples (e.g. slightly weathered – W2) is based on field identification, and the strength classification of the intact rock mass (e.g. strong – R4) is based on laboratory testing of bedrock core samples and is described in accordance with the International Society for Rock Mechanics (ISRM<sup>4</sup>) standard classification system, as presented in Table 3.5 of CFEM (2006).

Axial and diametral point load strength index tests (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification) were carried out on

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<sup>3</sup> Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition. The Canadian Geotechnical Society c/o BiTech Publisher Ltd., British Columbia.

<sup>4</sup> International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.





selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B.

The relationship between  $Is_{50}$  and uniaxial compressive strength (UCS) values, given by correlation factor (K), varies depending on the size of the core sample and the strength of the rock. For the SBL (as well as for the NBL) bridge, using the consolidated rock strength data from both sites, an average correlation factor (K) was calculated by matching UCS test values and point load test values at similar depths from the same boreholes. An average correlation factor (K) of 14 was estimated.

A detailed description of the subsurface conditions encountered in the boreholes in the area of each approach/abutment and at/in the area of each pier is provided in the following sections. Boreholes B501-11 and B501-12 and S502-01 were advanced between proposed pier locations rather than in proximity of the foundation elements, the soil stratigraphy (i.e., Record of Borehole sheets) and laboratory test results are presented in this report but are not discussed further in the following sections of this report.

Groundwater and lake water levels are subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year. For the lake boreholes, because the boreholes were advanced in the water, and water was introduced into the boreholes during the drilling process, the water level noted in the boreholes is not considered representative of the stabilized groundwater conditions.

## **4.3 South Abutment/Approach**

A total of six boreholes (B501-03 to B501-08 with B501-07 supplemented with B501-07A) were advanced in the vicinity of the proposed south approach/abutment. The interpreted stratigraphy at the south abutment/approach is shown in profile on Drawing 2 and in cross-section on Drawing 3.

### **4.3.1 Topsoil**

A 0.1 m to 0.2 m thick layer of topsoil was encountered from ground surface at all the boreholes advanced at the south approach/abutment with the ground surface at Elevations 192.7 m at the south approach (Borehole B501-03) and between Elevations 183.8 m and 183.4 m at the south abutment (Boreholes B501-04 to B501-08).

### **4.3.2 Sandy Silt to Sand**

A 0.6 m to 2.1 m thick deposit of non-cohesive soil comprised of sandy silt to silt and sand to sand to sandy silt and gravel was encountered below the topsoil in Boreholes B501-04 to B501-07 at Elevations between 183.6 m and 183.2 m.

The SPT 'N'-values measured within the deposit range between 2 blows and 21 blows per 0.3 m of penetration indicating a very loose to compact relative density.

The natural water content measured on samples of the deposit range between 28 per cent and 47 per cent.

The results of two grain size distribution tests completed on two samples of the silt and sand portion of the deposit are shown on Figure B2A.



### **4.3.3 Organic Sandy Silt to Organic Silt**

In Borehole B501-07, 0.7 m thick deposit of organic silt trace wood fragments and rootlets was encountered below the silt and sand deposit at Elevation 181.4 m. In Borehole B501-08, a 1.9 m thick deposit of organic sandy silt to organic silt was encountered below the topsoil at Elevation 183.3 m.

The natural water content measured on two samples of the deposit are 38 per cent and 43 per cent.

The result of a grain size distribution test completed on one sample of the organic silt portion of the deposit is shown on Figure B4.

An Atterberg limits test carried out on one sample of the organic deposit yielded a liquid limit of about 35 per cent, and a plastic limit of about 31 per cent, corresponding to a plasticity index of about 4 per cent, indicating that the material is classified as an organic silt of low plasticity. The result of the Atterberg limits test is shown on the plasticity chart on Figure B5.

### **4.3.4 Gravelly Silt and Sand to Sand and Gravel**

In Boreholes B501-04 to B501-08, a deposit comprised of gravelly silt and sand, sandy silt and gravel, silty sand and gravel or sand and gravel was encountered below the clayey silt, organic silt, or sandy silt to sand deposits. The deposit was encountered between Elevation 182.6 m and 180.7 m and the thickness of the deposit ranges between 0.4 m and 2.9 m. Cobbles were encountered in the lower portion of the deposit in several boreholes.

The SPT 'N'-values measured within this deposit range from 2 blows to 57 blows per 0.3 m of penetration, and up to 70 blows per 0.18 m of penetration, indicating a very loose to very dense relative density.

The natural water content measured on samples of the deposit range between 18 per cent and 33 per cent.

The results of grain size distribution tests completed on three samples of this deposit are shown on Figure B3.

### **4.3.5 Cobbles and Boulders**

A deposit of cobbles and boulders was encountered in Borehole B501-07A at a depth of 3.5 m below ground surface, corresponding to Elevation 180.2 m, and the thickness of the deposit is 1.8 m.

### **4.3.6 Bedrock/Refusal**

Bedrock core samples were recovered from Boreholes B501-05, B501-06 and B501-07A. Refusal to split-spoon or casing advancement was encountered in Boreholes B501-03, B501-04, B501-07 and B501-08. The corresponding bedrock surface elevations and refusal are summarized below.



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Foundation Element	Borehole	Bedrock Surface Elevation (m)	Comments
South Abutment/Approach	B501-03	192.6	Split-Spoon Refusal
	B501-04	180.7	Split-Spoon Refusal
	B501-05	181.3	Bedrock Cored
	B501-06	179.7	Bedrock Cored
	B501-07	180.2	Casing Refusal
	B501-07A	178.4	Bedrock Cored
	B501-08	180.8	Split-Spoon Refusal

In general, the bedrock surface along the south approach and in the area of the proposed south abutment, as inferred by refusal to further split spoon or casing advancement and from coring, slopes downward from south to north with the bedrock surface elevation changing by as much as 2.9 m at the abutment borehole locations and up to 14.2 m relative to the approach borehole 20 m south of the abutment.

Based on a review of the bedrock core samples recovered from Boreholes B501-05, B501-06 and B501-07A, the bedrock consists of granitic gneiss. In general the bedrock samples are described as slightly to moderately weathered, foliated, medium to coarse grained, weak to very strong, dark grey to red or red-brown, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photographs of the recovered core samples on Figures B9 and B10 in Appendix B.

The Rock Quality Designation (RQD) measured on the core samples generally ranges from 27 per cent to 100 per cent, generally indicating a rock mass of poor to excellent quality as per Table 3.10 of CFEM (2006). The RQD in the upper run/zone in Borehole B501-07A is 0 per cent. The Total Core Recovery (TCR) of samples recovered are between 84 per cent and 100 per cent.

The axial test carried out on five samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 0.9 MPa to 8.2 MPa and the diametral tests carried out on five samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 0.5 MPa to 9.0 MPa.

One Unconfined Compression (UC) test (ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens) was carried out on a selected sample of the granitic gneiss bedrock obtained in Borehole B501-06. The test result indicates a compressive strength of about 39 MPa as summarized in Table B2-1 and detailed in Table B2-3.

Based on the UCS and Point Load Test (PLT) results at the south abutment, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as weak to very strong (R2 to R5, 5 MPa < UCS < 250 MPa).

#### **4.3.7 Groundwater Conditions**

Borehole B501-03 was dry upon completion of drilling. The groundwater level in Boreholes B501-04, B501-05, B501-07 and B501-08, upon completion of drilling was measured between Elevation 182.4 m and 182.0 m, at depths between 1.1 m and 1.8 m below ground surface.



A standpipe piezometer was installed in Borehole B501-06 to allow monitoring of the groundwater level at the borehole location. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A and the groundwater level measured in the piezometer is summarized below.

Foundation Element	Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
South Abutment	B501-06	183.4	182.3	March 2, 2014

## 4.4 Pier 1

A total of five boreholes (B501-09 and B501-15 to B501-18) and one DCPT (B501-DC01) were advanced at or in the vicinity of the proposed Pier 1. The interpreted stratigraphy in cross-section along the centreline of the Pier 1 foundation area and perpendicular to the centreline of the foundation area on the west side of Pier 1 is shown on Drawing 3.

### 4.4.1 Ice/Water

The ice surface at Boreholes B501-09, B501-15 to B501-18 and DCPT B501-DC01 in Straight Lake in February 2014 was at Elevation 178.6 m and the depth of ice/water at the boreholes ranged between 2.7 m and 4.4 m.

### 4.4.2 Silty Sand

A deposit of silty sand was encountered below the water in Borehole B501-17. The top of the deposit was encountered at Elevation 175.9 m and the thickness of the deposit is 1.9 m.

The SPT 'N'-values measured within the silty sand deposit are 0 blows (weight of rod) per 0.3 m of penetration indicating a very loose relative density.

The natural water content measured on a sample of the deposit is 45 per cent.

The result of a grain size distribution test completed on one sample of the silty sand is shown on Figure B2B.

### 4.4.3 Organic Silty Clay / Organic Silt / Organic Silt and Sand

A deposit of organic silty clay, organic silt to silt and/or organic silt and sand was encountered below the water in Boreholes B501-09, B501-16 and B501-18, and below the silty sand in Borehole B501-17. The top of the deposit was encountered between Elevations 175.2 m and 174.0 m and the thickness of the deposit ranges from 1.1 m to 5.7 m.

The SPT 'N'-values measured within the organic deposit are 0 blows (weight of rod) per 0.3 m of penetration indicating a very loose relative density or very soft consistency. Two in situ field vane tests carried out within the organic silt and sand to silt trace organics portion of the deposit in Borehole B501-17 measured undrained shear strengths of 8 kPa, and the sensitivity is 2 and 3.

The natural water content measured on samples of the deposit range between 68 per cent and 201 per cent.

The organic content measured on four samples of the organic deposit range between 4 per cent and 8 per cent.



The result of a grain size distribution test completed on one sample of the organic silt and sand is shown on Figure B4.

Atterberg limits tests carried out on two samples of the organic deposit yielded liquid limits of about 42 per cent and 54 per cent, and plastic limits of about 22 per cent and 34 per cent, corresponding to plasticity indices of about 20 per cent, indicating that the material is classified as an organic silt of low plasticity or an organic silty clay of intermediate plasticity. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5.

#### **4.4.4 Bedrock / Refusal**

Bedrock was encountered and core samples were recovered from Boreholes B501-09, B501-15 and B501-18. Refusal to casing advancement was encountered in Boreholes B501-16 and B501-17. The corresponding bedrock surface elevations and refusal elevations are summarized below.

<b>Foundation Element</b>	<b>Borehole</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Comments</b>
Pier 1	B501-09	173.9	Bedrock Cored
	B501-15	176.0	Bedrock Cored
	B501-16	171.2	Casing Refusal
	B501-17	172.9	Casing Refusal
	B501-18	168.9	Bedrock Cored

In general, the bedrock surface in the area of the proposed Pier 1, inferred or proven by coring, slopes down from south to north and west to east, with the bedrock surface elevation varying by as much as 7.1 m at the borehole locations.

Based on a review of the bedrock core samples recovered from the boreholes, the bedrock consists of granitic gneiss. In general the bedrock samples are described as fresh to slightly weathered, foliated, medium to coarse grained, weak to very strong, dark grey to pink, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figures B10 and B12 in Appendix B.

The RQD measured on the core samples ranges between 85 per cent and 100 per cent, indicating the rock is of good to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples ranges from 96 per cent to 100 per cent.

Point load strength index tests (ASTM D5731) were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on six samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 6.0 MPa to 11.3 MPa and the diametral tests carried out on six samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 1.3 MPa to 10.9 MPa.

Three UC tests (ASTM D7012) carried out on selected samples of the granitic gneiss bedrock obtained in Boreholes B501-09, B501-15 and B501-18 measured compressive strengths of 50 MPa, 89 MPa and 113 MPa as summarized in Table B2-1 and detailed in Tables B2-4, B2-6 and B2-7, respectively, in Appendix B.

Table B1 also presents estimated UCS correlated to the PLT strengths based on the relationship between  $Is_{50}$  and UCS and applying an average correlation factor (K) of 14 as discussed in Section 4.3.1.



Based on the UCS and PLT results at Pier 1, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as weak to very strong (R2 to R5, 5 MPa < UCS < 250 MPa).

## **4.5 Pier 2 Area**

A total of two boreholes (B501-01 and B501-10) and one DCPT (B501-DC10) were advanced in the vicinity of the proposed Pier 2 with Borehole B501-01 located approximately 7.5 m south of Pier 2. The interpreted stratigraphy in the Pier 2 area is shown in cross-section on Drawing 4.

### **4.5.1 Ice/Water**

The ice surface at Boreholes B501-01 and B501-10 and DCPT B501-DC10 in Straight Lake in February 2013 and February 2014 was at Elevation 178.5 m and 178.6 m, respectively, and the depth of ice/water at the boreholes/DCPT was between 4.0 m and 4.3 m.

### **4.5.2 Organic Silt**

A deposit of dark grey organic silt was encountered below the water in Boreholes B501-01 and B501-10 with the top of the deposit at Elevations 174.6 m and 174.2 m, respectively, and the thickness of the deposit is 3.9 m and 4.2 m, at the respective boreholes.

The SPT 'N'-values measured within the organic silt are 0 blows (weight of rod) per 0.3 m of penetration, indicating a very loose relative density. Two in situ field vane tests carried out within this deposit measured undrained shear strengths of about 15 kPa, and the sensitivity is 2.

The natural water content measured on samples of the deposit range between 129 per cent and 162 per cent.

The organic content measured on three samples of the organic silt range between 9 per cent and 10 per cent.

An Atterberg limits test carried out on one sample of the organic silt deposit yielded a liquid limit of about 88 per cent and a plastic limit of about 62 per cent, corresponding to a plasticity index of 26 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B5, and indicate that the material is classified as organic silt of high plasticity.

### **4.5.3 Clayey Silt to Clay with Silt and Sand to Silty Sand Interlayers**

A 14.4 m and 13.8 m thick deposit of clayey silt, silty clay and clay with interlayers of silt and sand or silty sand was encountered below the organic silt deposit in Boreholes B501-01 and B501-10 at Elevations 170.7 m and 170.0 m, respectively. Silt seams were noted within several samples of the cohesive deposit and the silt and sand and silty sand interlayers are between 0.7 m and 4.3 m thick. Reportedly, Amec's Borehole ST-37 encountered occasional cobbles and a possible boulder at about approximate Elevation 166 m.

The SPT 'N'-values measured within the clayey silt to clay range between 0 blows (weight of hammer) and 6 blows per 0.3 m of penetration. In situ field vane tests carried out within the clayey silt to clay deposit measured undrained



shear strengths ranging between 12 kPa and greater than 96 kPa, suggesting a soft to very stiff consistency. The sensitivity ranges between 1 and 7.

The SPT 'N'-values measured within the silt and sand or silty sand interlayers range between 2 blows and 32 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The natural water content measured on samples of the clayey silt to clay range from 29 per cent to 65 per cent. The natural water content measured on samples of the silt and sand or silty sand interlayers range between 16 per cent and 26 per cent.

The result of a grain size distribution test completed on one sample of the clay is shown on Figure B1. The results of grain size distribution tests completed on two samples of the interlayers of silt and sand are shown on Figure B2A.

Atterberg limits test carried out on six samples of the clayey silt to clay deposit yielded liquid limits between about 22 per cent and 52 per cent and plastic limits between 13 per cent and 21 per cent, corresponding to plastic indices between 9 per cent and 31 per cent, indicating that the material is classified as a clayey silt of low plasticity to a clay of high plasticity. The results of the Atterberg limits tests are shown on the plasticity chart on Figures B6A and B6B.

#### **4.5.4 Silt**

A 2.5 m and 11.8 m thick deposit of grey silt was encountered below the clayey silt to clay deposit in Boreholes B501-01 and B501-10 at Elevations 156.3 m and 156.2 m, respectively. In Borehole B501-01, clayey silt lenses were encountered to a depth of 23.0 m, corresponding to Elevation 155.6 m.

The SPT 'N'-values measured within the silt range between 4 blows and 26 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on samples of the deposit range between 22 per cent and 28 per cent.

The results of grain size distribution tests completed on three samples of the silt deposit are shown on Figure B7A.

Atterberg limits tests carried out on two samples of the silt indicate that the material is non-plastic.

#### **4.5.5 Sand and Silt to Sand**

A 23.5 m and 15.1 m thick deposit of grey silt and sand to sand was encountered below the silt deposit in Boreholes B501-01 and B501-10 at Elevations 152.8 m and 144.4 m, respectively. Cobbles and/or boulders were encountered in Borehole B501-10 at a depth of 36.6 m and cobbles were encountered at depths between 43.3 m and 44.7 m, corresponding to Elevations 141.9 m and between Elevation 135.2 m and 133.8 m, respectively.

The SPT 'N'-values measured within the deposit range between 6 blows and 23 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on samples of the deposit range between 20 per cent and 24 per cent.

The results of grain size distribution tests completed on two samples of the deposit are shown on Figure B8.





#### **4.5.6 Cobbles and Boulders**

A 2.4 m thick deposit of cobbles and boulders was encountered in Borehole B501-10 at Elevation 129.3 m. Reportedly, Amec's Borehole ST-37 encountered occasional cobbles and a possible boulder at about approximate Elevation 166 m.

#### **4.5.7 Bedrock**

Bedrock was encountered and core samples were recovered from Boreholes B501-01 and B501-10 at Elevations 129.3 m and 126.9 m, respectively.

Based on a review of the bedrock core samples recovered from the boreholes, the bedrock consists of granitic gneiss. In general the bedrock samples are described as fresh to slightly weathered, foliated, medium to coarse grained, medium strong to very strong, grey, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figures B9 and B11 in Appendix B.

The RQD measured on the core samples ranges between 64 per cent and 77 per cent, indicating the rock is of fair to good quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples ranges from 83 per cent to 99 per cent.

Point load strength index tests (ASTM D5731) were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on four samples of the granitic gneiss bedrock core measured  $Is_{50}$  values of 7.1 MPa and 10.1 MPa and the diametral tests carried out on four samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 2.3 MPa to 7.9 MPa.

One UC test (ASTM D7012) carried out on a selected sample of the granitic gneiss bedrock obtained in Borehole B501-01 measured a compressive strength of about 88 MPa as summarized in Table B2-1 and detailed in Table B2-2.

Table B1 also presents estimated UCS correlated to the PLT strengths based on the relationship between  $Is_{50}$  and UCS and applying an average correlation factor (K) of 14 as discussed in Section 4.3.1.

Based on the UCS and PLT results at Pier 2, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as strong to very strong (R4 to R5, 50 MPa < UCS < 250 MPa).

#### **4.5.8 Groundwater Conditions**

In Borehole B501-10, an artesian groundwater condition was encountered during drilling between the depths of 35.7 m and 51.6 m below ice surface, corresponding to between Elevations 142.8 m and 126.9 m; the groundwater level was measured at 1.2 m above ice level, corresponding to Elevation 179.7 m (on February 9, 2014).

### **4.6 Pier 3 Area**

Borehole B501-02 was advanced approximately 4.4 m north of the proposed Pier 3. The interpreted stratigraphy at the Pier 3 area is shown in cross-section on Drawing 4.



#### **4.6.1 Ice / Water**

The ice surface at Borehole B501-02 in Straight Lake in March 2013 was at Elevation 178.6 m and the depth of ice/water at the borehole was 1.1 m.

#### **4.6.2 Organic Silt**

A 2.4 m thick deposit of brown organic silt was encountered below the water in Borehole B501-02 at Elevation 177.5 m.

The SPT 'N'-values measured within the organic silt are 0 blows (weight of rod/hammer) per 0.3 m of penetration, indicating a very loose relative density.

The natural water content of one sample of the deposit is 126 per cent.

#### **4.6.3 Clayey Silt**

A 6.7 m thick deposit of grey clayey silt was encountered in Borehole B501-02 below the organic silt deposit at Elevation 175.1 m. Silt layers were noted in the samples.

SPT 'N'-values measured within the clayey silt deposit are 1 blows and 2 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strength ranging between 30 kPa and 78 kPa and sensitivities between 3 and 9. The results of the field vane tests indicate that the clayey silt has a firm to stiff consistency.

The natural water content of three samples of the deposit ranges between 25 per cent and 43 per cent.

Atterberg limits testing carried out on two samples of the clayey silt deposit yielded liquid limits of 21 per cent and 31 per cent and plastic limits of 14 per cent and 15 per cent, corresponding to plasticity indices of 7 per cent and 16 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6A and indicate that the material is classified as a clayey silt of low plasticity.

An Atterberg limits test carried out on one sample of the silt layer within the clayey silt deposit yielded a liquid limit of 17 per cent and a plastic limit of 15 per cent, corresponding to plasticity index of 2 per cent. The result of the Atterberg limits tests is shown on the plasticity chart on Figure B6F, and indicates that the material is classified as a silt of slight plasticity.

#### **4.6.4 Silt (Upper Deposit)**

A 2.8 m thick deposit of grey silt was encountered at Elevation 168.4 m underlying the clayey silt deposit.

Two SPT 'N'-values measured within the silt deposit are 15 blow and 18 blows per 0.3 m of penetration, indicating a compact relative density.

The result of a gran size distribution test on one sample of the silt deposit is presented on Figure B2A.



#### **4.6.5 Silty Clay**

A 7.7 m thick deposit of silty clay was encountered at Elevation 165.6 m underlying the upper deposit of silt. An approximately 0.6 m thick layer of silt and sand was encountered within the silty clay deposit at Elevation 163.7 m.

The SPT 'N'-values measured within the silty clay deposit range between 1 blows and 6 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strength ranging between 42 kPa and greater than 96 kPa, and the sensitivity ranges between 2 and 5. The results of the field vane tests indicate that the deposit has a firm to very stiff consistency.

The natural water content measured on three samples of the deposit range between 40 per cent and 55 per cent.

Atterberg limits tests carried out on two samples of the cohesive deposit yielded liquid limits of 39 per cent and 42 per cent and plastic limits of 20 per cent and 21 per cent, corresponding to plasticity indices of 19 per cent and 21 per cent, respectively. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6A and indicate that the samples tested classified the deposit as a silty clay of intermediate plasticity.

#### **4.6.6 Silt (Lower Deposit)**

A 2.5 m thick deposit of grey silt was encountered at Elevation 157.9 m underlying the silty clay deposit.

One SPT 'N'-value measured within the silt is 12 blows per 0.3 m of penetration indicating a compact relative density.

#### **4.6.7 Silt, some Sand to Silt and Sand**

A 14.2 m thick deposit of grey silt some sand to silt and sand was encountered at Elevation 155.4 m underlying the lower deposit of silt.

The SPT 'N'-values measured within the silt to silt and sand deposit range between 3 blows and 15 blows per 0.3 m of penetration indicating a very loose to compact relative density.

The natural water content measured on samples of the deposit range between 20 per cent and 22 per cent.

The results of grain size distribution tests completed on two samples of the silt and sand deposit are shown on Figure B8.

#### **4.6.8 Boulder**

A 500 mm boulder was encountered at Elevation 145.4 m within this deposit.

#### **4.6.9 Bedrock**

Bedrock was encountered in Borehole B501-02 at Elevation 141.2 m, corresponding to a depth of 37.4 m below ice surface, and a 3.2 m length of core was recovered.

Based on a review of the bedrock core samples, the bedrock consists of granitic gneiss. In general the bedrock samples are described as slightly weathered to fresh, medium to coarse grained, strong to very strong, dark grey,



as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figure B9 in Appendix B.

The RQD measured on the core samples is 70 per cent and 91 per cent, indicating the rock is of fair to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples is 98 per cent and 99 per cent.

Point load strength index tests (ASTM D5731) were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on two samples of the granitic gneiss bedrock core measured  $Is_{50}$  values of 6.3 MPa and 8.5 MPa and the diametral tests carried out on four samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from 4.8 MPa to 8.6 MPa.

Based on the PLT results on the bedrock core from the Pier 3 area, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified very strong ( $R_5$ , 100 MPa < UCS < 250 MPa).

## **4.7 Pier 4 Area**

Borehole S502-03 was advanced approximately 2.6 m south of the proposed Pier 4. The interpreted stratigraphy at Pier 4 is shown in cross-section on Drawing 5.

### **4.7.1 Organic Silt**

A 0.2 m thick layer of dark brown organic silt was encountered at ground surface at Elevation 183.0 m.

### **4.7.2 Silt to Silt and Sand to Sand**

A 6.5 m thick deposit of interlayered brown to grey sand, silt and silt and sand was encountered below the organic silt in Borehole S502-03 at Elevation 183.8 m. Trace organics was encountered in the sand samples portion of the deposit to a depth of 0.8 m, corresponding to Elevation 182.2 m.

The SPT 'N'-values measured within the interlayered silt to sand deposit range between 2 blows and 9 blows per 0.3 m of penetration indicating a very loose to loose relative density.

The natural water content measured on samples of the deposit are between 15 per cent and 30 per cent.

The result of a grain size distribution test completed on two samples of the silt and sand portion of the deposit is shown on Figure B2F.

An Atterberg limits test carried out on one sample of the silt interlayer indicates that the material is non-plastic.

### **4.7.3 Clayey Silt to Clay**

An 8.3 m thick deposit of interlayered grey clayey silt to clay was encountered below the silt to sand deposit at Elevation 176.3 m in Borehole S502-03. Silt seams were noted in the lower two samples of the clayey silt interlayer.



The SPT 'N'-values measured within the clayey silt to clay deposit range between 1 blows and 4 blows per 0.3 m of penetration. In situ field vane tests carried out within the clayey silt to clay deposit measured undrained shear strengths between 35 kPa and 43 kPa, and the sensitivity ranges between 5 and 9. The results of the field vane tests indicate that the clayey silt to clay deposit has a firm consistency.

The natural water content measured on samples of the clayey silt to clay interlayer ranges between 30 per cent and 65 per cent.

The result of a grain size distribution test completed on one sample of the clayey silt interlayer stratum is shown on Figure B1.

Atterberg limits tests carried out on four samples of the clayey silt to clay interlayers yielded liquid limits ranging between 21 per cent and 55 per cent and plastic limits of ranging between 14 per cent and 21 per cent, corresponding to plastic indices ranging between 7 per cent and 34 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figures B6C and B6D, and indicate that the material is classified as a clayey silt of low plasticity to a clay of high plasticity.

#### **4.7.4 Silt**

A 1.3 m thick deposit of grey silt was encountered at Elevation 168.0 m underlying the lower silty clay interlayer in Borehole S502-03.

One SPT 'N'-value measured within the deposit is 7 blows per 0.3 m of penetration indicating a loose relative density.

#### **4.7.5 Refusal**

In Borehole S502-03, refusal to further split-spoon and auger advancement was encountered at Elevation 166.7 m, corresponding to a depth of 16.3 m below ground surface.

#### **4.7.6 Groundwater Conditions**

In Borehole S502-03, the water level upon completion of drilling was measured at a depth of 0.8 m below ground surface (Elevation 182.2 m).

### **4.8 North Abutment**

Borehole S502-07 was advanced approximately 5.1 m south of the proposed north abutment. The interpreted stratigraphy at the north abutment is shown in cross-section on Drawing 5.

#### **4.8.1 Peat**

A 0.2 m thick layer of peat was encountered at ground surface at Elevation 190.3 m in Borehole S502-07.



#### **4.8.2 Clayey Silt**

A 0.5 m thick clayey silt layer was encountered below the peat at Elevation 190.1 m in Borehole S502-07.

One SPT 'N'-value measured in the clayey silt is 5 blows per 0.3 m of penetration indicating a firm consistency.

#### **4.8.3 Silt to Sand, Clayey Silt Interlayers**

A 15.8 m thick deposit of interlayered brown to grey silt, silt and sand, silty sand, and sand was encountered below the clayey silt at Elevation 189.6 m in Borehole S502-07. A 0.3 m thick silty clay interlayer and a 1.2 m thick clayey silt interlayer were encountered at Elevations 186.8 m and 179.3 m, respectively. The bottom 0.6 m of the deposit in Borehole S502-07 consists of gravelly silt and sand.

The SPT 'N'-values measured within the deposit range between 1 blow and 15 blows per 0.3 m of penetration indicating a very loose to compact relative density.

One in situ field vane test carried out within the clayey silt interlayer measured an undrained shear strength of 28 kPa and a sensitivity of 6. The result of the field vane test indicates that the clayey silt interlayer has a firm consistency.

The natural water content measured on samples of the interlayers of silt to sand ranges between 10 per cent and 37 per cent and on the silty clay and the clayey silt interlayers are 37 per cent and 42 per cent, respectively.

The results of two grain size distribution tests completed on samples of the silt to sand are shown on Figure B2C and B7A. The results of one grain size distribution test completed on a sample of the gravelly silt and sand at the bottom of Borehole S502-07 is shown on Figure B3.

An Atterberg limits test carried out on a sample of the silt yielded a liquid limit of 15 per cent and a plastic limit of 13 per cent, corresponding to a plastic index of 2 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B6F, and indicate that the material is classified as a silt of low plasticity.

Atterberg limits tests carried out on two samples of the silty clay and clayey silt interlayers yielded liquid limits of 48 per cent and 35 per cent and plastic limits of 18 per cent and 19 per cent, corresponding to plastic indices of 30 and 16 per cent for the respective materials. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6D, and indicate that the material is classified as a silty clay of intermediate plasticity and clayey silt of low plasticity.

#### **4.8.4 Refusal**

Refusal to further split spoon and auger advancement was encountered at Elevation 173.8 m in Borehole S502-07, at a depth of 16.5 m below ground surface.

#### **4.8.5 Groundwater Conditions**

In Borehole S501-07, the water level upon completion of drilling was measured at a depth of 7.5 m below ground surface (Elevation 182.8 m).



## **4.9 North Approach**

A total of eight boreholes (Boreholes B501-13, B501-14, S502-05 to S502-09 and S502-21) and one DCPT (S502-DC03) were advanced in the area of the north approach embankment, including the front slope area of the north abutment. The interpreted stratigraphy at the north approach is shown in profile on Drawing 2.

### **4.9.1 Topsoil / Peat**

A 0.2 m thick layer of topsoil / peat was encountered at ground surface in all of the boreholes, between Elevation 191.0 m and 185.1 m.

### **4.9.2 Clayey Silt**

A 0.5 m to 0.7 m thick clayey silt layer was encountered below the topsoil/peat in Boreholes S502-06 to S502-09 between Elevation 190.8 m and 188.2 m.

SPT 'N'-values measured in the clayey silt layer range between 2 blows and 5 blows per 0.3 m of penetration suggesting a very soft to firm consistency.

### **4.9.3 Silt to Sand and Clayey Silt to Silty Clay Interlayers**

A 10.8 m to 18.8 m thick interlayered deposit of brown to grey silt, sandy silt, silt and sand, silty sand, sand, and clayey silt, silty clay or clay was encountered below the topsoil/peat or below the uppermost deposit of clayey silt in all of the boreholes between Elevation 190.2 m and 184.9 m. In each of the boreholes, the clayey interlayers were encountered at various depths and range in thickness between 0.3 m and 3.5 m, extending into a thick clayey silt to clay deposit (8.3 m thick at Borehole S502-03 and 19.4 m at Borehole S502-01) to the south towards the lake. The bottom 0.6 m of the deposit in Borehole S502-07 consists of gravelly silt and sand.

The SPT 'N'-values measured within the silt to sand interlayers range between 0 blows (i.e., weight of rods) and 29 blows per 0.3 m of penetration indicating a very loose to compact relative density.

SPT 'N'-values measured within the clayey silt to clay interlayers range between 0 blows (weight of hammer) and 4 blows per 0.3 m of penetration; and the in situ field vane tests carried out within the cohesive interlayers measured undrained shear strengths ranging between 28 kPa and 45 kPa, and sensitivities ranging between 4 and 10. The results of the field vane tests indicate that the clayey silt to clay interlayers have a firm consistency.

The natural water content measured on samples of the silt to sand interlayers ranges between 5 per cent; and 37 per cent and on the clayey silt to clay interlayers ranges between 30 per cent and 58 per cent.

The results of 26 grain size distribution tests completed on samples of the silt to sand interlayers are shown on Figure B2A to B2E. The results of one grain size distribution test completed on a sample of the gravelly silt and sand at the bottom of Borehole S502-07 is shown on Figure B3.

An Atterberg limits test carried out on one sample of a silt interlayer yielded a liquid limit of 15 per cent and a plastic limit of 13 per cent, corresponding to a plastic index of 2 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B6F, and indicate that the material is classified as a silt of slight plasticity.





Additionally, Atterberg limits tests carried out on six samples of the silt interlayers and one sample of the sandy silt interlayer indicate that the materials are non-plastic.

Atterberg limits tests carried out on thirteen samples of the clayey silt to clay interlayer yielded liquid limits ranging between 21 per cent and 56 per cent and plastic limits ranging between 12 per cent and 21 per cent, corresponding to plastic indices between 5 and 39 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6C to B6E, and indicate that the material is classified as a clayey silt of low plasticity to a clay of high plasticity.

#### **4.9.4 Bedrock/Refusal**

Bedrock was encountered in Borehole B501-13 at Elevation 171.5 m, corresponding to a depth of 13.6 m below ground surface, and core samples were recovered. Refusal to further split-spoon and/or auger advancement was encountered in the remaining boreholes between Elevations 170.8 m and 176.8 m. Refusal to further penetration was encountered in DCPT S502-DC03 at Elevation 178.1 m.

Based on a review of the bedrock core samples recovered from Borehole B501-13, the bedrock consists of granitic gneiss. In general the bedrock core samples are described as slightly weathered, fine to medium grained, medium strong, dark grey to pink, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph on Figure B12 in Appendix B.

The RQD measured on the core samples ranges between 81 per cent and 94 per cent, indicating the rock is of good to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples is 100 per cent.

Point load strength index tests (ASTM D5731) were carried out on selected samples of the bedrock core and the axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on two samples of the granitic gneiss bedrock core measured  $Is_{50}$  values of 1.0 MPa and 8.3 MPa and the diametral tests carried out on two samples of the granitic gneiss bedrock core measured  $Is_{50}$  values of 9.7 MPa to 9.8 MPa.

Based on the PLT results at B501-13, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as very strong ( $R_5$ ,  $100 \text{ MPa} < \text{UCS} < 250 \text{ MPa}$ ); and it is inferred that the PLT result of 1.0 MPa (Medium Strong,  $R_3$ ,  $\text{UCS} \geq 25 \text{ MPa}$ ) is attributed to a fracture in that portion of the core tested.

#### **4.9.5 Groundwater Conditions**

In each of the boreholes, the water level upon completion of drilling was measured between depths of 4.0 m and 7.6 m below ground surface, respectively (Elevation 180.2 m and 183.4 m).

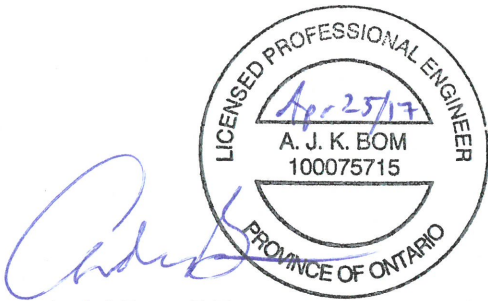
### **5.0 CLOSURE**

The drilling program was directed by Messrs. Mike Arthur, Indulis Dumpis, Trevor Moxam, Mat Riopelle and Matt Soderman. This report was prepared by Ms. Madison C. Kennedy, B.A.Sc and reviewed by Mr. André Bom, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and a Principal of Golder, conducted an independent quality control review of the report.



## Report Signature Page

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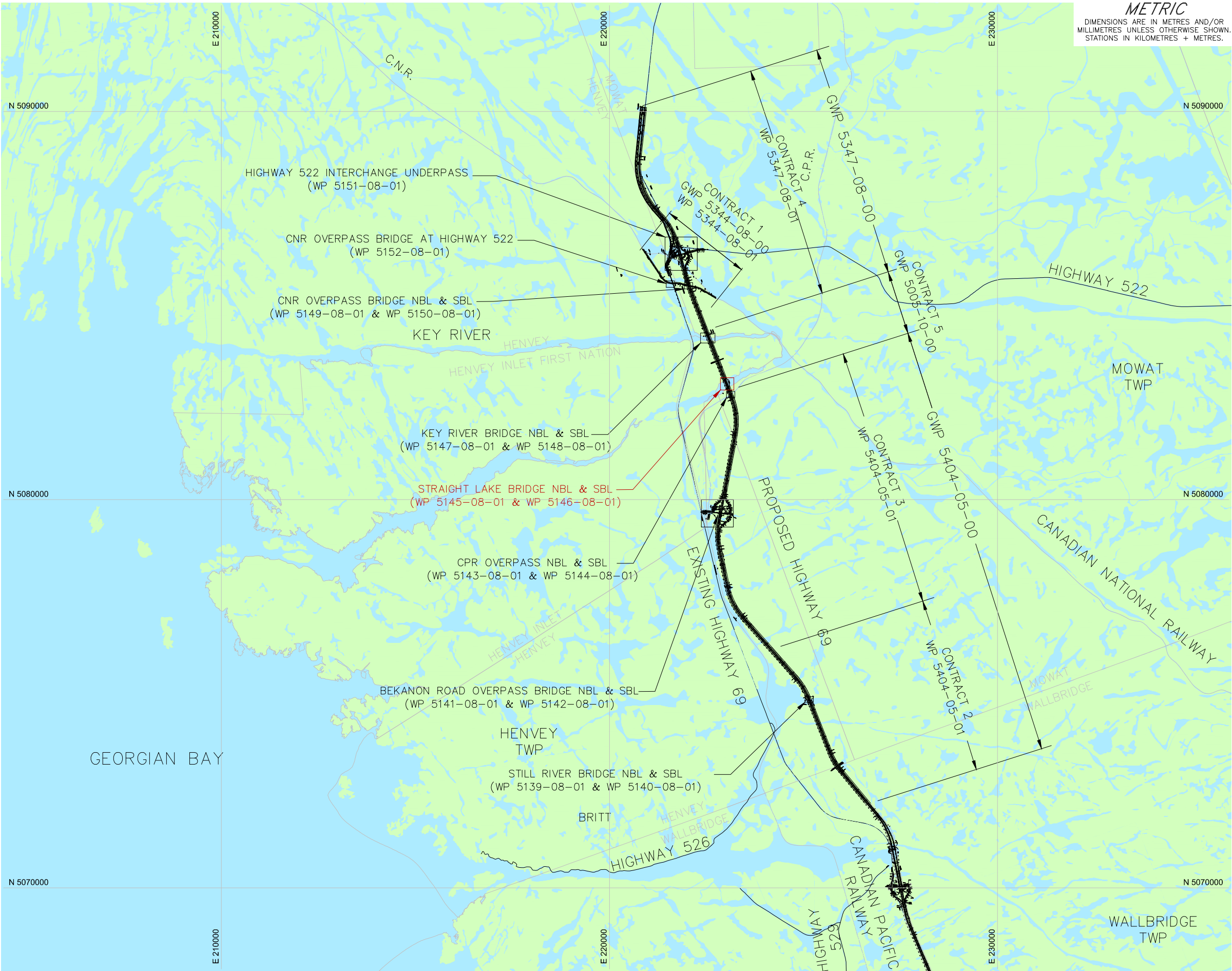
André Bom, P.Eng.  
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P. Eng.  
Designated MTO Foundations Contact, Senior Consultant

MCK/AB/JPD/JMAC/kp

N:\Active\2009\1190 Sudbury\09-1111-6014 Straight Lake Contract 5\Straight Lake\SBL\Final\09-1111-6014 RPT 17Apr25 Highway 69 - Straight Lake SBL FIDR.docx



PLAN

**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. .  
WP No. 5146-08-01

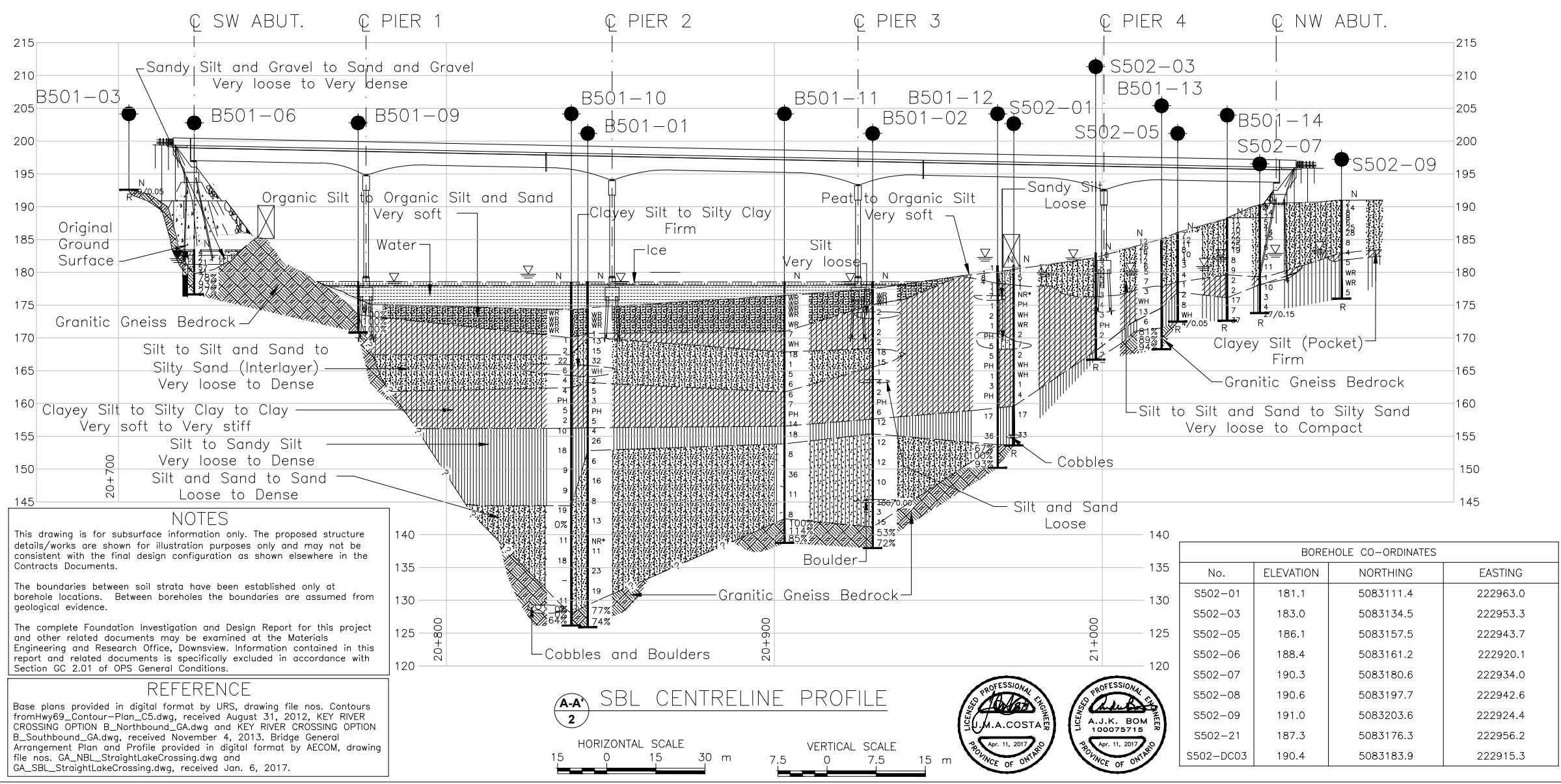
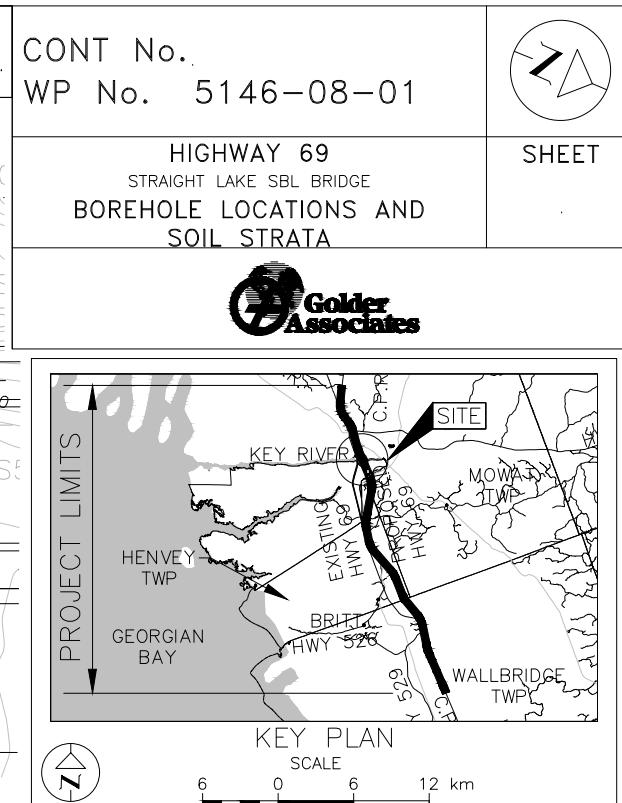
HIGHWAY 69  
STRAIGHT LAKE SBL BRIDGE  
INDEX PLAN



KEY PLAN  
SCALE  
6 0 6 12 km

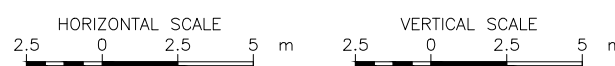
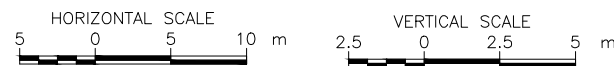
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Base Data - MNR NRVIS, obtained 2004, CANMAP v2008 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, ©Queens Printer 2008 Datum : NAD 83 Projection : MTM Zone 10			
NO.	DATE	BY	REVISION
Geocres No. 41H-166			
HWY. 69		PROJECT NO. 09-1111-6014	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: July 2015	SITE: 44-461/2
DRAWN: JFC/MR	CHKD. AB	APPD. JMAC	DWG. 1





BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B501-01	178.6	5082991.6	223013.2
B501-02	178.6	5083071.8	222979.6
B501-03	192.7	5082862.5	223067.2
B501-04	183.4	5082877.1	223055.7
B501-05	183.8	5082880.8	223054.2
B501-06	183.4	5082880.9	223059.5
B501-07	183.7	5082881.0	223064.9
B501-07A	183.7	5082880.8	223064.5
B501-08	183.5	5082884.6	223063.4
B501-09	178.6	5082927.0	223040.2
B501-10	178.5	5082987.0	223015.1
B501-11	178.6	5083046.9	222990.0
B501-12	181.0	5083106.9	222964.9
B501-13	185.1	5083153.0	222945.6
B501-14	188.3	5083171.5	222937.8
B501-15	178.6	5082921.3	223034.5
B501-16	178.6	5082926.9	223032.2
B501-17	178.6	5082927.1	223048.3
B501-18	178.6	5082932.7	223046.0
B501-DC01	178.6	5082929.8	223039.1
B501-DC10	178.5	5082987.0	223016.9

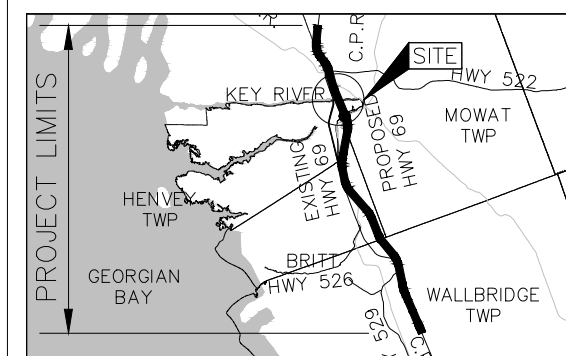
Geocres No. 41H-166			
HWY. 69		PROJECT NO. 09-1111-6014	DIST. .
SUBM'D. MCK	CHKD. .	DATE: Mar. 2016	SITE: 44-461/
DRAWN: JFC/MR	CHKD. AB	APPD. JMAC	DWG. 2



CONT No.  
WP No. 5146-08-01

HIGHWAY 69  
STRAIGHT LAKE SBL BRIDGE  
SOIL STRATA

SHEET








KEY PLAN  
SCALE



6 0 6 12 km

### LEGEND

- |   |  |
|---|--|
|    | Borehole – Current Investigation                                   |
|    | Seal   |
|    | Piezometer   |
| N   | Standard Penetration Test Value                                    |
| 16  | Blows/0.3m unless otherwise stated<br>(Std. Pen. Test, 475 j/blow) |
| 100%  | Rock Quality Designation (RQD)                                     |
|  | WL in piezometer, measured on March 2, 2014                        |
|  | WL upon completion of drilling                                     |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B501-04	183.4	5082877.1	223055.7
B501-05	183.8	5082880.8	223054.2
B501-06	183.4	5082880.9	223059.5
B501-07	183.7	5082881.0	223064.9
B501-07A	183.7	5082880.8	223064.5
B501-08	183.5	5082884.6	223063.4
B501-09	178.6	5082927.0	223040.2
B501-15	178.6	5082921.3	223034.5
B501-16	178.6	5082926.9	223032.2
B501-17	178.6	5082927.1	223048.3
B501-18	178.6	5082932.7	223046.0

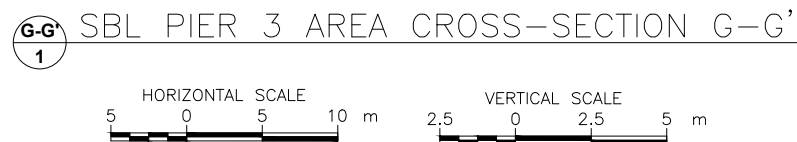
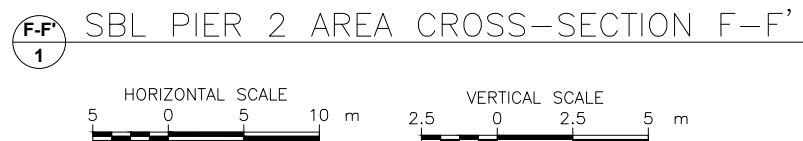
## NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

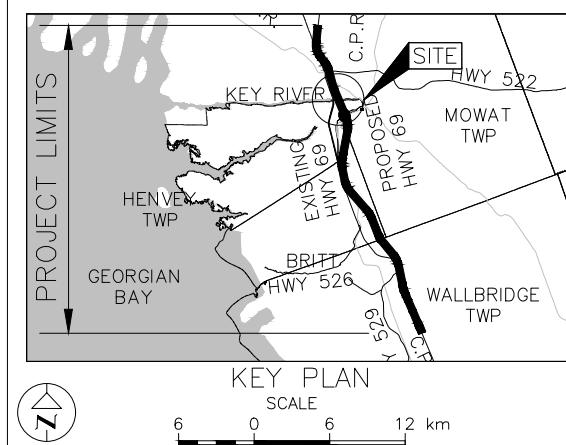
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**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOW  
STATIONS IN KILOMETRES + METRES.

HIGHWAY 69  
STRAIGHT LAKE SBL BRIDGE  
SOIL STRATA

SHEET



## LEGEND

- |   |  |
|---|--|
|  | Borehole – Current Investigation                                   |
|  | Dynamic Cone Penetration Test                                      |
| N   | Standard Penetration Test Value                                    |
| 16  | Blows/0.3m unless otherwise stated<br>(Std. Pen. Test, 475 j/blow) |
| 100%  | Rock Quality Designation (RQD)                                     |
|  | WL upon completion of drilling                                     |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B501-01	178.6	5082991.6	223013.2
B501-02	178.6	5083071.8	222979.6

## NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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NO.		DATE		BY		REVISION	
Geocres No. 41H-166							
HWY. 69			PROJECT NO. 09-1111-6014			DIST. .	
SUBM'D. MCK		CHKD. .		DATE: Mar. 2016		SITE: 44-461/2	
DRAWN: JFC/MR		CHKD. AB		APPD. JMCC		DWG. 4	



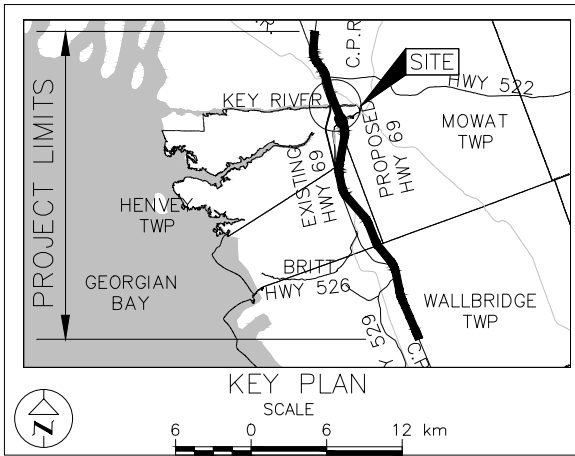
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. .  
WP No. 5146-08-01

HIGHWAY 69  
STRAIGHT LAKE SBL BRIDGE

SOIL STRATA

SHEET



LEGEND	
	Borehole - Current Investigation
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
	WL upon completion of drilling
R	Refusal

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
S502-03	183.0	5083134.5	222953.3
S502-07	190.3	5083180.6	222934.0

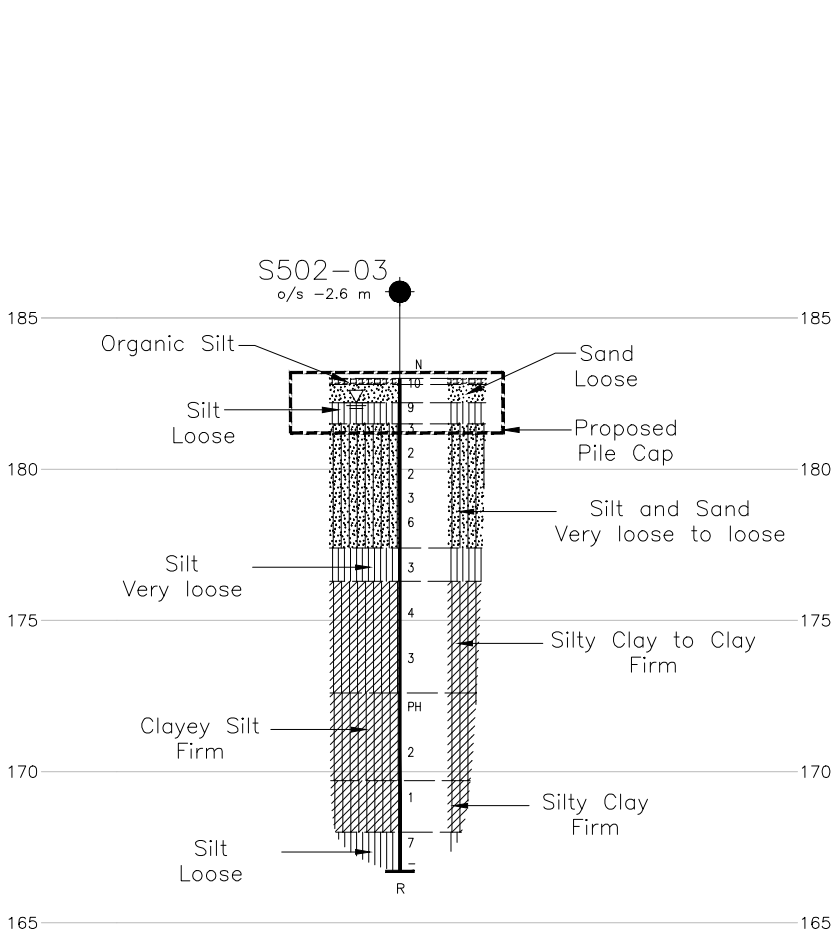
**NOTES**

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

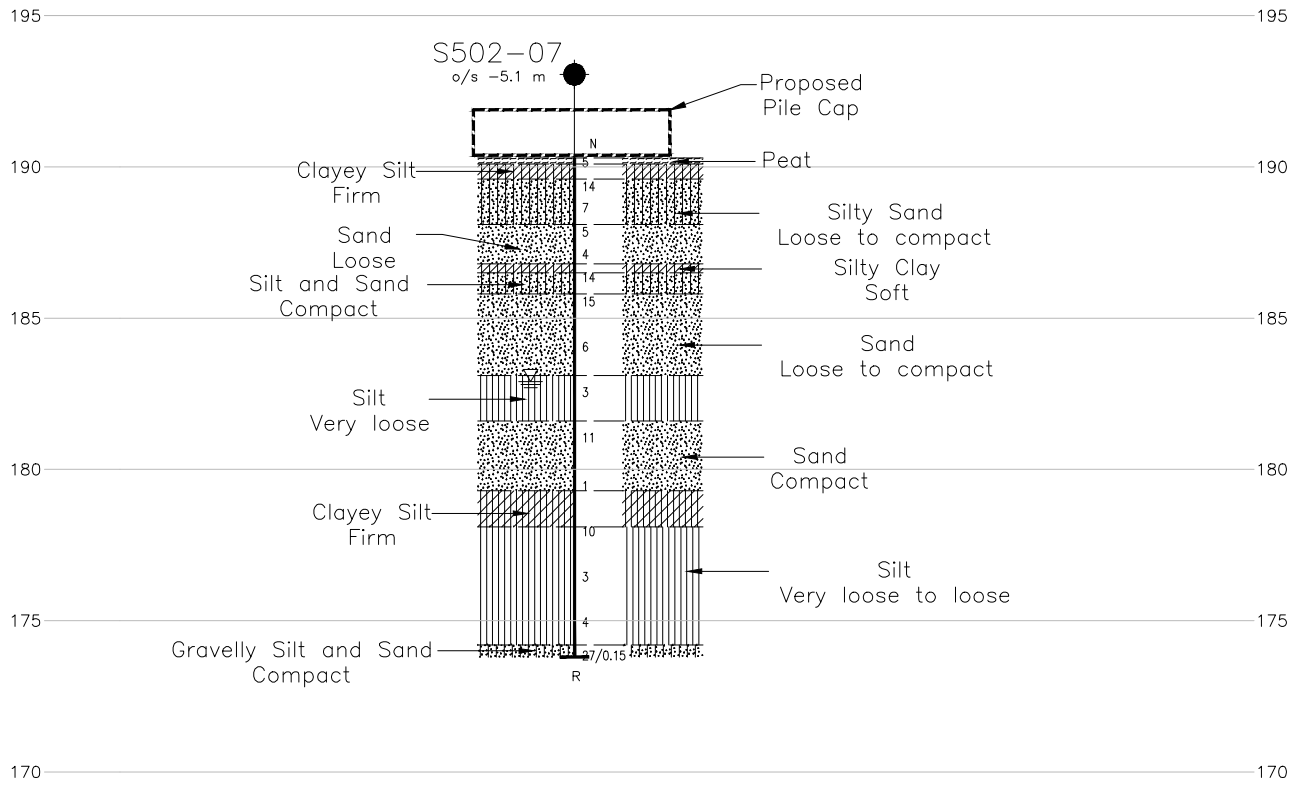
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

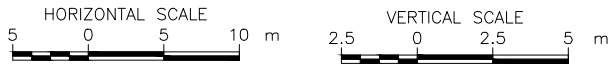
NO.	DATE	BY	REVISION
Geocres No. 41H-166			
HWY. 69		PROJECT NO. 09-1111-6014	DIST. .
SUBM'D. MCK	CHKD. .	DATE: Mar. 2016	SITE: 44-461/2
DRAWN: JFC/MR	CHKD. AB	APPD. JMAC	DWG. 5



**H-H'**  
1 SBL PIER 4 AREA CROSS-SECTION H-H'



**I-I'**  
1 SBL NORTH ABUTMENT AREA CROSS-SECTION I-I'







# APPENDIX A

## Record of Borehole and Drillhole Sheets



## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

### I. GENERAL

$\pi$	3.1416
$\ln x$ ,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

<b>(a)</b>	<b>Index Properties</b>
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
e	void ratio
n	porosity
S	degree of saturation

### (a) Index Properties (continued)

w	water content
$w_l$ or LL	liquid limit
$w_p$ or PL	plastic limit
$I_p$ or PI	plasticity index = $(w_l - w_p)$
$w_s$	shrinkage limit
$I_L$	liquidity index = $(w - w_p) / I_p$
$I_C$	consistency index = $(w_l - w) / I_p$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$I_D$	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

### (b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

### (c) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (over-consolidated range)
$C_s$	swelling index
$C_\alpha$	secondary compression index
$m_v$	coefficient of volume change
$C_v$	coefficient of consolidation (vertical direction)
$C_h$	coefficient of consolidation (horizontal direction)
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction = $\tan \delta$
$c'$	effective cohesion
$c_u, s_u$	undrained shear strength ( $\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
$p'$	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
$q_u$	compressive strength $(\sigma_1 - \sigma_3)$
$S_t$	sensitivity

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$
$$\text{shear strength} = (\text{compressive strength})/2$$



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### (b) Cohesive Soils Consistency

	kPa	Cu, Su	psf
Very soft	0 to 12		0 to 250
Soft	12 to 25		250 to 500
Firm	25 to 50		500 to 1,000
Stiff	50 to 100		1,000 to 2,000
Very stiff	100 to 200		2,000 to 4,000
Hard	over 200		over 4,000

#### Dynamic Cone Penetration Resistance (DCPT); Nd:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Qt), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### IV. SOIL TESTS

w	water content
w <sub>p</sub>	plastic limit
w <sub>l</sub>	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
D <sub>R</sub>	relative density (specific gravity, G <sub>s</sub> )
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

#### Per cent by Weight

Per cent by Weight	Modifier
0 to 5	Trace
5 to 12	Trace to Some (or Little)
12 to 20	Some
20 to 30	(ey) or (y)
over 30	And (non-cohesive (cohesionless)) or With (cohesive)

#### Example

Trace sand
Trace to some sand
Some sand
Sandy
Sand and Gravel
Silty Clay with sand / Clayey Silt with sand



## LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

### WEATHERINGS STATE

**Fresh:** no visible sign of weathering

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

### BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

### JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

### GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: \* Grains greater than 60 microns diameter are visible to the naked eye.

### CORE CONDITION

#### Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

#### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

#### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

### DISCONTINUITY DATA

#### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

#### Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

#### Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

#### Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

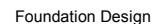
PROJECT <u>09-1111-6014</u>		<b>RECORD OF BOREHOLE No B501-01</b>		SHEET 1 OF 4		<b>METRIC</b>	
W.P. <u>5146-08-01</u>		LOCATION <u>N 5082991.6 ; E 223013.2</u>		ORIGINATED BY <u>MA</u>			
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring, NQ Coring</u>		COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 22 to 24, 2013</u>		CHECKED BY <u>AB</u>			

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × REMOULDED	W <sub>p</sub> W   W <sub>L</sub>					
178.6	ICE SURFACE													
0.0	ICE													
178.2														
0.4	WATER													
174.6														
4.0	ORGANIC SILT, trace clay Very soft Dark grey Wet													
			1	SS	WR									
			2	SS	WR									
			3	SS	WR									
170.7			4A	SS	1									
7.9	CLAY, some silt, trace sand, trace organics Very soft Grey Wet		4B											
170.1														
8.5	SILT and SAND, trace clay Compact to dense Grey Wet Layers of silty clay between depths of 9.1 m and 10.8 m		5	SS	13									
			6	SS	15									
			7	SS	32									
165.8														
12.8	SILTY CLAY, some sand Firm Grey Wet		8	SS	WH									
	Silt seams between depths of 13.7 m and 13.9 m													
163.9														
14.7														

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-6014			RECORD OF BOREHOLE No B501-01			SHEET 3 OF 4			METRIC									
W.P. 5146-08-01			LOCATION N 5082991.6 ; E 223013.2			ORIGINATED BY MA												
DIST _____ HWY 69			BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring			COMPILED BY MCK												
DATUM Geodetic			DATE February 22 to 24, 2013			CHECKED BY AB												
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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa										
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100					WATER CONTENT (%) 20 40 60						
146.7	SILT and SAND Loose to compact Grey Wet		17	SS	16													
31.9	SAND, trace to some silt, trace gravel Loose to compact Grey Wet																	
			18	SS	8													
			19	SS	13													
			20	SS	NR*													
			21	SS	11													
			22	SS	23													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16





+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-01**

SHEET 1 OF 1

LOCATION: N 5082991.6 ;E 223013.2

DRILLING DATE: February 24, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D55

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate												BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage												PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular												PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough												MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.												NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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DEPTH SCALE

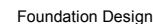
1 : 50



LOGGED: MA

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

**METRIC**

ORIGINATED BY MA/CS

COMPILED BY MCK

CHECKED BY AB

+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE		No B501-02		SHEET 3 OF 3		METRIC								
W.P. 5146-08-01		LOCATION		N 5083071.8 ; E 222979.6		ORIGINATED BY		MA/CS								
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring, NQ Coring		COMPILED BY								
MCK		DATE		March 6 to 8, 2013		CHECKED BY		AB								
DATUM		Geodetic														
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	SILT, some SAND to SILT and SAND, trace clay Compact Grey Wet		18	SS	10											
145.4																
33.2	BOULDER		19	SS	REC 100%											
144.9																
33.7	SILT, some sand to SILT and SAND, some gravel, trace clay Very loose to compact Grey Wet		20	SS	3											
			21	SS	15											13 15 70 2
141.2																
37.4	Granitic Gneiss (BEDROCK)		1	RC	REC 99%											RQD = 70%
	Bedrock cored from depths of 37.4 m to 40.6 m.  For bedrock coring details refer to Record of Drillhole B501-02.		2	RC	REC 98%											RQD = 91%
138.0																
40.6	END OF BOREHOLE															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-02**

SHEET 1 OF 1

LOCATION: N 5083071.8 ;E 222979.6

DRILLING DATE: March 8, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate										BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage										PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular										PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough										MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY K, cm/sec										Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn			Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn		Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn	Jn

DEPTH SCALE

1 : 50



LOGGED: MA/CS

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B501-03		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5082862.5 ; E 223067.2		ORIGINATED BY		TM								
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY								
MCK		DATE		March 18, 2014		CHECKED BY		AB								
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								
192.7	GROUND SURFACE						20	40	60	80	100					
0.0	TOPSOIL, trace wood fragments		1	SS	50/0.05											
0.1	Moist															
	END OF BOREHOLE															
	SPLIT-SPOON REFUSAL															
	NOTE:															
	1. Borehole located on Bedrock															
	Outcrop; dry upon completion of															
	sampling.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



PROJECT		RECORD OF BOREHOLE		No B501-04		SHEET 1 OF 1		METRIC									
W.P.		LOCATION		ORIGINATED BY		TM											
DIST		BOREHOLE TYPE		COMPILED BY		MCK											
DATUM		DATE		CHECKED BY		AB											
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									
183.4	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL																
0.2	Sandy SILT, some clay, trace gravel Very loose to loose Brown and grey Moist to wet		1	SS	9 *	▽	183										
			2	SS	4		182										
			3	SS	2												
181.1																	
180.7	SAND and GRAVEL, some silt Brown and grey Wet		4	SS	58/0.20		181										
2.7	END OF BOREHOLE SPLIT-SPOON REFUSAL																
NOTES:																	
1. Water level in open borehole at a depth of 1.2 m below ground surface (Elev. 182.2 m) upon completion of drilling.																	
* 'N' value is impacted by frost.																	

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B501-05		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5082880.8 ; E 223054.2		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		BW Casing, Wash Boring, Thin Wall NW Coring		COMPILED BY									
MCK		DATE		March 2 and 3, 2014		CHECKED BY		AB									
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									
183.8	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Silty SAND Loose to compact Grey to brown Moist		1	SS	2												
182.3			2	SS	10												
1.5	Gravelly SILT and SAND, trace clay Dense Brown Wet		3	SS	47												
181.7																	
181.3	GRAVEL and COBBLES Granitic Gneiss (BEDROCK)																
2.5	Bedrock cored from depths of 2.5 m to 5.6 m.  For bedrock coring details refer to Record of Drillhole B501-05.		1	RC	REC 100%												
			2	RC	REC 100%												
			3	RC	REC 97%												
			4	RC	REC 84%												
178.2	END OF BOREHOLE																
5.6	NOTE:  1. Water level in open borehole at a depth of 1.8 m below ground surface (Elev. 182.0 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS DRILLING

CHECKED: AB

PROJECT		RECORD OF BOREHOLE		No B501-06		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5082880.9 ; E 223059.5		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		BW Casing, Wash Boring, Thin Wall NW Coring		COMPILED BY									
DATUM		Geodetic		DATE		February 28 and March 1, 2014		CHECKED BY									
								AB									
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									
183.4	GROUND SURFACE																
0.0	TOPSOIL																
0.2	SAND, trace organics, trace clay Very loose to loose Brown Moist		1	SS	4												
182.6																	
0.8	SANDY SILT and GRAVEL, trace to some clay, trace organics Very loose to compact Dark grey Wet		2	SS	2												
			3	SS	21												
181.2																	
2.2	SAND and GRAVEL, some silt, trace clay Very dense Brown Wet Cobbles encountered at a depth of 2.9 m		4	SS	57												
			5	SS	41												
179.7																	
3.7	Granitic Gneiss (BEDROCK)																
	Bedrock cored from depths of 3.7 m to 6.2 m.		1	RC	REC 100%												
	For bedrock coring details refer to Record of Drillhole B501-06.																
			2	RC	REC 100%												
			3	RC	REC 100%												
177.2																	
6.2	END OF BOREHOLE																
	NOTE:  1. Water level in piezometer at a depth of 1.1 m below ground surface (Elev. 182.3 m) on March 2, 2014.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1



DATUM: Geodetic

DRILLING CONTRACTOR: OGS DRILLING

CHECKED: AB

PROJECT		RECORD OF BOREHOLE		No B501-07		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5082881.0 ; E 223064.9		ORIGINATED BY		TM									
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY									
MCK		DATE		March 4 and 10, 2014		CHECKED BY		AB									
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									
183.7	GROUND SURFACE																
0.0	TOPSOIL																
0.2	SILT and SAND, some clay Loose Brown Moist to wet		1	SS	5												
			2	SS	4												
			3	SS	3												
181.4																	
2.3	ORGANIC SILT, some sand, trace wood fragments and rootlets Very soft Brown Wet		4	SS	2												
180.7																	
3.0			5	SS	70/0.18												
180.2	SAND and GRAVEL, and cobble																
3.5	END OF BOREHOLE CASING REFUSAL																
NOTES: 1. Water level in open borehole at a depth of 1.6 m below ground surface (Elev. 182.1 m) upon completion of drilling. 2. An additional borehole was advanced about 0.5 m West of Borehole B501-07 and bedrock was cored between depths of 5.3 m and 8.6 m. For bedrock coring details refer to Record of Drillhole B501-07A.																	

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE				No B501-07A		SHEET 1 OF 1		METRIC							
W.P. 09-1111-6014		LOCATION		N 5082880.8 ; E 223064.5		ORIGINATED BY		TM									
DIST		HWY 69		BOREHOLE TYPE		BW Casing, Wash Boring, Thin Wall NW Coring		COMPILED BY		MCK							
DATUM		Geodetic		DATE		March 4, 2014		CHECKED BY		AB							
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									
183.7 0.0	GROUND SURFACE For soil description between depths of 0.0 m and 3.5 m refer to Record of Borehole B501-07.							20	40	60	80	100					
180.2 3.5	Cobbles and Boulders																
178.4 5.3	Granitic Gneiss (BEDROCK)  Bedrock cored from depths of 5.3 m to 8.6 m  For bedrock coring details refer to Record of Drillhole B501-07A.		1	RC	REC 100%												RQD = 0%
			2	RC	REC 100%												RQD = 90%
			3	RC	REC 100%												RQD = 63%
175.1 8.6	END OF BOREHOLE		4	RC	REC 100%												RQD = 100%

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS DRILLING

CHECKED: AB

PROJECT		RECORD OF BOREHOLE		No B501-08		SHEET 1 OF 1		METRIC					
W.P.		LOCATION		ORIGINATED BY		TM							
DIST		BOREHOLE TYPE		COMPILED BY		MCK							
DATUM		DATE		CHECKED BY		AB							
09-1111-6014		N 5082884.6 ; E 223063.4											
5146-08-01		Portable Equipment											
Geodetic		March 4, 2014											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	GR SA SI CL
183.5	GROUND SURFACE												
0.0	TOPSOIL												
0.2	ORGANIC Sandy SILT to ORGANIC SILT, some sand, some clay Very loose to loose Grey to brown Moist to wet		1	SS	5 *		183						
			2	SS	3		182						
			3	SS	2								
181.4	Silty SAND and GRAVEL Very dense Grey to brown Wet		4	SS	66/0.28		181						
2.7	END OF BOREHOLE SPLIT-SPOON REFUSAL												
NOTES: 1. Water level in open borehole at a depth of 1.1 m below ground surface (Elev. 182.4 m) upon completion of drilling. * 'N' value is impacted by frost.													

PROJECT		RECORD OF BOREHOLE		No B501-09		SHEET 1 OF 1		METRIC									
W.P. 5146-08-01		LOCATION		N 5082927.0 ; E 223040.2		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring, NQ Coring		COMPILED BY									
DATUM		Geodetic		DATE		February 20, 2014		CHECKED BY									
								AB									
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									WATER CONTENT (%)
178.6 0.0	ICE SURFACE ICE																
177.9 0.7	WATER																
175.2 3.4	ORGANIC SILT and SAND, some clay, trace wood fragments Very soft Dark grey Wet		1	SS	WR												
173.9 4.7	Granitic Gneiss (BEDROCK)		2	SS	WR												
	Bedrock cored from depths of 4.7 m to 7.8 m.  For bedrock coring details refer to Record of Drillhole B502-09.		1	RC	REC 100%												RQD = 100%
			2	RC	REC 100%												RQD = 100%
			3	RC	REC 100%												RQD = 100%
170.8 7.8	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-09**

SHEET 1 OF 1

LOCATION: N 5082927.0 ;E 223040.2

DRILLING DATE: February 20, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
								RECOVERY		R.Q.D. %	FRACT INDEX PER 0.25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn		10 <sup>-6</sup>			10 <sup>-5</sup>	10 <sup>-4</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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5	NW Casing	Continued from Record of Borehole B501-09		173.94																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															</

10.9 MPa  
10.5 MPa (Axial)11.3 MPa (Axial)  
1.3 MPa  
UCS = 50.0 MPa

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT 09-1111-6014				RECORD OF BOREHOLE No B501-10				SHEET 1 OF 4				METRIC					
W.P. 5146-08-01				LOCATION N 5082987.0 ; E 223015.1				ORIGINATED BY MR									
DIST HWY 69				BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring				COMPILED BY MCK									
DATUM Geodetic				DATE February 6 to 12, 2014				CHECKED BY AB									
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									
178.5	ICE SURFACE							20	40	60	80	100					
0.0	ICE																
178.0							178										
0.5	WATER																
							177										
							176										
							175										
174.2																	
4.3	ORGANIC SILT Very soft Dark grey Wet		1	SS	WR		174									142.2	
			2	SS	WR		173										
			3	SS	WR		172										
			4	SS	WR		171									162	OC = 9.5%
170.0								2									
8.5	CLAYEY SILT, trace sand, silt seams throughout Soft Grey Wet		5	SS	1		170										
			6	SS	2		169	1									
167.4							168										
11.1	SILT and SAND, trace clay Compact Grey Wet		7	SS	22		167										
165.9							166										
12.6	CLAYEY SILT, trace to some sand Firm Grey Wet		8	SS	6		165										
164.3																	
14.2	Silty SAND Loose Grey Wet		9	SS	4		164										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT <u>09-1111-6014</u>		<b>RECORD OF BOREHOLE No B501-10</b>		SHEET 2 OF 4		<b>METRIC</b>	
W.P. <u>5146-08-01</u>		LOCATION <u>N 5082987.0 ; E 223015.1</u>		ORIGINATED BY <u>MR</u>			
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring, NQ Coring</u>		COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 6 to 12, 2014</u>		CHECKED BY <u>AB</u>			

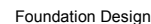
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100	20 40 60 80 100					
	--- CONTINUED FROM PREVIOUS PAGE ---													
162.4	Silty SAND Loose Grey Wet						163							
16.1	SILTY CLAY Firm to stiff Grey Wet		10	SS	4		162							
							161	7 +	5 +					
			11	TO	PH		160		6 +	5 +				
			12	SS	5		159							
							158		6 +	>96 +				
	Silt seam at a depth of 20.7 m		13	SS	2		157		3 +	2 +				
156.2	SILT, some sand, trace to some clay Loose to compact Grey Wet		14	SS	10		156							0 0 90 10 Non-Plastic
22.3							155							
							154							
			15	SS	18		153							0 13 85 2
							152							
							151							
			16	SS	9		150							
							149							

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16





+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-10**

SHEET 1 OF 1

LOCATION: N 5082987.0 ;E 223015.1

DRILLING DATE: February 11 and 12, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	COLOUR	FLUSH	RECOVERY	R.Q.D.	FRACT. INDEX	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY	Diametral Point Load Index	RMC	NOTES					
				DEPTH (m)							TOTAL CORE %	SOLID CORE %	%	PER 0.25	TYPE AND SURFACE DESCRIPTION					Jr Ja Jn					K, cm/sec	MPa	AVG		
															B Angle	DIP w.r.t. CORE AXIS													
		Continued from Record of Borehole B501-10		126.93																									
52	NW Casing February 11 and 12, 2014	Slightly weathered, foliated, grey, medium grained, medium strong to strong GRANITIC GNEISS		51.60	1																8.0 MPa (Axial) 2.3 MPa								
		END OF DRILLHOLE		126.17																									
				52.36																									
53																													
54																													
55																													
56																													
57																													
58																													
59																													
60																													
61																													

8.0 MPa (Axial)  
2.3 MPa

DEPTH SCALE

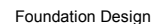
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LOGGED: MR

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16



+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-6014			RECORD OF BOREHOLE No B501-11			SHEET 2 OF 3			METRIC												
W.P. 5146-08-01			LOCATION N 5083046.9 ; E 222990.0			ORIGINATED BY ID															
DIST HWY 69			BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring			COMPILED BY MCK															
DATUM Geodetic			DATE February 7 and 10 to 12, 2014			CHECKED BY AB															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> 20 40 60			kN/m <sup>3</sup>	GR SA SI CL				
161.8	SILT, trace to some sand, trace to some clay Very loose to compact Grey Wet		11	SS	6		163														
16.8	CLAYEY SILT to CLAY, trace sand Firm to stiff Brown to grey Wet		12	SS	6		162														
							161														
			13	SS	7		160														
							159														
			14	TO	PH		158														
							157														
156.7	SILT Compact Grey Wet		15	SS	14		156														
21.9							155														
			16	SS	18		154														
153.9	SILT and SAND, trace to some gravel, trace clay Loose to dense Grey Wet						153														
24.7			17	SS	8		152														
							151														
							150														
			18	SS	36		149														

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B501-11				SHEET 3 OF 3		METRIC									
W.P. 5146-08-01		LOCATION N 5083046.9 ; E 222990.0				ORIGINATED BY ID											
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring				COMPILED BY MCK											
DATUM Geodetic		DATE February 7 and 10 to 12, 2014				CHECKED BY AB											
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									WATER CONTENT (%)
--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					20 40 60					
142.5	SILT and SAND, trace to some gravel, trace clay Loose to dense Grey Wet		19	SS	11		148										
							147										
							146										
							145										
							144										
			20	SS	8		143									0 69 30 1	
36.1	Granitic Gneiss (BEDROCK)						142										
	Bedrock cored from depths of 36.1 m to 39.8 m  For bedrock coring details refer to Record of Drillhole B501-11.		1	RC	REC 100%		141										RQD = 100%
			2	RC	REC 100%		140										RQD = 100%
			3	RC	REC 90%		139										RQD = 85%
138.8	END OF BOREHOLE																
39.8																	

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-11**

SHEET 1 OF 1

LOCATION: N 5083046.9 ;E 222990.0

DRILLING DATE: February 11 and 12, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
		Continued from Record of Borehole B501-11		142.43									
	NW Casing	Fresh, foliated, medium grained, grey, medium strong GRANITIC GNEISS		36.12									
37					1								
38					2								
39					3								
40		END OF DRILLHOLE		138.76 39.79									
41													
42													
43													
44													
45													
46													

DEPTH SCALE

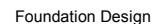
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LOGGED: ID

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16



T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16


+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No B501-12</b>		SHEET 2 OF 3		<b>METRIC</b>														
W.P. 5146-08-01		LOCATION N 5083106.9; E 222964.9		ORIGINATED BY MR																
DIST HWY 69		BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY MCK																
DATUM Geodetic		DATE March 6 and 7, 2014		CHECKED BY AB																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> ——— W ——— W <sub>L</sub> 20 40 60							
--- CONTINUED FROM PREVIOUS PAGE ---																				
	SILTY CLAY, silt and sand seams throughout Firm to stiff Brown to grey Wet		14	TO	PH		165													
			15	SS	1		164													
			16	SS	3		163													
			17	TO	PH		162													
			18	SS	17		161													
			19	SS	36		160													
159.4	SILT, trace sand, trace clay, trace gravel Compact to dense Grey Wet						159													
21.6							158													
							157													
							156													
							155													
153.7	Cobbles						154													
27.4	Granitic Gneiss (BEDROCK)						153													
	Bedrock cored from depths of 27.4 m to 30.9 m.		1	RC	REC 94%		152													
	For bedrock coring details refer to Record of Drillhole B501-12.		2	RC	REC 100%															
			3	RC	REC 97%															

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+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No B501-12</b>				SHEET 3 OF 3		<b>METRIC</b>															
W.P. 5146-08-01		LOCATION N 5083106.9 ; E 222964.9				ORIGINATED BY MR																	
DIST HWY 69		BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring				COMPILED BY MCK																	
DATUM Geodetic		DATE March 6 and 7, 2014				CHECKED BY AB																	
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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa															
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>																
150.2 30.9	END OF BOREHOLE  NOTE:  1. Between 26.8 m and 27.4 m depth, corresponding to Elev. 154.2 m to Elev. 153.6 m, artesian conditions encountered. After pulling core barrel and pulling casing tip to 26.2 m depth (Elev. 154.8 m), Artesian stabilized at 1.3 m above ground surface (Elev. 182.3 m) and dissipated after pulling casing tip to 23.2 m (Elev. 157.8 m).		3	RC	REC 97%												RQD = 93%						

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16






PROJECT		RECORD OF BOREHOLE		No B501-13		SHEET 1 OF 2		METRIC							
W.P. 5146-08-01		LOCATION		N 5083153.0 ; E 222945.6		ORIGINATED BY		MAS							
DIST		HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY							
DATUM		Geodetic		DATE		March 11, 2014		CHECKED BY							
								AB							
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
185.1	GROUND SURFACE														
0.0	TOPSOIL		1A		12										
0.2	SILT and SAND, trace to some clay Loose to compact Brown becoming grey below 6.1 m depth Moist to wet		1B	SS											
			2	SS	26										
			3	SS	16										
			4	SS	17										
			5	SS	12										
			6	SS	6										
			7	SS	5										
			8	SS	7										
177.9	SILTY CLAY Firm Grey Wet		9	SS	3										
7.2			10	SS	WH										
174.6	SILT, trace to some sand, trace clay Loose to compact Grey Wet		11	SS	13										
10.5			12	SS	6										
171.5	Granitic Gneiss (BEDROCK)		1	RC	REC 100%										
13.6	Bedrock cored from depths of 13.6 m to 16.8 m.  For bedrock coring details refer to Record of Drillhole B501-13.		2	RC	REC 100%										

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+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA-GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B501-13		SHEET 2 OF 2		METRIC									
W.P. 5146-08-01		LOCATION		N 5083153.0 ; E 222945.6		ORIGINATED BY		MAS									
DIST		HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY									
DATUM		Geodetic		DATE		March 11, 2014		CHECKED BY									
								AB									
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 (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
	Granitic Gneiss (BEDROCK)		2	RC	REC 100%												RQD = 89%
	Bedrock cored from depths of 13.6 m to 16.8 m.  For bedrock coring details refer to Record of Drillhole B501-13.		3	RC	REC 100%												
168.3	END OF BOREHOLE																
16.8	NOTE:  1. Water level in open borehole at a depth of 4.9 m below ground surface (Elev. 180.2 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-13**

SHEET 1 OF 1

LOCATION: N 5083153.0 ;E 222945.6

DRILLING DATE: March 11, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
14	NW Casing	Continued from Record of Borehole B501-13		171.51									
14		Slightly weathered, dark grey to pink rock, fine to medium grained, non-porous, medium strong GRANITIC GNEISS		13.56	1								9.7 MPa 8.3 MPa (Axial)
15	NQRC March 11, 2014	Frequent micro-defects in rock i.e. healed features			2								
16					3								1.0 MPa (Axial) 9.8 MPa
17		END OF DRILLHOLE		168.27									
17				16.80									
18													
19													
20													
21													
22													
23													

DEPTH SCALE

1 : 50



LOGGED: MAS

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT 09-1111-6014			RECORD OF BOREHOLE No B501-14			SHEET 1 OF 2			METRIC																		
W.P. 5146-08-01			LOCATION N 5083171.5; E 222937.8			ORIGINATED BY MAS																					
DIST _____ HWY 69			BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring			COMPILED BY MCK																					
DATUM Geodetic			DATE March 12, 2014			CHECKED BY AB																					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE																				
188.3	GROUND SURFACE																										
0.0	TOPSOIL																										
0.2	SILT and SAND, trace clay Loose to compact Brown becoming grey below a depth of 6.1 m Moist to wet		1	SS	11		188																				
			2	SS	12		187																				
			3	SS	10		186																				
			4	SS	22		185																				
			5	SS	29		184																				
			6	SS	25		183																				
			7	SS	19		182																				
			8	SS	8		181																				
			9	SS	9		180																				
			10	SS	2		179																				
179.6	CLAY Firm Grey Wet		11	SS	2		178																				
8.7			12	SS	17		177																				
			13	SS	7		176																				
176.1	SILT, trace to some clay, trace sand Loose to compact Grey Wet						175																				
12.2							174																				
173.5																											
14.8																											

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE				No B501-14		SHEET 2 OF 2		METRIC							
W.P. 09-1111-6014		LOCATION				N 5083171.5; E 222937.8		ORIGINATED BY MAS									
DIST		HWY 69		BOREHOLE TYPE				150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring									
DATUM Geodetic		DATE		March 12, 2014				COMPILED BY MCK									
								CHECKED BY AB									
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									
	--- CONTINUED FROM PREVIOUS PAGE ---																
172.6	SILT and SAND Dense Grey Wet		14	SS	37		173										
15.7	END OF BOREHOLE SPLIT-SPOON REFUSAL  NOTE:  1. Water level in open borehole at a depth of 6.1 m below ground surface (Elev. 182.2 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B501-15				SHEET 1 OF 1		METRIC									
W.P. 5146-08-01		LOCATION N 5082921.3 ; E 223034.5				ORIGINATED BY MR											
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring				COMPILED BY MCK											
DATUM Geodetic		DATE February 24, 2014				CHECKED BY AB											
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									
178.6 0.0	WATER SURFACE ICE							20	40	60	80	100					
178.0 0.6	WATER						178										
							177										
							176										
176.0 2.7	Granitic Gneiss (BEDROCK)  Bedrock cored from depths of 2.7 m to 5.8 m.  For bedrock coring details refer to Record of Drillhole B501-15.		1	RC	REC 100%		175										RQD = 100%
			2	RC	REC 96%		174										RQD = 85%
172.8 5.8	END OF BOREHOLE						173										

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-15**

SHEET 1 OF 1

LOCATION: N 5082921.3 ;E 223034.5

DRILLING DATE: February 24, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY				FRACT. INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
								TOTAL CORE %	SOLID CORE %	R.Q.D. %	TYPE AND SURFACE DESCRIPTION				Jr	Ja	Jn	10 10 10 10	10 10 10 10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
		Continued from Record of Borehole B501-15		175.95 2.65																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16



PROJECT 09-1111-6014		RECORD OF BOREHOLE No B501-16				SHEET 1 OF 1		METRIC									
W.P. 5146-08-01		LOCATION N 5082926.9 ; E 223032.2				ORIGINATED BY MR											
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring				COMPILED BY MCK											
DATUM Geodetic		DATE February 24, 2014				CHECKED BY AB											
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									WATER CONTENT (%)
178.6 0.0	WATER SURFACE ICE							20	40	60	80	100					
178.1 0.5	WATER						178										
							177										
							176										
							175										
174.2 4.4	ORGANIC SILT and SAND to SILT, some sand, trace organics Very soft Dark grey Wet		1	SS	WR		174										
			2	SS	WR		173								90.7	OC = 4.3%	
			3	SS	WR										125.8		
							172										
171.2 7.4	END OF BOREHOLE CASING REFUSAL																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B501-17				SHEET 1 OF 1		METRIC						
W.P. 5146-08-01		LOCATION N 5082927.1 ; E 223048.3				ORIGINATED BY MR								
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring				COMPILED BY MCK								
DATUM Geodetic		DATE February 24, 2014				CHECKED BY AB								
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						
178.6	WATER SURFACE													
0.0	ICE													
178.1	WATER													
0.5														
175.9														
2.7	SILTY SAND, trace to some clay, trace organics Very loose Dark brown Wet		1	SS	WR									
			2	SS	WR									
174.0			3A	SS	WR									
4.6	ORGANIC SILTY CLAY Very soft Dark grey Wet		3B											
			4	SS	WR									
172.9			5	SS	WR									
5.7	END OF BOREHOLE CASING REFUSAL													

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B501-18		SHEET 1 OF 1		METRIC												
W.P. 5146-08-01		LOCATION N 5082932.7 ; E 223046.0		ORIGINATED BY MR														
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring		COMPILED BY MCK														
DATUM Geodetic		DATE February 23, 2014		CHECKED BY AB														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)					
178.6 0.0	WATER SURFACE ICE							20 40 60 80 100	20 40 60 80 100	20 40 60	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR SA SI CL			
178.1 0.5	WATER						178											
							177											
							176											
							175											
174.5 4.1	ORGANIC SILT Very soft Dark grey Wet		1	SS	WR		174							171.6				
			2	SS	WR		173											
			3	SS	WR		172							201.2				
			4	SS	WR		171							81.3	OC = 7.9%			
			5	SS	WR		170											
			6	SS	WR		169							141.9				
			7	SS	WR		168											
168.9 9.8	Granitic Gneiss (BEDROCK)  Bedrock cored from depths of 9.8 m to 13.0 m.  For bedrock coring details refer to Record of Drillhole B501-18.		1	RC	REC 100%		167								RQD = 99%			
			2	RC	REC 100%		166								RQD = 98%			
165.7 13.0	END OF BOREHOLE																	

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B501-18**

SHEET 1 OF 1

LOCATION: N 5082932.7 ;E 223046.0

DRILLING DATE: February 23, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
								TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION				K, cm <sup>3</sup> /sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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10	NW Casing	Continued from Record of Borehole B501-18  Slightly weathered to fresh, foliated, medium to coarse grained, dark grey to pink, faintly porous, medium strong, GRANITIC GNEISS		168.85 9.75	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					</

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No S502-01</b>		SHEET 1 OF 2		<b>METRIC</b>	
W.P. 5005-10-01		LOCATION N 5083111.4 ; E 222963.0				ORIGINATED BY MA	
DIST HWY 69		BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring				COMPILED BY AV	
DATUM Geodetic		DATE March 9 and 10, 2013				CHECKED BY CN	

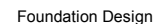
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+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16



+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT		09-1111-6014		RECORD OF BOREHOLE No S502-03		SHEET 1 OF 2		METRIC							
W.P.		5005-10-01		LOCATION		N 5083134.5 ; E 222953.3		ORIGINATED BY ID							
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL/AV							
DATUM		Geodetic		DATE		March 15, 2013		CHECKED BY CN							
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							
183.0	GROUND SURFACE														
0.0	ORGANIC SILT Dark brown		1A	SS	10										
0.2	SAND, trace gravel, trace organics		1B	SS											
182.2	Loose Brown Moist		2	SS	9										
0.8	SILT, trace clay														
181.5	Loose Brown Wet		3	SS	3										
1.5	SILT and SAND, trace clay Very loose to loose Grey Wet		4	SS	2										
			5	SS	2										
			6	SS	3										
			7	SS	6										
177.4	SILT, trace clay Very loose Grey Wet		8	SS	3										
5.6															
176.3	SILTY CLAY to CLAY Firm Grey Wet		9	SS	4										
6.7			10	SS	3										
172.6	CLAYEY SILT, trace sand, silt seams Firm Grey Wet		11	TO	PH										
10.4			12	SS	2										
169.7	SILTY CLAY Firm Grey Wet		13	SS	1										
13.3															
168.0															

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-03		SHEET 2 OF 2		METRIC								
W.P. 09-1111-6014		LOCATION		N 5083134.5; E 222953.3		ORIGINATED BY		ID								
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY								
GRL/AV		DATE		March 15, 2013		CHECKED BY		CN								
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								
	--- CONTINUED FROM PREVIOUS PAGE ---															
15.0	SILT, trace clay Loose Grey Wet		14	SS	7											
166.7						167										
16.3	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL  NOTE:  1. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 182.2 m) upon completion of drilling.		15	SS												

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16



PROJECT		RECORD OF BOREHOLE		No S502-05		SHEET 1 OF 2		METRIC																			
W.P.		LOCATION		ORIGINATED BY		ID																					
DIST		BOREHOLE TYPE		COMPILED BY		GRL																					
DATUM		DATE		CHECKED BY		CN																					
PROJECT 09-1111-6014		N 5083157.5 ; E 222943.7																									
5005-10-01		106 mm I.D. Continuous Flight Hollow Stem Augers																									
Geodetic		February 28, 2013																									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa					W <sub>p</sub>			W			W <sub>L</sub>			γ			GR SA SI CL		
186.1	0.0	GROUND SURFACE		1A		7	186	20 40 60 80 100					20 40 60			20 40 60			kN/m <sup>3</sup>								
0.2		PEAT (Fibrous) Dark brown Wet		1B	SS																						
		SAND, trace silt Loose to compact Brown Wet		2	SS	12	185																				
				3	SS	11	184																				
				4	SS	8	183																				
183.1	3.0	Sandy SILT, trace clay Very loose to loose Brown Wet		5	SS	10	182															0 26 72 2					
				6	SS	4	181															0 29 68 3					
				7	SS	3	180																				
				8	SS	4	179																				
178.5	7.6	CLAYEY SILT, trace to some sand, with silt lenses Very soft Grey Wet		9	SS	1	178															Non-Plastic					
177.0	9.1	SILT, trace to some sand, trace to some clay Very loose Grey Wet		10	SS	2	177															0 9 80 11 Non-Plastic					
175.8	10.3	SILT and SAND, trace clay Very loose to loose Grey Wet		11	SS	8	176																				
				12	SS	WH	175															0 34 65 1					
				13	SS	4/0.05	174																				
172.5	13.6						173																				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No S502-05</b>				SHEET 2 OF 2		<b>METRIC</b>								
W.P. 5005-10-01		LOCATION N 5083157.5 ; E 222943.7				ORIGINATED BY ID										
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY GRL										
DATUM Geodetic		DATE February 28, 2013				CHECKED BY CN										
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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL  NOTE:  1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 180.9 m) upon completion of drilling.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-06		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5083161.2 ; E 222920.1		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
GRL		DATE		March 12, 2013		CHECKED BY		CN									
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									WATER CONTENT (%)
188.4	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A														
0.2	CLAYEY SILT, some sand, trace organics		1B	SS	3												
187.6	Soft																
0.8	Brown Moist		2	SS	12												
	SAND, trace silt																
	Loose to compact																
	Brown Moist to wet		3	SS	8												
185.9	CLAYEY SILT		4A	SS	4												
2.5	Firm		4B	SS	4												
185.4	Grey Wet																
3.0	Sandy SILT, trace clay		5	SS	12												
	Compact																
	Brown Moist to wet		6	SS	19												
			7	SS	19												
182.8	SAND, some silt, trace clay																
5.6	Compact																
	Brown Wet		8	SS	12												
181.2	SILT, some sand, trace clay																
7.2	Very loose																
	Grey Wet		9	SS	2												
179.7	CLAYEY SILT																
8.7	Firm																
	Grey Wet		10	SS	WH												
178.0	SILT																
10.4	Very loose																
	Grey Wet		11	SS	1												
176.8	END OF BOREHOLE		12	SS													
11.6	SPLIT-SPOON AND AUGER REFUSAL																
	NOTE:																
	1. Water level in open borehole at a depth of 7.4 m below ground surface (Elev. 181.0 m) upon completion of drilling.																



## METRIC

ORIGINATED BY ID

COMPILED BY BM

CHECKED BY CN

+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-07				SHEET 2 OF 2		METRIC									
W.P. 5005-10-01		LOCATION N 5083180.6 ; E 222934.0				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY BM											
DATUM Geodetic		DATE March 18, 2013				CHECKED BY CN											
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
174.2	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		14	SS	4		175										
173.8	Gravelly SILT and SAND, trace clay Compact Grey Wet		15	SS	27/0.15		174										21 46 30 3
16.5	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL  NOTE:  1. Water level in open borehole at a depth of 7.5 m below ground surface (Elev. 182.8 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No S502-08</b>		SHEET 1 OF 2		<b>METRIC</b>	
W.P. 5005-10-01		LOCATION N 5083197.7 ; E 222942.6		ORIGINATED BY SA			
DIST _____ HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL			
DATUM Geodetic		DATE March 6 and 7, 2013		CHECKED BY CN			

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 (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
190.6	GROUND SURFACE		1A													
0.0	PEAT (Fibrous)		1B	SS	2											
0.2	Very soft Dark brown Wet															
189.7	CLAYEY SILT		2A													
0.9	Very soft Brown Wet		2B	SS	17											
	SAND, trace to some silt, trace clay Loose to compact Brown to becoming grey below a depth of 3.8 m Moist to Wet		3	SS	15											
			4	SS	7											
			5	SS	6											
			6	SS	17											
			7	SS	20											
185.0																
5.6	Sandy SILT, trace clay Loose Grey Wet		8	SS	7											
183.4																
7.2	CLAYEY SILT Firm Grey Wet		9	SS	2											
			10	SS	WH											
180.5																
10.1	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		11	SS	3											
			12	SS	5											
177.3																
13.3	CLAYEY SILT, containing silt seams Soft Grey Wet		13	SS	3											
175.8																
14.8																

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-08		SHEET 2 OF 2		METRIC							
W.P. 09-1111-6014		LOCATION		N 5083197.7 ; E 222942.6		ORIGINATED BY		SA							
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY							
GRL		DATE		March 6 and 7, 2013		CHECKED BY		CN							
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100							
172.7	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		14	SS	9		175								0 10 87 3
							174								
			15	SS	WR		173								
17.9	SILT and SAND, trace clay Very loose Grey Wet		16	SS	3		172								0 39 57 4
170.9	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL		17	SS			171								
19.7	NOTE:  1. Water level in open borehole at a depth of 6.7 m below ground surface (Elev. 183.9 m) upon completion of drilling.														

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>		<b>RECORD OF BOREHOLE No S502-09</b>		SHEET 1 OF 2		<b>METRIC</b>	
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083203.6 ; E 222924.4</u>		ORIGINATED BY <u>ID</u>			
DIST <u>        </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>AV</u>			
DATUM <u>Geodetic</u>		DATE <u>March 12 and 13, 2013</u>		CHECKED BY <u>CN</u>			

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED					
191.0	GROUND SURFACE													
0.0	TOPSOIL		1A											
0.2	CLAYEY SILT, trace sand		1B	SS	2									
190.2	Soft Brown Wet													
0.8	SAND, trace silt, trace clay		2	SS	14									0 93 5 2
	Loose to compact Brown Wet													
			3	SS	8									
			4	SS	8									
			5	SS	6									
			6	SS	25									
			7	SS	28									
185.3	SILT and SAND, trace clay													
5.7	Loose Brown Wet		8	SS	8									0 64 35 1
			9A	SS	4									
182.9	CLAYEY SILT, trace to some sand		9B											
8.1	Firm Grey Wet													
181.9	SILT and SAND, trace clay		10	SS	5									0 37 59 4
	Loose Grey Wet													
180.8	SILT, trace to some sand, trace clay													
10.2	Very loose to loose Grey Wet		11	SS	WR									Non-Plastic
			12	SS	WR									Non-Plastic
			13	SS	5									0 9 87 4
176.0														

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16



PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No S502-09</b>				SHEET 2 OF 2		<b>METRIC</b>																	
W.P. 5005-10-01		LOCATION N 5083203.6 ; E 222924.4				ORIGINATED BY ID																			
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY AV																			
DATUM Geodetic		DATE March 12 and 13, 2013				CHECKED BY CN																			
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																	
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>																		
15.0	END OF BOREHOLE AUGER REFUSAL  NOTE:  1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 183.4 m) upon completion of drilling.																								

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>		<b>RECORD OF BOREHOLE No S502-21</b>		SHEET 1 OF 2		<b>METRIC</b>	
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083176.3 ; E 222956.2</u>		ORIGINATED BY <u>ID</u>			
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>GRL</u>			
DATUM <u>Geodetic</u>		DATE <u>February 27, 2013</u>		CHECKED BY <u>CN</u>			

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED					
187.3	GROUND SURFACE													
0.0	TOPSOIL		1A											
0.2	Silty SAND, trace clay Loose Brown Moist		1B	SS	4									
			2	SS	6									
			3	SS	8									
185.1														
2.2	SILT and SAND, trace to some clay Very loose to compact Brown Moist to wet		4	SS	11									
			5	SS	5									
			6	SS	3									
	Containing clayey silt seams below a depth of 4.6 m.		7	SS	3									
181.7														
5.6	CLAYEY SILT, trace to some sand Very soft Grey Moist		8A											
180.9			8B	SS	1									
6.4	SILT and SAND, trace clay Very loose Grey Wet													
			9	SS	1									
178.6														
8.7	SILTY CLAY Firm Grey Wet		10	SS	WH									
			11	SS	WH									
175.1														
12.2	SILT, some sand, trace clay Very loose to loose Grey Wet		12	SS	WH									
			13	SS	9									

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA-GDT 07/25/16

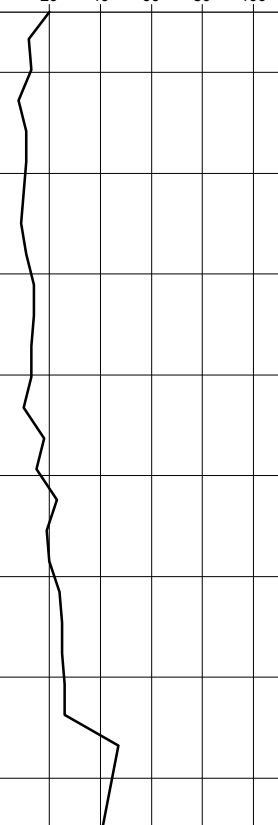
PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-21				SHEET 2 OF 2		METRIC								
W.P. 5005-10-01		LOCATION N 5083176.3 ; E 222956.2				ORIGINATED BY ID										
DIST _____ HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY GRL										
DATUM Geodetic		DATE February 27, 2013				CHECKED BY CN										
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100					WATER CONTENT (%) 20 40 60				
170.8	SILT, some sand, trace clay Very loose to loose Grey Wet		14	SS	4		172									
16.5	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL  NOTE:  1. Water level in open borehole at a depth of 4.0 m below ground surface (Elev. 183.3 m) upon completion of drilling.		15	SS	-		171									

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

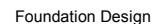


+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

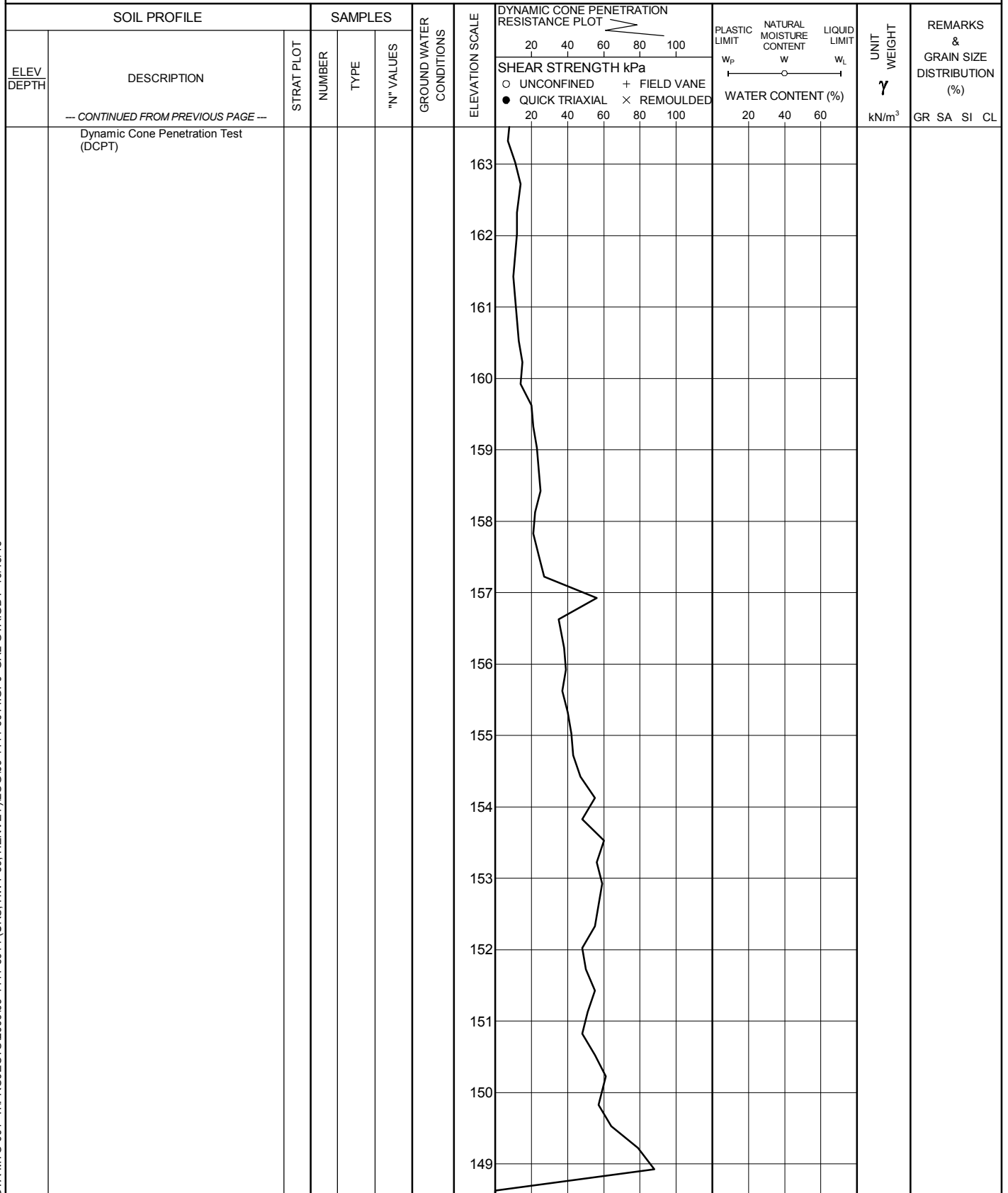
PROJECT 09-1111-6014		<b>RECORD OF DCPT No B501-DC01</b>		SHEET 2 OF 2		<b>METRIC</b>												
W.P. 5146-08-01		LOCATION N 5082929.8 ; E 223039.1		ORIGINATED BY MA														
DIST _____ HWY 69		BOREHOLE TYPE Dynamic Cone Penetration Test		COMPILED BY MCK														
DATUM Geodetic		DATE February 22, 2013		CHECKED BY AB														
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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa										
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>											
155.4																		
23.2																		
	Dynamic Cone Penetration Test (DCPT) Inferred Bedrock Surface at a depth of 15.6 m below ground surface (Elev. 163.0 m). *																	
	END OF DCPT  NOTE:  * Upon completion of DCPT, it was noted that the lower 7.6 m of the drill rods were bent. It is estimated that the bedrock surface may have been encountered at a depth of about 15.6 m below ground surface (Elev. 163.0 m) and the rods travelled along the sloped bedrock surface for the lower portion of the DCPT test.																	

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>09-1111-6014</u>		<b>RECORD OF DCPT No B501-DC10</b>		SHEET 2 OF 3		<b>METRIC</b>	
W.P. <u>5146-08-01</u>		LOCATION <u>N 5082987.0 ; E 223016.9</u>		ORIGINATED BY <u>MR</u>			
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>		COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 26 and 27, 2013</u>		CHECKED BY <u>AB</u>			



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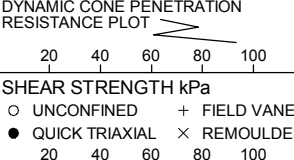
+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014					<b>RECORD OF DCPT No B501-DC10</b>					SHEET 3 OF 3		<b>METRIC</b>				
W.P. 5146-08-01		LOCATION N 5082987.0 ; E 223016.9					ORIGINATED BY MR									
DIST		HWY 69		BOREHOLE TYPE Dynamic Cone Penetration Test					COMPILED BY MCK							
DATUM Geodetic		DATE February 26 and 27, 2013					CHECKED BY AB									
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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>									
141.9	Dynamic Cone Penetration Test (DCPT)					148										
						147										
						146										
						145										
						144										
						143										
141.9 36.6	END OF DCPT					142										
	NOTE:  1. DCPT advanced to a depth of 29.9 m below ground surface (Elev. 148.6 m) on February 26, 2014. On February 27, 2014, drilled to a depth of 31.7 m (Elev. 147.8 m) and resumed DCPT.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



PROJECT 09-1111-6014		<b>RECORD OF DCPT No S502-DC03</b>		SHEET 1 OF 1		<b>METRIC</b>				
W.P. 5005-10-01		LOCATION N 5083183.9 ; E 222915.3		ORIGINATED BY EHS						
DIST _____ HWY 69		BOREHOLE TYPE Dynamic Cone Penetration Test		COMPILED BY AV						
DATUM Geodetic		DATE March 4, 2013		CHECKED BY JPD						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT (Wp)   NATURAL MOISTURE CONTENT (W)   LIQUID LIMIT (Wl) WATER CONTENT (%)	UNIT WEIGHT (γ)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
190.4 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)									
						190 189 188 187 186 185 184 183 182 181 180 179				
178.1 12.3	END OF DCPT Refusal to Further Penetration									

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

1 OF 5

G.W.P. <u>5377-02-00</u>	LOCATION <u>Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E</u>	ORIGINATED BY <u>JF</u>
DIST <u>54</u> HWY <u>69</u>	BOREHOLE TYPE <u>Portable Drilling Equipment - Wash Boring</u>	COMPILED BY <u>SN</u>
DATUM <u>Geodetic</u>	DATE <u>18 February 2006 - 21 February 2006</u>	CHECKED BY <u>IH</u>
PROJECT <u>Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522</u>		JOB NO. <u>TT53126</u>

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

G.W.P. 5377-02-00 LOCATION Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E ORIGINATED BY JF  
 DIST 54 HWY 69 BOREHOLE TYPE Portable Drilling Equipment - Wash Boring COMPILED BY SN  
 DATUM Geodetic DATE 18 February 2006 - 21 February 2006 CHECKED BY IH  
 PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522 JOB NO. TT53126

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE



G.W.P. <u>5377-02-00</u>	LOCATION <u>Center of Straight Lake, Mowat Township, Co-ords: 5083027 N: 223022 E</u>	ORIGINATED BY <u>JF</u>
DIST <u>54</u> HWY <u>69</u>	BOREHOLE TYPE <u>Portable Drilling Equipment - Wash Boring</u>	COMPILED BY <u>SN</u>
DATUM <u>Geodetic</u>	DATE <u>18 February 2006 - 21 February 2006</u>	CHECKED BY <u>IH</u>
PROJECT <u>Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522</u>		JOB NO. <u>TT53126</u>

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

G.W.P. 5377-02-00 LOCATION Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 2230222 E ORIGINATED BY JF  
 DIST 54 HWY 69 BOREHOLE TYPE Portable Drilling Equipment - Wash Boring COMPILED BY SN  
 DATUM Geodetic DATE 18 February 2006 - 21 February 2006 CHECKED BY IH  
 PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522 JOB NO. TT53126

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE



# APPENDIX B

## Laboratory Test Results and Bedrock Core Photographs

**TABLE B1**  
**POINT LOAD TEST RESULTS ON ROCK SAMPLES**

Foundation Element	Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) <sup>(2)</sup>	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
South Abutment	B501-05	1	3.0	180.8	Granitic Gneiss	Axial	55	45	7.1	99
	B501-05	2	3.5	180.3	Granitic Gneiss	Diametral	95	45	7.3	103
	B501-05	4	5.2	178.6	Granitic Gneiss	Diametral	110	45	9.0	127
	B501-05	4	5.3	178.5	Granitic Gneiss	Axial	45	45	8.2	115
	B501-06	1	4.2	179.2	Granitic Gneiss	Diametral	110	45	0.5	7
	B501-06	2	4.9	178.5	Granitic Gneiss	Axial	45	45	3.1	44
	B501-07A	1	6.1	177.6	Granitic Gneiss	Axial	55	45	0.9	13
	B501-07A	2	6.4	177.3	Granitic Gneiss	Diametral	135	45	1.2	16
	B501-07A	4	8.4	175.3	Granitic Gneiss	Axial	45	45	2.4	34
	B501-07A	4	8.5	175.2	Granitic Gneiss	Diametral	95	45	1.1	16
Pier 1	B501-09	2	5.6	173.0	Granitic Gneiss	Diametral	125	45	10.9	152
	B501-09	2	5.7	172.9	Granitic Gneiss	Axial	45	45	10.5	146
	B501-09	2	6.7	171.9	Granitic Gneiss	Axial	45	45	11.3	158
	B501-09	3	6.8	171.8	Granitic Gneiss	Diametral	100	45	1.3	18
	B501-15	1	3.3	175.3	Granitic Gneiss	Diametral	110	45	6.0	84
	B501-15	1	3.4	175.2	Granitic Gneiss	Axial	50	45	10.2	143
	B501-15	2	4.4	174.2	Granitic Gneiss	Axial	45	45	7.0	98
	B501-15	2	4.4	174.2	Granitic Gneiss	Diametral	95	45	3.9	55
	B501-18	1	10.7	167.9	Granitic Gneiss	Diametral	105	45	5.5	77
	B501-18	1	10.8	167.8	Granitic Gneiss	Axial	40	45	6.0	84
	B501-18	2	11.8	166.8	Granitic Gneiss	Diametral	90	45	7.3	102
	B501-18	2	11.9	166.7	Granitic Gneiss	Axial	50	45	10.0	140
Pier 2	B501-01	1	50.4	128.2	Granitic Gneiss	Axial	34	47	10.1	142
	B501-01	1	50.4	128.2	Granitic Gneiss	Diametral	91	47	7.7	108
	B501-01	2	51.2	127.4	Granitic Gneiss	Axial	38	47	7.1	99
	B501-01	2	51.2	127.4	Granitic Gneiss	Diametral	103	47	7.2	100
	B501-01	2	52.5	126.1	Granitic Gneiss	Axial	40	47	9.3	131
	B501-01	2	52.5	126.1	Granitic Gneiss	Diametral	127	47	7.9	111
	B501-10	1	52.0	126.5	Granitic Gneiss	Axial	34	45	8.0	112
	B501-10	1	52.1	126.5	Granitic Gneiss	Diametral	77	45	2.3	32
Between Piers 2 and 3	B501-11	1	37.3	141.3	Granitic Gneiss	Axial	45	45	11.4	160
	B501-11	1	37.4	141.2	Granitic Gneiss	Diametral	65	45	6.9	96
	B501-11	2	38.1	140.6	Granitic Gneiss	Axial	34	45	8.9	125
	B501-11	2	38.1	140.5	Granitic Gneiss	Diametral	70	45	9.1	128
	B501-11	3	39.1	139.5	Granitic Gneiss	Diametral	70	45	6.3	88
Pier 3	B501-02	1	37.4	141.2	Granitic Gneiss	Diametral	70	48	8.6	120
	B501-02	1	37.5	141.1	Granitic Gneiss	Axial	35	48	8.5	119
	B501-02	1	37.5	141.1	Granitic Gneiss	Diametral	78	48	7.3	102
	B501-02	1	39.0	139.6	Granitic Gneiss	Axial	46	48	6.3	88
	B501-02	1	39.0	139.6	Granitic Gneiss	Diametral	104	48	4.8	67
	B501-02	2	40.5	138.1	Granitic Gneiss	Diametral	102	48	5.5	77
Between Piers 3 and 4	B501-12	2	28.3	152.8	Granitic Gneiss	Diametral	150	45	5.8	81
	B501-12	2	29.1	151.9	Granitic Gneiss	Axial	60	45	4.3	60
	B501-12	2	29.6	151.4	Granitic Gneiss	Diametral	120	45	8.3	117
North Approach	B501-13	1	13.8	171.4	Granitic Gneiss	Diametral	105	45	9.7	136
	B501-13	1	13.9	171.3	Granitic Gneiss	Axial	62	45	8.3	116
	B501-13	2	15.7	169.4	Granitic Gneiss	Axial	42	45	1.0	14
	B501-13	2	15.9	169.2	Granitic Gneiss	Diametral	120	45	9.8	137

<sup>(1)</sup>  $Is_{50} \times K$ , from ASTM Designation: D 5731 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications". A value of  $K = 14$  has been used based on 14 UCS tests for both the SBL and NBL bridges.

#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

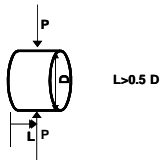
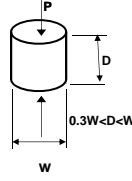
note: Diametral tests are perpendicular to core axis  
(planes of weakness)

#### AXIAL SPECIMEN SHAPE REQUIREMENTS



TABLE B1

## POINT LOAD TEST RESULTS ON ROCK SAMPLES

Foundation Element	Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) <sup>(2)</sup>	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
 <p><math>L &gt; 0.5 D</math></p>						 <p><math>0.3W &lt; D &lt; W</math></p>	<p>note: Axial tests are parallel to core axis (planes of weakness)</p>			
<p>Page 1/1</p>							<p>Compiled By: MCK Checked By: AB Reviewed By: JPD/JMAC</p>			

**TABLE B2-1**  
**SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS**  
**STRAIGHT LAKE SBL BRIDGE**  
**HIGHWAY 69 GWP 5404-05-00; WP 5146-08-01**

<b>Borehole Number (Core Run)</b>	<b>Sample Depth (m)</b>	<b>Sample Elevation (m)</b>	<b>Rock Type</b>	<b>Core Diameter (mm)</b>	<b>Uniaxial Compressive Strength (MPa)</b>
B501-01 (1)	50.3	128.3	Granitic Gneiss	47.4	88.2
B501-06 (2)	5.0	178.4	Granitic Gneiss	50.0	38.5
B501-09 (3)	7.0	171.6	Granitic Gneiss	47.6	50.0
B501-12 (2)	29.5	151.5	Granitic Gneiss	47.5	51.5
B501-15 (2)	4.9	173.7	Granitic Gneiss	47.5	89.3
B501-18 (1)	11.1	167.5	Granitic Gneiss	47.4	113.3

Compiled By: MTReviewed By: AB

**Table B2-2**

**UNCONFINED COMPRESSION TEST (UC)  
ASTM D 7012-07**

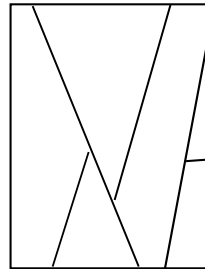
SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	B501-01	SAMPLE DEPTH, m	50.25-50.37

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.24

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.63	WATER CONTENT, (specimen) %	0.06
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m <sup>3</sup>	26.58
SAMPLE AREA, cm <sup>2</sup>	17.65	DRY UNIT WT., kN/m <sup>3</sup>	26.56
SAMPLE VOLUME, cm <sup>3</sup>	187.54	SPECIFIC GRAVITY	-
WET WEIGHT, g	508.42	VOID RATIO	-
DRY WEIGHT, g	508.12		

**VISUAL INSPECTION**

**FAILURE SKETCH**



TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	88.2

REMARKS:

DATE:

3/15/2013

Checked By: AB

**Golder Associates**

**Table B2-3**

**UNCONFINED COMPRESSION TEST (UC)  
ASTM D 7012-07**

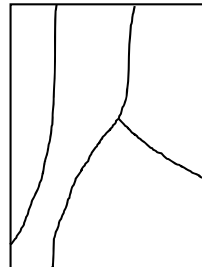
SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	B501-06	SAMPLE DEPTH, m	4.95-5.10

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.22

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.11	WATER CONTENT, (specimen) %	0.40
SAMPLE DIAMETER, cm	5.00	UNIT WEIGHT, kN/m <sup>3</sup>	25.29
SAMPLE AREA, cm <sup>2</sup>	19.64	DRY UNIT WT., kN/m <sup>3</sup>	25.19
SAMPLE VOLUME, cm <sup>3</sup>	218.27	SPECIFIC GRAVITY	-
WET WEIGHT, g	563.07	VOID RATIO	-
DRY WEIGHT, g	560.83		

**VISUAL INSPECTION**

**FAILURE SKETCH**



TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	38.5

REMARKS:

DATE:

4/17/2014

Checked By: AB

**Golder Associates**

**Table B2-4**

**UNCONFINED COMPRESSION TEST (UC)  
ASTM D 7012-07**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	B501-09	SAMPLE DEPTH, m	6.89-7.10

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.16

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.28	WATER CONTENT, (specimen) %	0.11
SAMPLE DIAMETER, cm	4.76	UNIT WEIGHT, kN/m <sup>3</sup>	27.67
SAMPLE AREA, cm <sup>2</sup>	17.78	DRY UNIT WT., kN/m <sup>3</sup>	27.64
SAMPLE VOLUME, cm <sup>3</sup>	182.84	SPECIFIC GRAVITY	-
WET WEIGHT, g	516.01	VOID RATIO	-
DRY WEIGHT, g	515.44		

**VISUAL INSPECTION**

**FAILURE SKETCH**



TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	50.0

REMARKS:

DATE:

4/17/2014

Checked By: AB

**Golder Associates**

**Table B2-5**

**UNCONFINED COMPRESSION TEST (UC)  
ASTM D 7012-07**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	B501-12	SAMPLE DEPTH, m	29.35-29.60

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.16

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.26	WATER CONTENT, (specimen) %	0.12
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m <sup>3</sup>	29.55
SAMPLE AREA, cm <sup>2</sup>	17.70	DRY UNIT WT., kN/m <sup>3</sup>	29.51
SAMPLE VOLUME, cm <sup>3</sup>	181.65	SPECIFIC GRAVITY	-
WET WEIGHT, g	547.54	VOID RATIO	-
DRY WEIGHT, g	546.88		

**VISUAL INSPECTION**

**FAILURE SKETCH**



TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	51.5

REMARKS:

DATE:

4/17/2014

Checked By: AB

**Golder Associates**

Table B2-6

# **UNCONFINED COMPRESSION TEST (UC)** **ASTM D 7012-07**

## **SAMPLE IDENTIFICATION**

PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	B501-15	SAMPLE DEPTH, m	4.78-5.00

## **TEST CONDITIONS**

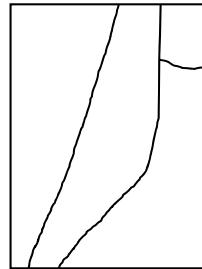
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.19

## **SPECIMEN INFORMATION**

SAMPLE HEIGHT, cm	10.41	WATER CONTENT, (specimen) %	0.11
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m <sup>3</sup>	26.64
SAMPLE AREA, cm <sup>2</sup>	17.68	DRY UNIT WT., kN/m <sup>3</sup>	26.61
SAMPLE VOLUME, cm <sup>3</sup>	183.99	SPECIFIC GRAVITY	-
WET WEIGHT, g	499.95	VOID RATIO	-
DRY WEIGHT, g	499.40		

## **VISUAL INSPECTION**

## **FAILURE SKETCH**



## **TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	89.3
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REMARKS:

DATE:

4/17/2014

Checked By: AB

**Golder Associates**

Table B2-7

**UNCONFINED COMPRESSION TEST (UC)****ASTM D 7012-07****SAMPLE IDENTIFICATION**

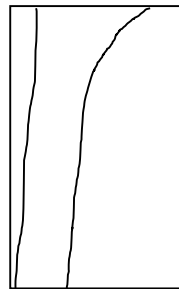
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	B501-18	SAMPLE DEPTH, m	11.00-11.20

**TEST CONDITIONS**

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.22

**SPECIMEN INFORMATION**

SAMPLE HEIGHT, cm	10.55	WATER CONTENT, (specimen) %	0.13
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m <sup>3</sup>	26.68
SAMPLE AREA, cm <sup>2</sup>	17.66	DRY UNIT WT., kN/m <sup>3</sup>	26.65
SAMPLE VOLUME, cm <sup>3</sup>	186.25	SPECIFIC GRAVITY	-
WET WEIGHT, g	506.90	VOID RATIO	-
DRY WEIGHT, g	506.24		

**VISUAL INSPECTION****FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	113.3
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REMARKS:

DATE:

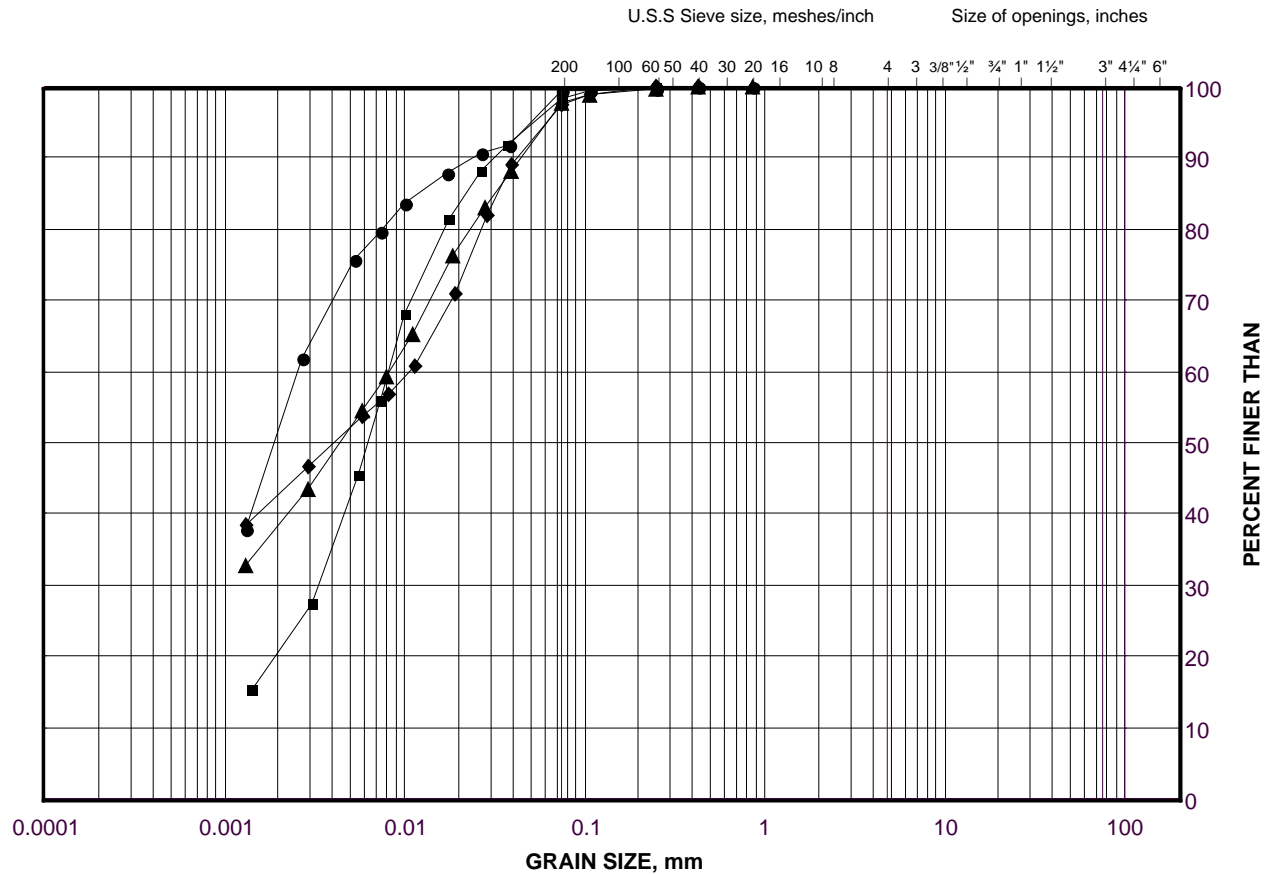
4/17/2014



# GRAIN SIZE DISTRIBUTION

Clayey Silt to Clay

FIGURE B1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B501-01	11	160.5
■	B501-11	15	157.0
◆	B501-12	5	178.0
▲	B501-12	8	174.9

Project Number: 09-1111-6014

Checked By: AB

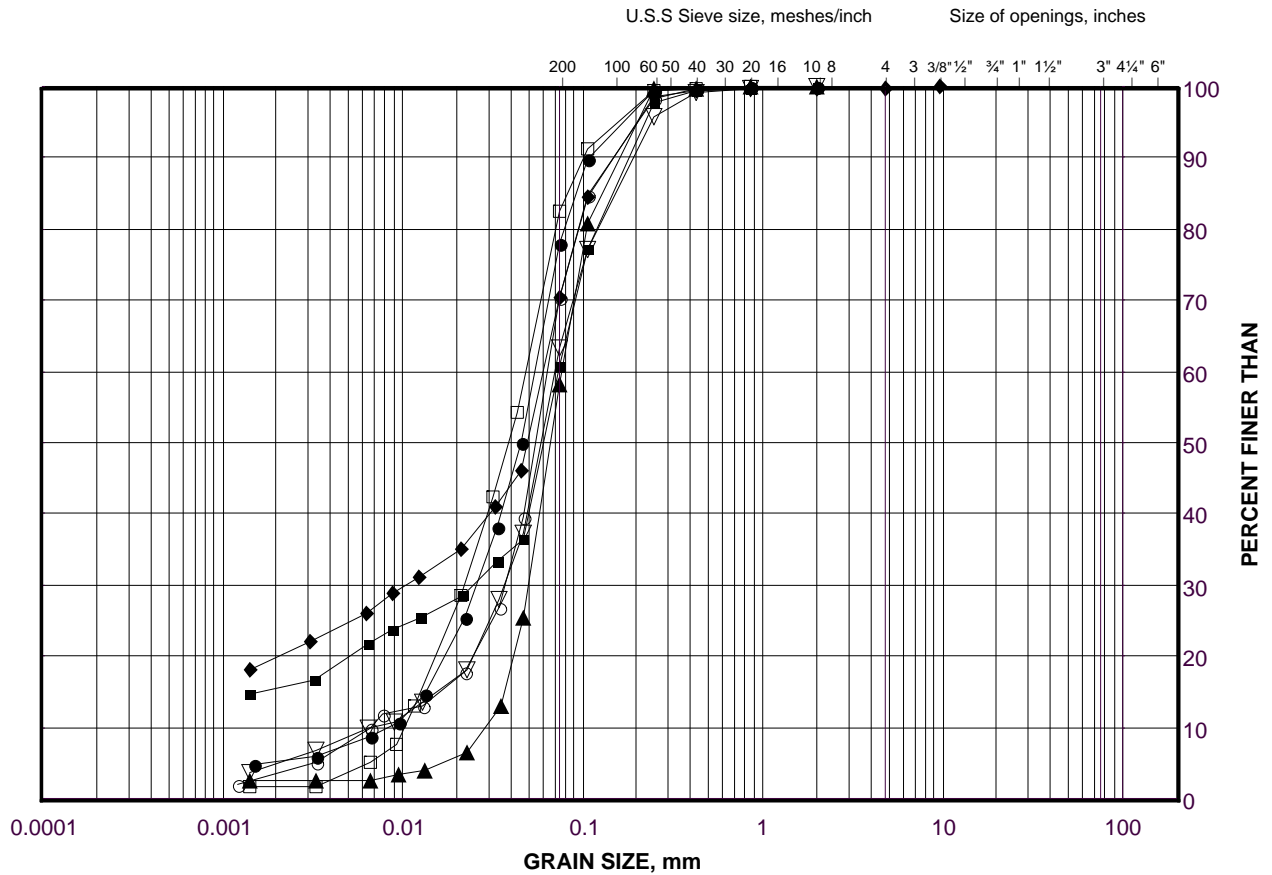
**Golder Associates**

Date: 28-Jun-16

# GRAIN SIZE DISTRIBUTION

Silt to Silt and Sand (Upper /Interlayer in Lake)

FIGURE B2A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B501-12	12	168.9
■	B501-07	3	182.0
◆	B501-04	3	181.6
▲	B501-13	5	181.8
▽	B501-10	7	166.6
○	B501-01	7	166.6
□	B501-02	9	166.3

Project Number: 09-1111-6014

Checked By: AB

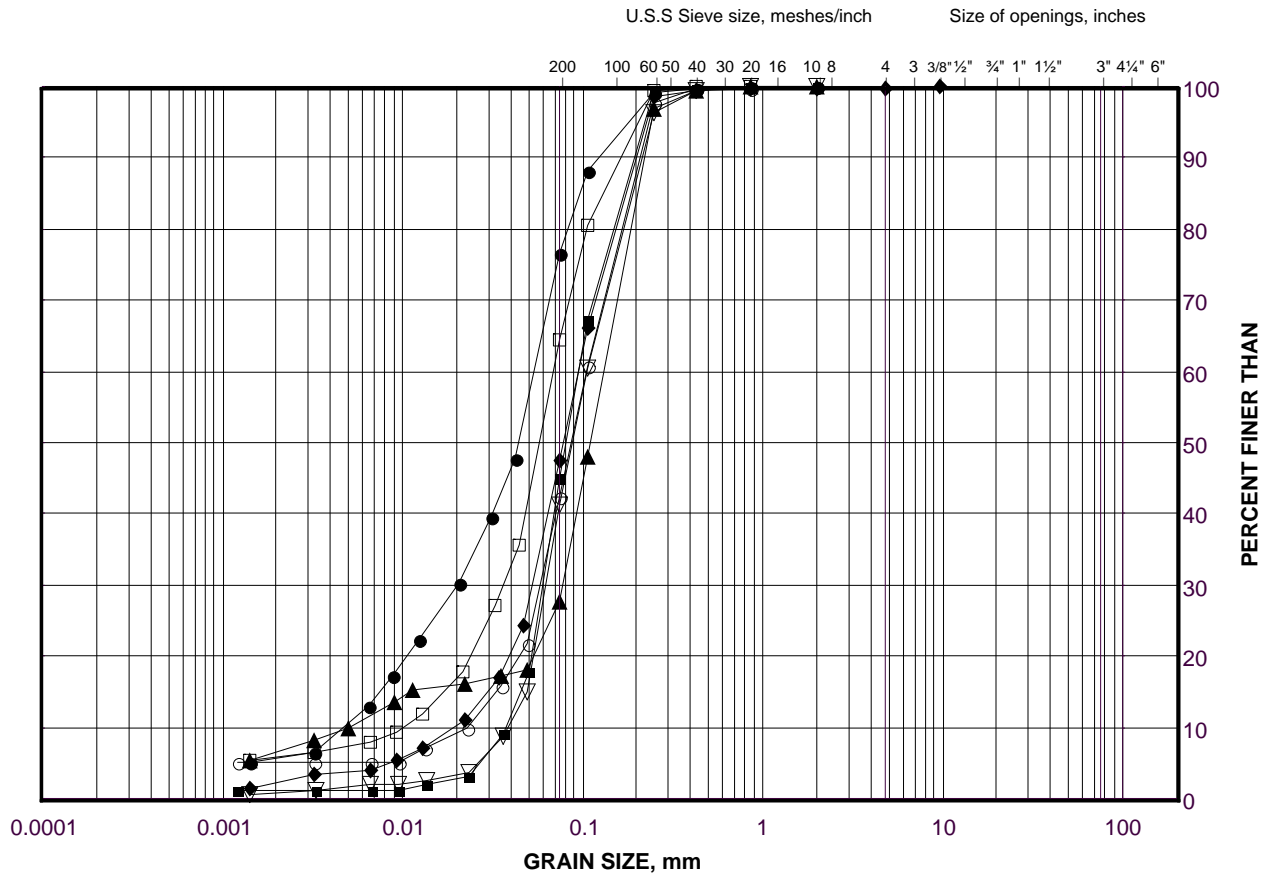
**Golder Associates**

Date: 15-Sep-15

# GRAIN SIZE DISTRIBUTION

Sandy Silt to Silty Sand (Upper/Interlayer in Lake)

FIGURE B2B



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-01	11	169.1
■	S502-03	3	181.2
◆	S502-01	3	179.3
▲	B501-17	3A	174.3
▽	B501-14	4	185.7
○	S502-03	7	178.1
□	B501-13	8	178.7

Project Number: 09-1111-6014

Checked By: AB

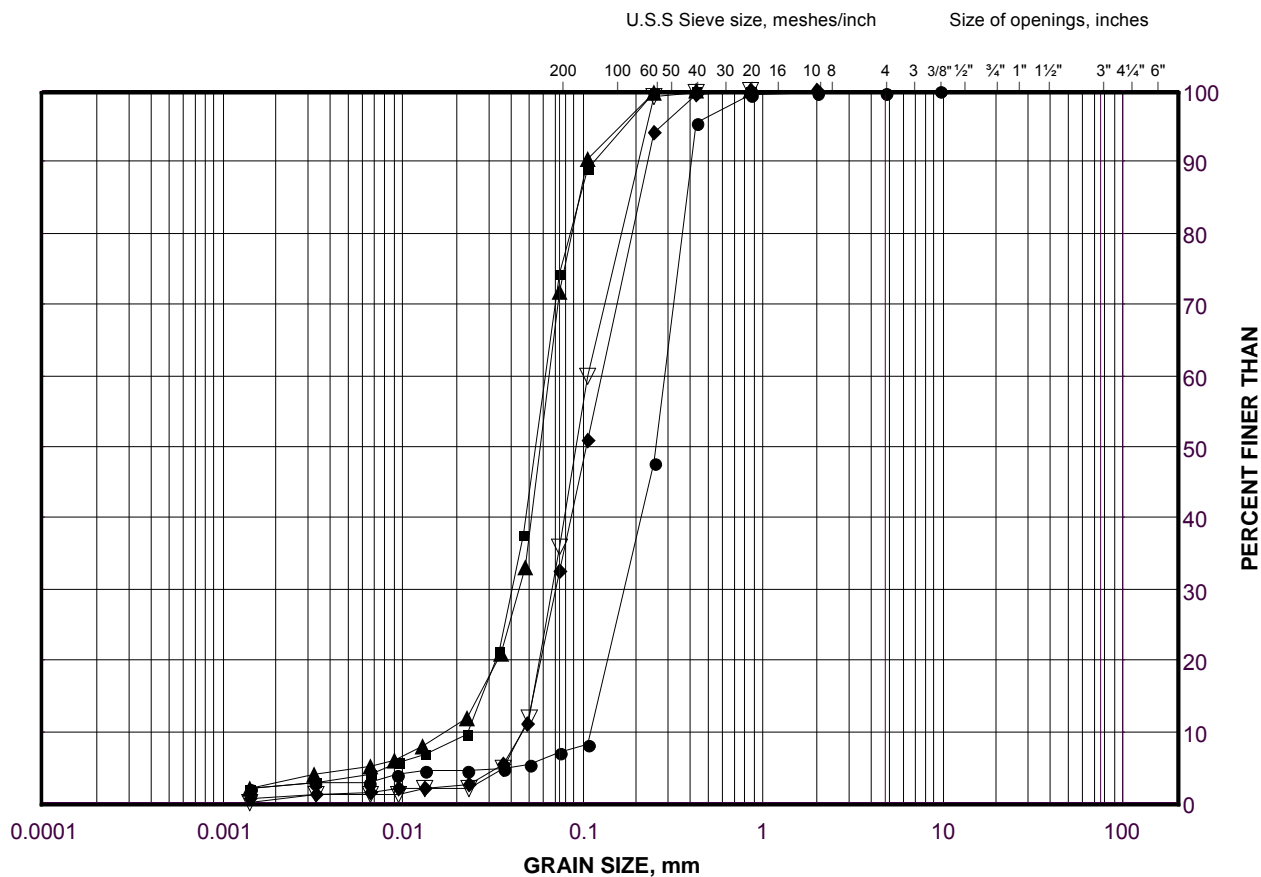
**Golder Associates**

Date: 15-Sep-15

# GRAIN SIZE DISTRIBUTION

Silt to Sand (Upper/Interlayer in Lake)

FIGURE B2C



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-09	2	189.8
■	S502-05	5	182.8
◆	S502-07	6	186.2
▲	S502-05	6	182.0
▽	S502-09	8	184.6

Project Number: 09-1111-6014

Checked By: AB

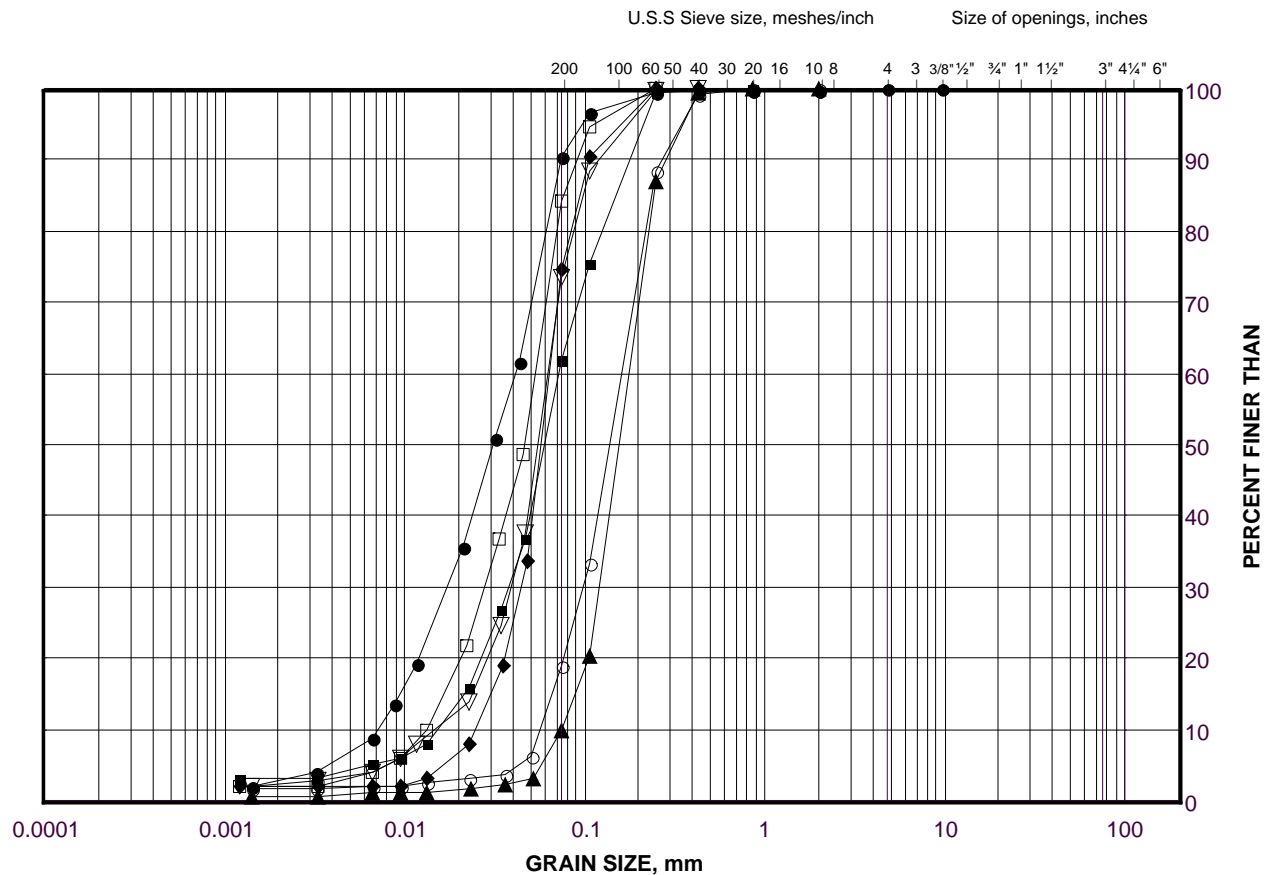
**Golder Associates**

Date: 25-Jan-16

# GRAIN SIZE DISTRIBUTION

Silt to Sand

FIGURE B2D



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-08	14	175.1
■	S502-08	16	172
◆	S502-06	7	183.5
▲	S502-08	7	185.8
▽	S502-08	8	184.2
○	S502-06	8	182.0
□	S502-06	9	180.5

Project Number: 09-1111-6014

Checked By: \_\_\_\_\_

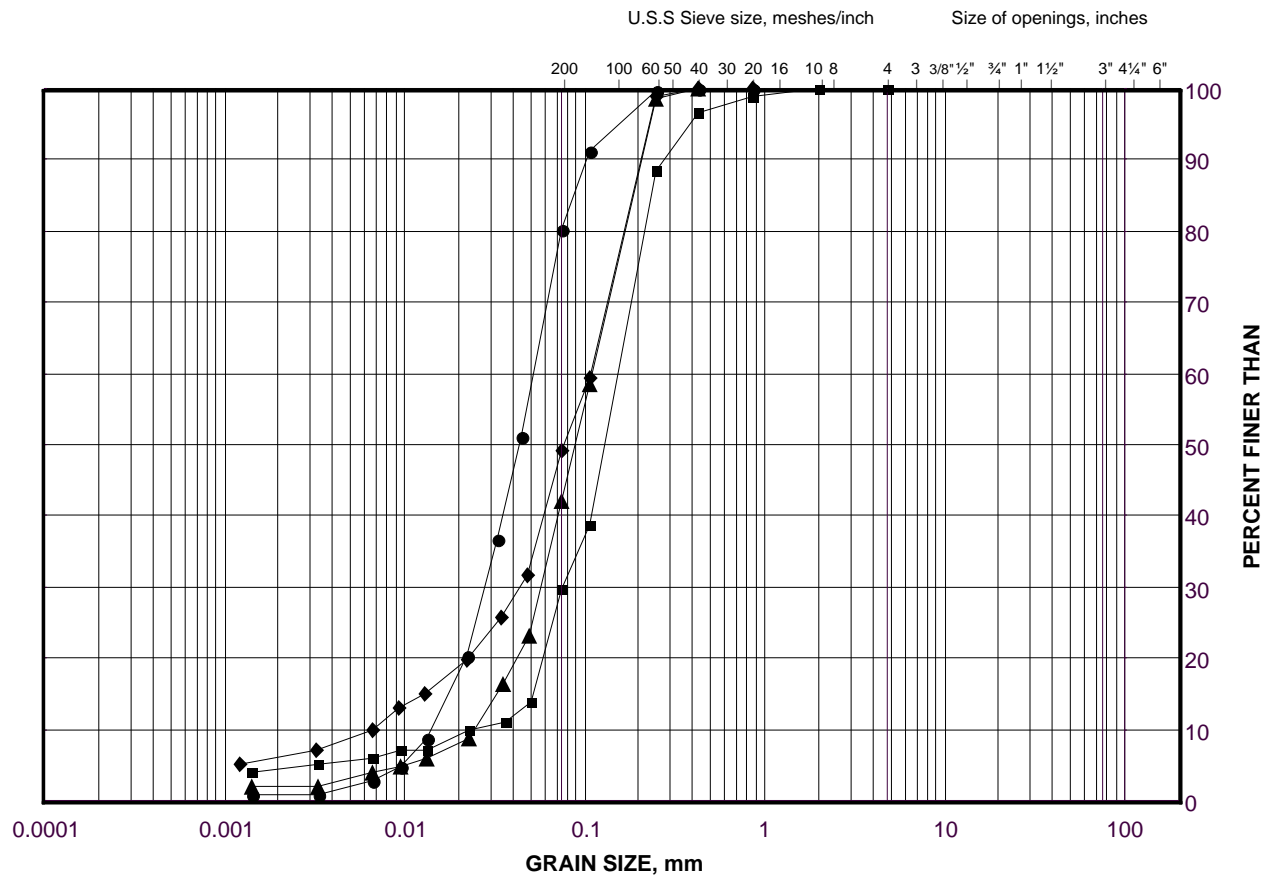
**Golder Associates**

Date: 09-Mar-16

# GRAIN SIZE DISTRIBUTION

Silt to Sand

FIGURE B2E



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-21	13	173.6
■	S502-21	3	185.7
◆	S502-21	7	182.7
▲	S502-21	8B	180.9

Project Number: 09-1111-6014

Checked By: \_\_\_\_\_

**Golder Associates**

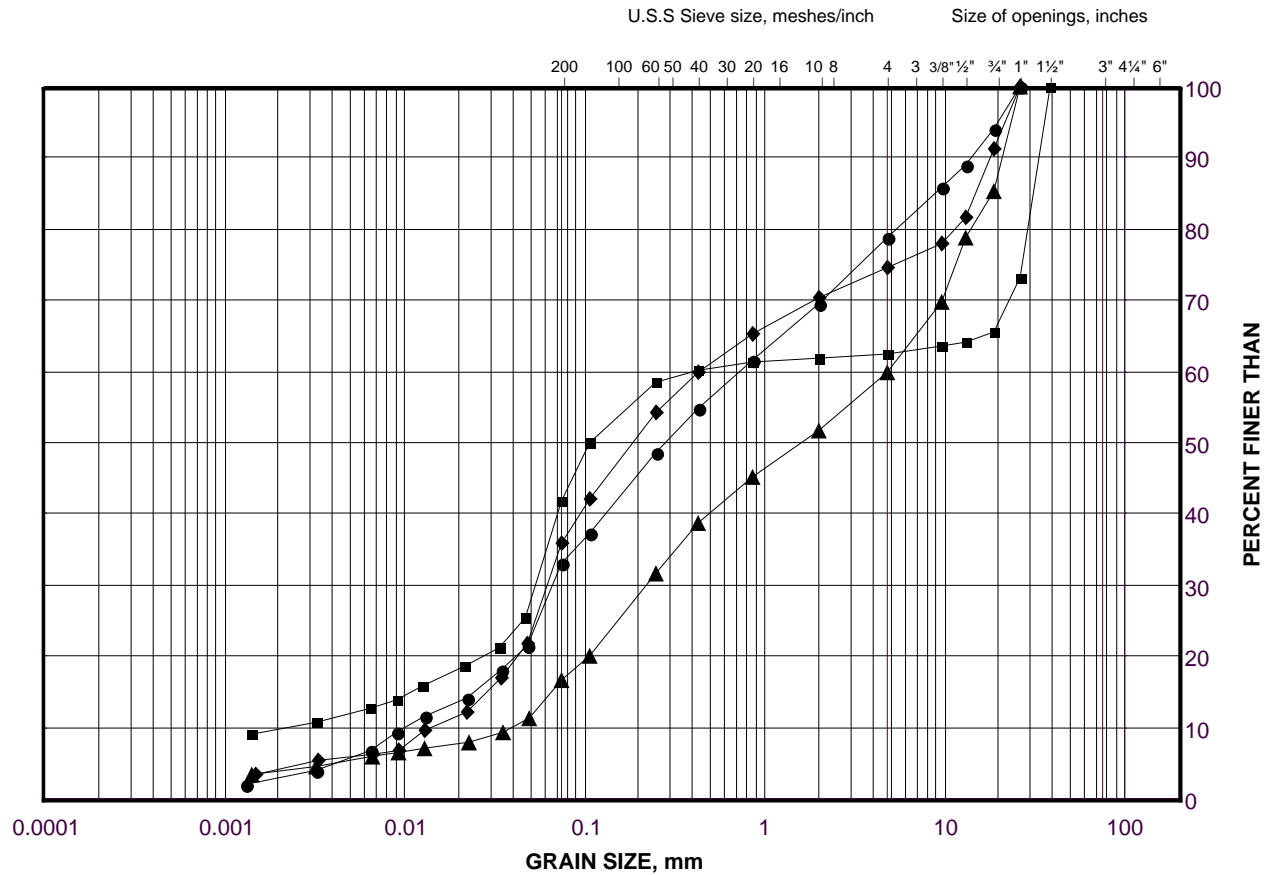
Date: 09-Mar-16



# GRAIN SIZE DISTRIBUTION

Gravely Silt and Sand to Sand and Gravel

FIGURE B3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-07	15	173.9
■	B501-06	3	181.7
◆	B501-05	3	182.0
▲	B501-06	4	180.8

Project Number: 09-1111-6014

Checked By: AB

**Golder Associates**

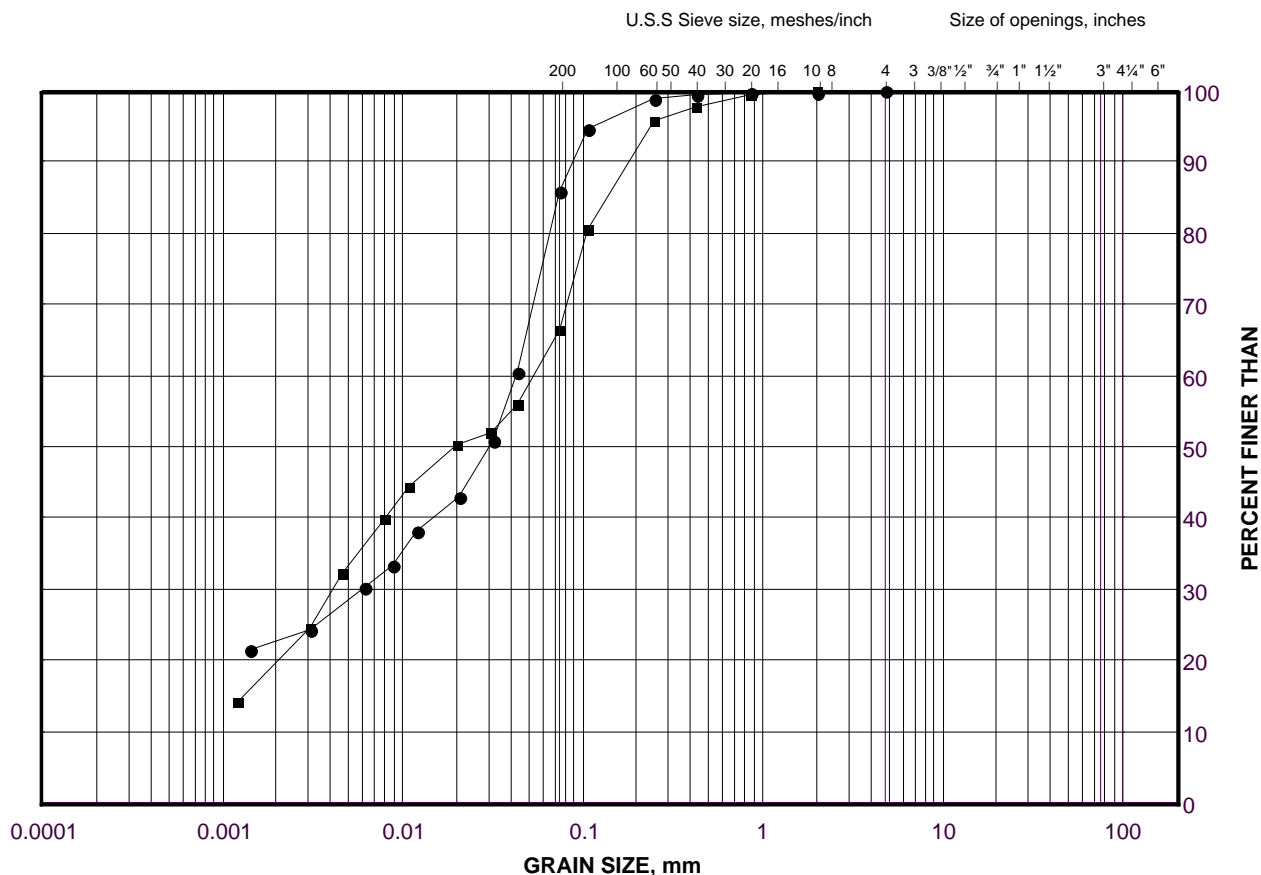
Date: 18-Sep-15



# GRAIN SIZE DISTRIBUTION

Organic Silt to Organic Silt and Sand

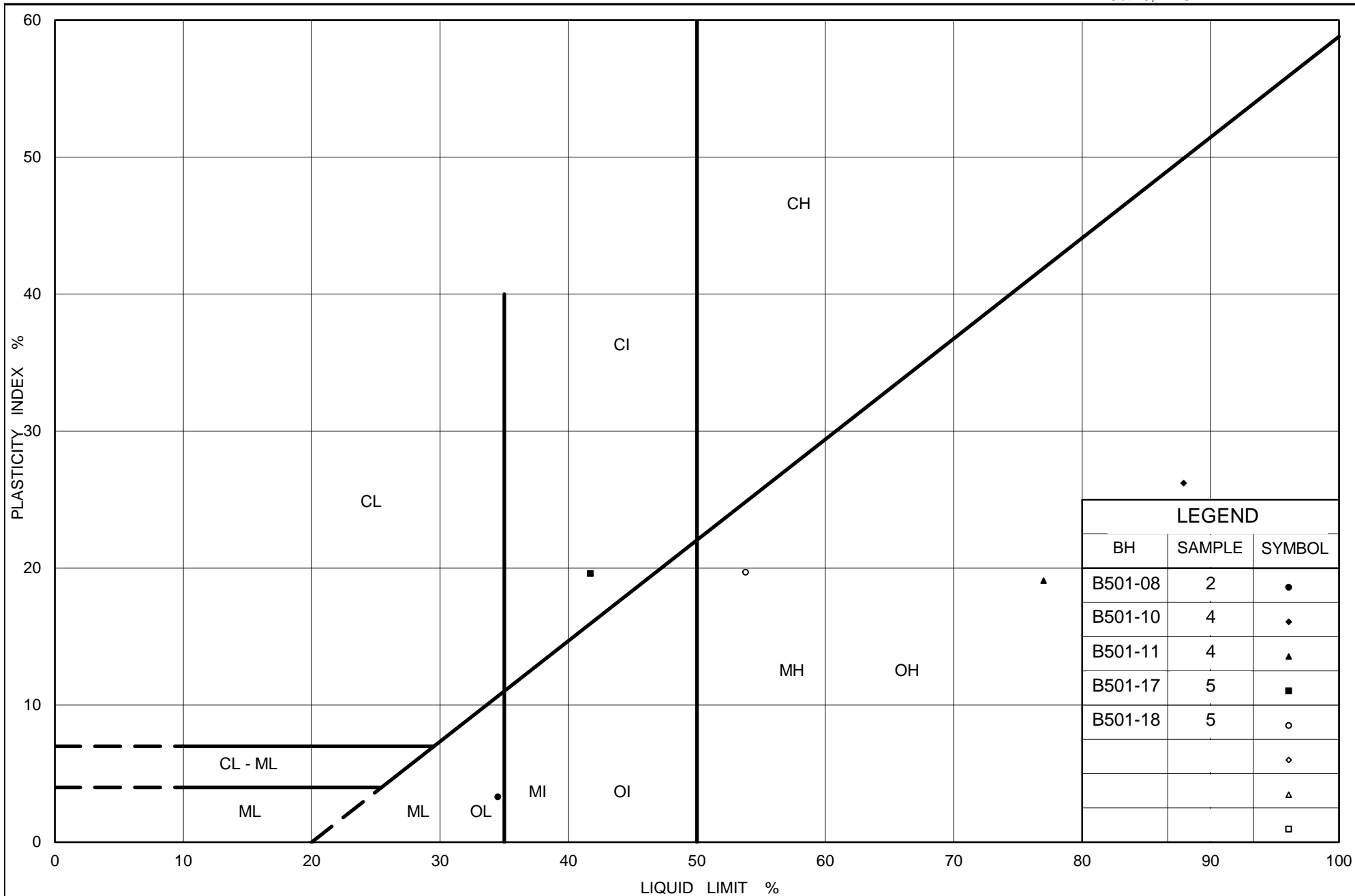
FIGURE B4



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B501-08	2	182.4
■	B501-09	2	174.3



Ministry of Transportation

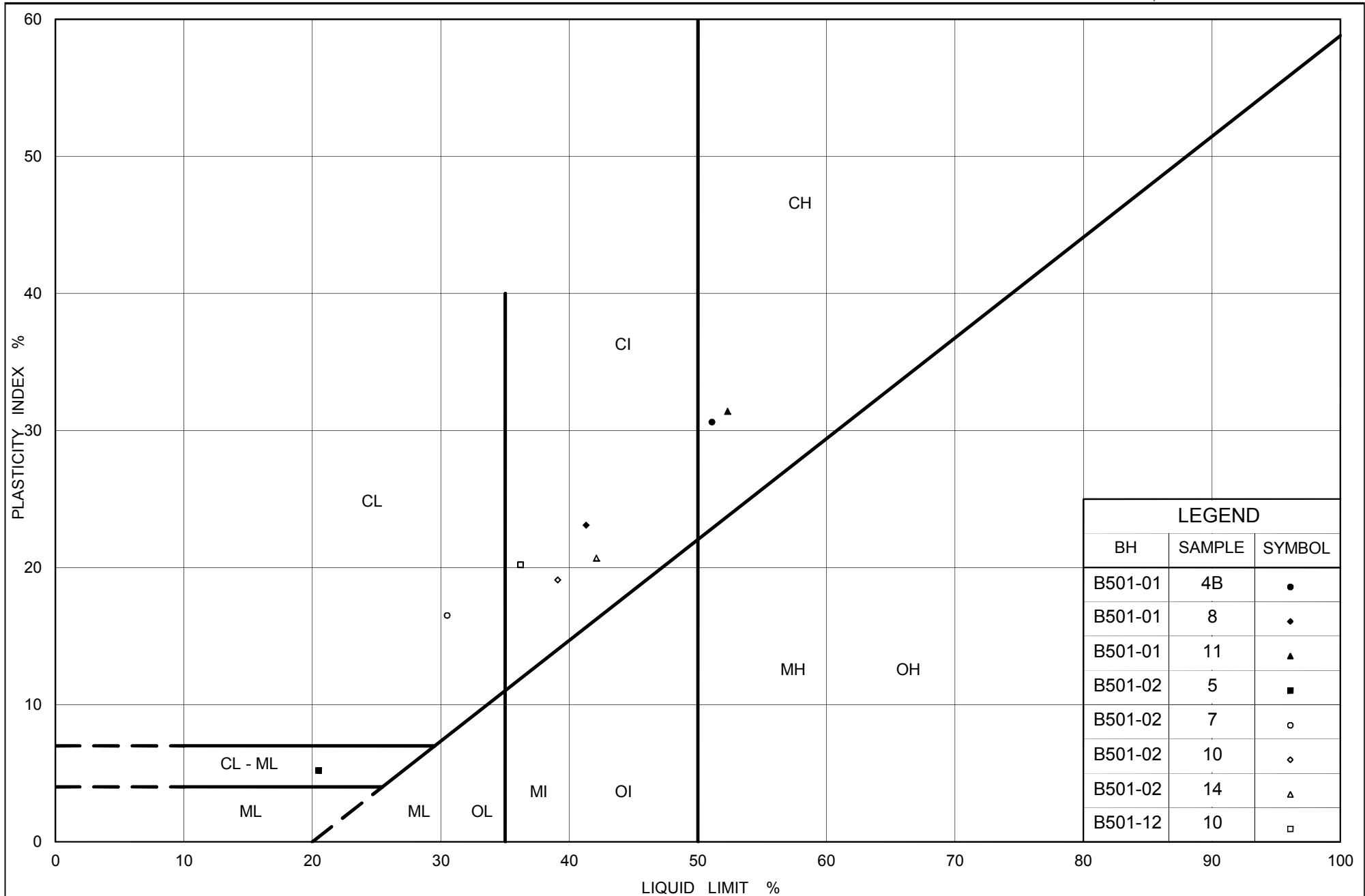
Ontario

# PLASTICITY CHART Organic Silt to Organic Silty Clay

Figure No. B5

Project No. 09-1111-6014

Checked By: AB



Ministry of Transportation

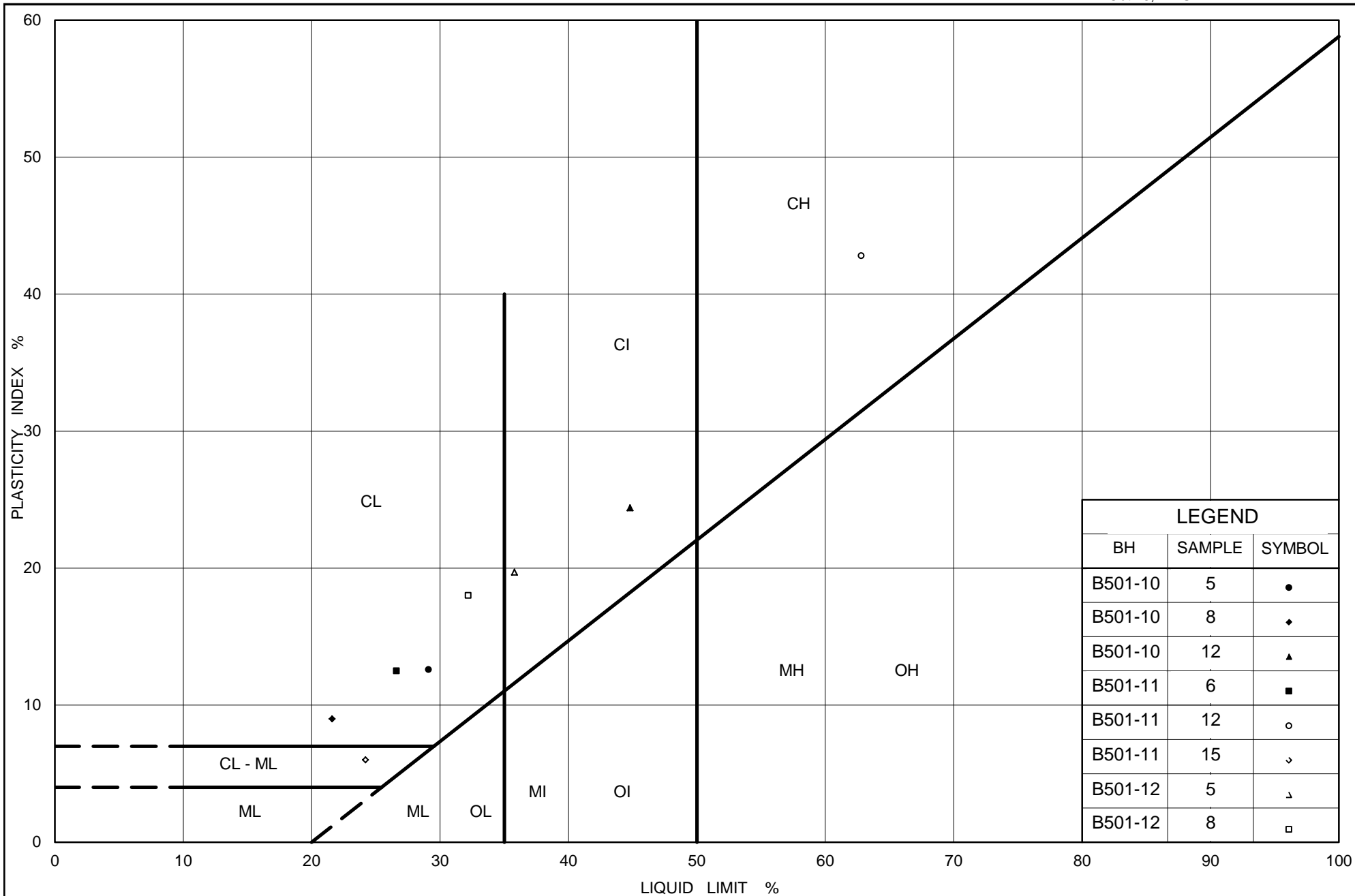
Ontario

# PLASTICITY CHART Clayey Silt to Clay

Figure No. B6A

Project No. 09-1111-6014

Checked By: AB



Ministry of Transportation

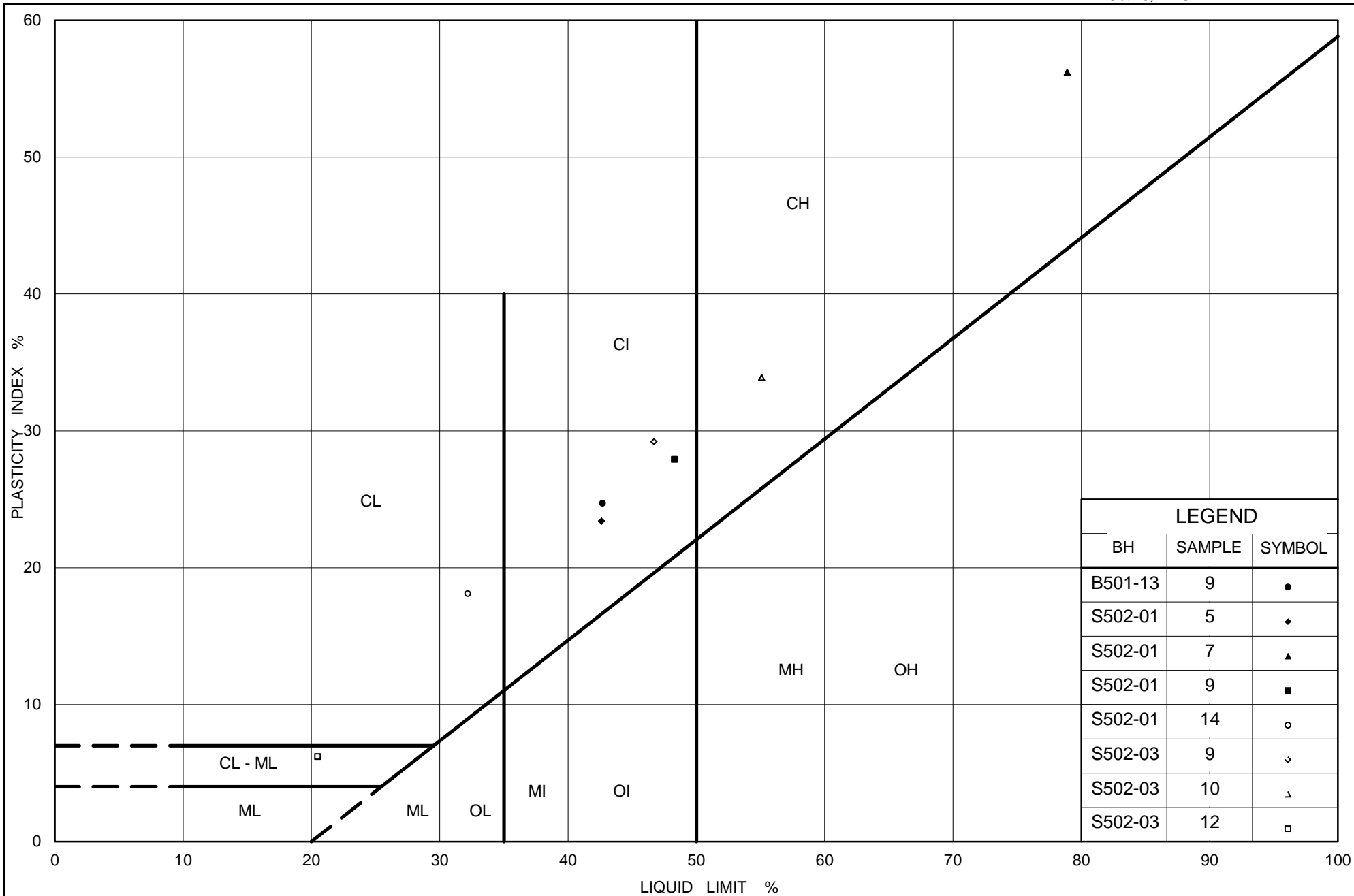
Ontario

# PLASTICITY CHART Clayey Silt to Clay

Figure No. B6B

Project No. 09-1111-6014

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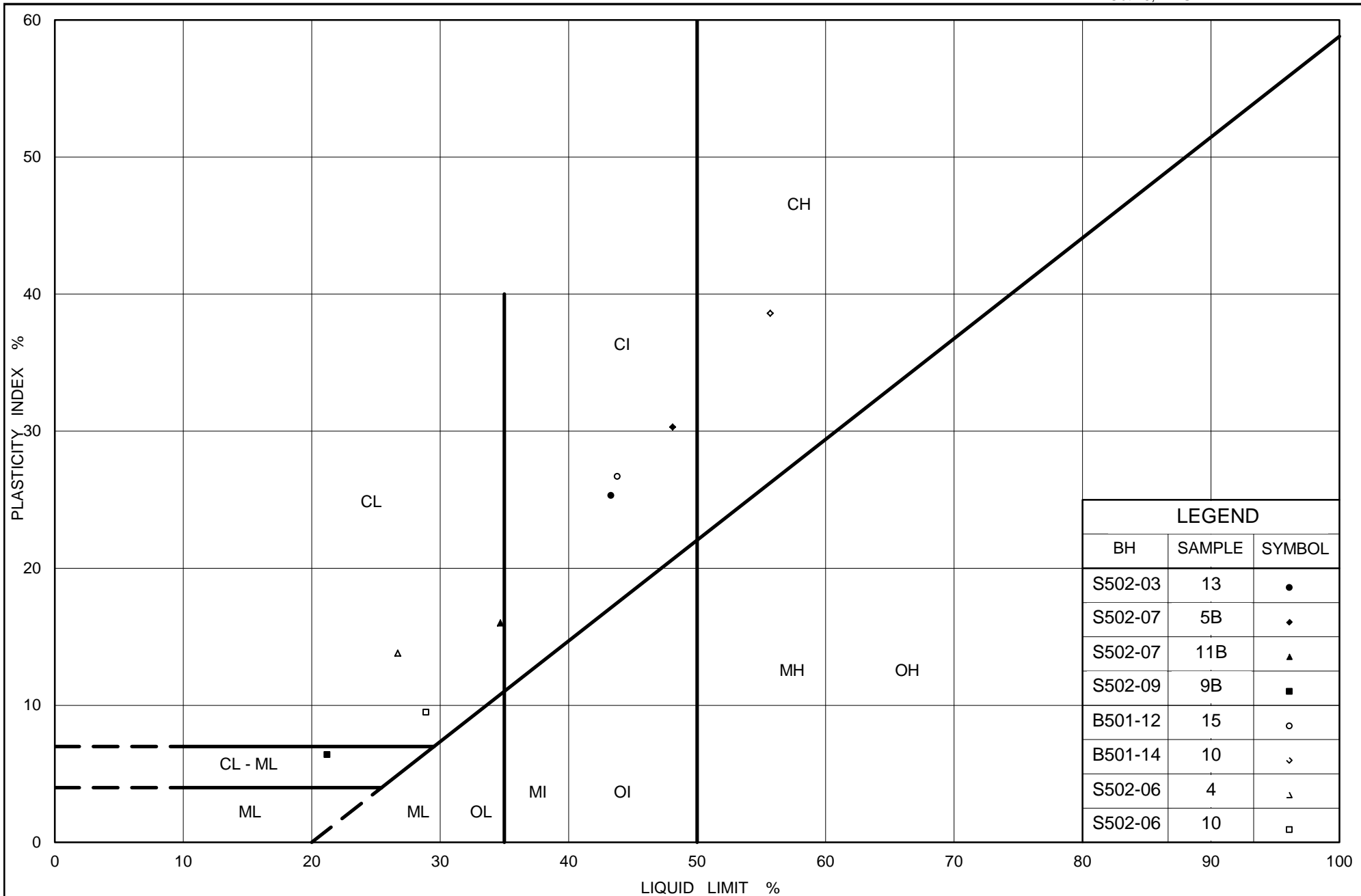
## PLASTICITY CHART

### Clayey Silt to Clay

Figure No. B6C

Project No. 09-1111-6014

Checked By: AB



Ministry of Transportation

Ontario

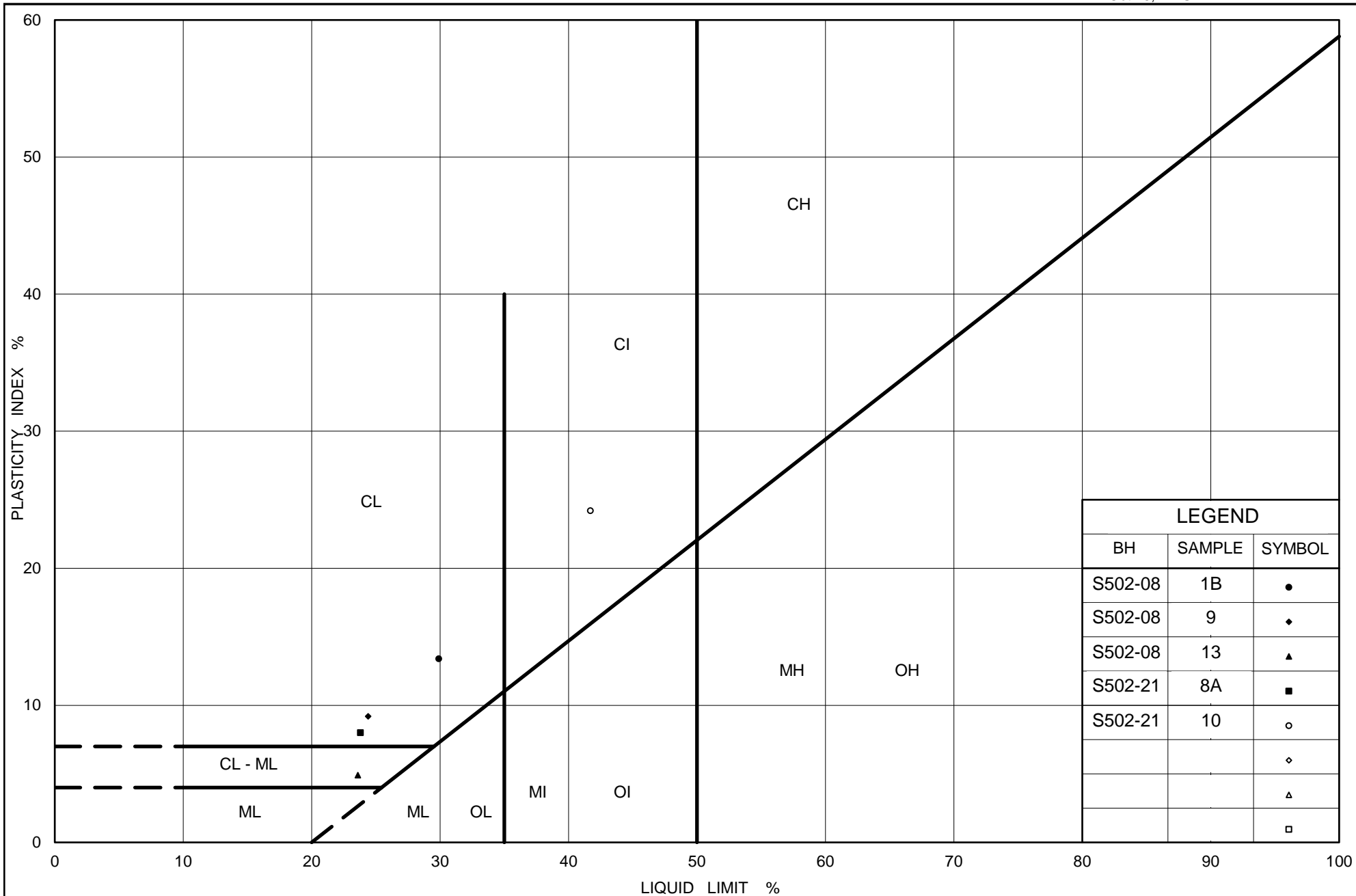
## PLASTICITY CHART

### Clayey Silt to Clay

Figure No. B6D

Project No. 09-1111-6014

Checked By: AB



Ministry of Transportation

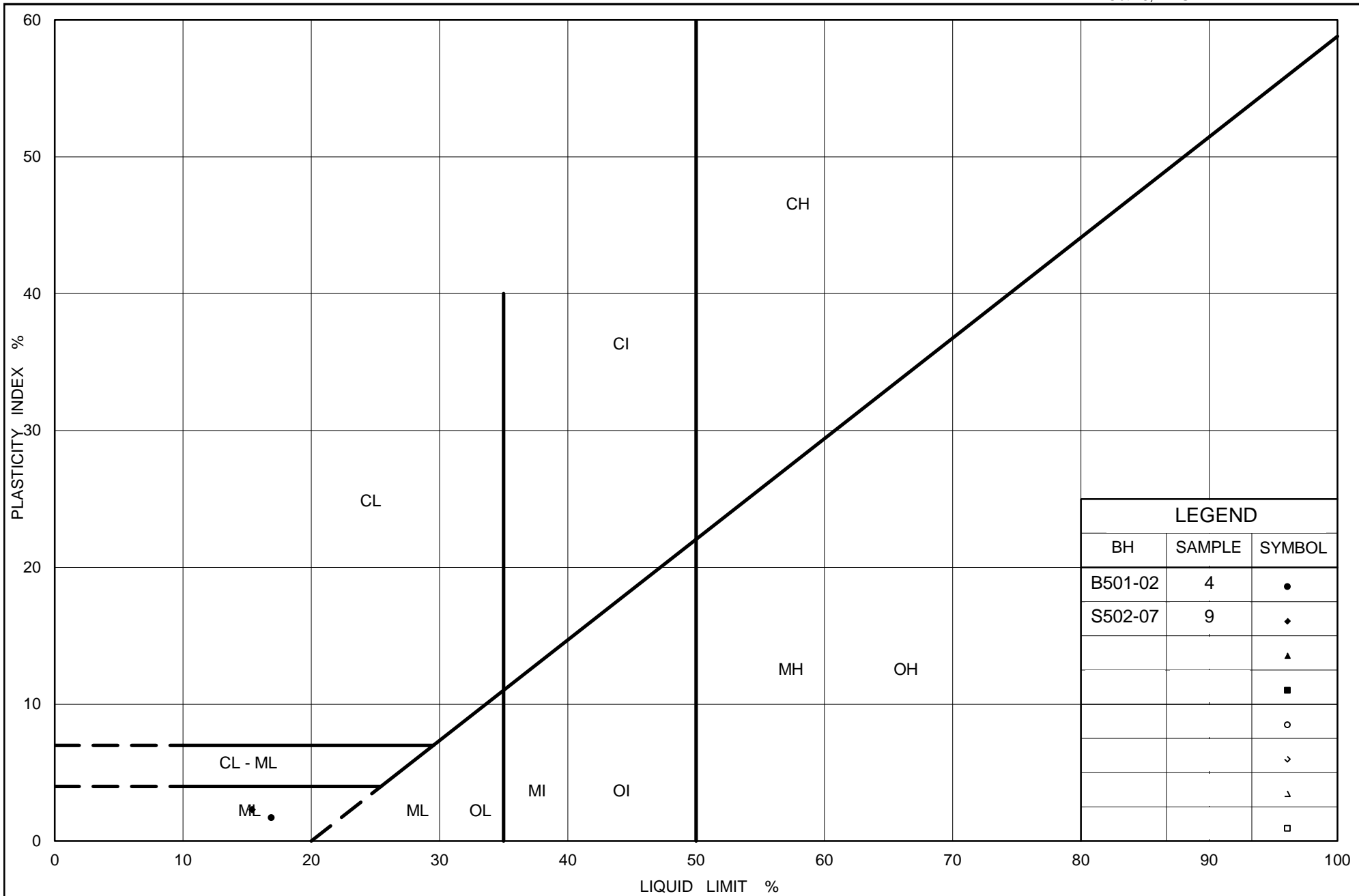
Ontario

# PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. B6E

Project No. 09-1111-6014

Checked By: AB



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## PLASTICITY CHART Silt (Lens)

Figure No. B6F

Project No. 09-1111-6014

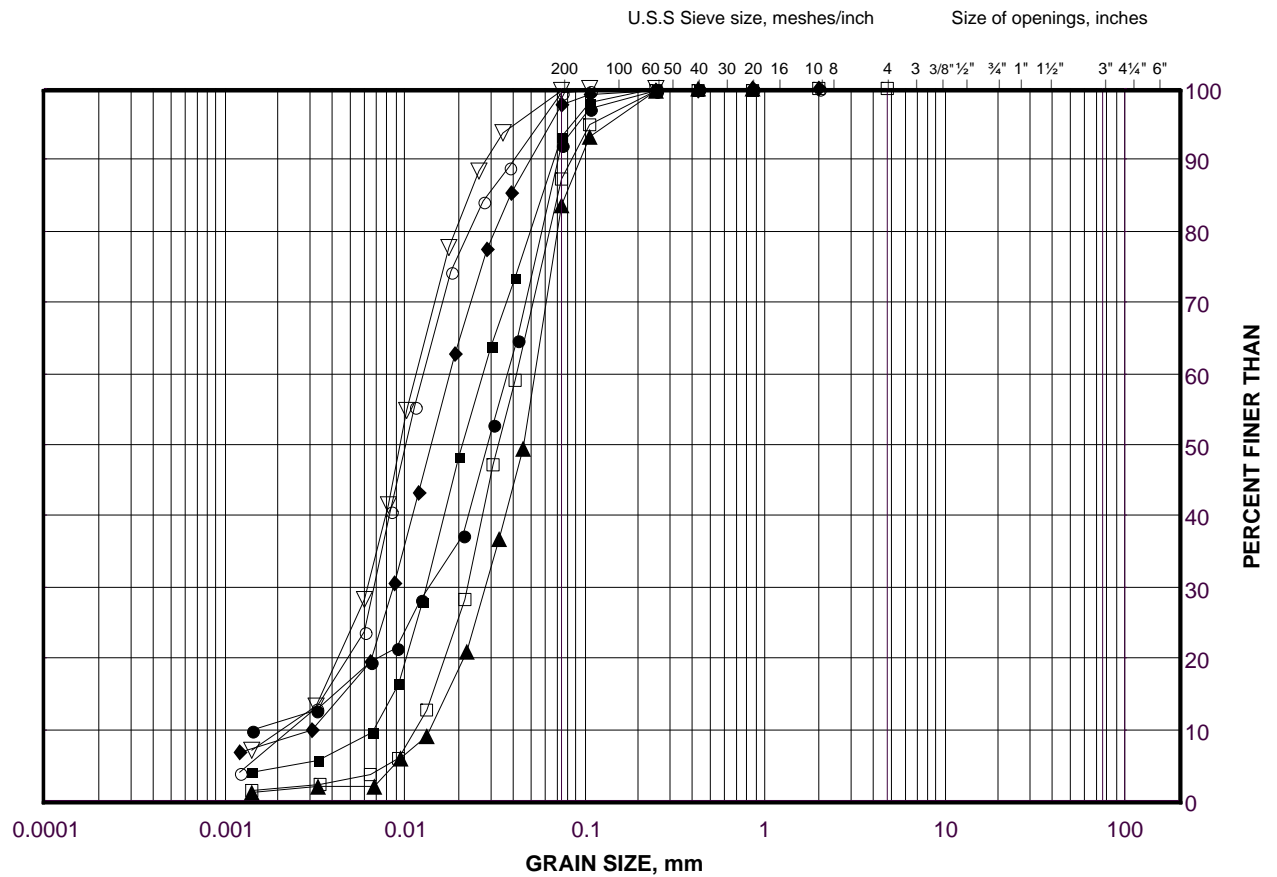
Checked By: AB



# GRAIN SIZE DISTRIBUTION

Silt (Lower)

FIGURE B7A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-05	10	176.7
■	B501-13	11	174.1
◆	B501-14	12	175.8
▲	S502-07	13	176.3
▽	B501-10	14	155.9
○	B501-01	14	155.9
□	B501-10	15	152.9

Project Number: 09-1111-6014

Checked By: AB

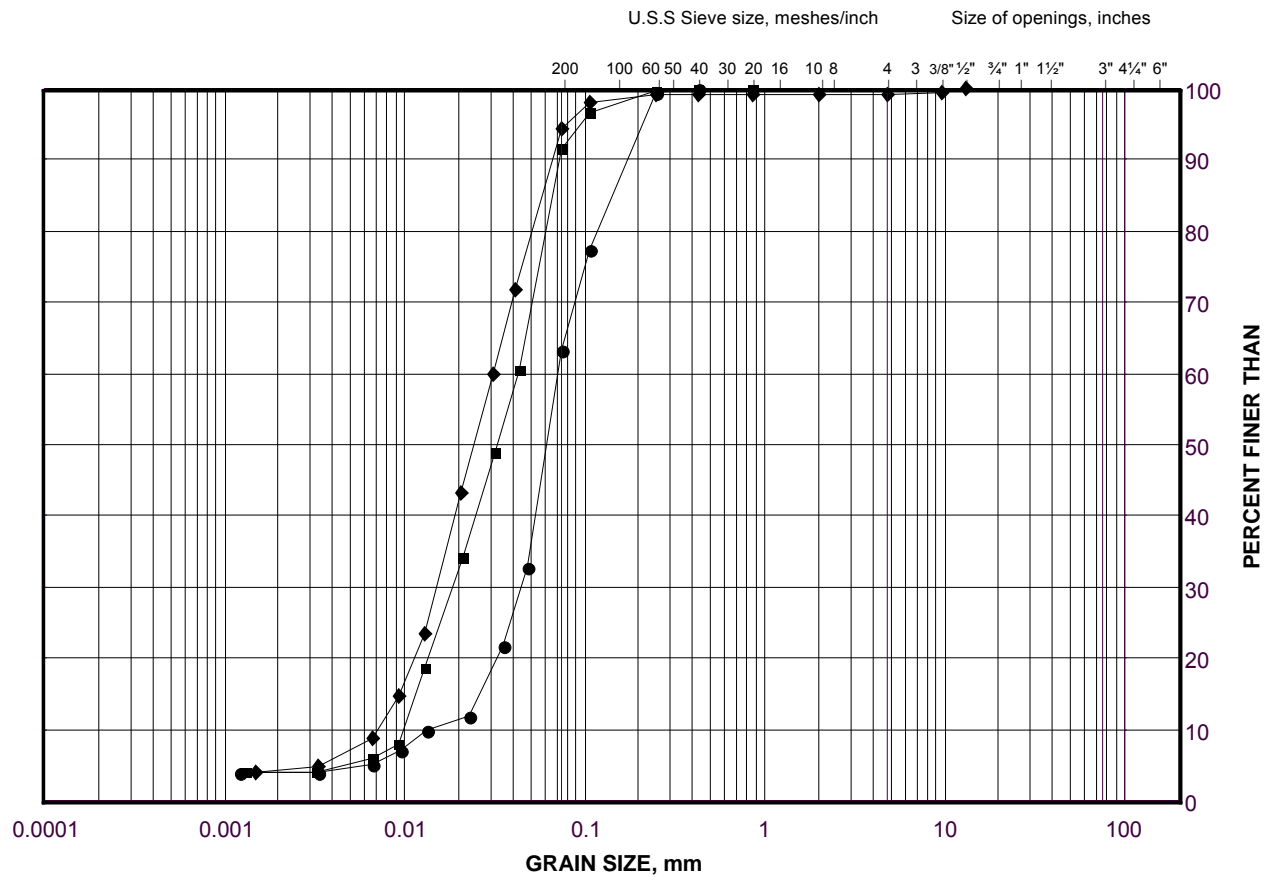
**Golder Associates**

Date: 16-Sep-15

# GRAIN SIZE DISTRIBUTION

Silt (Lower)

FIGURE B7B



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-09	10	181.5
■	S502-09	13	177.0
◆	B501-12	18	158.2

Project Number: 09-1111-6014

Checked By: AB

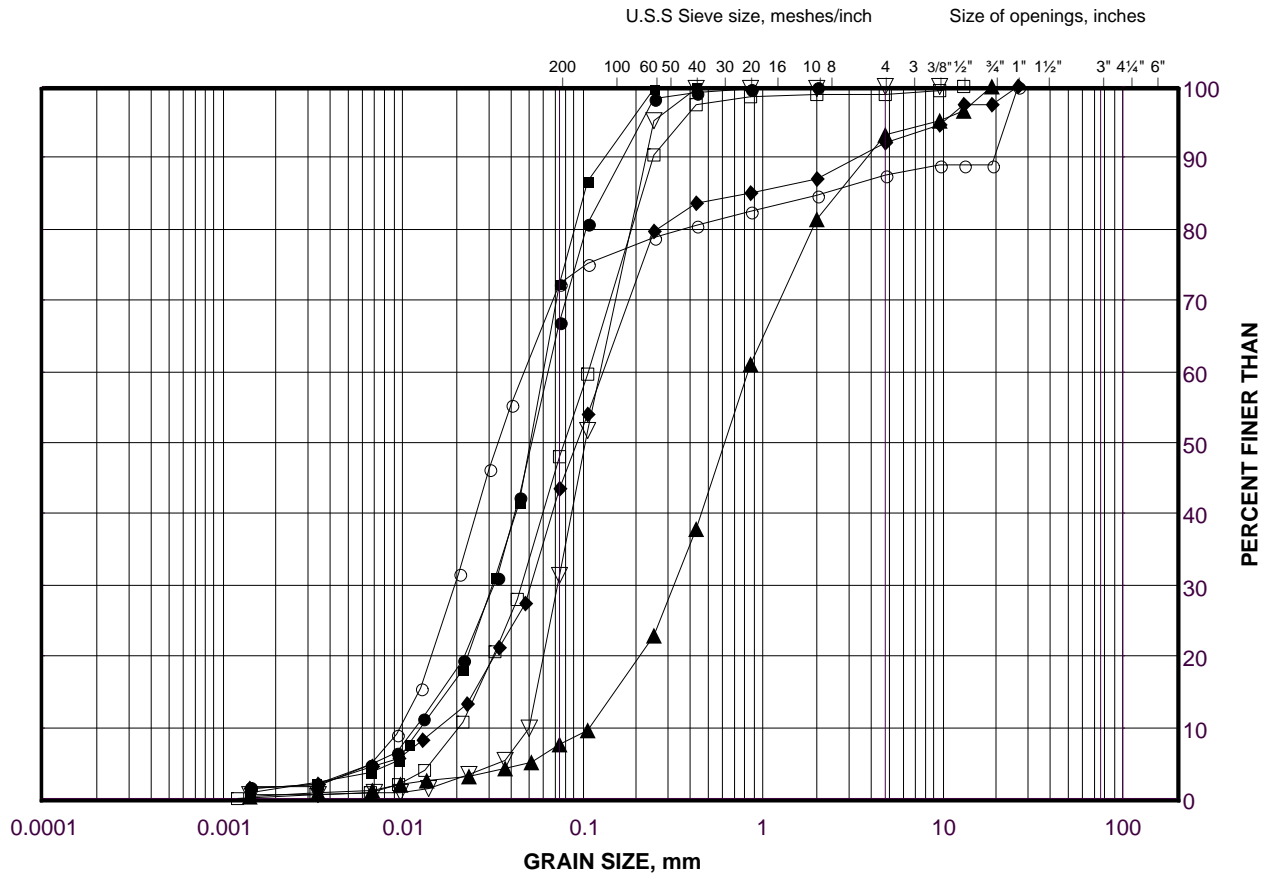
**Golder Associates**

Date: 25-Jan-16

# GRAIN SIZE DISTRIBUTION

Silt Some Sand to Sand (Lower)

FIGURE B8



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-05	12	173.6
■	B501-02	16	154.3
◆	B501-11	18	149.3
▲	B501-10	18	143.8
▽	B501-11	20	143.1
○	B501-02	21	141.9
□	B501-01	23	131.5

Project Number: 09-1111-6014

Checked By: AB

**Golder Associates**

Date: 16-Sep-15

### Borehole B501-01



Box 1: 49.30 m – 52.70 m

### Borehole B501-02

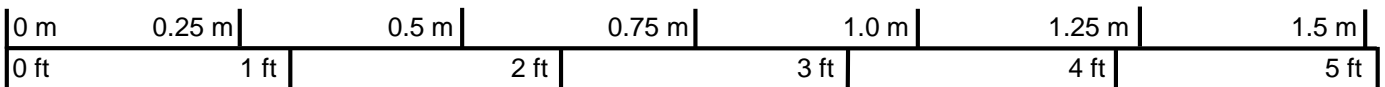


Box 1: 37.40 m – 40.60 m

### Borehole B501-05



Box 1: 2.51 m – 5.56 m



Scale

PROJECT					
Straight Lake SBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5146-08-01					
TITLE					
Bedrock Core Photographs Boreholes B501-01, B501-02 & B501-05					
PROJECT No. 09-1111-6014			FILE No. ----		
DESIGN	KP	SEP15	SCALE	NTS	REV.
CADD	--		FIGURE B9		
CHECK	AB	SEP 15			
REVIEW	JMAC	SEP 15			



## Borehole B501-06



Box 1: 3.66 m – 6.16 m

## Borehole B501-07A



Box 1: 5.33 m – 8.63 m


## Borehole B501-09



Box 1: 4.66 m – 7.77 m

0 m	0.25 m	0.5 m	0.75 m	1.0 m	1.25 m	1.5 m
0 ft	1 ft	2 ft	3 ft	4 ft	5 ft	

Scale

PROJECT		Straight Lake SBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5146-08-01			
TITLE		Bedrock Core Photographs Boreholes B501-06, B501-07A & B501-09			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	KP	SEP15	SCALE NTS
		CADD	--		REV.
		CHECK	AB	SEP 15	FIGURE B10
		REVIEW	JMAC	SEP 15	



### Borehole B501-10



Box 1: 51.60 m – 52.36 m

### Borehole B501-11



Box 1: 36.12 m – 39.79 m


### Borehole B501-12



Box 1: 27.43 m – 30.85 m

0 m	0.25 m	0.5 m	0.75 m	1.0 m	1.25 m	1.5 m
0 ft	1 ft	2 ft	3 ft	4 ft	5 ft	

Scale

PROJECT		Straight Lake SBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5146-08-01			
TITLE		Bedrock Core Photographs Boreholes B501-10, B501-11 & B501-12			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	KP	SEP15	SCALE NTS
		CADD	--		REV.
		CHECK	AB	SEP 15	FIGURE B11
		REVIEW	JMAC	SEP 15	

### Borehole B501-13



Box 1: 13.56 m – 16.80 m

### Borehole B501-15

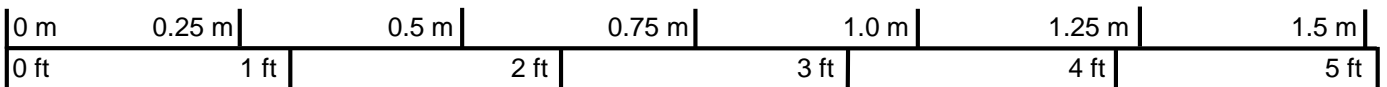


Box 1: 2.65 m – 5.82 m


### Borehole B501-18



Box 1: 9.75 m – 13.00 m



Scale

PROJECT		Straight Lake SBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5146-08-01			
TITLE		Bedrock Core Photographs Boreholes B501-13, B501-15 & B501-18			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	KP	SEP15	SCALE NTS
		CADD	--		REV.
		CHECK	AB	SEP 15	FIGURE B12
		REVIEW	JMAC	SEP 15	

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