



**March 12, 2015**

## **FOUNDATION INVESTIGATION REPORT**

**SHAWANAGA RIVER NBL BRIDGE STRUCTURE, SITE NO. 44-443/1  
HIGHWAY 69 FOUR-LANING FROM 1.0 KM NORTH OF THE NEW HIGHWAY  
559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF HIGHWAY 7182  
(SHEBESHEKONG ROAD) FOR 17 KM  
MINISTRY OF TRANSPORTATION, ONTARIO  
G.W.P. 5111-07-00; W.P. 5187-06-01 (Phase 2 of G.W.P. 5402-05-00)**

**Submitted to:**

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**REPORT**



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## Table of Contents

### **PART A – FOUNDATION INVESTIGATION REPORT**

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>2</b>
3.1 Foundation Investigation.....	2
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>4</b>
4.1 Regional Geology .....	4
4.2 Subsurface Conditions.....	4
4.3 South Abutment and Approach Area .....	5
4.3.1 Topsoil .....	5
4.3.2 Silty Sand.....	5
4.3.3 Bedrock.....	5
4.3.4 Rock Mapping .....	7
4.3.5 Groundwater Conditions .....	7
4.4 South Pier (Pier 3) .....	8
4.4.1 Topsoil .....	8
4.4.2 Cobbles/Rock Fragments and Bedrock .....	8
4.4.3 Groundwater Conditions .....	9
4.5 North Pier (Pier 4).....	9
4.5.1 Sand Fill .....	10
4.5.2 Rock Fill .....	10
4.5.3 Bedrock.....	10
4.5.4 Groundwater Conditions .....	11
4.6 North Abutment and Approach Embankment .....	11
4.6.1 Asphalt.....	12
4.6.2 Topsoil .....	12
4.6.3 Sand to Sand and Gravel Fill .....	12
4.6.4 Rock Fill .....	12
4.6.5 Sand to Sand and Silt .....	12



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

4.6.6	Clayey Silt.....	13
4.6.7	Silt.....	13
4.6.8	Cobbles and Boulders.....	13
4.6.9	Bedrock.....	13
4.6.10	Groundwater Conditions .....	15
<b>5.0</b>	<b>CLOSURE .....</b>	<b>15</b>

### DRAWINGS

Drawing 1	Site Location Plan
Drawing 2	Borehole Locations and Soil Strata
Drawing 3	Soil Strata

### APPENDICES

#### Appendix A Record of Boreholes, Drillholes and Field Test Pit Logs

List of Symbols and Abbreviations	
Lithological and Geotechnical Rock Description Terminology	
Field Test Pit Logs	B4-TP1 to B4-TP3
Record of Boreholes	B4-01 to B4-21
Record of Drillholes	B4-01 to B4-11, B4-15 and B4-18

#### Appendix B Laboratory Test Results

Table B1	Point Load Test Results on Rock Samples
Table B2-1	Summary of Unconfined Compression Test Results
Table B2-2	Unconfined Compression (UC) Test – Borehole B4-06, Run No. 2
Table B2-3	Unconfined Compression (UC) Test – Borehole B4-09, Run No. 2
Figure B1-1	Grain Size Distribution –Sand (Fill), North Pier (Pier 4)
Figure B1-2	Grain Size Distribution – Sand and Silt, North Abutment
Figure B1-3	Plasticity Chart – Clayey Silt, North Abutment

#### Appendix C Rock Mapping

Figures C1 to C5	Rock Mapping Figures and Photos
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# **PART A**

## **FOUNDATION INVESTIGATION REPORT**

**SHAWANAGA RIVER NBL BRIDGE STRUCTURE, SITE NO. 44-443/1**

**HIGHWAY 69 FOUR-LANING FROM 1.0 KM NORTH OF THE NEW  
HIGHWAY 559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF  
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**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5111-07-00; W.P. 5187-06-01**





## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin (MRC), a member of MMM Group Limited on behalf of Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the proposed three-span Shawanaga River Northbound Lanes (NBL) Bridge structure over the Shawanaga River (Site No. 44-443/1). The proposed work is part of the four-laning of Highway 69 from 1.0 km north of the new Highway 559 Interchange northerly to 1.5 km north of Highway 7182 (Shebeshekong Road), which involves high fill embankments and embankments over swamps, the New Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, as well as culvert crossings. The general location of this bridge structure along the new Highway 69 four-laning alignment is shown on Drawing 1.

The Terms of Reference and the Scope of Work for the foundation engineering services are outlined in MTO's Request for Proposal, dated July 2006. Golder's proposal for foundation engineering services associated with the Shawanaga River NBL Bridge is contained in Section 6.8 of MRC's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for this project, dated July 4, 2007. The General Arrangement (GA) Drawing for the proposed Shawanaga River NBL Bridge structure was provided to Golder by MRC on January 15, 2009.

This report addresses the investigation carried out for the Shawanaga River NBL Bridge and the associated approach embankments only. Separate reports address the foundation investigations for the swamp crossings, high fill areas associated with interchange ramps and roadways, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed structure, including the associated approach embankments, by borehole drilling, rock coring, test pitting and geological mapping of bedrock outcrops and laboratory testing on selected samples. The bridge structure centerline and the foundation units/limits for this investigation were located in the field prior to drilling by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The investigation area is shown in plan on Drawing 2.

## **2.0 SITE DESCRIPTION**

The proposed Shawanaga River NBL Bridge is located approximately 450 m north of the intersection of the existing Shebeshekong Road and Highway 69 and is approximately 20.5 km northwest of Nobel, Ontario. The proposed new Highway 69 alignment runs generally in a southeast-northwest direction on the west side of the existing Highway 69, which will become part of the future Shawanaga River Service Road (Site No. 9) in this area.

In general, the topography in the area of the overall project limits consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamps and rivers. The proposed bridge structure and associated approach embankments are to be situated on a bedrock outcrop on the south side of the Shawanaga River and on the side slope of the existing Highway 69 rock fill embankment on the north side of the river. On the south side of the river, the ground surface within the limits of the proposed structure ranges from about Elevation 212.9 m at the south approach embankment, to about Elevation 207.5 m at the south abutment and to as low as about Elevation 202.0 m at the south pier. On the north side, the ground surface ranges from about Elevation 201.0 m at the north pier to about Elevations 202 m to 205.4 m at the north abutment and about Elevations 200.0 m to 202.5 m at the north approach. All elevations are referenced to Geodetic datum.



## **3.0 INVESTIGATION PROCEDURES**

### **3.1 Foundation Investigation**

The field work for the Shawanaga River NBL Bridge subsurface investigation was carried out between February 6 and 9, 2009, between March 21 and 26, 2009, on April 2, 2009 and between July 20 and 26, 2009 during which time a total of twenty-one (21) boreholes and three (3) test pits were advanced: five (5) boreholes at the south abutment; five (5) boreholes at the south pier (Pier 3); four (4) boreholes and three (3) test pits at the north pier (Pier 4); five (5) boreholes at the north abutment; and one (1) borehole at each approach embankment. The boreholes, designated as Boreholes B4-01 to B4-21 and the test pits, designated as B4-TP1 to B4-TP3, were advanced at the locations shown in plan on Drawing 2.

The boreholes were drilled using a track-mounted Diedrich D-25 drill rig supplied and operated by Walker Drilling Co. Ltd. of Utopia, Ontario and portable equipment supplied and operated by OGS Inc. of Almonte, Ontario. The test pits were excavated using a 240 John Deere excavator operated by Weeks Construction Inc. of Parry Sound, Ontario. Hand excavation methods were used as appropriate depending on the terrain. The boreholes were advanced through the overburden using 165 mm O.D. solid-stem augers and/or 'BW' and 'NW' casing. Soil samples were obtained at intervals of depth of about 0.75 m using a 50 mm outside diameter (O.D.) split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the Soil). Boreholes advanced by portable equipment employed one-third ( $\frac{1}{3}$ ) weight hammers lifted manually. Chunk samples were obtained in five (5) boreholes at locations of thin overburden over bedrock outcrops. Samples of the bedrock were obtained using an 'NQ' or 'BQ' size rock core barrel.

The boreholes at the foundation elements were typically advanced to casing and/or sampler refusal (i.e. inferred bedrock) and bedrock was confirmed by coring in selected boreholes. The boreholes at the approaches were advanced to the bedrock surface / sampler refusal and extended into bedrock by coring at the north approach. The boreholes were drilled to depths of up to about 10.2 m below existing ground surface, including coring of bedrock for core lengths between about 3.0 m and 10.2 m in Boreholes B4-01 to B4-11, B4-15 and B4-18.

The test pits at the proposed north pier were excavated to bucket refusal to depths between 0.8 m to 2.1 m below existing ground surface and the bedrock surface was confirmed by exposure at the base of the test pits.

The groundwater conditions in the open boreholes and test pit excavations were observed during the drilling and on completion of test pitting operations and a total of four (4) piezometers were installed in Boreholes B4-01, B4-07, B4-15 and B4-18 to permit monitoring of the water level at these locations. The piezometers consist of 32 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the boreholes. The boreholes and annulus surrounding the piezometer pipe above the screen sand pack were backfilled to the surface with bentonite pellets/grout. Piezometer installation details and water level readings are described on the Record of Borehole sheets presented in Appendix A. All boreholes in which standpipe piezometers were not installed were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended). The test pit excavations were backfilled with the excavated soil which was nominally compacted by the backhoe bucket and the ground surface was graded to the surrounding ground surface.

The field work was observed by members of our engineering and technical staff who located the boreholes and test pits, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes and test pits, 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



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. Strength tests such as unconfined compression and point load index, were carried out on specimen of the rock core. The results of the laboratory testing are included in Appendix B.

The as-drilled borehole and test pits locations and ground surface elevations were surveyed by a member of our technical staff, referenced to the survey stakes put down by Callon Dietz. The borehole / test pit locations given in the Record of Borehole/Drillhole sheets and Field Test Pit Logs and shown on Drawings 2 and 3 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum and are summarized below.

Borehole / Test Pit	Location (MTM Nad 83)		Ground Surface Elevation (m)	Depth Drilled / Excavated (m)
	Northing	Easting		
B4-TP1	5045843.4	243508.3	199.3	1.1
B4-TP2	5045846.6	243510.3	199.6	2.1
B4-TP3	5045847.0	243506.5	201.4	0.8
B4-01	5045857.8	243498.8	203.5	6.0
B4-02	5045853.5	243493.5	201.7	4.3
B4-03	5045856.8	243490.0	201.2	5.3
B4-04	5045871.6	243474.4	200.2	3.8
B4-05	5045846.6	243510.3	201.8	6.0
B4-06	5045847.0	243506.5	201.5	5.5
B4-07	5045850.8	243512.1	202.4	6.9
B4-08	5045846.8	243514.4	201.8	8.1
B4-09	5045866.1	243505.4	205.3	7.0
B4-10	5045860.9	243510.8	205.5	6.2
B4-11	5045815.2	243536.2	207.6	10.2
B4-12	5045818.8	243534.4	204.5	0.0
B4-13	5045818.8	243539.1	205.0	0.1
B4-14	5045819.1	243544.2	202.3	0.2
B4-15	5045823.7	243541.0	202.0	6.5
B4-16	5045802.5	243546.3	208.3	1.1



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Borehole / Test Pit	Location (MTM Nad 83)		Ground Surface Elevation (m)	Depth Drilled / Excavated (m)
	Northing	Easting		
B4-17	5045805.3	243543.4	207.5	0.3
B4-18	5045807.7	243550.6	207.2	6.4
B4-19	5045809.0	243559.7	208.2	0.1
B4-20	5045811.8	243556.8	206.5	0.1
B4-21	5045793.8	243565.0	212.9	0.1

Additional field work was completed on August 26, 2009 for geological mapping of the bedrock outcrops to supplement the foundation investigation for the Shawanaga River NBL Bridge structure. The location of rock mapping is shown in plan on Figure C1 found in Appendix C.

## 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 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 very shallow deposits of sand, silt and clay underlain by metamorphic bedrock; numerous bare knobs and ridges of bedrock are present throughout the area. Localized low lying swampy areas, containing peat and/or organic soils underlain by soft/loose native soils, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of 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>. Deposition of Palaeozoic strata initially covered, and later erosion during glaciation subsequently exposed, these Precambrian rocks.

### 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and test pits advanced for this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock

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

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



core samples, are presented in the record of Boreholes sheets provided in Appendix A. The results of the laboratory tests are also provided in Appendix B. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4.3 to 4.6 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawings 2 and 3 is a simplification of the subsurface conditions.

In general, the subsurface conditions in the area of the of the south abutment and south pier consist of bedrock outcrops and surficial layers of topsoil over bedrock, while the areas of the north abutment and north pier consist of sand fill and rock fill over bedrock.

A detailed description of the subsurface conditions encountered in the boreholes and test pits advanced at the abutments, piers and approach areas is provided in the following sections.

### **4.3 South Abutment and Approach Area**

A total of five (5) boreholes (Boreholes B4-16 to B4-20) were advanced at the location of the south abutment and one (1) borehole (Borehole B4-21) was advanced on the centerline at the south approach. In general, the subsurface conditions consist of topsoil, underlain by silty sand at some locations over bedrock.

#### **4.3.1 Topsoil**

Up to about 0.1 m of topsoil was encountered at the ground surface at all borehole locations.

#### **4.3.2 Silty Sand**

A deposit of silty sand containing trace to some gravel, trace to some clay, rootlets and rock fragments was encountered below the topsoil in Boreholes B4-16 and B4-17. The top of this deposit was encountered at about Elevations 208.2 m and 207.4 m and its thickness is about 1.0 m and 0.2 m at the respective boreholes.

The Standard Penetration Test (SPT) 'N'-values measured within this deposit range from about 1 blow to 23 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on two (2) samples of this deposit is about 14 percent and 64 percent with the higher water content value indicating the presence of organics.

#### **4.3.3 Bedrock**

Bedrock was encountered and core samples were recovered below the topsoil in Borehole B4-18. The presence of bedrock was inferred by refusal to split-spoon advancement in Boreholes B4-16 and B4-17 and by exposure in hand excavations at B4-19 to B4-21.

The depth to bedrock below ground surface and corresponding bedrock surface elevation is summarized below.



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Foundation Element / Approach Area	Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Refusal Type
South Approach	B4-21	0.1	212.8	Hand Shovel
South Abutment	B4-16	1.1	207.2	Split-Spoon
	B4-17	0.3	207.2	Split-Spoon
	B4-18	0.1	207.1	Bedrock Cored
	B4-19	0.1	208.1	Hand Shovel
	B4-20	0.1	206.4	Hand Shovel

Across the east edge of the south abutment footprint (a distance of approximately 4.0 m between borehole locations), the bedrock surface elevation varies by about 1.7 m corresponding to an approximately 2.4H:1V slope or a dip of approximately 23° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered, coarse grained, highly foliated, slightly to moderately porous, dark to light grey and containing quartz veins. The Rock Quality Designation (RQD) measured on the core samples is between 83 percent to 100 percent, indicating a rock mass of good to excellent quality, according to Table 3.10 in CFEM (2006)<sup>3</sup>. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples are 100 percent and between 58 percent and 100 percent, respectively.

Point load strength tests were performed on selected samples of the rock core. The diametral point load strength index values are shown on the Record of Drillhole sheets in Appendix A and are presented in Table B1 in Appendix B. The diametral tests carried out on four (4) core samples of the granite gneiss bedrock from this location measured  $Is_{50}$  values ranging from about 1.1 MPa to 4.9 MPa.

Also presented in Table B1 are the estimated Unconfined Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS which is given by a correlation factor (K) in accordance with ASTM D5731 Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification, which may vary depending on the size of the core sample and the strength of the rock. For this site, the UCS values are based on an estimated average correlation factor (K) of 11, which was calculated based on a comparison of the two UC test results and the average of nine (9) of the corresponding point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UCS tests.

Based on the point load testing results, according to Table 3.5 in CFEM (2006)<sup>3</sup> the granite gneiss bedrock at this location is classified as weak (R2, 5 MPa < UCS < 25 MPa) to medium strong (R3, 25 MPa < UCS < 50 MPa) at this location but is noted to be classified as strong (R4, 50 MPa < UCS < 100 MPa) in immediately adjacent areas.

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





#### **4.3.4 Rock Mapping**

Geological mapping of the bedrock outcrops within the vicinity of the existing south approach and abutment was carried out to collect information on the geological conditions of the general area of the south abutment of the Shawanaga River NBL Bridge structure and the Service Road (Site No. 9) bridge structure. The data collected includes estimates of rock strength, fracture characteristics and orientation, and groundwater conditions, which, combined with the geotechnical borehole investigation described in Section 4.3.3, addresses specific rock foundations engineering considerations.

The inspected areas are shown on Figure C1, in Appendix C. The data mapped from the rock outcrops is shown in stereonet format on Figure C2, in Appendix C. Joint condition data is presented below and refers to major joint sets defined on Figure C2.

<b>Joint Set</b>	<b>Spacing (m)*</b>	<b>Surface condition</b>
J1	0.2-3 (2.0)	Planar to Undulating, Slightly Rough to Rough
J2	0.5-2 (1.5)	Planar to Undulating, Smooth to Slightly Rough
J3	0.4-1.5 (1)	Planar to Undulating, Smooth to Slightly Rough

\*Average spacing values given in parentheses.

Based on the site mapping (observations), the bedrock outcrops are described as consisting of dark orangeish to reddish grey, slightly weathered, coarse-grained, non-porous, strong to very strong igneous intrusive (granite). The bedrock is faintly foliated parallel to the J2 set and weathering on joint surfaces comprises of orange iron oxide staining or slight alteration. The rock mass mapped was drained above the water line of the adjacent Shawanaga River.

In general the bedrock exhibits strong rock characteristics. The stability of the rock cut slopes (faces) excavated for the bridge abutment will be controlled by the orientation, spacing and persistency of the discontinuities that exist within the rock mass.

The south abutment area bedrock mapping indicates two sub-vertical sets (J1 and J2) and a moderately dipping set J3, as shown on Figure C2. These joints appear to be moderately to widely spaced (0.5 m to greater than 1 m). For a cut face excavated with a strike angle of 245°, the outcrop data presented on Figure C2 suggests that the cut slope will be kinematically favourable with respect to wedge, planar and toppling failure. Should the cut face be oriented to align with the J3 set, there would be increased potential for planar failure along a joint surface with that orientation.

Based on the above observations, pre-supporting the rock face with dowels does not appear necessary for the possible cut orientation shown on Figure C2. Once excavated, the cut face and bench surface should be inspected by the geotechnical engineer to verify rock conditions.

#### **4.3.5 Groundwater Conditions**

A standpipe piezometer was installed in Borehole B4-18 to allow monitoring of the groundwater level at this location. Details of the piezometer installations are shown on the Record of Borehole and Drillhole sheets in Appendix A. In general, the overburden samples taken in the boreholes advanced in this area were moist. The groundwater levels measured in the piezometer installation are summarized below.



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
South Abutment	B4-18	207.2	203.3 202.5	July 28, 2009 August 26, 2009

It should be noted that the groundwater level in the area is subject to seasonal fluctuations due to snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during parts of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

### 4.4 South Pier (Pier 3)

A total of five (5) boreholes (Borehole B4-11 to B4-15) were advanced at the location of proposed south pier (Pier 3). In general, the subsurface conditions consist of bedrock (exposed at ground surface) or topsoil over bedrock.

#### 4.4.1 Topsoil

A layer of topsoil up to about 0.2 m thick was encountered at the ground surface in Boreholes B4-13 and B4-14.

#### 4.4.2 Cobbles/Rock Fragments and Bedrock

An approximately 0.5 m thick layer of cobbles/rock fragments was encountered at ground surface in Borehole B4-15. In general, the size of the recovered cobbles/rock fragments ranges from about 38 mm to 102 mm.

Bedrock was encountered and core samples were recovered in Boreholes B4-11 and B4-15, and bedrock was also observed to outcrop at Borehole B4-12. At Boreholes B4-13 and B4-14, the bedrock surface was identified upon being exposed by shovel excavation.

The depth to bedrock below ground surface and corresponding bedrock surface elevation is summarized below.

Foundation Element	Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Refusal Type
South Pier (Pier 3)	B4-11	0.0	207.6	Bedrock Cored
	B4-12	0.0	204.5	Bedrock Outcrop
	B4-13	0.1	204.9	Hand Shovel
	B4-14	0.2	202.1	Hand Shovel
	B4-15	0.5	201.5	Bedrock Cored

Across the south pier from the southwest corner to the northeast corner of the pier footprint (a distance of approximately 9.5 m between borehole locations), the bedrock surface elevation varies by about 6.1 m corresponding to an approximately 1.6H:1V slope or a dip angle of approximately 32° from the horizontal.



Based on the bedrock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered, coarse grained, highly foliated, slightly to moderately porous, dark to light grey. The Rock Quality Designation (RQD) measured on the cores samples is between 65 percent to 100 percent, indicating a rock mass of fair to excellent quality, according to Table 3.10 in CFEM (2006)<sup>3</sup>, except for the near-surface core sample in Borehole B4-15 where a RQD of 45 percent was recorded, indicating a rock mass of poor quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of core samples are 100 percent and between 33 percent and 100 percent, respectively.

Point load strength tests were performed on selected samples of the rock core. The diametral point load strength index values are shown on the Record of Drillhole sheets in Appendix A and are presented in Table B1 in Appendix B. The diametral tests carried out on nine (9) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 2.9 MPa to 8.8 MPa.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and an estimated average correlation factor (K) of 11, which was calculated based on a comparison of the two UC test results and the average of nine (9) of the corresponding point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UCS test.

Based on the point load testing results, according to Table 3.5 in CFEM (2006)<sup>3</sup> the granite gneiss bedrock at this location is classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to strong (R4, 50 MPa < UCS < 100 MPa).

#### 4.4.3 Groundwater Conditions

A standpipe piezometer was installed in Borehole B4-15 to allow monitoring of the groundwater level at the site. Details of the piezometer installation are shown on the Record of Borehole and Drillhole sheets in Appendix A. In general the overburden samples taken in the boreholes advanced in this area were moist. The groundwater levels measured in the piezometer installation are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
South Pier (Pier 3)	B4-15	202.0	202.6* 201.7	July 28, 2009 August 26, 2009

\*Water level above ground surface due to heavy rain.

It should be noted that groundwater level in the area is subject to seasonal fluctuations, snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during parts of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

#### 4.5 North Pier (Pier 4)

A total of four (4) boreholes (Boreholes B4-05 to B4-08) were drilled and a total of three (3) test pits (Test Pits B4-TP1 to B4-TP3) were excavated at the location of the proposed north pier (Pier 4). In general, the subsurface conditions consist of sand fill and rock fill over bedrock.



#### **4.5.1 Sand Fill**

A deposit of fill comprised of sand containing some gravel, trace to some silt, trace clay and occasional cobbles was encountered at the ground surface in all borehole at this location. The top of the sand fill varies between about Elevations 202.4 m and 201.5 m and the thickness ranges from about 1.1 m to 2.2 m. A 0.1 m thick layer of sand and gravel fill containing some silt, organics and wood fragments was encountered in Borehole B4-06 immediately over the bedrock surface.

The SPT 'N'-values measured within the fill deposit range from 5 blows to 20 blows per 0.3 m of penetration, indicating a loose to compact relative density. A SPT 'N'-value of 23 blows per 0.2 m of penetration was recorded in Borehole B4-08 immediately above the rock fill deposit.

The natural water content measured on samples of this fill deposit ranges from about 5 percent to 12 percent.

A grain size distribution of a sample from this deposit is shown on Figure B1-1 in Appendix B.

#### **4.5.2 Rock Fill**

Rock fill containing sand, topsoil and rootlets was encountered at the ground surface in Test Pits B4-TP1 to B4-TP3 and below the sand fill in all boreholes except at Borehole B4-06. The top of the rock fill deposit varies between about Elevations 201.4 m and 199.3 m and the thickness of the deposit ranges from about 0.4 m to 2.1 m.

#### **4.5.3 Bedrock**

Bedrock was encountered below the rock fill or the sand to sand and gravel fill and core samples were recovered at all borehole locations. The bedrock surface was exposed in all test pits locations.

The depth to bedrock below ground surface and corresponding bedrock surface elevation is summarized below.

<b>Foundation Element</b>	<b>Borehole / Test Pit No.</b>	<b>Depth to Bedrock Surface (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Refusal Type</b>
North Pier (Pier 4)	B4-05	2.6	199.2	Bedrock Cored
	B4-06	1.9	199.6	Bedrock Cored
	B4-07	2.5	199.9	Bedrock Cored
	B4-08	3.1	198.7	Bedrock Cored
	B4-TP1	1.1	198.2	Bucket Refusal
	B4-TP2	2.1	197.5	Bucket Refusal
	B4-TP3	0.8	200.6	Bucket Refusal

Across the north pier from about the centre of the pier to the northwest corner of the pier footprint (a distance of approximately 4 m between test pit locations) the bedrock surface elevation varies by about 3.1 m corresponding to an approximately 1.3H:1V slope or a dip angle of approximately 38° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered to fresh, fine to medium grained with feldspar banding, highly foliated, black, pink and grey colour. The Rock Quality Designation (RQD) measured on the core samples are typically between 30 percent and 80 percent, indicating a rock mass of poor to good quality according to Table 3.10 in



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

CFEM (2006)<sup>3</sup>. RQD values between 0 percent and 13 percent were measured on the cores samples from near the bedrock surface, indicating an upper rock mass of poor quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are typically between 74 percent and 100 percent and 11 percent and 80 percent, respectively.

Point load strength tests were performed on selected samples of the rock core. The diametral point load strength index values are shown on the Record of Drillhole sheets in Appendix A and are presented in Table B1 in Appendix B. The diametral tests carried out on six (6) samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 6.9 MPa to 11.1 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7102 Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens on a selected core sample of granite gneiss bedrock from Borehole B4-06 and measured a compressive strength of about 78 MPa, as summarized in Table B2-1 and detailed in Table B2-2 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and an estimated average correlation factor (K) of 11, which was calculated based on a comparison of the two UC test results and the average of nine (9) of the corresponding point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UCS test.

Based on the laboratory UC test and the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup> the granite gneiss bedrock at this location is classified as strong ( $R4$ ,  $50 \text{ MPa} < \text{UCS} < 100 \text{ MPa}$ ) to very strong ( $R5$ ,  $100 \text{ MPa} < \text{UCS} < 250 \text{ MPa}$ ).

### 4.5.4 Groundwater Conditions

A standpipe piezometer was installed in Borehole B4-07 to allow monitoring the groundwater level at the site. Details of the piezometer installation are shown on the Record of the Borehole and Drillhole sheets in Appendix A. In general the overburden samples taken in the boreholes advanced in this area were moist. The groundwater levels measured in the piezometer installation are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Pier (Pier 4)	B4-07	202.4	199.2	March 26, 2009
			199.2	April 16, 2009
			198.5	August 26, 2009

It should be noted that groundwater level in the area is subject to seasonal fluctuations, snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during parts of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

### 4.6 North Abutment and Approach Embankment

A total of five (5) boreholes (Boreholes B4-01 to B4-03, B4-09 and B4-10) were advanced at the location of the proposed north abutment and one (1) borehole (Borehole B4-04) was advanced on the west side of the north



approach. In general, the subsurface conditions consist of sand fill and rock fill underlain in places by layers of sand to sand and silt or clayey silt to silt, over bedrock.

#### **4.6.1 Asphalt**

An approximately 0.2 m thick layer of asphalt was encountered at the ground surface in Boreholes B4-09 and B4-10.

#### **4.6.2 Topsoil**

An approximately 0.1 m thick layer of topsoil was encountered at the ground surface in Borehole B4-03.

#### **4.6.3 Sand to Sand and Gravel Fill**

A deposit of fill comprised of sand containing trace gravel, trace silt, cobbles, boulders and organics to sand and gravel containing trace silt, organics and wood fragments was encountered at the ground surface in Borehole B4-01 and underlying the asphalt layer in Boreholes B4-09 and B4-10. The top of this fill deposit varies between about Elevations 205.3 m and 203.5 m and the thickness of this deposit ranges from about 0.7 m to 2.1 m.

A 0.5 m thick deposit of fill comprised of silt, some sand, trace to some clay, containing organics was encountered in Borehole B4-04 at ground surface.

The SPT 'N'-values measured within the sand to sand and gravel fill typically range from 20 blows to 98 blows per 0.3 m of penetration indicating a compact to very dense relative density. The higher blow counts measured are attributed to the presence of cobbles or boulders. A SPT 'N'-value of 5 blows per 0.3 m of penetration was recorded with the silt fill, indicating a loose relative density.

The natural water content measured on samples of the sand fill ranges from about 4 percent to 15 percent while the natural water content of about 22 percent was measured on a sample of the silt fill.

#### **4.6.4 Rock Fill**

Rock fill was encountered underlying the sand fill deposit in Borehole B4-01. The top of rock fill deposit was encountered at about Elevation 202.8 m and its thickness is about 2.0 m.

#### **4.6.5 Sand to Sand and Silt**

A cohesionless deposit comprised of sand containing trace gravel, organics and rootlets to sand and silt containing trace to some gravel and trace clay was encountered at the ground surface and below the sand and gravel fill in Boreholes B4-02 and B4-09, respectively. The top of this deposit was encountered at about Elevations 201.7 m and 203.0 m and its thickness is about 0.7 m and 0.6 m in the respective boreholes.

Two (2) SPT 'N'-values measured within this deposit are 4 blows and 5 blows per 0.3 m of penetration, indicating a loose relative density.





The natural water contents measured on two (2) samples within the sand and silt to sand deposit are about 16 percent and 21 percent.

The grain size distribution of a sample of this deposit is shown on Figure B1-2 in Appendix B.

#### **4.6.6 Clayey Silt**

A cohesive stratum comprised of clayey silt containing trace sand, organics and rootlets was encountered underlying the topsoil in Borehole B4-03. The top of the clayey silt stratum is at about Elevation 201.1 m and its thickness is about 0.6 m.

An SPT 'N'–value measured within clayey silt stratum is 4 blows per 0.3 m of penetration, suggesting a soft to firm consistency.

The natural water content and organic content measured on a sample of clayey silt is about 30 percent and 4 percent, respectively.

An Atterberg limits test was carried out on a sample of the clayey silt and yielded liquid and plastic limit of about 24 percent and 18 percent, respectively, corresponding a plasticity index of about 6 percent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B1-3 in Appendix B and indicates that this material is a clayey silt of low plasticity.

#### **4.6.7 Silt**

A 0.7 m thick deposit of silt, trace sand and trace clay was encountered underlying the cohesive layer in Borehole B4-03, at about Elevation 200.5 m.

An SPT 'N'–value measured within the silt deposit is 26 blows per 0.3 m of penetration, indicating a compact relative density.

#### **4.6.8 Cobbles and Boulders**

A deposit of cobbles and boulders was encountered below the silt deposit in Borehole B4-03. The cobbles and boulders were encountered at about Elevation 199.8 m and the deposit is about 0.9 m thick.

#### **4.6.9 Bedrock**

Bedrock was encountered and core samples were recovered all boreholes at this location. The depth to the bedrock surface from the ground surface and the corresponding bedrock elevation is summarized below.



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Foundation Element / Approach Embankment	Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Refusal Type
North Abutment	B4-01	2.7	200.8	Bedrock Cored
	B4-02	0.7	201.0	Bedrock Cored
	B4-03	2.3	198.9	Bedrock Cored
	B4-09	2.9	202.4	Bedrock Cored
	B4-10	2.3	203.2	Bedrock Cored
North Approach Embankment	B4-04	0.5	199.7	Bedrock Cored

Across the north abutment from the northwest corner to the southwest corner of the abutment footprint (a distance of approximately 4.7 m between borehole locations) the bedrock surface varies in elevation by about 2.1 m corresponding to an approximately 2.2H:1V slope or a dip angle of about approximately 24° from the horizontal.

Based on the cored samples of bedrock, the bedrock consists of granite gneiss bedrock. In general, the bedrock samples are described as fresh to slightly weathered, fine to medium grained with feldspar banding, faintly to moderately porous, weakly to moderately foliated, black, pink and grey colour. In general, the Rock Quality Designation (RQD) measured on the core samples ranges between about 54 percent and 100 percent, with values typically increasing with depth, indicating a rock mass of fair quality to excellent quality, according to Table 3.10 in CFEM (2006)<sup>3</sup>. RQD values ranging between about 0 percent and 39 percent were encountered on the upper portions of the bedrock in some boreholes, indicating an upper rock mass of very poor to poor quality at some locations. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples are typically between about 75 percent and 100 percent and 30 percent and 100 percent, respectively. TCR and SCR values ranging between 40 percent and 58 percent and between 0 percent and 17 percent, respectively, were measured on some of the cored samples generally corresponding to the zones of lower RQD.

Point load strength tests were performed on selected sample of the rock core. The axial and diametral point load strength index values are shown on the Record of the Drillhole sheets in Appendix A and in Table B1 in Appendix B. The axial point load index ( $Is_{50}$ ) results from the laboratory tests carried out on three (3) core samples of the granite gneiss bedrock range from approximately 10.3 MPa to 10.8 MPa. The diametral tests carried out on fifteen (15) core samples of granite gneiss bedrock measured  $Is_{50}$  values ranging from about 4.6 MPa to 8.6 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7102 Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens, on a selected core sample of the granite gneiss bedrock from Borehole B4-09 and measured a compressive strength of about 86 MPa, as summarized in Table B2-1 and detailed in Table B2-3 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and an estimated average correlation factor (K) of 11, which was calculated based on a comparison of the two UC test results and the average of nine (9) of the corresponding point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UCS test.



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Based on the laboratory UC test and the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup> the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

### 4.6.10 Groundwater Conditions

A standpipe piezometer was installed in Borehole B4-01 to allow monitoring of the groundwater level at the site. Details of the piezometer installations are shown the Record of Borehole and Drillhole sheets in Appendix A. In general, the overburden samples taken in the boreholes advanced in this area were moist to wet. The groundwater levels measured in the piezometer installation are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Abutment	B4-01	203.5	202.0 201.6	April 16, 2009 August 26, 2009

It should be noted that groundwater level in the area is subject to seasonal fluctuations, snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during parts of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

## 5.0 CLOSURE

Messrs. Matt Rhody, Chris Radway and Indulis Dumpis, senior technicians with Golder, directed the drilling program. Messrs. Marc Rougier, David Chesser and Adam Horwitz completed the field work for rock mapping. This report was prepared by Ms. T. Veronica Ayetan, P.Eng. and Mr. Christopher Ng, P.Eng., and was reviewed by Mr. J. Paul Dittrich, Ph.D., P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



## FOUNDATION REPORT – SHAWANAGA RIVER NBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

### Report Signature Page

Christopher Ng, P. Eng.  
Geotechnical Engineer, Associate



Jorge M. A. Costa, P. Eng.  
Designated MTO Contact, Principal

TVA/CN/JPD/JMAC/J



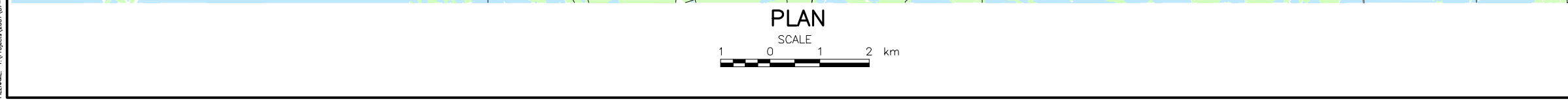
J. Paul Dittrich, Ph.D., P. Eng.,  
Senior Geotechnical Engineer, Principal

\\golder.gds\gal\mississauga\active\2007\1111\07-1111-0029 - mrc - hwy 69 four-laning -\report\final\9 - shawanaga river nbl bridge\07-1111-0029-9 fidr  
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# **DRAWINGS**





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

CONT No.  
WP No. 5187-06-01



HIGHWAY 69  
SITE LOCATION PLAN



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
NOT TO SCALE

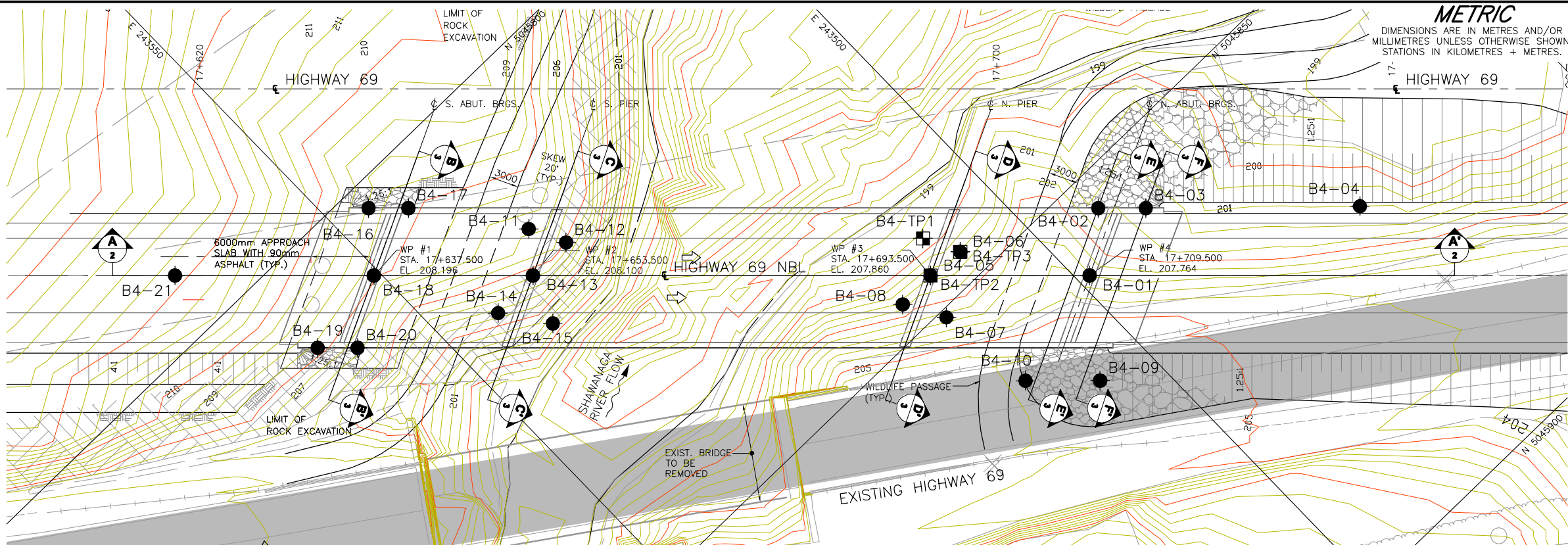


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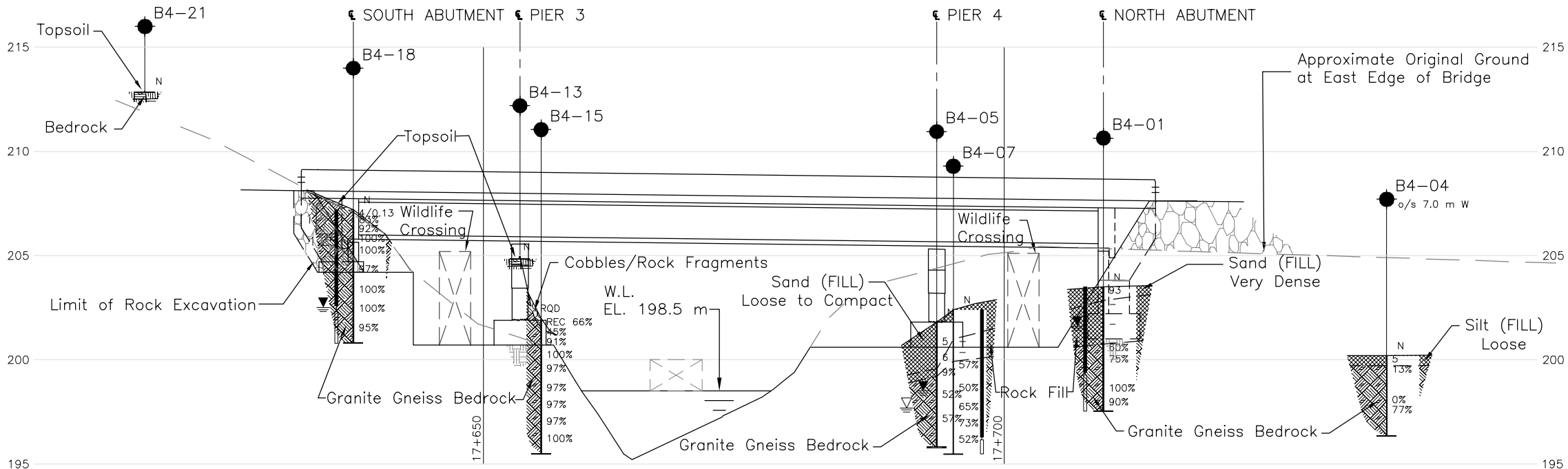
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Datum : NAD 83 Projection : MTM Zone 10

NO.	DATE	BY	REVISION	
Geocres No. 41H-145				
HWY. 69		PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA	DATE: Mar. 2015	SITE: 44-443/1	
DRAWN: DD/CD	CHKD. CN	APPD. JPD/JMAC	DWG. 1	





PLAN



NOTES

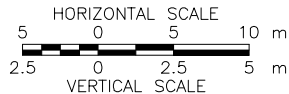
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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.

A-A'  
2

CENTRELINE PROFILE



CONT No.  
WP No. 5187-06-01

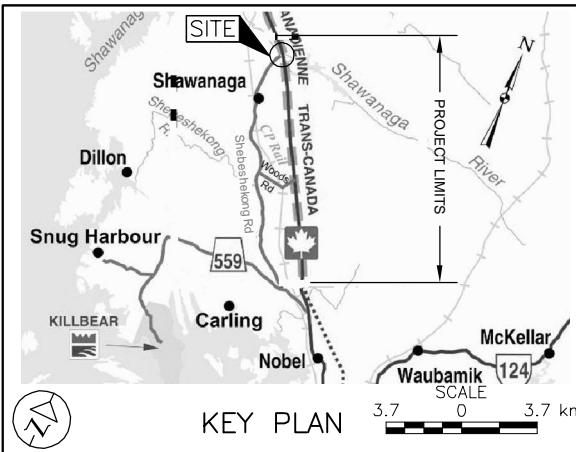


HIGHWAY 69  
SHAWANAGA RIVER BRIDGE (NBL)  
BOREHOLE LOCATIONS  
AND SOIL STRATA

SHEET



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- Test Pit - Approximate Location
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- REC Recovery
- WL in piezometer, measured on 26/08/2009
- WL upon completion of drilling
- R Refusal

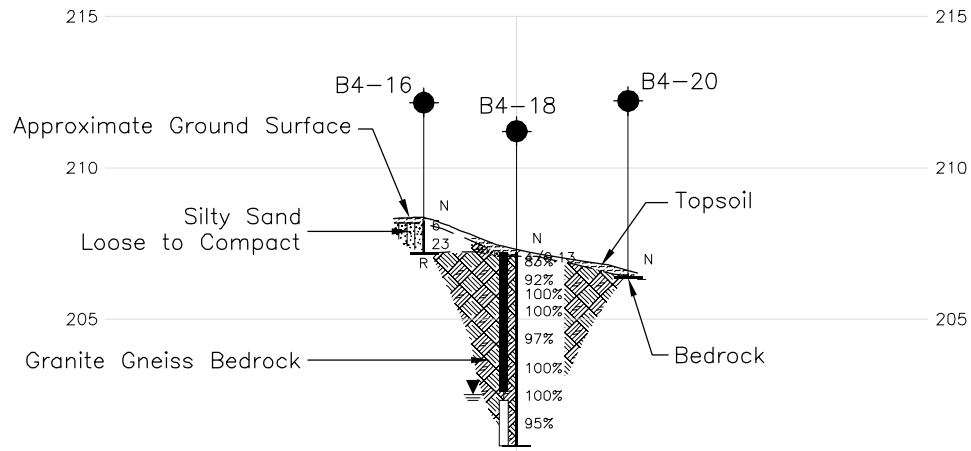
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B4-TP3	201.4	5045847.0	243506.5
B4-01	203.5	5045857.8	243498.8
B4-02	201.7	5045853.5	243493.5
B4-03	201.2	5045856.8	243490.0
B4-04	200.2	5045871.6	243474.4
B4-05	201.8	5045846.6	243510.3
B4-06	201.5	5045847.0	243506.5
B4-07	202.4	5045850.8	243512.1
B4-08	201.8	5045846.8	243514.4
B4-09	205.3	5045866.1	243505.4
B4-10	205.5	5045860.9	243510.8
B4-11	207.6	5045815.2	243536.2
B4-12	204.5	5045818.8	243534.4
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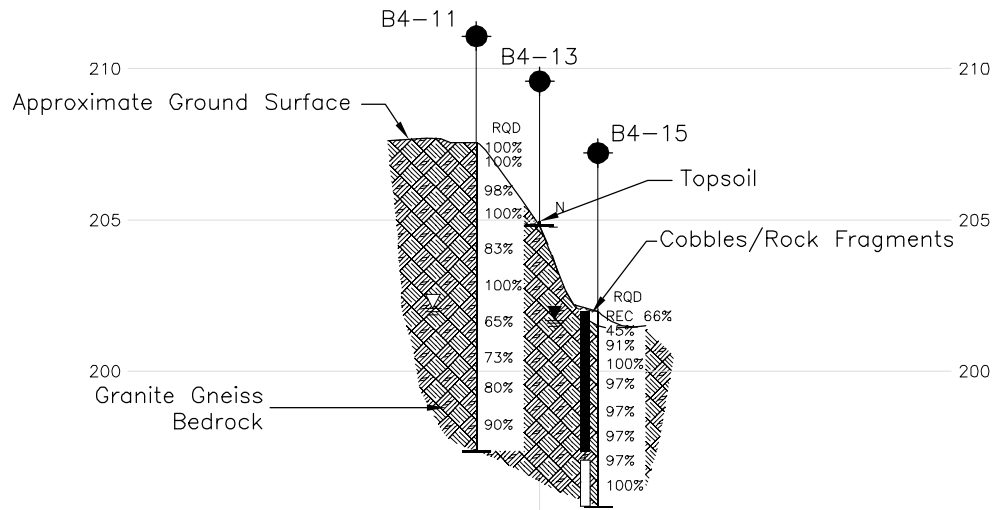
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NO.	DATE	BY	REVISION
Geocres No.	41H-145		
HWY.	69	PROJECT NO.	07-1111-0029
SUBM'D. VA	CHKD. VA/OK	DATE:	Mar. 2015
DRAWN: RJ/JS	CHKD. CN	APPD. JPD/JMAC	DWG. 2

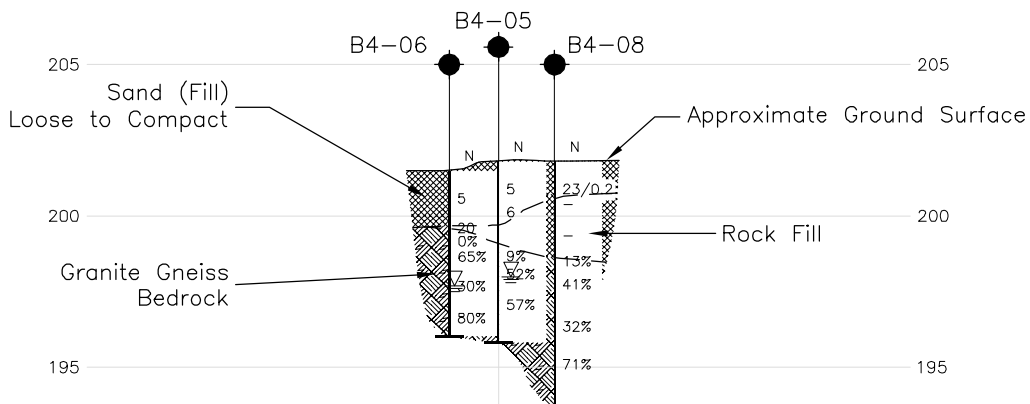




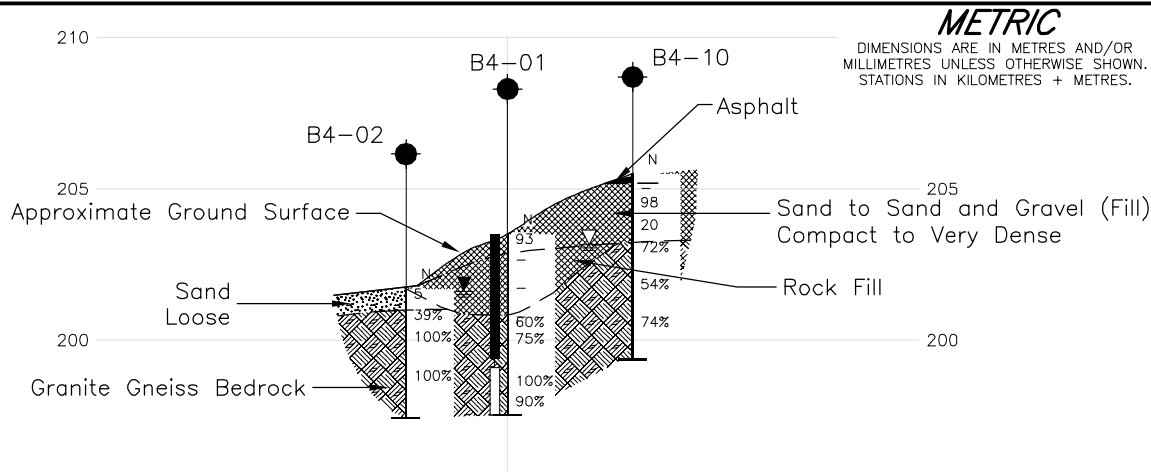
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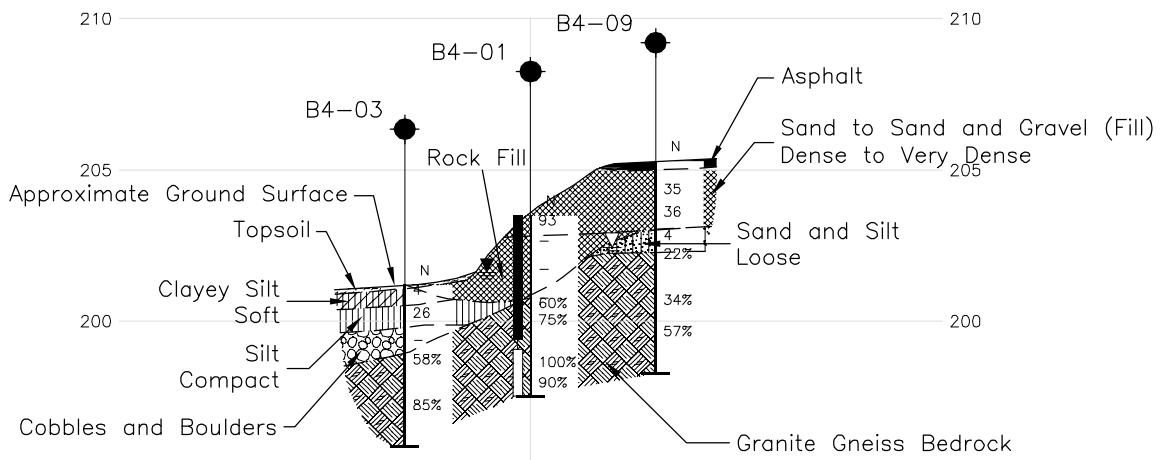
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VERTICAL SCALE  
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**NORTH ABUTMENT (FRONT)**  
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VERTICAL SCALE  
2.5 0 2.5 5 m



**NORTH ABUTMENT (BACK)**  
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HORIZONTAL SCALE  
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VERTICAL SCALE  
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**REFERENCE**  
Base plans provided in digital format by MRC, drawing files 271XB01.DWG, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and S6878-305-001GA.dwg, received January 15, 2009.

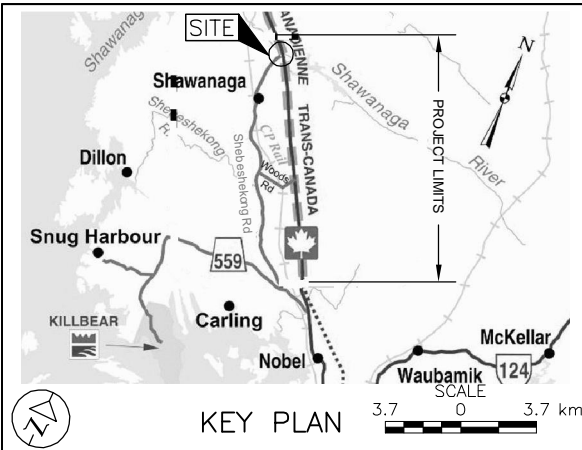
CONT No.  
WP No. 5187-06-01

HIGHWAY 69  
SHAWANAGA RIVER BRIDGE (NBL)  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



**LEGEND**

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- REC Recovery
- WL in piezometer, measured on 26/08/2009
- WL upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
B4-01	203.5	5045857.8	243498.8
B4-02	201.7	5045853.5	243493.5
B4-03	201.2	5045856.8	243490.0
B4-05	201.8	5045846.6	243510.3
B4-06	201.5	5045847.0	243506.5
B4-08	201.8	5045846.8	243514.4
B4-09	205.3	5045866.1	243505.4
B4-10	205.5	5045860.9	243510.8
B4-11	207.6	5045815.2	243536.2
B4-13	205.0	5045818.8	243539.1
B4-15	202.0	5045823.7	243541.0
B4-16	208.3	5045802.5	243546.3
B4-17	207.5	5045805.3	243543.4
B4-18	207.2	5045807.7	243550.6
B4-19	208.2	5045809.0	243559.7
B4-20	206.5	5045811.8	243556.8

**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-145			
HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Mar. 2015	SITE: 44-443/1
DRAWN: RJ/JS	CHKD. CN	APPD. JPD/JMAC	DWG. 3



# APPENDIX A

## RECORD OF BOREHOLES, DRILLHOLES and FIELD TEST PIT LOGS





## 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

#### (a) Index Properties

$\rho(\gamma)$	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

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

#### (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

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (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) 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.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

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 ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

#### (b) Cohesive Soils Consistency

	$c_u, s_u$	
	kPa	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

### 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, $G_s$ )
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)
$\gamma$	unit weight

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

### V. MINOR SOIL CONSTITUENTS

Percent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (cohesionless) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERING 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	



## FIELD TEST PIT LOG

<b>JOB NUMBER:</b>	07-1111-0029	<b>JOB NAME:</b>	MRC / Highway 69 Four-Laning / Shawanaga NBL Structure		<b>DATE:</b>	Mar 21, 2009
<b>TEST PIT NUMBER:</b>	B4-TP1	<b>APPROXIMATE LOCATION:</b>	N 5045843.4; E 243508.3		<b>APPROXIMATE ELEVATION:</b>	199.3 m
<b>MACHINE TYPE:</b>	240 John Deere Excavator	<b>TEST PIT SIZE:</b>	N/A		<b>DATUM:</b>	Geodetic
<b>TEMP/WEATHER:</b>	Sunny, 2.5°C	<b>CONTRACTOR:</b>	Weeks Construction Inc.			

Elev.		Soil Description	Samples		Remarks
Depth			No.	Depth (m)	
From (m)	To (m)				
0.0	1.1	Rock fill, containing topsoil and rootlets	--	--	Exposed bedrock at a depth of 1.1 m
198.2					
1.1		End of Test Pit Bedrock			

Comments:

Water Conditions in Test Pit: Dry



JOB No.	07-1111-0029
TEST PIT No.:	B4-TP1
TECHNICIAN:	MR
COMPILED BY:	VA

## FIELD TEST PIT LOG

<b>JOB NUMBER:</b>	07-1111-0029	<b>JOB NAME:</b>	MRC / Highway 69 Four-Laning / Shawanaga NBL Structure	<b>DATE:</b>	Mar 21, 2009
<b>TEST PIT NUMBER:</b>	B4-TP2	<b>APPROXIMATE LOCATION:</b>	N 5045846.6; E 243510.3	<b>APPROXIMATE ELEVATION:</b>	199.6 m
<b>MACHINE TYPE:</b>	240 John Deere Excavator	<b>TEST PIT SIZE:</b>	N/A	<b>DATUM:</b>	Geodetic
<b>TEMP/WEATHER:</b>	Sunny, 2.5°C	<b>CONTRACTOR:</b>	Weeks Construction Inc.		

Elev.		Soil Description	Samples		Remarks
Depth			No.	Depth (m)	
From (m)	To (m)				
0.0	2.1	Rock fill, containing sand, topsoil and rootlets	--	--	Exposed bedrock at a depth of 2.1 m
197.5					
2.1		End of Test Pit Bedrock			

*Comments:*

*Water Conditions in Test Pit: Dry*

For additional soil and bedrock details, see Record of Borehole B4-05



JOB No.	07-1111-0029
TEST PIT No.:	B4-TP2
TECHNICIAN:	MR
COMPILED BY:	VA

## FIELD TEST PIT LOG

<b>JOB NUMBER:</b>	07-1111-0029	<b>JOB NAME:</b>	MRC / Highway 69 Four-Laning / Shawanaga NBL Structure		<b>DATE:</b>	Mar 21, 2009
<b>TEST PIT NUMBER:</b>	B4-TP3	<b>APPROXIMATE LOCATION:</b>	N 5045847.0; E 243506.5		<b>APPROXIMATE ELEVATION:</b>	201.4 m
<b>MACHINE TYPE:</b>	240 John Deere Excavator	<b>TEST PIT SIZE:</b>	N/A		<b>DATUM:</b>	Geodetic
<b>TEMP/WEATHER:</b>	Sunny, 2.5°C	<b>CONTRACTOR:</b>	Weeks Construction Inc.			

Elev.		Soil Description	Samples		Remarks
Depth			No.	Depth (m)	
From (m)	To (m)				
0.0	0.8	Rock fill, containing topsoil and rootlets	--	--	Exposed bedrock at a depth of 0.8 m
200.6					
0.8		End of Test Pit Bedrock			

*Comments:*

*Water Conditions in Test Pit: Dry*

For additional soil and bedrock details, see Record of Borehole B4-06



JOB No.	07-1111-0029
TEST PIT No.:	B4-TP3
TECHNICIAN:	MR
COMPILED BY:	VA

PROJECT		RECORD OF BOREHOLE		No B4-01		SHEET 1 OF 1		METRIC								
W.P. 07-1111-0029		LOCATION		N 5045857.8 ; E 243498.8		ORIGINATED BY		MR								
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY								
VA		DATE		February 6 & 7, 2009		CHECKED BY		OK								
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
203.5	GROUND SURFACE															
0.0	Sand, trace gravel, trace silt, containing organics and cobbles (FILL)		1	SS	93											
202.8	Very dense Brown Wet ROCK FILL		2	RC	-											
0.7			3	RC	-											
			4	RC	-											
200.8	Granite Gneiss (BEDROCK)		1	RC	REC 95%											RQD = 60%
2.7	Bedrock cored from depths of 2.7 m to 6.0 m		2	RC	REC 100%											RQD = 75%
	For bedrock coring details, refer to Record of Drillhole B4-01		3	RC	REC 100%											RQD = 100%
			4	RC	REC 96%											RQD = 90%
197.5	END OF BOREHOLE															
6.0	NOTE: 1. Water level measurements in Piezometer.  Date      Depth (m)      Elev. (m) 16/04/09    1.5          202.0 26/08/09    1.9          201.6															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-01

SHEET 1 OF 1

LOCATION: N 5045857.8 ;E 243498.8

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: 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
NO RC	February 7, 2009	Continued from Record of Borehole B4-01		200.76 2.74	1								
3		GRANITE GNEISS Fresh to slightly weathered, medium grained, faintly to moderately porous, strong, weakly to moderately foliated, grey with black stippling, minor chloritic alteration and oxidation											
4					2								
5		GRANITE GNEISS Slightly weathered, medium grained, faintly to moderately porous, medium strong to strong, moderately to strongly foliated, grey and green, striping and stippling, moderate chloritic alteration		198.75 4.75	3								
6		END OF DRILLHOLE		197.53 5.97	4								
7													
8													
9													
10													
11													
12													

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



PROJECT		RECORD OF BOREHOLE		No B4-02		SHEET 1 OF 1		METRIC					
W.P.		LOCATION		ORIGINATED BY		MR							
DIST		BOREHOLE TYPE		COMPILED BY		VA							
DATUM		DATE		CHECKED BY		OK							
PROJECT 07-1111-0029		N 5045853.5 ; E 243493.5											
5187-06-01		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring											
Geodetic		February 7, 2009											
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
201.7	GROUND SURFACE												
0.0	SAND, trace gravel, containing organics and rootlets		1	SS	5		201						
201.0	Loose Brown Wet												
0.7	Granite Gneiss (BEDROCK)		1	RC	REC 89%		200						RQD = 39%
	Bedrock cored from depths of 0.7 m to 4.3 m		2	RC	REC 100%		199						RQD = 100%
	For bedrock coring details, refer to Record of Drillhole B4-02		3	RC	REC 100%		198						RQD = 100%
197.4	END OF BOREHOLE												
4.3	NOTE: 1. Open borehole dry upon completion of overburden drilling.												

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B4-02**

SHEET 1 OF 1

LOCATION: N 5045853.5 ;E 243493.5

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: 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 0.3 m	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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1	NW Casing February 7, 2009	Continued from Record of Borehole B4-02  GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey		201.00 0.70	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										</

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B4-03		SHEET 1 OF 1		METRIC								
W.P. 07-1111-0029		LOCATION		N 5045856.8 ; E 243490.0		ORIGINATED BY		MR								
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY								
VA		DATE		February 8, 2009		CHECKED BY		OK								
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
201.2	GROUND SURFACE															
0.0	TOPSOIL															
200.5	CLAYEY SILT, trace sand, containing organics and rootlets Soft to firm		1	SS	4											OC=3.7%
0.7	Brown to grey Moist		2	SS	26											
199.8	SILT, trace sand, trace clay Compact															
1.4	Brown Wet															
198.9	COBBLES AND BOULDERS		3	RC	-											
2.3	Granite Gneiss (BEDROCK)															
	Bedrock cored from depths of 2.3 m to 5.3 m		1	RC	REC 95%											RQD = 58%
	For bedrock coring details, refer to Record of Drillhole B4-03		2	RC	REC 92%											RQD = 85%
195.9	END OF BOREHOLE															
5.3	NOTE:  1. Open borehole dry upon completion of overburden drilling.															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-03

SHEET 1 OF 1

LOCATION: N 5045856.8 ;E 243490.0


DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY			Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES				
				DEPTH (m)	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>	10 <sup>-3</sup>							
		Continued from Record of Borehole B4-03		198.91 2.29																								
3	NQ RC February 8, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey			1																							
4																												
5																												
		END OF DRILLHOLE			195.87 5.33																							
6																												
7																												
8																												
9																												
10																												
11																												
12																												

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B4-04		SHEET 1 OF 1		METRIC									
W.P. 5187-06-01		LOCATION		N 5045871.6; E 243474.4		ORIGINATED BY		MR									
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY									
VA		DATE		February 9, 2009		CHECKED BY		OK									
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
200.2	GROUND SURFACE							20	40	60	80	100					
0.0	Silt, some sand, trace to some clay, containing organics (FILL)		1	SS	5												
199.7	Loose Brown Moist																
0.5	Granite Gneiss (BEDROCK)		1	RC	REC 75%												RQD = 13%
	Bedrock cored from depths of 0.5 m to 3.8 m		2	RC	REC 76%												RQD = 0%
	For bedrock coring details, refer to Record of Drillhole B4-04		3	RC	REC 98%												RQD = 77%
196.4	END OF BOREHOLE																
3.8	NOTE: 1. Open borehole dry upon completion of overburden drilling.																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B4-04**

SHEET 1 OF 1

LOCATION: N 5045871.6 ;E 243474.4

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: 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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
								RECOVERY			R.Q.D. %	FRACT. INDEX PER 0.3 m	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	K <sub>10</sub>	K <sub>50</sub>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B4-05		SHEET 1 OF 1		METRIC																					
W.P.		LOCATION		ORIGINATED BY		MR																							
DIST		BOREHOLE TYPE		COMPILED BY		TZ																							
DATUM		DATE		CHECKED BY		OK																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			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																								
201.8	GROUND SURFACE																												
0.0	Sand, some gravel, trace silt (FILL) Loose Brown Moist		1	SS	5																								
			2	SS	6																								
199.6	ROCK FILL																												
199.2	Granite Gneiss (BEDROCK)		1	RC	REC 74%																								
2.6	Bedrock cored from depths of 2.6 m to 6 m  For bedrock coring details, refer to Record of Drillhole B4-05		2	RC	REC 93%																								
			3	RC	REC 100%																								
195.8	END OF BOREHOLE																												
6.0	NOTES:  1. Water level in open borehole at a depth of 4.1 m below ground surface (Elev. 197.7 m) upon completion of drilling.  2. Sand fill placed as backfill to Test Pit B4-TP2 to allow for bedrock coring.																												

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

CHECKED: OK

PROJECT		RECORD OF BOREHOLE		No B4-06		SHEET 1 OF 1		METRIC											
W.P.		LOCATION		N 5045847.0 ; E 243506.5		ORIGINATED BY		MR											
DIST		HWY		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY											
TZ		DATE		March 24, 2009		CHECKED BY		OK											
DATUM		Geodetic																	
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 (%)			γ	GR SA SI CL	
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30	kN/m <sup>3</sup>				
201.5	0.0	GROUND SURFACE Sand, some gravel, trace to some silt, trace clay (FILL) Loose to compact Brown Moist						201											
				1	SS	5													
199.7				2A	SS	20		200										20 67 11 2	
1.9		Sand and gravel, some silt, containing organics and wood fragments (FILL) Compact Brown Moist Granite Gneiss (BEDROCK)  Bedrock cored from depths of 1.9 m to 5.5 m  For bedrock coring details, refer to Record of Drillhole B4-05		2P	RC	REC 100%												RQD = 0%	
				2	RC	REC 96%		199										RQD = 65%	
				3	RC	REC 95%		198										RQD = 30%	
				4	RC	REC 100%		197										RQD = 80%	
196.0	5.5	END OF BOREHOLE																	
NOTES:																			
1. Open borehole dry upon completion of drilling.																			
2. Sand fill placed as backfill to Test Pit B4-TP3 to allow for bedrock coring.																			

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-06

SHEET 1 OF 1

LOCATION: N 5045847.0 ;E 243506.5

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
				DEPTH (m)	K, cm <sup>3</sup> /sec				TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 °	10 °	10 °	10 °																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
2	NW Casing March 24, 2009	Continued from Record of Borehole B4-06  GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey		199.61 1.89	1										JN,UN,RO JN,UN,RO																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

8.1 MPa  
9.3 MPaUC=78.1  
MPa

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-07		SHEET 1 OF 1		METRIC																						
W.P. 5187-06-01		LOCATION N 5045850.8 ; E 243512.1		ORIGINATED BY MR																								
DIST HWY 69		BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY TZ																								
DATUM Geodetic		DATE March 24, 2009		CHECKED BY OK																								
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 (%)			γ	GR SA SI CL											
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30														
202.4 0.0	GROUND SURFACE Sand, some gravel, containing cobbles (FILL) Brown Moist						202																					
201.1 1.3	ROCK FILL		1	RC	-		201																					
199.9 2.5	Granite Gneiss (BEDROCK)  Bedrock cored from depths of 2.5 m to 6.9 m  For bedrock coring details, refer to Record of Drillhole B4-07		2	RC	-		200																					
			1	RC	REC 92%		199									RQD = 57%												
			2	RC	REC 100%		198									RQD = 50%												
			3	RC	REC 100%		197									RQD = 65%												
			4	RC	REC 100%		196									RQD = 73%												
			5	RC	REC 94%											RQD = 52%												
195.5 6.9	END OF BOREHOLE																											
NOTES: 1. Water level in open borehole at a depth of 3.1 m below ground surface (Elev. 199.3 m) upon completion of drilling. 2. Water level measurements in piezometer: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev. (m)</th> </tr> </thead> <tbody> <tr> <td>26/03/09</td> <td>3.2</td> <td>199.2</td> </tr> <tr> <td>16/04/09</td> <td>3.2</td> <td>199.2</td> </tr> <tr> <td>26/08/09</td> <td>3.9</td> <td>198.5</td> </tr> </tbody> </table>																	Date	Depth (m)	Elev. (m)	26/03/09	3.2	199.2	16/04/09	3.2	199.2	26/08/09	3.9	198.5
Date	Depth (m)	Elev. (m)																										
26/03/09	3.2	199.2																										
16/04/09	3.2	199.2																										
26/08/09	3.9	198.5																										

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-07

SHEET 1 OF 1

LOCATION: N 5045850.8 ;E 243512.1


DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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		Continued from Record of Borehole B4-07		199.93																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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3	NQ RC March 25, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, laminated, dark grey and pink			1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

DEPTH SCALE



1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MASS.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-08		SHEET 1 OF 1		METRIC												
W.P. 5187-06-01		LOCATION N 5045846.8 ; E 243514.4		ORIGINATED BY MR														
DIST HWY 69		BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY TZ														
DATUM Geodetic		DATE March 25 & 26, 2009		CHECKED BY OK														
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 (%)			γ kN/m <sup>3</sup>	GR SA SI CL	
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30						
201.8 0.0	GROUND SURFACE Sand, some gravel, trace silt (FILL) Compact Brown Moist		1	SS	23/0.2		201											
200.7 1.1	ROCK FILL		2	RC	-		200											
			3	RC	-		199											
198.7 3.1	Granite Gneiss (BEDROCK)  Bedrock cored from depths of 3.1 m to 8.1 m  For bedrock coring details, refer to Record of Drillhole B4-08	1	RC	REC 100%	198												RQD = 13%	
		2	RC	REC 98%	197													RQD = 41%
		3	RC	REC 100%	196													RQD = 32%
		4	RC	REC 98%	195													RQD = 71%
193.7 8.1	END OF BOREHOLE  NOTE:  1. Water level in open borehole at a depth of 3.8 m below ground surface (Elev. 198.0 m) upon completion of drilling.							194										

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-08

SHEET 1 OF 1

LOCATION: N 5045846.8 ;E 243514.4

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm <sup>3</sup> /sec				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES				
								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>	10 <sup>3</sup>								
																						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
		Continued from Record of Borehole B4-08		198.66																									
		GRANITE GNEISS Slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink and grey		3.14																									
4					1																								
					2																								
5																													
			</																										

8.6 MPa  
11.1 MPa

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		07-1111-0029		RECORD OF BOREHOLE No B4-09		SHEET 1 OF 1		METRIC									
W.P.		5187-06-01		LOCATION		N 5045866.1 ; E 243505.4		ORIGINATED BY ID									
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY TZ									
DATUM		Geodetic		DATE		April 2, 2009		CHECKED BY OK									
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 (%)
205.3	GROUND SURFACE																
0.0	ASPHALT																
0.2	Sand, trace gravel, trace silt (FILL) Dense Brown Moist		1A	SS	35												
204.0			1B														
1.3	Sand and gravel, trace silt, containing wood fragments (FILL) Dense Brown Moist		2	SS	36												
203.0																	
2.3	SAND and SILT, trace to some gravel, trace clay Loose Brown Moist		3	SS	4												9 39 51 1
202.4																	
2.9	Granite Gneiss (BEDROCK)  Bedrock cored from depths of 2.9 m to 7 m  For bedrock coring details, refer to Record of Drillhole B4-09		1	RC	REC 56%												RQD = 22%
			2	RC	REC 40%												RQD = 34%
			3	RC	REC 63%												RQD = 57%
198.3																	
7.0	END OF BOREHOLE																
NOTE: 1. Water level in open borehole at a depth of 2.9 m below ground surface (Elev. 202.4 m) upon completion of drilling.																	

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-09

SHEET 1 OF 1

LOCATION: N 5045866.1 ;E 243505.4

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: 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 <b>NOTE:</b> For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	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 10 10 10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-10		SHEET 1 OF 1		METRIC											
W.P. 5187-06-01		LOCATION N 5045860.9 ; E 243510.8		ORIGINATED BY ID													
DIST HWY 69		BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY TZ													
DATUM Geodetic		DATE April 2, 2009		CHECKED BY OK													
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 (%)			γ kN/m <sup>3</sup>	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30					
205.5	GROUND SURFACE																
0.0	ASPHALT																
0.2	Sand, some gravel, trace silt (FILL) Brown Moist		1	AS	-		205										
204.6																	
0.9	Sand and gravel, trace silt, containing organics and cobbles (FILL) Compact to very dense Brown Moist		2	SS	98		204										
			3	SS	20												
203.2																	
2.3	Granite Gneiss (BEDROCK)						203										
	Bedrock cored from depths of 2.3 m to 6.2 m		1	RC	REC 98%		202										
	For bedrock coring details, refer to Record of Drillhole B4-10		2	RC	REC 98%		201										
			3	RC	REC 99%		200										
199.3																	
6.2	END OF BOREHOLE																
	NOTE: 1. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 203.2 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: **B4-10**

SHEET 1 OF 1

LOCATION: N 5045860.9 ;E 243510.8

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: 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 0.3 m	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	Tc				Dc																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-11		SHEET 1 OF 1		METRIC							
W.P. 5187-06-01		LOCATION N 5045815.2 ; E 243536.2		ORIGINATED BY CR									
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY VA									
DATUM Geodetic		DATE July 22 & 23, 2009		CHECKED BY OK									
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
207.6	GROUND SURFACE					20	40	60	80	100			
0.0	Granite Gneiss (BEDROCK)		1	RC	REC 100%								RQD = 100%
	Bedrock cored from ground surface to a depth of 10.2 m		2	RC	REC 100%								RQD = 100%
	For bedrock coring details, refer to Record of Drillhole B4-11		3	RC	REC 100%								RQD = 98%
			4	RC	REC 100%								RQD = 100%
			5	RC	REC 100%								RQD = 83%
			6	RC	REC 100%								RQD = 100%
			7	RC	REC 100%								RQD = 65%
			8	RC	REC 100%								RQD = 73%
			9	RC	REC 100%								RQD = 80%
			10	RC	REC 100%								RQD = 90%
197.4	END OF BOREHOLE												
10.2	NOTE: 1. Water level in open borehole at a depth of 5.5 m below ground surface (Elev. 202.1 m) upon completion of drilling.												

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-11

SHEET 1 OF 2

LOCATION: N 5045815.2 ;E 243536.2

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY			FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES			
								TOTAL CORE %	SOLID CORE %	R.Q.D. %								10	10	10	10						
																									JN - Joint	BD - Bedding	PL - Planar
SH - Shear	CO - Contact	UN - Undulating	PO - Polished	K - Slickensided	SM - Smooth	NOTE: For additional abbreviations refer to list of abbreviations & symbols.																					
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough	MB - Mechanical Break																							
CJ - Conjugate	CL - Cleavage	IR - Irregular	VR - Very Rough	BR - Broken Rock																							

0		GROUND SURFACE		207.57																		
		GRANITE GNEISS		0.00	1																	
		Grey to light grey, highly foliated, coarse grained, slightly to moderately porous																				
									</													

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50



LOGGED: CR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-11

SHEET 2 OF 2

LOCATION: N 5045815.2 ;E 243536.2

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

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 <b>NOTE:</b> For additional abbreviations refer to list of abbreviations & symbols.																NOTES
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	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	
								TOTAL CORE %	SOLID CORE %									10	10	10			
10		-- CONTINUED FROM PREVIOUS PAGE -- Becoming dark grey at a depth of 9.9 m		197.36 10.21	10																		
		END OF DRILLHOLE																					
11																							
12																							
13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							

DEPTH SCALE

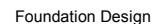
1 : 50



LOGGED: CR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC




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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



PROJECT		RECORD OF BOREHOLE				No B4-13		SHEET 1 OF 1		METRIC						
W.P. 07-1111-0029		LOCATION				N 5045818.8 ; E 243539.1		ORIGINATED BY CR								
DIST		HWY 69		BOREHOLE TYPE		Hand Excavation		COMPILED BY VA								
DATUM Geodetic		DATE		July 20, 2009				CHECKED BY OK								
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								
205.0	GROUND SURFACE															
0.0	TOPSOIL	///	1	CS	-											
0.1	END OF EXCAVATION BEDROCK															
	NOTE:  1. Hand digging carried out at proposed borehole location to expose bedrock (Dry).															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT <u>07-1111-0029</u>		<b>RECORD OF BOREHOLE No B4-14</b>				SHEET 1 OF 1		<b>METRIC</b>									
W.P. <u>5187-06-01</u>		LOCATION <u>N 5045819.1 ;E 243544.2</u>				ORIGINATED BY <u>CR</u>											
DIST <u>        </u> HWY <u>69</u>		BOREHOLE TYPE <u>Hand Excavation</u>				COMPILED BY <u>VA</u>											
DATUM <u>Geodetic</u>		DATE <u>July 21, 2009</u>				CHECKED BY <u>OK</u>											
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	<div style="display: flex; justify-content: space-between; width: 100%;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between; width: 100%;"> <span>○ UNCONFINED + FIELD VANE</span> <span>● QUICK TRIAXIAL × REMOULDED</span> </div>					W <sub>p</sub>	W	W <sub>L</sub>	γ	GR SA SI CL
202.3	GROUND SURFACE																
0.0	TOPSOIL		1	CS	-												
0.2	END OF EXCAVATION BEDROCK																
	NOTE:  1. Hand digging carried out at proposed borehole location to expose bedrock (Dry).																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-15		SHEET 1 OF 1		METRIC											
W.P. 5187-06-01		LOCATION N 5045823.7 ; E 243541.0		ORIGINATED BY CR													
DIST HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY VA													
DATUM Geodetic		DATE July 21 & 22, 2009		CHECKED BY OK													
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 (%)			γ kN/m <sup>3</sup>	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30	10 20 30	10 20 30					
202.0	GROUND SURFACE																
0.0	Cobbles/Rock Fragments		1	RC	REC 66%												
201.5	Granite Gneiss (BEDROCK)		2	RC	REC 100%		201										RQD = 45%
0.5	Bedrock cored from depths of 0.5 m to 6.5 m		3	RC	REC 100%												RQD = 91%
	For bedrock coring details, refer to Record of Drillhole B4-15		4	RC	REC 100%		200										RQD = 100%
			5	RC	REC 100%		199										RQD = 97%
			6	RC	REC 100%		198										RQD = 97%
			7	RC	REC 100%		197										RQD = 97%
			8	RC	REC 100%		196										RQD = 100%
195.5	END OF BOREHOLE		9	RC	REC 100%												
6.5	NOTE: 1. Water level measurements in piezometer:  Date Depth (m) Elev. (m) 28/07/09 -0.6* 202.6 26/08/09 0.3 201.7  *Water level above ground surface due to heavy rain.																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-15

SHEET 1 OF 1

LOCATION: N 5045823.7 ;E 243541.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

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 0.3 m	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	10 <sup>-6</sup>	10 <sup>-5</sup>			10 <sup>-4</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
0	BW Casing July 21, 2009	GROUND SURFACE COBBLES Moderately weathered, dark grey, highly foliated, coarse grained, slightly to moderately porous GRANITE GNEISS Slightly weathered, dark to light grey, highly foliated, coarse grained, slightly to moderately porous		201.98 0.00 201.50 0.48																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

DEPTH SCALE

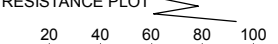
1 : 50



LOGGED: CR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE No B4-16				SHEET 1 OF 1		METRIC										
W.P.		LOCATION				ORIGINATED BY												
DIST		BOREHOLE TYPE				COMPILED BY												
DATUM		DATE				CHECKED BY												
07-1111-0029		N 5045802.5 ; E 243546.3				CR												
5187-06-01		Portable Equipment				VA												
Geodetic		July 20, 2009				OK												
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	 20 40 60 80 100					W <sub>p</sub>	W	W <sub>L</sub>	γ	GR SA SI CL	
208.3	GROUND SURFACE																	
0.0	TOPSOIL		1A		6		208											
0.1	Silty SAND, some gravel, rock fragments, containing rootlets Loose to compact Brown Moist		1B	SS														
207.2			2	SS	23													
1.1	END OF BOREHOLE SPOON REFUSAL																	
NOTES:																		
1. Borehole advanced using portable drilling equipment with one-third weight hammer. SPT 'N' values shown have been adjusted to infer values that would be obtained with standard weight hammer.																		
2. Open borehole dry upon completion of drilling.																		

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B4-17		SHEET 1 OF 1		METRIC								
W.P. 5187-06-01		LOCATION		N 5045805.3 ; E 243543.4		ORIGINATED BY		CR								
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY								
VA		DATE		July 20, 2009		CHECKED BY		OK								
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
207.5	GROUND SURFACE															
0.0	TOPSOIL		1A	SS	1											
0.3	Silty SAND, trace to some clay, trace gravel, containing rootlets Very loose Brown Moist END OF BOREHOLE SPOON REFUSAL  NOTES: 1. Borehole advanced using portable drilling equipment with one-third weight hammer. SPT 'N' value shown has been adjusted to infer value that was obtained with standard weight hammer.  2. Open borehole dry upon completion of drilling.		1B													

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B4-18		SHEET 1 OF 1		METRIC															
W.P. 07-1111-0029		LOCATION		N 5045807.7 ; E 243550.6		ORIGINATED BY		CR															
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY															
VA		DATE		July 20 & 21, 2009		CHECKED BY		OK															
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 (%)			γ			GR SA SI CL				
207.2	GROUND SURFACE							20	40	60	80	100	20	40	60	80	100	10	20	30			
0.0	TOPSOIL		1	SS	4/0.13		207																
0.1	Granite Gneiss (BEDROCK)		1	RC	REC 100%		207																RQD = 83%
	Bedrock cored from depths of 0.1 m to 6.4 m		2	RC	REC 100%		206																RQD = 92%
	For bedrock coring details refer to Record of Drillhole B4-18		3	RC	REC 100%		206																RQD = 100%
			4	RC	REC 100%		205																RQD = 100%
			5	RC	REC 100%		204																RQD = 97%
			6	RC	REC 100%		203																RQD = 100%
			7	RC	REC 100%		202																RQD = 100%
			8	RC	REC 100%		201																RQD = 95%
200.8	END OF BOREHOLE																						
6.4	NOTES:																						
	1. Borehole advanced using portable drilling equipment with one-third weight hammer. SPT 'N' value shown has been adjusted to infer value that was obtained with standard weight hammer.																						
	2. Water level measurements in piezometer:																						
	Date      Depth (m)      Elev. (m)																						
	28/07/09      3.9      203.3																						
	26/08/09      4.7      202.5																						

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B4-18

SHEET 1 OF 1

LOCATION: N 5045807.7 ;E 243550.6

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	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 %					TYPE AND SURFACE DESCRIPTION	Jr	Ja					Un
1	BQRC July 20 & 21, 2009	Continued from Record of Borehole B4-18		207.07																	
		GRANITE GNEISS		0.13																	
		Slightly weathered, dark to light grey, highly foliated, coarse grained, slightly to moderately porous		0.28																	
		QUARTZ VEIN		208.74																	
				0.46																	
		GRANITE GNEISS																			
		Slightly weathered, dark to light grey, highly foliated, coarse grained, slightly to moderately porous																			
		QUARTZ VEIN		205.83																	
				1.37																	
				205.63																	
2		GRANITE GNEISS		1.57																	
		Slightly weathered, dark to light grey, highly foliated, coarse grained, slightly to moderately porous																			
3																					
4																					
5																					
6																					
7		END OF DRILLHOLE		200.80																	
				6.40																	
8																					
9																					
10																					

DEPTH SCALE

1 : 50



LOGGED: CR

CHECKED: OK

PROJECT		RECORD OF BOREHOLE				No B4-19		SHEET 1 OF 1		METRIC							
W.P. 07-1111-0029		LOCATION				N 5045809.0 ; E 243559.7		ORIGINATED BY CR									
DIST		HWY 69		BOREHOLE TYPE		Hand Excavation		COMPILED BY VA									
DATUM Geodetic		DATE		July 21, 2009				CHECKED BY OK									
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									
208.2	GROUND SURFACE																
0.0	TOPSOIL		1	CS													
	END OF EXCAVATION BEDROCK																
	NOTE:  1. Hand digging carried out at proposed borehole location to expose bedrock (DRY).																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE				No B4-20		SHEET 1 OF 1		METRIC							
W.P. 07-1111-0029		LOCATION				N 5045811.8 ; E 243556.8		ORIGINATED BY CR									
DIST		HWY 69		BOREHOLE TYPE		Hand Excavation		COMPILED BY VA									
DATUM Geodetic		DATE		July 21, 2009				CHECKED BY OK									
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									
206.5	GROUND SURFACE																
0.0	TOPSOIL	///	1	CS	-												
0.1	END OF EXCAVATION BEDROCK																
NOTE: 1. Hand digging carried out at proposed borehole location to expose bedrock (DRY).																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B4-21				SHEET 1 OF 1		METRIC								
W.P. 5187-06-01		LOCATION N 5045793.8 ;E 243565.0				ORIGINATED BY CR										
DIST HWY 69		BOREHOLE TYPE Hand Excavation				COMPILED BY VA										
DATUM Geodetic		DATE July 24, 2009				CHECKED BY OK										
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								
212.9	GROUND SURFACE															
8.9	TOPSOIL															
	END OF EXCAVATION BEDROCK															
	NOTE:  1. Hand digging carried out at proposed borehole location to expose bedrock (DRY).															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



# APPENDIX B

## LABORATORY TEST RESULTS

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

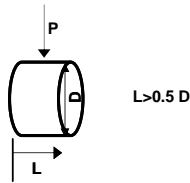
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. <sup>(1)</sup> UCS (MPa)
B4-01	3	5.31	198.2	Granite Gneiss	Diametral	6.252	69.0
B4-01	4	5.47	198.0	Granite Gneiss	Diametral	7.504	83.0
B4-01	4	5.54	195.7	Granite Gneiss	Diametral	8.573	94.0
B4-02	1	1.0	200.7	Granite Gneiss	Diametral	6.185	68.0
B4-02	1	1.0	200.7	Granite Gneiss	Diametral	6.394	70.0
B4-02	1	1.2	200.5	Granite Gneiss	Diametral	5.175	57.0
B4-02	2	2.0	199.7	Granite Gneiss	Diametral	5.501	61.0
B4-02	2	2.1	199.6	Granite Gneiss	Diametral	6.052	67.0
B4-02	2	2.2	199.5	Granite Gneiss	Diametral	4.591	51.0
B4-06	2	2.6	198.9	Granite Gneiss	Diametral	6.995	77.0
B4-06	2	2.8	198.7	Granite Gneiss	Diametral	8.072	89.0
B4-06	2	2.9	198.6	Granite Gneiss	Diametral	9.291	102.0
B4-08	2	5.0	196.8	Granite Gneiss	Diametral	8.640	95.0
B4-08	2	5.1	196.7	Granite Gneiss	Diametral	11.102	122.0
B4-08	2	5.2	196.6	Granite Gneiss	Diametral	6.862	75.0
B4-09	1	3.1	202.2	Granite Gneiss	Axial	10.322	114.0
B4-09	1	3.2	202.1	Granite Gneiss	Diametral	5.543	61.0
B4-09	1	3.3	202.0	Granite Gneiss	Axial	10.509	116.0
B4-09	1	3.3	202.0	Granite Gneiss	Axial	10.828	119.0
B4-09	1	3.3	202.0	Granite Gneiss	Diametral	5.735	63.0
B4-09	1	3.4	201.9	Granite Gneiss	Diametral	6.386	70.0
B4-09	2	4.8	200.5	Granite Gneiss	Diametral	7.830	86.0
B4-09	2	4.9	200.4	Granite Gneiss	Diametral	8.272	91.0
B4-09	2	5.0	200.3	Granite Gneiss	Diametral	6.928	76.0
B4-11	6	4.6	203.0	Granite Gneiss	Diametral	6.331	70.0
B4-11	7	6.3	201.3	Granite Gneiss	Diametral	4.853	53.0
B4-11	9	8.6	199.0	Granite Gneiss	Diametral	2.940	32.0
B4-11	10	9.3	198.3	Granite Gneiss	Diametral	4.878	54.0
B4-11	10	9.8	197.8	Granite Gneiss	Diametral	5.797	64.0
B4-15	5	3.1	198.9	Granite Gneiss	Diametral	6.717	74.0
B4-15	7	4.1	197.9	Granite Gneiss	Diametral	8.827	97.0
B4-15	8	5.1	196.9	Granite Gneiss	Diametral	8.573	94.0
B4-15	9	6.3	195.8	Granite Gneiss	Diametral	4.073	45.0
B4-18	6	3.9	203.3	Granite Gneiss	Diametral	3.375	37.0
B4-18	6	4.6	202.7	Granite Gneiss	Diametral	2.110	23.0
B4-18	7	5.1	202.1	Granite Gneiss	Diametral	1.059	12.0
B4-18	9	5.9	201.3	Granite Gneiss	Diametral	4.927	54.0

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

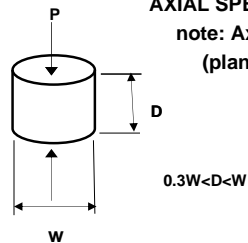
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. <sup>(1)</sup> UCS (MPa)
<sup>(1)</sup> $Is_{50} \times K$ (actual value could be confirmed by UCS testing), from ISRM. This range has been given based on $K = 11$ , calculated from $Is_{50}$ Average (9 tests) equal to 7.2 MPa on Diametral orientation on samples from BH B4-06 and B4-09, and UCS Average (2 tests) equal to 81.5 MPa on a sample from end of BH B4-06 and B4-09. "Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.							

**DIAMETRAL SPECIMEN SHAPE REQUIREMENTS**

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


**AXIAL SPECIMEN SHAPE REQUIREMENTS**

**note: Axial tests are parallel to core axis (planes of weakness)**



Compiled By: OK  
Checked By: CN  
Reviewed By: JPD/JMAC

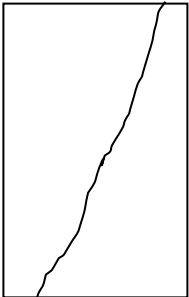


**TABLE B2-1**  
**SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS**  
**SHAWANAGA RIVER NBL BRIDGE STRUCTURE**  
**HIGHWAY 69, TOWNSHIP OF PARRY SOUND**  
**GWP 5111-07-00, W.P 5187-06-01**

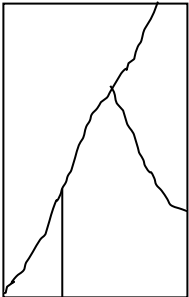
<b>Borehole Number (Core Run)</b>	<b>Sample Depth (m)</b>	<b>Sample Elevation (m)</b>	<b>Rock Type</b>	<b>Core Diameter (mm)</b>	<b>Unconfined Compressive Strength (MPa)</b>
B4-06 (2)	3.3	198.2	Granite Gneiss	47.4	78.1
B4-09 (2)	4.7	200.6	Granite Gneiss	47.5	85.5

Compiled By: OKChecked By: CNReviewed By: JPD/JMAC

**TABLE B2-2**  
**UNCONFINED COMPRESSION (UC) TEST**  
**ASTM D 7012-07**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	RUN NUMBER	2
BOREHOLE NUMBER	B4-06	SAMPLE DEPTH, m	3.1-3.4
TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.11
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.00	WATER CONTENT, (specimen) %	0.13
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m <sup>3</sup>	26.10
SAMPLE AREA, cm <sup>2</sup>	17.65	DRY UNIT WT., kN/m <sup>3</sup>	26.07
SAMPLE VOLUME, cm <sup>3</sup>	176.46	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	469.90	VOID RATIO	0.02
DRY WEIGHT, g	469.29		
VISUAL INSPECTION	FAILURE SKETCH		
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	78.1
REMARKS:	N/A	DATE:	6/16/2009
CHECKED BY:	CN	REVIEWED BY:	JPD/JMAC

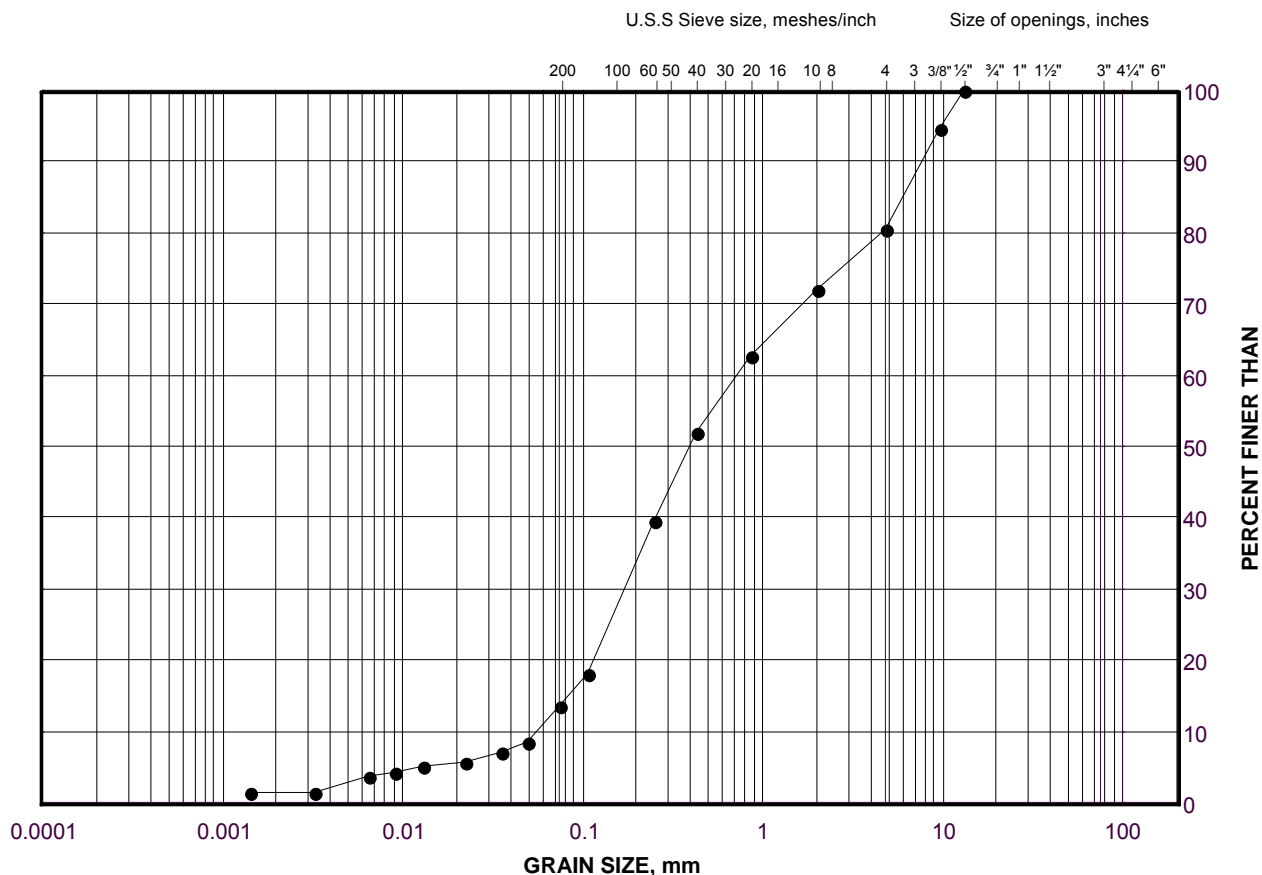
**TABLE B2-3**  
**UNCONFINED COMPRESSION (UC) TEST**  
**ASTM D 7012-04**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	RUN NUMBER	2
BOREHOLE NUMBER	B4-09	SAMPLE DEPTH, m	4.5-4.8
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	10.25	WATER CONTENT, (specimen) %	0.12
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m <sup>3</sup>	26.91
SAMPLE AREA, cm <sup>2</sup>	17.68	DRY UNIT WT., kN/m <sup>3</sup>	26.88
SAMPLE VOLUME, cm <sup>3</sup>	181.25	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	497.61	VOID RATIO	-0.02
DRY WEIGHT, g	497.01		
VISUAL INSPECTION	FAILURE SKETCH		
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	85.5
REMARKS:	N/A	DATE:	6/16/2009
CHECKED BY:	CN	REVIEWED BY:	JPD/JMAC

# GRAIN SIZE DISTRIBUTION

Sand (Fill)  
North Pier (Pier 4 )

FIGURE B1-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	B4-06	2A	199.9

Project Number: 07-1111-0029

Checked By: CN

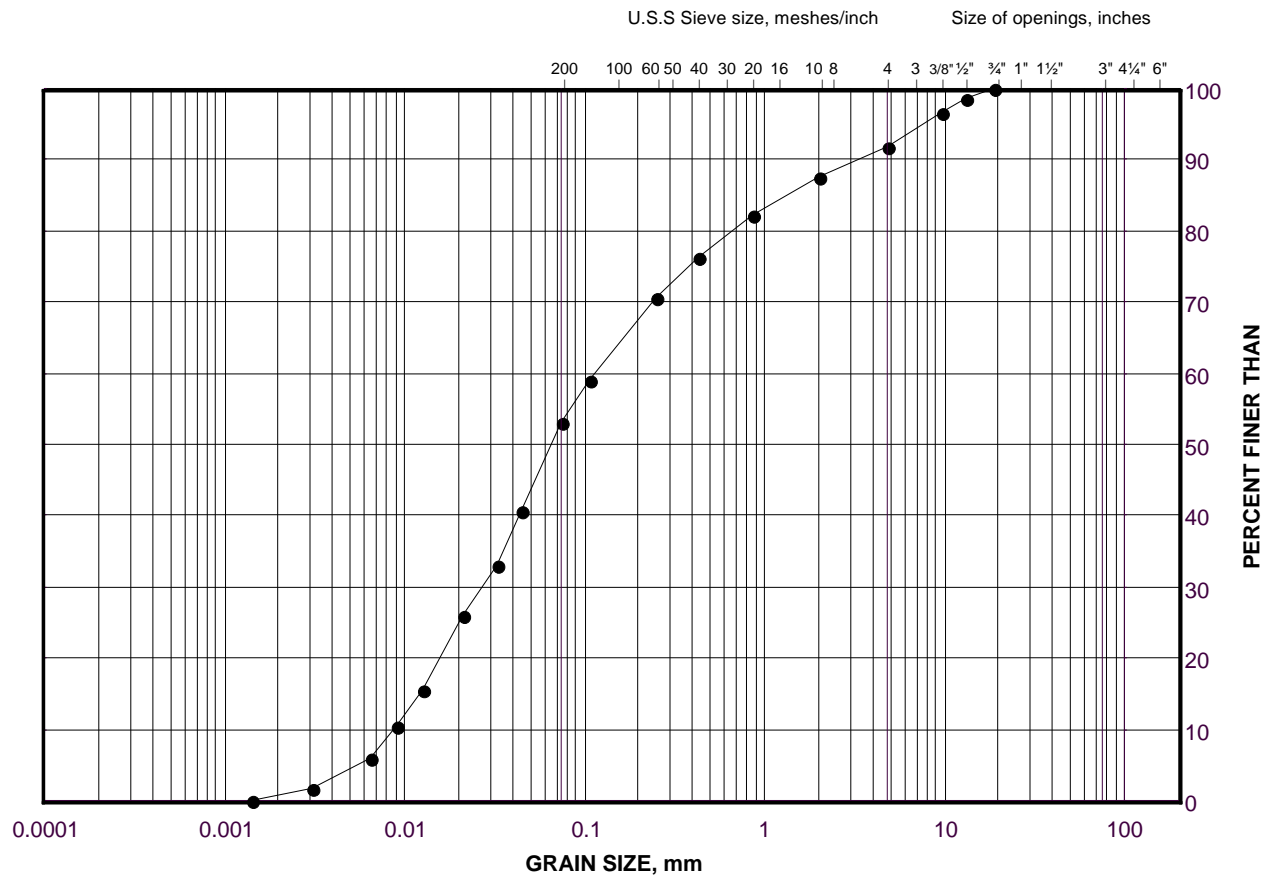
**Golder Associates**

Date: 12-Aug-10

# GRAIN SIZE DISTRIBUTION

Sand and Silt  
North Abutment

FIGURE B1-2



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

## LEGEND

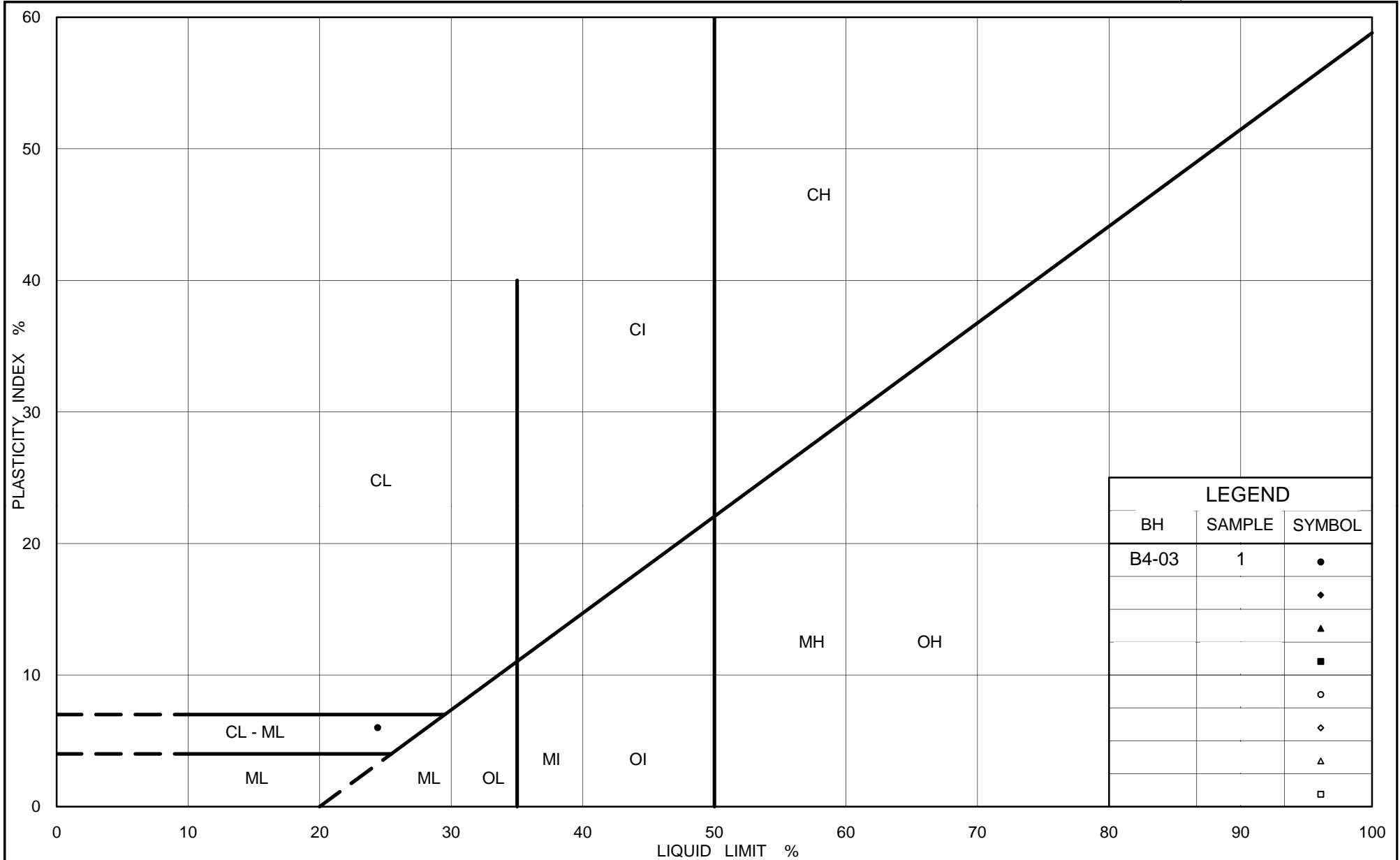
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	B4-09	3	202.7

Project Number: 07-1111-0029

Checked By: CN

**Golder Associates**

Date: 12-Aug-10



Ministry of Transportation

Ontario

# PLASTICITY CHART Clayey Silt North Abutment

Figure No. B1-3

Project No. 07-1111-0029

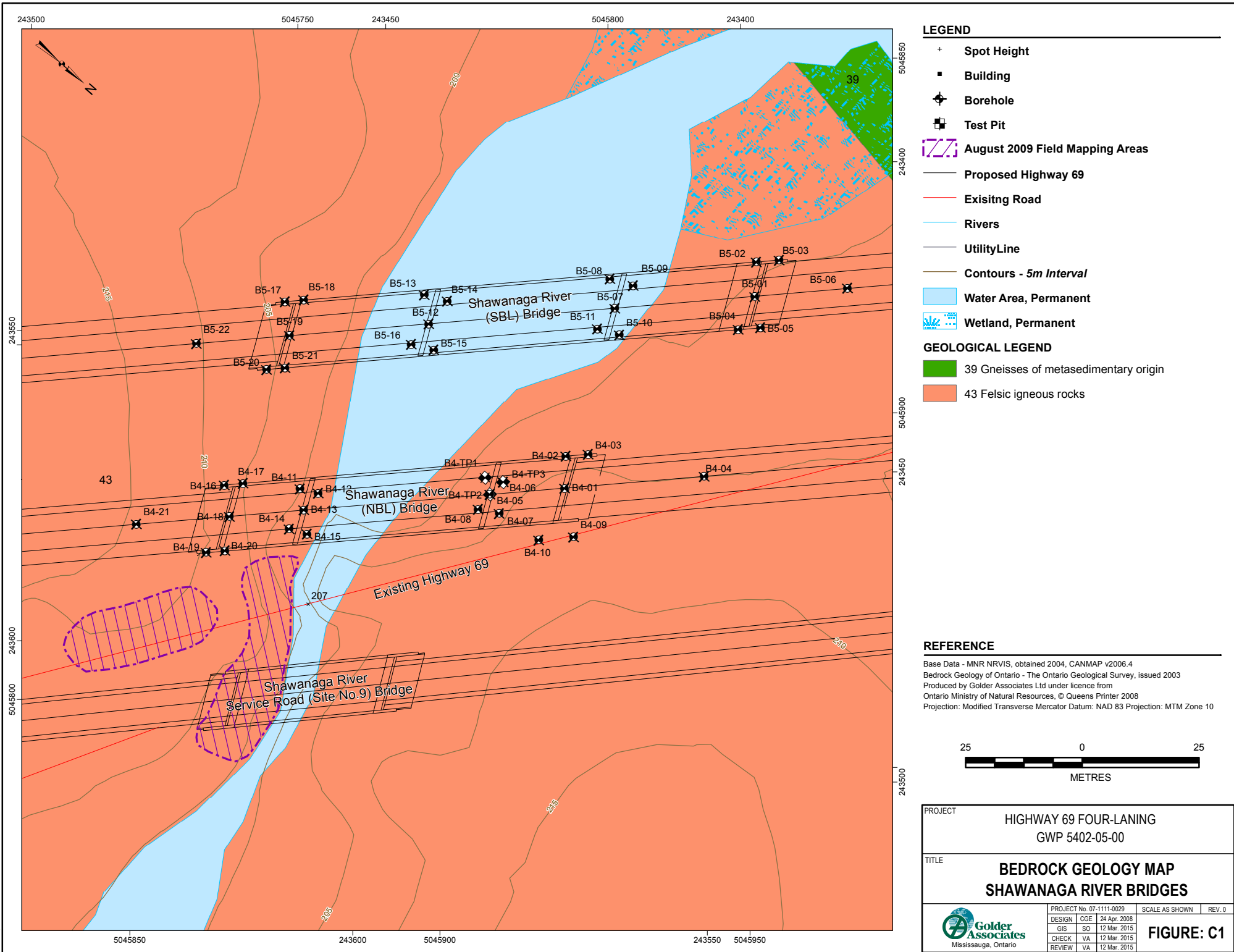
Checked By: CN



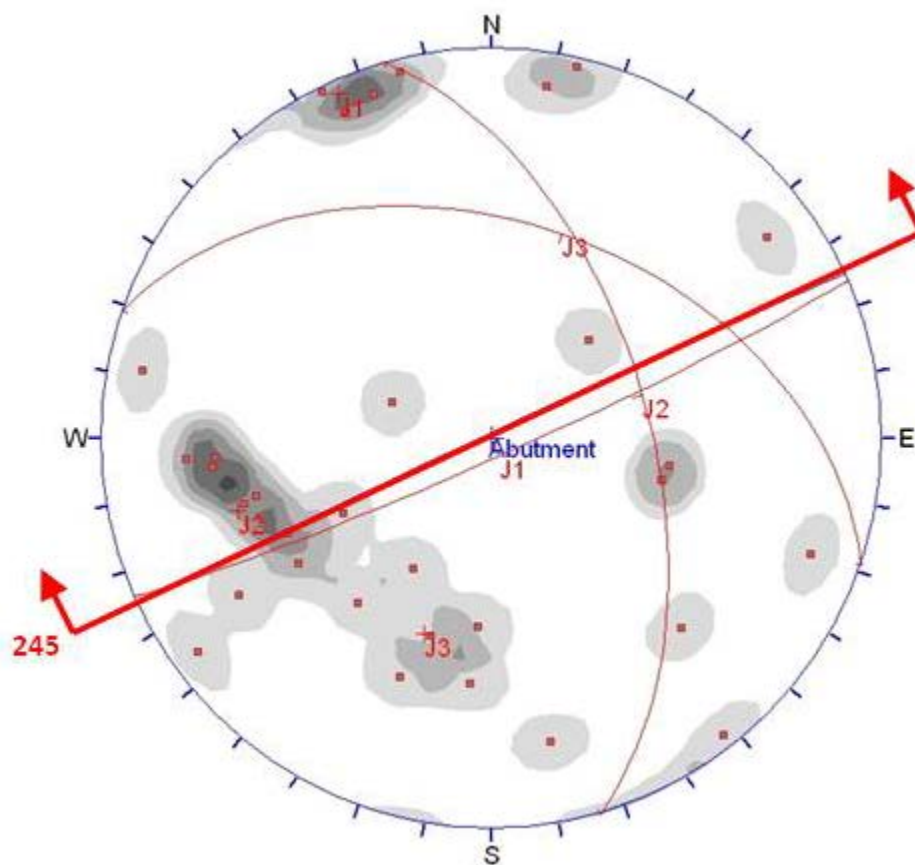
# APPENDIX C

## ROCK MAPPING

G:\Projects\2007\07-1111-0029\_MRC\_ParrySoundGIS\MXDs\Draft\Bedrock-Geology\_8.5x11\_Rotated.mxd







Fisher  
Concentrations  
% of total per 1.0 % area



0.00 ~ 2.00 %  
2.00 ~ 4.00 %  
4.00 ~ 6.00 %  
6.00 ~ 8.00 %  
8.00 ~ 10.00 %  
10.00 ~ 12.00 %  
12.00 ~ 14.00 %

Orientations

ID		Dip / Direction
J1	m	86 / 156
J2	m	57 / 074
J3	m	44 / 019

No Bias Correction  
Max. Conc. = 10.7163%

Equal Area  
Lower Hemisphere  
32 Poles  
32 Entries

PROJECT Highway 69 Shawanaga River Bridge (NBL)  
Structure

TITLE  
**Shawanaga River Bridge (NBL) South Abutment  
Bedrock Outcrop Data**



PROJECT No. 07-1111-0029			FILE No. ----	
DESIGN	DAC	APR 2011	SCALE	AS SHOWN
CADD	DAC	APR 2011	REV.	
CHECK	JPD	APR 2011		
REVIEW	JMAC	APR 2011		


**Figure C2**

**Old Highway 69 South Abutment (pre-1957)**



**Existing Highway 69 South Abutment**



PROJECT		Highway 69 Shawanaga River Bridge (NBL) Structure			
TITLE		Rock Mapping Photos			
		PROJECT No. 07-1111-0029		FILE No. ----	
		DESIGN	DAC	APR 2011	SCALE AS SHOWN
		CADD	DAC	APR 2011	REV.
		CHECK	JPD	APR 2011	
		REVIEW	JMAC	APR 2011	
					<b>Figure C3</b>




## Proposed Shawanaga River Bridge (NBL) South Abutment



## East Side of Proposed Highway 69 NBL between about STA 17+ 620 and 17+650




PROJECT		Highway 69 Shawanaga River Bridge (NBL) Structure			
TITLE		Rock Mapping Photos			
		PROJECT No. 07-1111-0029		FILE No. ----	
		DESIGN	DAC	APR 2011	SCALE AS SHOWN
		CADD	DAC	APR 2011	REV.
		CHECK	JPD	APR 2011	
		REVIEW	JMAC	APR 2011	
					<b>Figure C4</b>



## East Side of Proposed Shawanaga River Bridge (NBL) South Abutment

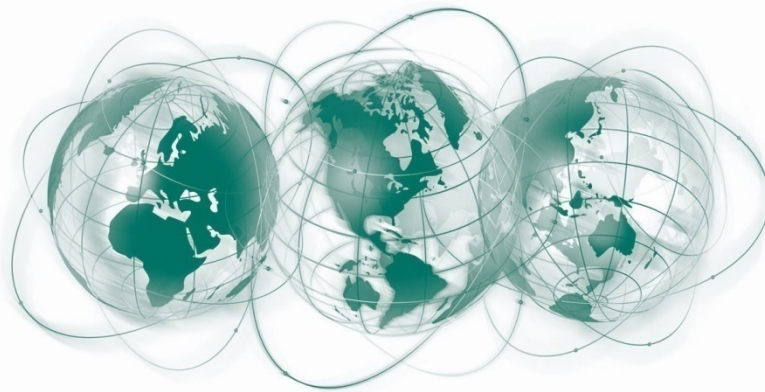


PROJECT		Highway 69 Shawanaga River Bridge (NBL) Structure			
TITLE		Rock Mapping Photo			
	PROJECT No. 07-1111-0029			FILE No. ----	
	DESIGN	DAC	APR 2011	SCALE AS SHOWN	REV.
	CADD	DAC	APR 2011	Figure C5	
	CHECK	JPD	APR 2011		
	REVIEW	JMAC	APR 2011		

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