



**JULY 2012**

## **FOUNDATION INVESTIGATION AND DESIGN REPORT**

**OVERHEAD SIGNS  
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. 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>1</b>
3.1 Foundation Investigation .....	1
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....</b>	<b>3</b>
4.1 Regional Geology.....	3
4.2 Subsurface Conditions .....	3
4.3 Overhead Sign 1 - STA 14+529 (Township of Carling) .....	4
4.3.1 Topsoil.....	4
4.3.2 Sand .....	4
4.3.3 Bedrock .....	4
4.3.4 Groundwater Conditions .....	5
4.4 Overhead Sign 3 - STA 12+750 (Township of Shawanaga).....	5
4.4.1 Asphalt .....	5
4.4.2 Sand and Gravel to Sand Fill.....	5
4.4.3 Bedrock .....	6
4.4.4 Groundwater Conditions .....	6
4.5 Overhead Sign 4 - STA 13+675 (Township of Shawanaga).....	6
4.5.1 Sand to Sand and Gravel Fill.....	7
4.5.2 Bedrock .....	7
4.5.3 Groundwater Conditions .....	8
<b>5.0 CLOSURE .....</b>	<b>8</b>

### **PART B – FOUNDATION DESIGN REPORT**

<b>6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS .....</b>	<b>10</b>
6.1 General .....	10
6.2 Overhead Sign Foundations.....	10
6.2.1 Caissons.....	10
6.2.2 Spread Footings .....	12



## FOUNDATION REPORT – OVERHEAD SIGNS – HIGHWAY 69 G.W.P. 5402-05-00

6.2.2.1	Geotechnical Axial Resistance.....	12
6.2.2.2	Resistance to Lateral Loads.....	13
6.3	Construction Considerations .....	13
<b>7.0</b>	<b>CLOSURE .....</b>	<b>14</b>

### References

Lists of Symbols and Abbreviations

Lithological and Geotechnical Rock Description Terminology

### LIST OF TABLES

Table 1	Evaluation of Foundation Alternatives – Overhead Signs 1, 3 and 4
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### LIST OF DRAWINGS

Drawing 1	Site Location Plan
Drawing 2	Highway 69 – Overhead Signs (OHS) – Index Plan

### LIST OF APPENDICES

#### **Appendix A** Highway 69 NBL – Overhead Sign 1 – STA 14+529

Record of Boreholes	OHS-1A and OHS-1B
Record of Drillholes	OHS-1A and OHS-1B
Drawing A1	Borehole Locations and Soil Strata
Figure A1	Grain Size Distribution – Sand
Table A1	Point Load Test on Rock Samples

#### **Appendix B** Highway 69 NBL – Overhead Sign 3 – STA 12+750

Record of Boreholes	OHS-3A and OHS-3B
Record of Drillholes	OHS-3A and OHS-3B
Drawing B1	Borehole Locations and Soil Strata
Table B1	Point Load Test on Rock Samples

#### **Appendix C** Highway 69 Existing – Overhead Sign 4 – STA 13+675

Record of Boreholes	OHS-4A and OHS-4B
Record of Drillholes	OHS-4A and OHS-4B
Drawing C1	Borehole Locations and Soil Strata
Figure C1	Grain Size Distribution – Sand and Gravel Fill
Table C1	Point Load Test on Rock Samples

#### **Appendix D** Non-Standard Special Provisions

Mass Concrete	– Item No.
Dowels into Rock	– Item No.
Control of Overburden Soils	– Item No.



# **PART A**

**FOUNDATION INVESTIGATION REPORT**

**OVERHEAD SIGNS**

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**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5402-05-00**





## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for three (3) proposed overhead signs (OHS) within the Phase 1 limits of the new Highway 69 alignment. 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/extent of the Phase 1 new Highway 69 four-laning alignment within which the overhead signs are located is shown on the Site Location Plan on Drawing 1. The general locations of the three overhead signs are shown on Drawings 1 and 2.

The Terms of Reference and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated January 2007. Golder's proposal for foundation engineering services associated with the overhead signs in Phase 1 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 Project Specific Supplementary Specialty Plan for foundation engineering services for this project, dated July 4, 2007.

This report addresses the investigation carried out for the three proposed overhead signs along Highway 69 in Phase 1 only. Separate reports address the foundation investigations and design for the related swamp crossings, high fill areas for the associated 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 overhead sign foundations by borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The foundation limits for this investigation were located in the field using survey stakes put down by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The area of the investigation is shown in plan on Drawing 2.

## **2.0 SITE DESCRIPTION**

The proposed Overhead Sign 1 (OHS-1) is located at STA 14+529, on the proposed Highway 69 NBL alignment, in the Township of Carling, while the proposed Overhead Sign 3 (OHS-3) and Overhead Sign 4 (OHS-4) are located at STA 12+750 on the proposed Highway 69 NBL alignment and STA 13+675 on the existing Highway 69 alignment, respectively, in the Township of Shawanaga.

In general, the topography in the area of the sign locations consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water and various types of vegetation and organic soils. The proposed overhead signs are to be located in areas of bedrock outcrop or areas with thin overburden or existing fills over bedrock.

The ground surface at the proposed overhead sign locations is at between about Elevation 224.2 m and 221 m at the Overhead Sign 1 (OHS-1), at about Elevation 217.5 m at Overhead Sign 3 (OHS-3), and at about Elevation 214.1 m at Overhead Sign 4 (OHS-4).

## **3.0 INVESTIGATION PROCEDURES**

### **3.1 Foundation Investigation**

The field work for the overhead signs investigation was carried out between October 5 and 25, 2010, during which time a total of six (6) boreholes were advanced, two (2) boreholes at each of the proposed overhead sign structure (i.e. one (1) at each foundation element). The boreholes, designated as Boreholes OHS-1A, OHS-1B,



OHS-3A, OHS-3B, OHS-4A and OHS-4B, were advanced at the locations shown in plan on Drawings A1, B1 and C1, in Appendices A to C.

The field investigation was carried out using a track-mounted Diedrich D-50 drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario and a track-mounted CME-850 drill rig supplied by Landcore Drilling of Chelmsford, Ontario. The boreholes were advanced through the overburden using 165 mm outside diameter (O.D.) solid-stem augers and 'NW' casing. Soil samples were obtained continuously or 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). Samples of the bedrock were obtained using an 'NQ' size rock core barrel.

The boreholes were advanced through the overburden to auger and/or sampler refusal (i.e. inferred bedrock) and bedrock was confirmed by coring in all of the boreholes. The boreholes were advanced to depths of up to about 5.4 m below existing ground surface, including coring of bedrock for core lengths between about 2.7 m and 5.4 m.

The groundwater conditions in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to C. It should be noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since water was introduced into the boreholes for coring operations and the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended).

The field work was observed by members of our technical staff who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing, such as water content and grain size distribution, was carried out on selected soil samples. Classification of the bedrock rock mass quality with respect to the Rock Quality Description (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (2006)<sup>1</sup>. Point load strength tests, both perpendicular to the core axis (diametral test) and along the core axis (axial test) were performed on selected samples of the rock core to provide an indication of the point load strength index ( $Is_{50}$ )<sup>2</sup> of the rock. The bedrock was then classified with respect to strength based on the  $Is_{50}$  values as suggested in Table 3.5 of the Canadian Foundation Engineering Manual (2006)<sup>1</sup>. The results of the laboratory testing for the overhead signs are included in Appendices A to C.

The as-drilled borehole locations and ground surface elevations were surveyed by members of our technical staff, referenced to the survey stakes put down by Callon Dietz. The borehole locations provided in the Record of Borehole and Drillhole sheets as well as on Drawings A1, B1 and C1 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.

<sup>1</sup> Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

<sup>2</sup> International Society for Rock Mechanics (ISRM), 1985. Suggested Method for Determining Point Load Strength. Int. J. Rock Mech. Min. Sci. and Geomech. Abst., Vol. 22, pp 51-60.



Borehole No.	Location (MTM NAD 83)		Collar Elevation (Geodetic Datum) (m)	Depth Drilled (m)
	Northing	Easting		
OHS-1A	5035506.9	253807.7	224.2	5.4
OHS-1B	5035520.3	253822.4	221.1	4.5
OHS-3A	5042403.6	247029.2	217.5	4.8
OHS-3B	5042413.6	247039.8	217.4	4.0
OHS-4A	5043091.1	246402.0	214.1	3.9
OHS-4B	5043075.6	246389.1	214.2	4.7

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in The Physiography of Southern Ontario<sup>3</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 native 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>4</sup>. Deposition of Palaeozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

### 4.2 Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced for this investigation, together with the results of the laboratory tests carried out on selected soil and rock core samples, are presented on the attached Record of Borehole and Drillhole sheets in Appendices A to C. 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. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

<sup>3</sup> Chapman, L.J. and Putnam, D.F., 1984. The Physiography of Southern Ontario, Ontario Geological Survey Special Volume 2, Third Edition. Accompanied by Map P.2715, SSscale 1:600,000.

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



In general, the subsurface conditions in the area of the proposed overhead signs typically consist of a cohesionless deposit of sand or sand and gravel fill underlain by granite gneiss bedrock. At one borehole location, exposed bedrock was encountered at ground surface.

The following sections provide information on the subsoils and groundwater conditions encountered in the boreholes advanced at each of the proposed overhead sign location.

### **4.3 Overhead Sign 1 - STA 14+529 (Township of Carling)**

Two (2) boreholes (Boreholes OHS-1A and OHS-1B) were advanced at the proposed locations of the foundation support elements for the OHS-1. In general, bedrock was encountered at ground surface or below a thin deposit of sand.

#### **4.3.1 Topsoil**

A 0.1 m thick surficial layer of topsoil was encountered at the ground surface in Borehole OHS-1B on the east side of the proposed overhead sign location.

#### **4.3.2 Sand**

A deposit of dark brown sand trace to some silt, trace gravel, trace clay and containing organics and rootlets was encountered below the topsoil in Borehole OHS-1B. The top of the sand deposit is at about Elevation 221.0 m and its thickness is about 1.0 m.

The Standard Penetration Test (SPT) 'N'-values measured within this deposit are 2 blows and 50 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The natural water content measured on one (1) sample of this deposit is about 29 percent. The grain size distribution of one (1) sample of the sand deposit is presented on Figure A1 in Appendix A.

#### **4.3.3 Bedrock**

Bedrock was encountered and core samples were recovered at the ground surface and below the deposit of sand in Boreholes OHS-1A and OHS-1B, respectively. The depth to bedrock below ground surface and the corresponding bedrock surface elevation are summarized below.

<b>Borehole No.</b>	<b>Depth to Bedrock Surface (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Refusal Type</b>
OHS-1A	0.0	224.2	Bedrock Cored
OHS-1B	1.1	220.0	Bedrock Cored

Based on the rock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered to fresh, foliated, coarse grained and pink to grey to black. The Rock Quality Designation (RQD) measured on the core samples ranges from 36 percent to 100 percent, indicating a rock mass of poor to excellent quality. The Total Core Recovery (TCR) of the core samples is between 91 percent and 100 percent and the Solid Core Recovery (SCR) of samples recovered is between 59 percent and 100 percent.



Laboratory point load strength tests were performed on selected samples of the rock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table A1 in Appendix A. The axial tests carried out on six (6) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 6.8 MPa to 8.6 MPa and the diametral tests carried out on eight (8) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 3.7 MPa to 7.3 MPa.

Also presented in Table A1 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, as well as the estimated UCS of bedrock core samples from other structure sites in the area of the overhead sign. For this site, the UCS values are based on an estimated average correlation factor (K) of 20.

Based on the axial point load testing results in accordance with Table 3.5 in CFEM (2006) the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.3.4 Groundwater Conditions**

The overburden samples taken in the boreholes were moist. The water level observed in one of the boreholes during drilling was at about Elevation 220.5 m, or at a depth of about 0.6 m below ground surface.

It should be noted that the groundwater level given above, as measured during the drilling operation, is not stabilized, is subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.

### **4.4 Overhead Sign 3 - STA 12+750 (Township of Shawanaga)**

Two (2) boreholes (Boreholes OHS-3A and OHS-3B) were advanced at the proposed locations of the foundation support elements for the OHS-3. In general, the subsurface conditions consist of sand and gravel to sand fill over bedrock.

#### **4.4.1 Asphalt**

A 0.1 m thick layer of asphalt was encountered at the ground surface in Borehole OHS-3A on the west side of the proposed overhead sign location.

#### **4.4.2 Sand and Gravel to Sand Fill**

A deposit of fill associated with the existing highway embankment was encountered below the asphalt layer in Borehole OHS-3A and at the ground surface in Borehole OHS-3B. The fill consists of grey sand and gravel to brown sand, trace to some gravel, trace to some silt and contains rootlets and; at one of the borehole locations, cobbles were inferred to be present based on the augers grinding during the drilling operations. The top of the fill deposit is at about Elevation 217.4 m and its thickness is about 1.3 m and 0.8 m in Boreholes OHS-3A and OHS-3B, respectively.

The SPT 'N'-values measured within the fill deposit are between 9 blows and 72 blows per 0.3 m of penetration, indicating a loose to very dense relative density.

The natural water content measured on four (4) samples of this deposit ranges between about 4 percent and 9 percent.



#### **4.4.3 Bedrock**

Bedrock was encountered and core samples were recovered below the fill in Boreholes OHS-3A and OHS-3B. The depth to bedrock below ground surface and the corresponding bedrock surface elevation are summarized below.

<b>Borehole No.</b>	<b>Depth to Bedrock Surface (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Refusal Type</b>
OHS-3A	1.4	216.1	Bedrock Cored
OHS-3B	0.8	216.6	Bedrock Cored

Based on the rock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as moderately weathered to slightly weathered, foliated, coarse grained and pink to grey to black with occasional white strips. The Rock Quality Designation (RQD) measured on the core samples ranges between 40 percent and 100 percent, indicating a rock mass of poor to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the samples recovered are between 92 percent and 100 percent, and between 50 percent and 100 percent, respectively.

Laboratory point load strength tests were performed on selected samples of the rock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on four (4) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 6.1 MPa to 13.5 MPa and the diametral tests carried out on eight (8) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 4.3 MPa to 9.1 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, as well as the estimated UCS of bedrock core samples from other structure sites in the area of the overhead sign. For this overhead sign site, the UCS values are based on an estimated average correlation factor (K) of 18.

Based on the axial point load testing results the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.4.4 Groundwater Conditions**

In general, the overburden fill samples taken in the boreholes advanced in this area were moist. The water level observed in the boreholes upon completion of drilling operations was about Elevation 216.6 m and 216.0 m, or at depths of about 1.5 m and 0.8 m below ground surface, respectively.

It should be noted that the groundwater levels given above, as measured during the drilling operation, are not stabilized, are subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.

### **4.5 Overhead Sign 4 - STA 13+675 (Township of Shawanaga)**

Two (2) boreholes (Boreholes OHS-4A and OHS-4B) were advanced at the proposed west and east foundation support elements for the OHS-4. In general, the subsurface conditions consist of sand to sand and gravel fill over bedrock.





#### **4.5.1 Sand to Sand and Gravel Fill**

A deposit of fill associated with the existing highway embankment was encountered at the ground surface in both boreholes advanced at this site. The fill consists of brown sand some gravel, to sand and gravel, trace to some silt and rootlets. The top of the fill deposit is about Elevation 214.1 m and 214.2 m and its thickness is about 0.4 m and 2.0 m at Boreholes OHS-4A and OHS-4B, respectively. In Borehole OHS-4B, an approximately 0.2 m thick layer of cobbles was encountered at a depth of about 1.2 m below ground surface (at about Elevation 213.0 m).

The SPT 'N'-values measured within the fill deposit range between 7 blows and 26 blows per 0.3 m of penetration and one value of 43 blows per 0.28 m of penetration, indicating a loose to dense relative density.

The natural water content measured on three (3) samples of the fill deposit ranges from about 1 percent to 10 percent.

The grain size distribution of one (1) sample of the sand and gravel fill deposit is presented on Figure C1 in Appendix C.

#### **4.5.2 Bedrock**

Bedrock was encountered and core samples were recovered below the fill in Boreholes OHS-4A and OHS-4B. The depth to bedrock below ground surface and the corresponding bedrock surface elevation are summarized below.

<b>Borehole No.</b>	<b>Depth to Bedrock Surface (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Refusal Type</b>
OHS-4A	0.4	213.7	Bedrock Cored
OHS-4B	2.0	212.2	Bedrock Cored

Based on the rock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered, foliated, coarse grained and dark grey to black. The Rock Quality Designation (RQD) measured on the core samples ranges between 47 percent and 100 percent, indicating a rock mass of poor to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the samples recovered are between 93 percent and 100 percent, and between 60 percent and 100 percent, respectively.

Laboratory point load strength tests were performed on selected samples of the rock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table C1 in Appendix C. The axial tests carried out on four (4) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 7.3 MPa to 9.0 MPa and the diametral tests carried out on six (6) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from about 4.1 MPa to 10.1 MPa.

Also presented in Table C1 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, as well as the estimated UCS of bedrock core samples from other structure sites in the area of the overhead sign. For this overhead sign site, the UCS values are based on an estimated average correlation factor (K) of 18.



Based on the axial point load testing results the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.5.3 Groundwater Conditions**

In general, the overburden samples taken in the boreholes advanced in this area were moist. The water level observed in the boreholes during and upon completion of drilling operations was at about Elevation 214.1 m and 212.5 m, at depths of 0.0 m (i.e. ground surface) and 1.7 m below ground surface, respectively.

It should be noted that the groundwater levels given above, as measured during the drilling operation, are not stabilized, are subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.

### **5.0 CLOSURE**

Messrs. Matt Rhody and Ed H. Savard, senior field technicians with Golder, directed the drilling program. 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, 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.





## Report Signature Page

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TVA/CN/JPD/JMAC/sf

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# **PART B**

**FOUNDATION DESIGN REPORT**

**OVERHEAD SIGNS**

**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. 5402-05-00**



## **6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS**

This section of the report provides geotechnical parameters and recommendations for the design and construction of foundations for the proposed overhead signs. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation for this project. The interpretation and recommendations presented are intended to provide the designers with sufficient information to design the proposed sign foundations. Where comments are made on construction, they are provided in order to highlight those aspects which could affect the planning of the project, and for which special provisions or operational constraints may be required during construction. Those requiring information on the aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

### **6.1 General**

Golder Associates Ltd. (Golder) was retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of Ministry of Transportation, Ontario (MTO) to provide an assessment of foundation options, geotechnical parameters and recommendations on foundation aspects for three (3) proposed overhead signs to be located along the new and existing Highway 69 at approximately STA 14+529, in the Township of Carling and STA 12+750 and STA 13+675 in the Township of Shawanaga.

The overall project involves the design of a 17 km section of the new Highway 69 four-laning alignment north of Nobel, Ontario, including high fill embankments and embankments over swamps, the Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, as well as culvert crossings and variable message sign.

### **6.2 Overhead Sign Foundations**

Overhead sign supports, understood to be tri-chord static sign supports for these sites, are typically designed with a “standard” caisson foundation design, in accordance with the requirements in MTO’s *Sign Support Manual* (2011). However, given that the bedrock at the proposed three overhead sign locations at this site is present at the ground surface or at relatively shallow depths below ground surface, the foundations for the support of the overhead signs can be designed as caissons socketted into bedrock or as spread footings dowelled into the bedrock. Recommendations for these two foundation options are provided in Sections 6.2.1 and 6.2.2. The advantages, disadvantages, relative costs and risks/consequences for each of the foundation options are summarized in Table 1.

#### **6.2.1 Caissons**

As noted above, caisson foundations for overhead sign supports should be designed in accordance with the requirements in MTO’s *Sign Support Manual* (2011). The *Sign Support Manual* includes a standard caisson foundation design for tri-chord static sign supports (Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5), in which the caisson extends 5 m below the design frost depth, except where bedrock is encountered within this depth. As shown on the depth of frost penetration isopleths for Southern Ontario in OPD 3090.101 (Foundation Frost Penetration Depths), the estimated depth of frost penetration at the site is approximately 1.8 m.



## FOUNDATION REPORT – OVERHEAD SIGNS – HIGHWAY 69 G.W.P. 5402-05-00

In accordance with Standard Drawing SS118-3 of MTO's *Sign Support Manual*, where bedrock is encountered at a depth less than 5 m below the bottom of the depth of frost penetration, the required depth of the caisson foundation below the frost depth may be taken as follows:

$$L = Y + \frac{5-Y}{2}$$

where:

L = length of caisson below depth of frost penetration (m)

Y = distance between depth of frost penetration and depth to bedrock (m)

Based on the above equation, the lengths of caissons as well as the length of caisson socketted into the gneiss bedrock for the three overhead signs are summarized below.

Overhead Sign	Borehole No.	Depth to Bedrock (m)	Depth of Frost Penetration (m)	Distance between Depth of Frost Penetration and Depth to Bedrock, Y (m)	Caisson Length Below Depth of Frost Penetration, L (m)	Total Caisson Length (m)	Length of Caisson Socketted into Bedrock (m)
OHS-1	OHS-1A	0.0	0.0	$0.0 - 0.0 = 0.0$	2.5	$2.5 + 0.0 = 2.5$	$2.5 - 0.0 = 2.5$
	OHS-1B	1.1	1.1	$1.1 - 1.1 = 0.0$	2.5	$2.5 + 1.1 = 3.6$	$3.6 - 1.1 = 2.5$
OHS-3	OHS-3A	1.4	1.4	$1.4 - 1.4 = 0.0$	2.5	$2.5 + 1.4 = 3.9$	$3.9 - 1.4 = 2.5$
	OHS-3B	0.8	0.8	$0.8 - 0.8 = 0.0$	2.5	$2.5 + 0.8 = 3.3$	$3.3 - 0.8 = 2.5$
OHS-4	OHS-4A	0.4	0.4	$0.4 - 0.4 = 0.0$	2.5	$2.5 + 0.4 = 2.9$	$2.9 - 0.4 = 2.5$
	OHS-4B	2.0	1.8	$2.0 - 1.8 = 0.2$	2.6	$2.6 + 1.8 = 4.4$	$4.4 - 2.0 = 2.4$

Because the overburden at the proposed overhead sign locations is thinner than the estimated depth of frost penetration at essentially all of the proposed sign location (except at the west support of OHS-4 where a very thin layer of soil exists below the frost penetration depth), the overburden will not provide any resistance to lateral loadings and the caissons should be designed to derive lateral resistance from the portion of the caisson socketted into bedrock only. As such, the geotechnical design parameters for the overburden soils are not required nor provided herein.

The bedrock at the proposed overhead sign locations is classified as strong to very strong and as such, appropriate equipment and construction procedures (such as coring or churn drilling techniques) would be required to advance the sockets into the bedrock.



### **6.2.2 Spread Footings**

As an alternative to caissons socketted into bedrock, consideration could be given to using spread footings to support the overhead signs. At the proposed sign locations, all of the spread footing should be founded on bedrock. The advantage of constructing spread footings as compared to constructing caissons is the elimination of coring or churn drilling into strong to very strong bedrock. However, the disadvantages of using spread footings for support of the overhead signs is the need for larger excavations, and potential need for dewatering.

Based on information provided by MRC on July 28, 2011, it is understood that spread footings founded on bedrock is the preferred option for these locations. Spread footings founded on bedrock is also the preferred option from a foundation perspective as the excavation depth to bedrock is relatively shallow and drilling of/into bedrock is not required. However, because of the shallow depth to bedrock it may be necessary to anchor the footing to bedrock to achieve adequate lateral resistance. In addition, variations in the bedrock surface elevation are to be expected in the areas of the proposed overhead signs and as such, mass concrete and/or hoe ramming may be required to achieve a level footing at the design elevations.

The bedrock encountered at the proposed overhead sign locations is of generally good quality, but nevertheless, the founding surface should be properly prepared (i.e. sub-excavated of any loose and fractured bedrock). Where the bedrock surface is above the design elevation of the footing, hoe ramming may be required to achieve the founding grade of the underside of the footing. Conversely, where bedrock surface is below the design elevation of the footing, mass concrete would be required to raise the founding grade to the design elevation of the underside of the footing. Given the uneven and sloping nature of the bedrock surface, a Non-Standard Special Provision (NSSP) for mass concrete should be included in the Contract Documents in the event that a thicker footing is required; an example NSSP is provided in Appendix D.

Excavations for the proposed spread footings should be carried out in accordance with the latest Occupational Health and Safety Act for Construction Projects (OHSA). When referencing OHSA, the granular fills and native sand deposit should be considered as "Type 3 Soil". As such, excavations should be sloped at a gradient of 1 Horizontal to 1 Vertical (1H:1V) or flatter. For excavations into the bedrock, if necessary, the overall slope to the cut face may be formed vertically, or near vertically (i.e. about 0.5H:1V).

Given the anticipated limited size of the excavation and limited overburden thickness, seepage into the excavation should be adequately controlled by pumping from properly filtered sumps. However, it should be noted that the groundwater levels are subject to seasonal fluctuations and precipitation events and as such, the proposed construction method and/or the construction schedule should be planned accordingly.

During construction, stockpiles should be placed well away from the edge of the excavation, and their height should be controlled so they do not surcharge the sides of the excavation and/or overall existing embankment slopes. Generally, for the sign proposed to be located on the existing highway, the distance between the crest of the excavation and the toe of the stockpile should be greater than the depth of adjacent excavation.

Inspection and approval of the foundation areas by the Quality Verification Engineer prior to footing construction should be carried out as required in accordance with OPSS 902 (Excavating and Backfilling), to ensure that all loose soils and/or fractured rock has been removed from the foundation areas and that the foundation base has been properly prepared for the placement of concrete.

#### **6.2.2.1 Geotechnical Axial Resistance**

For spread footings bearing directly on the bedrock surface or on mass concrete over bedrock, a factored geotechnical axial resistance at Ultimate Limit States (ULS) of 10 MPa may be used for design (in accordance with Section 9.2 in CFEM (2006)). Serviceability Limit States (SLS) conditions do not apply for footings founded on bedrock or on mass concrete.



The geotechnical resistances provided above are given for loads applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Clauses 6.7.4 and C6.7.4 of the *Canadian Highway Bridge Design Code (CHBDC)* and its *Commentary*.

### **6.2.2.2 Resistance to Lateral Loads**

Resistance to lateral forces/sliding resistance between the concrete footings and the prepared bedrock surface should be calculated in accordance with Section 6.7.5 of the *CHBDC*. The following summarizes the coefficient of friction,  $\tan \delta$ , for the interface materials.

Interface Materials	Coefficient of Friction ( $\tan \delta$ )
Concrete footing on Bedrock	0.70

This value represents an unfactored value; in accordance with *CHBDC*, a factor of 0.8 is to be applied in calculating horizontal resistance.

For footings on bedrock, the sliding/lateral resistance between the concrete footing/mass concrete and the bedrock may be supplemented by dowelling into the bedrock, if necessary. The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. A factored ULS value of 750 kPa may be assumed for the grout-to-rock bond stress along the shaft/socket of the dowel in the bedrock. This value refers to the rock-grout interface strength and can be used for tension design. The actual bond stress along the rock-grout interface may vary from the design value and should therefore be verified in the field as noted below. For the proposed overhead sign locations where the rock mass is stronger than concrete, the design of the dowels into the bedrock may be considered in the same way as dowels embedded into the concrete. This assumes that the Unconfined Compressive Strength (USC) of the grout will be similar to that of the concrete. The dowels should have a 1 m minimum embedded length within the bedrock, and the structural strength of the dowel and compressive strength of the grout should not be exceeded. If dowelling is required for structural considerations, a Non-Standard Special Provision (NSSP) should be included in the Contract Documents to specify the installation, materials and testing of the dowels; an example is provided in Appendix D.

## **6.3 Construction Considerations**

The excavations around and above the spread footings may be backfilled using an approved granular material such as MTO's Special Provision 110S13 (Aggregates) Granular 'A' or 'B' Type I placed and compacted in accordance with OPSS 501, or Granular 'B' Type II placed and compacted in accordance with Special Provision 314S01 (Granular 'B' Type II).

The final grade surrounding the sign support should be sloped to promote surface water drainage and pavement structure drainage away from the pavement and sign support, to the adjacent ditches.

As the excavations, either for spread footings or for caissons, will extend through granular overburden and likely to below the groundwater level(s), it is recommended that a NSSP be included in the Contract Documents to warn the Contractor of these conditions which may affect the installation of the overhead sign foundations. An example NSSP is provided in Appendix D.



## **7.0 CLOSURE**

This report was prepared by Ms. T. Veronica Ayetan, P. Eng. and Mr. Christopher Ng, P. Eng. The technical aspects were reviewed by Mr. J. Paul Dittrich, 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.





## Report Signature Page

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## REFERENCES

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- Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA-S6-06. 2006. CSA Special Publication, S6.1-06. Canadian Standard Association.
- Chapman, L.J. and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.
- Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 2. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.
- International Society for Rock Mechanics (ISRM), 1985. Suggested Method for Determining Point Load Strength, International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock Mech. Min. Sci. and Geomech. Abst., Vol 22, No 2, pp 51-60.; as referenced in ASTM Designation: D 5731-08 "Standard Test Method for Determination of Point Load Strength Index of Rock and Application to Rock Strength Classification"
- Ministry of Transportation, Ontario, 2011. Sign Support Manual. Policy, Planning and Standards Division, Engineering Standards Branch, Bridge Office

### STANDARDS:

#### ASTM International:

ASTM D 1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D 5731	Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

#### Ministry of Transportation Ontario:

Special Provision 110S13	Amendment to OPSS 1010 – Material Specification for Aggregates, -Base, Subbase, Select Subgrade and Backfill Material.
Special Provision 314S01	Amendment to OPSS 314 – Construction Specification for Untreated Granular, Subbase, Base, Surface Shoulder and Stockpiling.

#### Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91	Construction Projects
Ontario Regulation 443/09	Amendment to Ontario Regulation 213

#### Ontario Provisional Standard Drawing:

OPSD 3090.101	Foundation Frost Penetration Depths for Southern Ontario.
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#### Ontario Provincial Standard Specification:

OPSS 902	Construction Specification for Excavating and Backfilling – Structures
OPSS 501	Construction Specification for Compacting

#### Ontario Water Resources Act:

Ontario Regulation 903	Well
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## 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

### 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.

### 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

#### (b) Cohesive Soils Consistency

	kPa	$C_u, S_u$	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
$w_p$	plastic limit
$w_l$	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>
$D_R$	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
$SO_4$	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

## WEATHERINGS STATE

**Fresh:** no visible sign of weathering

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

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

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

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

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

## BEDDING THICKNESS

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

## JOINT OR FOLIATION SPACING

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

## GRAIN SIZE

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

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

## CORE CONDITION

### Total Core Recovery (TCR)

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

### Solid Core Recovery (SCR)

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

### Rock Quality Designation (RQD)

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

## DISCONTINUITY DATA

### Fracture Index

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

### Dip with Respect to Core Axis

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

### Description and Notes

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

### Abbreviations

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



## FOUNDATION REPORT – OVERHEAD SIGNS HIGHWAY 69 G.W.P. 5402-05-00

**TABLE 1**  
**EVALUATION OF FOUNDATION ALTERNATIVES – OVERHEAD SIGNS 1, 3 and 4**

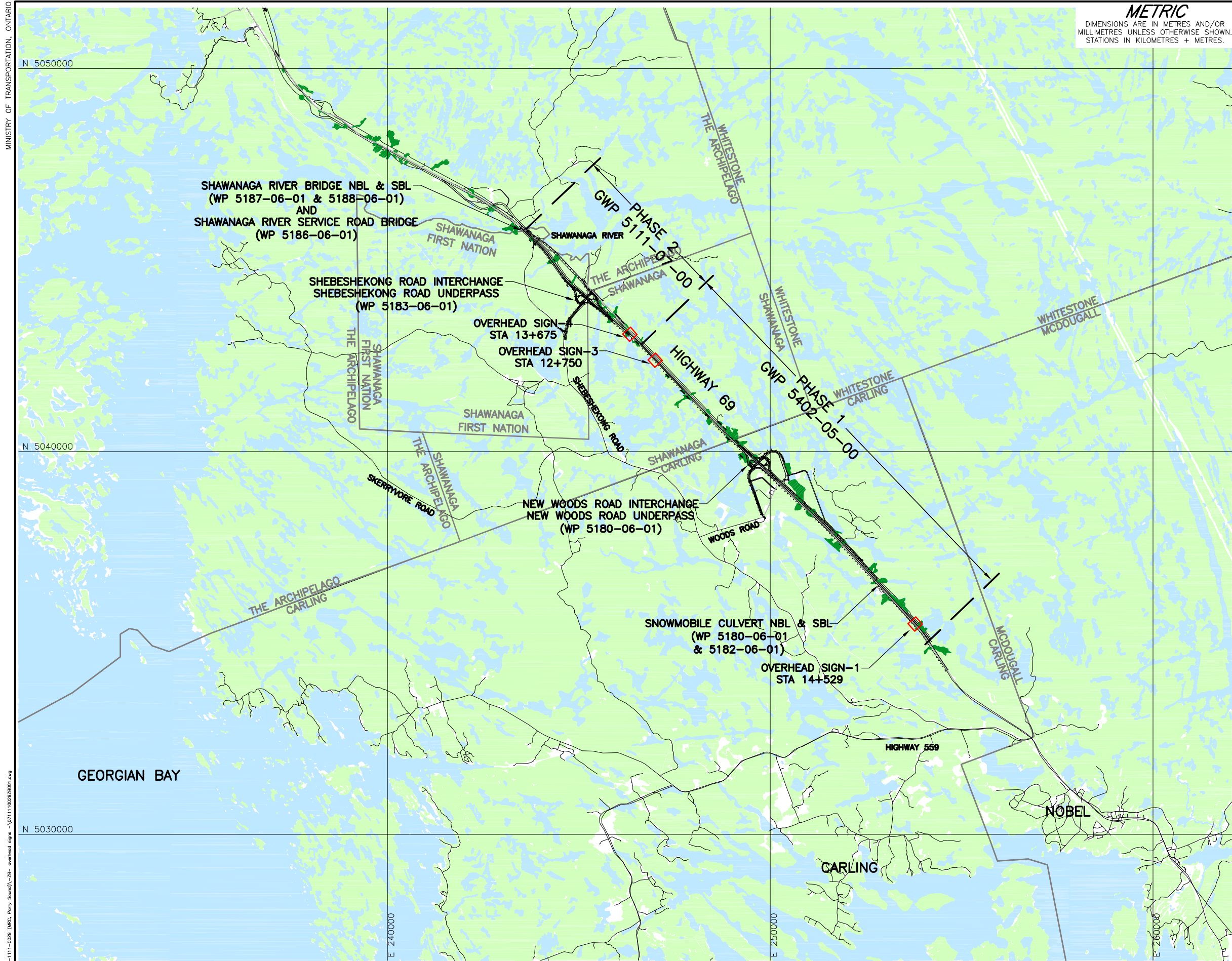
<i>Option</i>	<i>Rank</i>	<i>Advantages</i>	<i>Disadvantages</i>	<i>Relative Costs</i>	<i>Risks / Consequences</i>
Caissons socketted into Bedrock	2	<ul style="list-style-type: none"> <li>No post-construction settlement; and,</li> <li>Soil cover for frost protection is not required for caissons socketted into bedrock.</li> <li>Bedrock at/near ground surface</li> </ul>	<ul style="list-style-type: none"> <li>Coring or churn drilling into the strong to very strong bedrock will be required to advance sockets for caisson construction.</li> </ul>	<ul style="list-style-type: none"> <li>Relatively higher cost of installation compared to spread footings; and,</li> <li>Additional cost associated with specialized drilling equipment to advance the caisson holes into the bedrock.</li> </ul>	<ul style="list-style-type: none"> <li>Specialized drilling equipment will be required to socket caissons into bedrock.</li> </ul>
Spread Footings founded on and dowelled into Bedrock	1	<ul style="list-style-type: none"> <li>Relative ease of construction;</li> <li>No bedrock coring and/or churn drilling required;</li> <li>No post-construction settlement; and,</li> <li>Soil cover for frost protection is not required for footings on bedrock.</li> <li>Very high geotechnical axial resistance</li> <li>Bedrock at/near ground surface</li> </ul>	<ul style="list-style-type: none"> <li>Larger excavation of overburden is required;</li> <li>Larger volume of excavation spoils will be produced;</li> <li>Mass concrete may be required to achieve level footing;</li> <li>Dowels may be required to anchor spread footings (due to structural considerations); and,</li> <li>Groundwater control may be required.</li> </ul>	<ul style="list-style-type: none"> <li>Relatively lower cost in comparison to caissons socketted into bedrock;</li> <li>Additional cost required for the disposal of larger volume of excavation spoils; and,</li> <li>Additional costs required for installation of dowells into the bedrock.</li> </ul>	<ul style="list-style-type: none"> <li>Risk that additional excavation and mass concrete may be required if bedrock is encountered below the design founding elevation during construction; and,</li> <li>Must ensure foundation base is properly prepared for concrete placement.</li> </ul>

Prepared By: TVA/CN

Reviewed By: JPD/JMAC

n:\active\2007\1111\07-1111-0029 - mrc - hwy 69 four-laning -report\final\11 - overhead signs\tables\07-1111-0029-11 tbl 1 evaluation of foundation alternatives - overhead sign support structures.docx





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

CONT No.  
GWP No. 5402-05-00

HIGHWAY 69  
SITE LOCATION PLAN

SHEET

**Golder Associates**

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

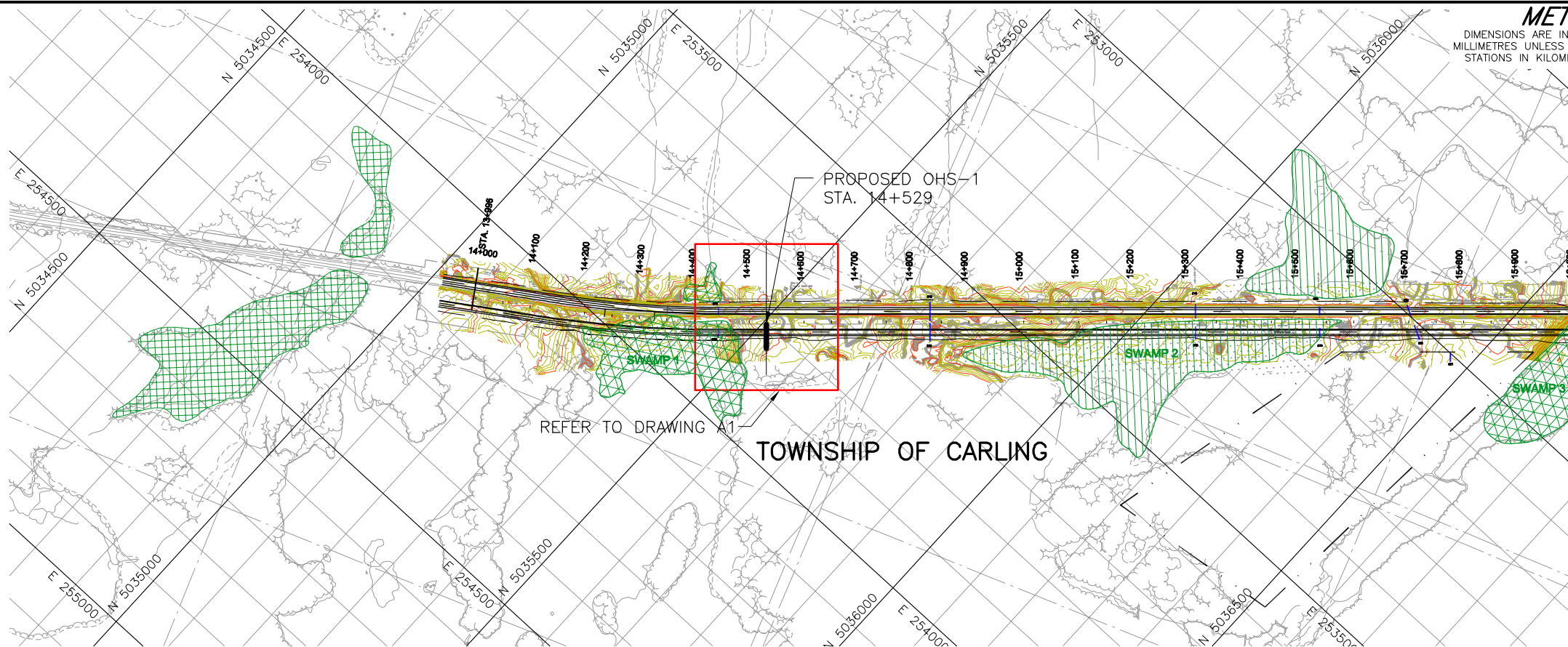


PLAN

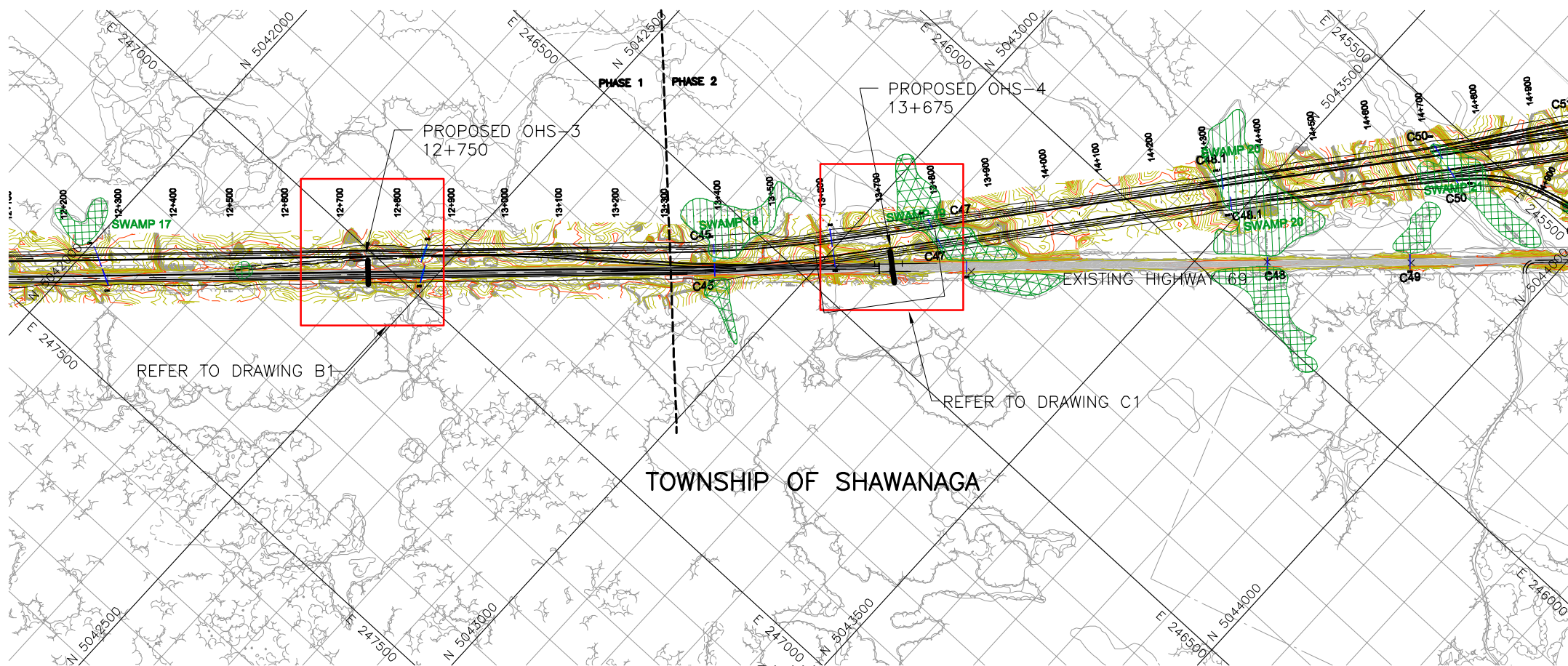


REFERENCE				
Base Data – MNR NRVIS, obtained 2004, CANMAP v2006.4 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008 Datum : NAD 83 Projection : MTM Zone 10				
NO.	DATE	BY	REVISION	
Geocres No. 41H-112				
HWY. 69		PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA		CHKD. VA	DATE: May 2012	SITE:
DRAWN: JFC/CD		CHKD. CN	APPD. JPD/JMAC	DWG. 1





PLAN



PLAN



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

CONT No.  
GWP No. 5402-05-00

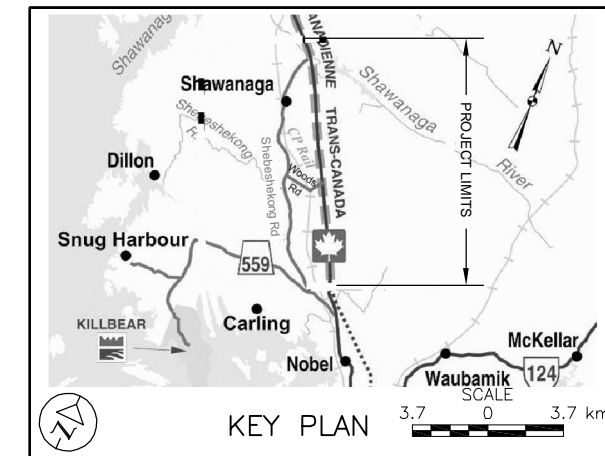
HIGHWAY 69  
OVERHEAD SIGNS (OHS)  
INDEX PLAN



SHEET



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



KEY PLAN

REFERENCE

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPB-ARCHIPELAGO.dwg, 5271-XPB-Carling.dwg, 5271-XPB-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and h6878\_PHASE1\_XA1, h6878\_PHASE1\_XN1.dwg, received January 21, 2009, h6878\_PHASE2\_XA1, h6878\_PHASE2\_XN1.dwg, received January 21, 2009 and h6878\_PHASE1\_XN1.dwg, received September 19, 2011.

NO.	DATE	BY	REVISION
Geocres No. 41H-112			
HWY. 69		PROJECT NO. 07-1111-0029	
SUBM'D. VA		DIST.	
CHKD. VA		DATE: Feb. 2012	
DRAWN: JFC		SITE:	
CHKD. CN		APPD. JPD/JMAC	
		DWG. 2	




# APPENDIX A

## Highway 69 NBL – Overhead Sign 1 – STA 14+529



PROJECT <u>07-1111-0029</u>		<b>RECORD OF BOREHOLE No OHS-1A</b>		1 OF 1 <b>METRIC</b>	
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5035506.9 ; E 253807.7</u>		ORIGINATED BY <u>MR</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>NQ Casing, Wash Boring</u>		COMPILED BY <u>OK</u>	
DATUM <u>Geodetic</u>		DATE <u>October 5, 2010</u>		CHECKED BY <u>VA</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED	+ FIELD VANE				WATER CONTENT (%)				
								● QUICK TRIAXIAL	× REMOULDED								
224.2	GROUND SURFACE						20	40	60	80	100						
0.0	Granite Gneiss (BEDROCK)		1	RC	REC 100%												
	Bedrock cored from depths of 0.0 m to 5.4 m																
	For bedrock coring details, refer to Record of Drillhole OHS-1A		2	RC	REC 98%												
			3	RC	REC 100%												
			4	RC	REC 100%												
218.8	END OF BOREHOLE																
5.4	NOTE:  1. Water level in open borehole was not noted upon completion of drilling.																

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: OHS-1A

SHEET 2 OF 2

LOCATION: N 5035506.9 ; E 253807.7

DRILLING DATE: October 5, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-50

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate										BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage										PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular										PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough										MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	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	Jh	10°	10°	10°	10°	10°	10°	10°	10°																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: AH/VA

GTA-RCK 018 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS.GDT 2/24/12 DD/SAC

PROJECT 07-1111-0029				<b>RECORD OF BOREHOLE No OHS-1B</b>				1 OF 1		<b>METRIC</b>							
G.W.P. 5402-05-00		LOCATION N 5035520.3 ; E 253822.4				ORIGINATED BY MR											
DIST _____ HWY 69		BOREHOLE TYPE 165 mm O.D Continuous Flight Solid Stem Auger, NW Casing, Wash Boring				COMPILED BY OK											
DATUM Geodetic		DATE October 5, 2010				CHECKED BY VA											
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									
221.1	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	2												
0.1	SAND, trace to some silt, trace clay, trace gravel, containing organics and rootlets Very loose to dense Dark brown Moist		1B	SS	50												5 89 (6)
220.0	Granite Gneiss (BEDROCK)		1	RC	REC 91%												RQD = 36%
1.1	Bedrock cored from depths of 1.1 m to 4.5 m  For bedrock coring details, refer to Record of Drillhole OHS-1B		2	RC	REC 98%												RQD = 72%
			3	RC	REC 98%												RQD = 98%
216.6	END OF BOREHOLE																
4.5	NOTE:  1. Water level encountered in open borehole at a depth of 0.6 m below ground surface (Elevation 220.5 m) during drilling.																

GTA-MTO 001 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS.GDT 2/24/12 DD/SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: OHS-1B

SHEET 2 OF 2

LOCATION: N 5035520.3 ; E 253822.4

DRILLING DATE: October 5, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-50

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	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.	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY			Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
				DEPTH (m)								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	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>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
				FLUSH								TOTAL CORE %	SOLID CORE %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

DEPTH SCALE

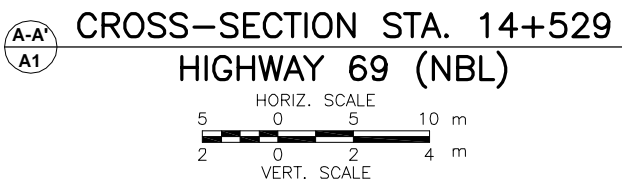
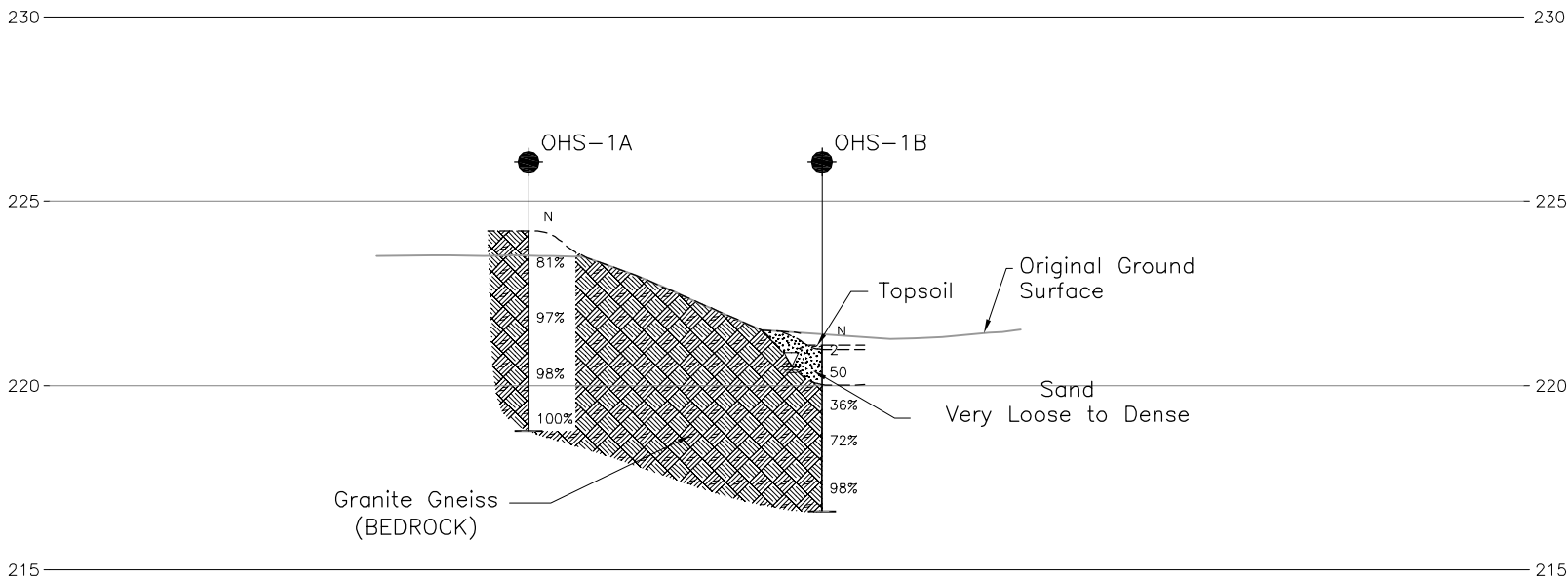
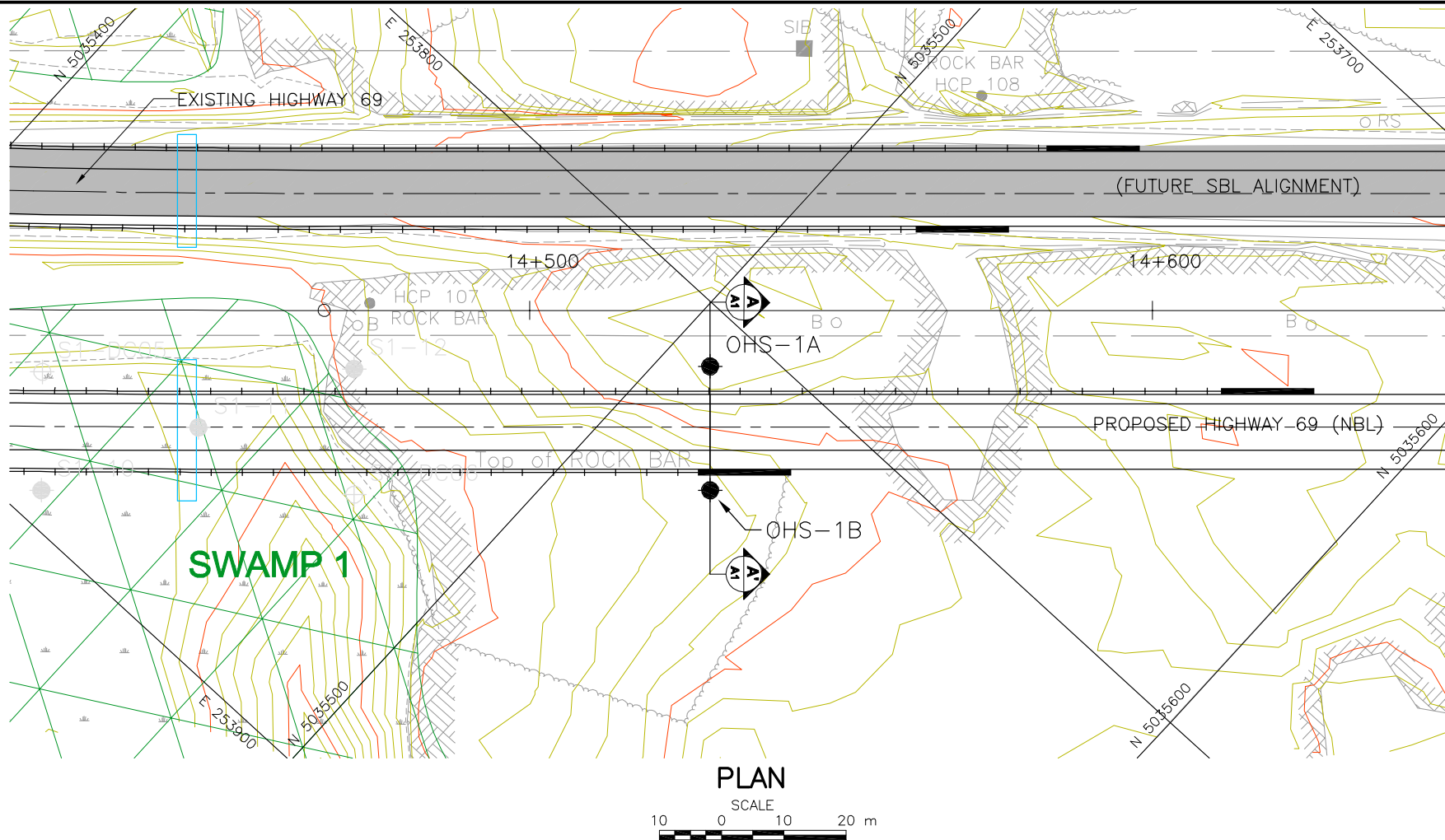
1 : 50



LOGGED: MR

CHECKED: AH/VA

GTA-RCK 018 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS GDT 2/24/12 DD/SAC

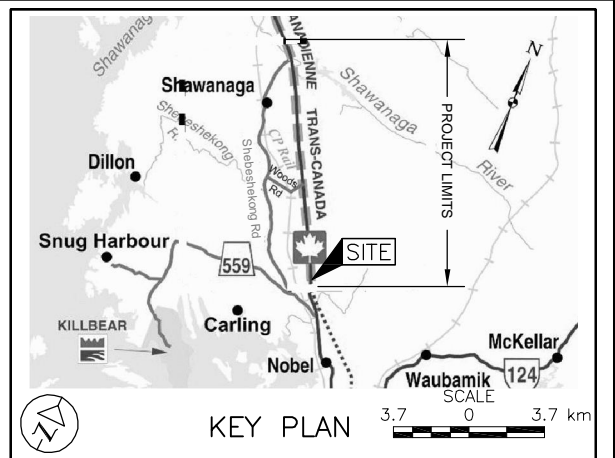


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No. 5402-05-00

HIGHWAY 69 (NBL)  
OVERHEAD SIGN 1, STA 14+529  
BOREHOLE LOCATIONS AND SOIL STRATA

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



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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
OHS-1A	224.2	5035506.9	253807.7
OHS-1B	221.1	5035520.3	253822.4

**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.

**REFERENCE**

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPB-ARCHIPELAGO.dwg, 5271-XPB-Carling.dwg, 5271-XPB-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007 and h6878\_PHASE1\_XA1, h6878\_PHASE1\_XN1.dwg, received January 21, 2009 and h6878\_PHASE1\_XN1.dwg, received September 19, 2011.



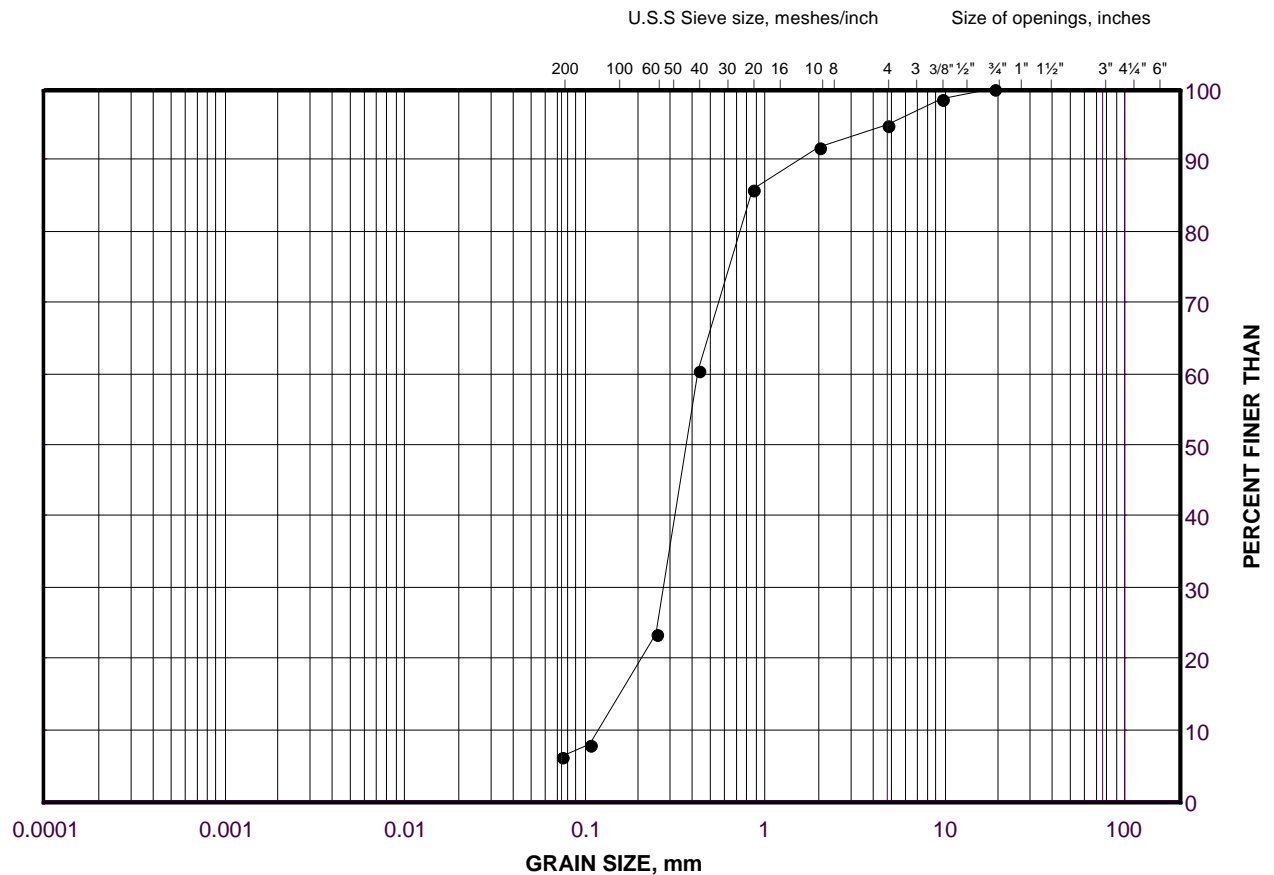
Geocres No. 41H-112			
NO.	DATE	BY	REVISION
HWY: 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA	DATE: Feb. 2012	SITE:
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC	DWG. A1

# GRAIN SIZE DISTRIBUTION

Sand

Highway 69 (NBL) STA 14+529 - Overhead Sign 1

FIGURE A1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OHS-1B	2	220.3

Project Number: 07-1111-0029

Checked By: TVA

**Golder Associates**

Date: 28-Jul-11

**TABLE A1**  
**POINT LOAD TEST ON ROCK SAMPLES**

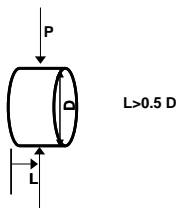
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) <sup>(2)</sup>	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
OHS-1A	1	0.73	223.5	Granite Gneiss	Diametral	141.50	47.20	3.674	73
OHS-1A	1	0.73	223.5	Granite Gneiss	Axial	31.90	47.50	8.335	167
OHS-1A	2	2.23	222.0	Granite Gneiss	Diametral	101.50	42.80	5.472	109
OHS-1A	2	2.23	222.0	Granite Gneiss	Axial	28.00	47.40	6.873	137
OHS-1A	3	3.75	220.5	Granite Gneiss	Diametral	96.10	45.60	5.677	114
OHS-1A	3	3.75	220.5	Granite Gneiss	Axial	44.60	47.40	8.602	172
OHS-1A	4	4.97	219.2	Granite Gneiss	Diametral	103.20	44.60	4.445	89
OHS-1A	4	4.97	219.2	Granite Gneiss	Diametral	123.40	47.50	3.786	76
OHS-1B	1	1.35	219.8	Granite Gneiss	Diametral	99.30	43.80	3.715	74
OHS-1B	1	1.35	219.8	Granite Gneiss	Axial	45.00	47.30	6.839	137
OHS-1B	2	2.31	218.8	Granite Gneiss	Diametral	106.30	43.00	7.339	147
OHS-1B	2	2.31	218.8	Granite Gneiss	Axial	51.20	47.20	6.967	139
OHS-1B	3	3.75	217.4	Granite Gneiss	Diametral	95.90	47.30	5.720	114
OHS-1B	3	3.75	217.4	Granite Gneiss	Axial	50.00	47.20	7.168	143

<sup>(1)</sup>  $Is_{50} \times K$ , from ASTM Designation: D 5731-08 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications. A value of  $K = 20$  has been estimated for this site.

<sup>(2)</sup> Actual distance between point load cones at time of failure.

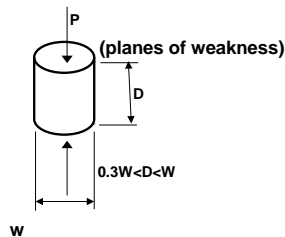
#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



#### AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis



Compiled by: OK  
Reviewed by: TVA/CN



# APPENDIX B

## Highway 69 NBL – Overhead Sign 3 – STA 12+750



PROJECT		RECORD OF BOREHOLE		No OHS-3A		1 OF 1		METRIC					
G.W.P.		LOCATION		ORIGINATED BY		MR							
DIST		BOREHOLE TYPE		COMPILED BY		OK							
DATUM		DATE		CHECKED BY		VA							
07-1111-0029		N 5042403.6 ; E 247029.2											
5402-05-00		165 mm O.D Continuous Flight Solid Stem Auger, NW Casing, Wash Boring											
Geodetic		October 7, 2010											
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
217.5	GROUND SURFACE												
0.0	ASPHALT												
216.7	Sand and gravel, trace to some silt (FILL) Very dense Grey Moist		1	SS	72		217						
0.8			2	SS	29		216						
216.1	Sand, some gravel, trace to some silt (FILL) Compact Brown Moist		1	RC	REC 92%		215						
1.4	Granite Gneiss (BEDROCK)		2	RC	REC 100%		214						
	Bedrock cored from depths of 1.4 m to 4.8 m		3	RC	REC 100%		213						
	For bedrock coring details, refer to Record of Drillhole OHS-3A												
212.7	END OF BOREHOLE												
4.8	NOTE:  1. Water level in open borehole at a depth of 1.5 m below ground surface (Elevation 216.0 m) upon completion of drilling.												

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

CHECKED: AH/NA

PROJECT 07-1111-0029		<b>RECORD OF BOREHOLE No OHS-3B</b>				1 OF 1 <b>METRIC</b>											
G.W.P. 5402-05-00		LOCATION N 5042413.6 ;E 247039.8				ORIGINATED BY EHS											
DIST _____ HWY 69		BOREHOLE TYPE 165 mm O.D Continuous Flight Solid Stem Auger, NW Casing, Wash Boring				COMPILED BY OK											
DATUM Geodetic		DATE October 25, 2010				CHECKED BY VA											
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									
217.4 0.0	GROUND SURFACE							20	40	60	80	100					
0.2	Sand and gravel, trace silt, containing rootlets (FILL) Grey Moist	1A 1B 1C	SS	9		217											
216.6 0.8	Sand, trace to some silt, trace to some gravel, containing cobbles (FILL) Loose Brown Moist		1	RC	REC 100%	216											RQD = 74%
	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 0.8 m to 4.0 m		2	RC	REC 100%	215											RQD = 100%
	For bedrock coring details, refer to Record of Drillhole OHS-3B		3	RC	REC 100%	214											RQD = 100%
213.4 4.0	END OF BOREHOLE																
	NOTE:  1. Water level in open borehole at a depth of 0.8 m below ground surface (Elevation 216.6 m) upon completion of drilling.																

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: OHS-3B**

SHEET 2 OF 2

LOCATION: N 5042413.6 ;E 247039.8

DRILLING DATE: October 25, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-850

DRILLING CONTRACTOR: Landore 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 <b>NOTE:</b> For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	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	Jh	10 <sup>-2</sup>	10 <sup>-3</sup>	10 <sup>-4</sup>	10 <sup>-5</sup>	10 <sup>-6</sup>	10 <sup>-7</sup>	10 <sup>-8</sup>	10 <sup>-9</sup>	10 <sup>-10</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
1	NQ RC October 25, 2010	Continued from Record of Borehole OSH-3B		216.6 0.8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

DEPTH SCALE

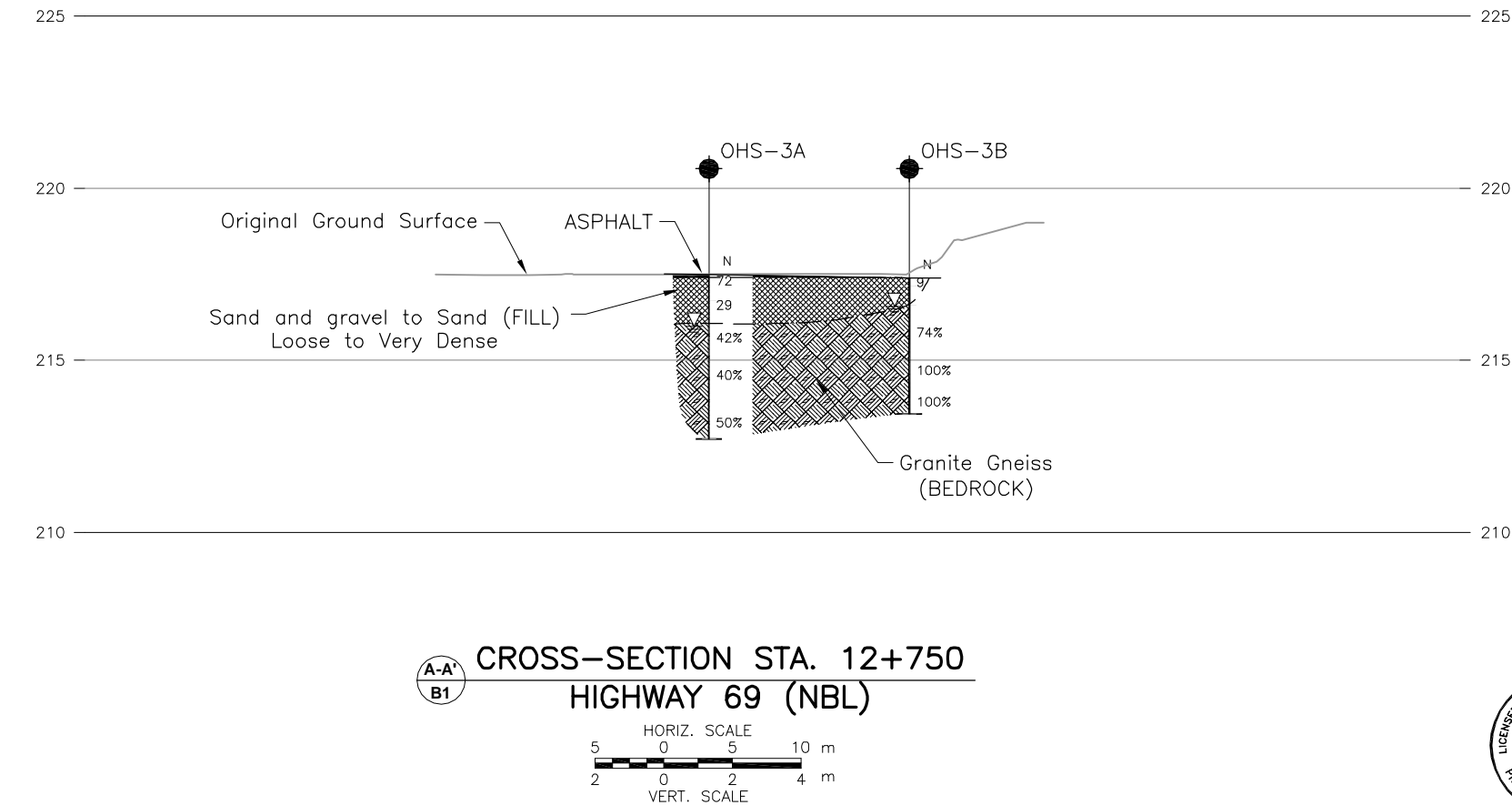
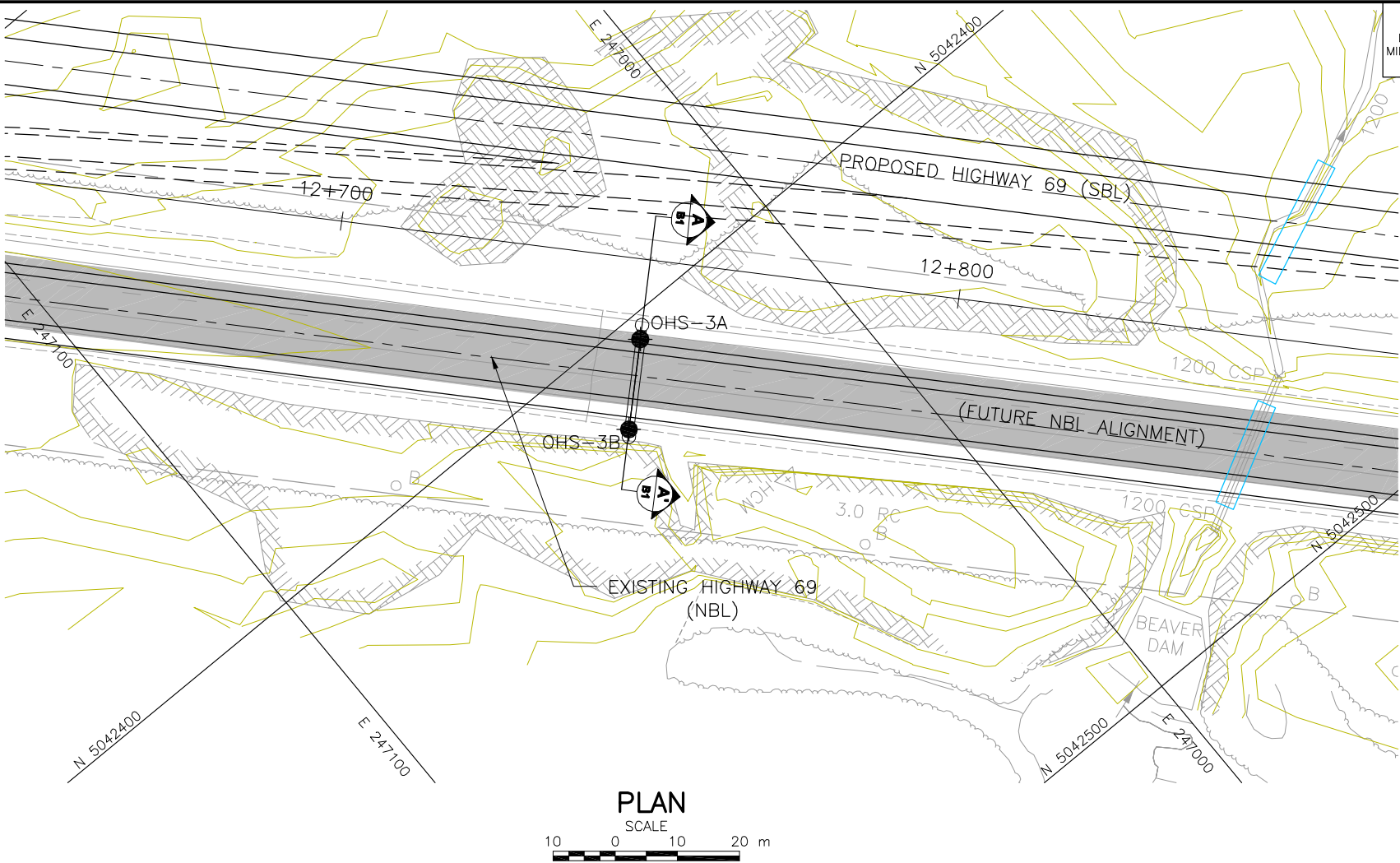
1 : 50



LOGGED: EHS

CHECKED: AH/VA

GTA-RCK 018 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS.GDT 2/24/12 DD/SAC



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

CONT No.  
GWP No. 5402-05-00

HIGHWAY 69 (NBL)  
OVERHEAD SIGN 3, STA 12+750  
BOREHOLE LOCATIONS AND SOIL STRATA

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

**KEY PLAN**

**LEGEND**

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

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
OHS-3A	217.5	5042403.6	247029.2
OHS-3B	217.4	5042413.6	247039.8

**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.

**REFERENCE**

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007 and h6878\_PHASE1\_XA1, h6878\_PHASE1\_XN1.dwg, received January 21, 2009 and h6878\_PHASE1\_XN1.dwg, received September 19, 2011.

NO.	DATE	BY	REVISION

Geocres No. 41H-112

HWY: 69	PROJECT NO. 07-1111-0029	DIST.
SUBM'D. VA	CHKD. VA	DATE: Feb. 2012
SITE:		
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC
DWG. B1		

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

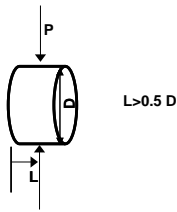
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) <sup>(2)</sup>	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
OHS-3A	1	1.71	215.8	Granite Gneiss	Diametral	99.20	44.60	7.497	135
OHS-3A	1	1.71	215.8	Granite Gneiss	Axial	41.40	47.30	8.025	144
OHS-3A	2	2.81	214.7	Granite Gneiss	Diametral	102.50	46.60	7.469	134
OHS-3A	2	2.81	214.7	Granite Gneiss	Axial	43.90	47.40	6.090	110
OHS-3A	3	4.18	213.3	Granite Gneiss	Diametral	94.40	39.60	8.088	146
OHS-3A	3	4.18	213.3	Granite Gneiss	Diametral	83.00	44.70	5.720	103
OHS-3B	1	1.46	215.9	Granite Gneiss	Diametral	94.00	45.00	6.313	114
OHS-3B	1	1.60	215.8	Granite Gneiss	Axial	36.20	47.30	13.451	242
OHS-3B	2	2.66	214.7	Granite Gneiss	Diametral	116.20	47.00	4.332	78
OHS-3B	2	2.56	214.8	Granite Gneiss	Axial	51.30	47.00	7.839	141
OHS-3B	3	3.48	213.9	Granite Gneiss	Diametral	73.10	47.10	5.799	104
OHS-3B	3	3.48	213.9	Granite Gneiss	Diametral	72.80	41.60	9.138	164

<sup>(1)</sup>  $Is_{50} \times K$ , from ASTM Designation: D 5731-08 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications. A value of  $K = 18$  has been estimated for this site.

<sup>(2)</sup> Actual distance between point load cones at time of failure.

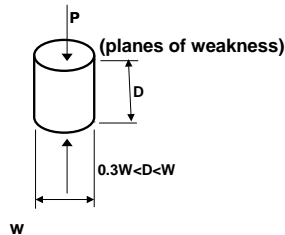
#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



#### AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis



Compiled by: OK  
Reviewed by: TVA/CN



# APPENDIX C

## Highway 69 (Existing) – Overhead Sign 4 – STA 13+675

PROJECT		RECORD OF BOREHOLE		No OHS-4A		1 OF 1		METRIC																																																																							
G.W.P.		LOCATION		ORIGINATED BY		MR																																																																									
DIST		BOREHOLE TYPE		COMPILED BY		OK																																																																									
DATUM		DATE		CHECKED BY		VA																																																																									
07-1111-0029		N 5043091.1 ; E 246402.0																																																																													
5402-05-00		165 mm O.D Continuous Flight Solid Stem Auger, NW Casing, Wash Boring																																																																													
Geodetic		October 6, 2010																																																																													
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <p><b>SOIL PROFILE</b></p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>ELEV DEPTH</th> <th>DESCRIPTION</th> <th>STRAT PLOT</th> <th>NUMBER</th> <th>TYPE</th> <th>"N" VALUES</th> </tr> </thead> <tbody> <tr> <td>214.1</td> <td>GROUND SURFACE</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0.0</td> <td>Sand, some gravel, trace to some silt, containing rootlets (FILL)</td> <td></td> <td>1</td> <td>SS</td> <td>43/0.28</td> </tr> <tr> <td>213.7</td> <td>Dense Brown</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0.4</td> <td>Granite Gneiss (BEDROCK)</td> <td></td> <td>1</td> <td>RC</td> <td>REC 93%</td> </tr> <tr> <td></td> <td>Bedrock cored from depths of 0.4 m to 3.9 m</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>For bedrock coring details, refer to Record of Drillhole OHS-4A</td> <td></td> <td>2</td> <td>RC</td> <td>REC 100%</td> </tr> <tr> <td></td> <td></td> <td></td> <td>3</td> <td>RC</td> <td>REC 98%</td> </tr> <tr> <td>210.2</td> <td>END OF BOREHOLE</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3.9</td> <td>NOTE: 1. Water level at the ground surface (Elevation 214.1 m) upon completion of drilling.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> </div> <div style="width: 30%;"> <p><b>SAMPLES</b></p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>GROUND WATER CONDITIONS</th> <th>ELEVATION SCALE</th> </tr> </thead> <tbody> <tr> <td></td> <td>214</td> </tr> <tr> <td></td> <td>213</td> </tr> <tr> <td></td> <td>212</td> </tr> <tr> <td></td> <td>211</td> </tr> </tbody> </table> </div> <div style="width: 40%;"> <p><b>DYNAMIC CONE PENETRATION RESISTANCE PLOT</b></p> <p><b>SHEAR STRENGTH kPa</b></p> <p>○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED</p> <p>20 40 60 80 100</p> <p>20 40 60 80 100</p> <p><b>WATER CONTENT (%)</b></p> <p>10 20 30</p> <p><b>UNIT WEIGHT</b></p> <p>γ</p> <p>kN/m<sup>3</sup></p> <p><b>REMARKS &amp; GRAIN SIZE DISTRIBUTION (%)</b></p> <p>GR SA SI CL</p> </div> </div>										ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	214.1	GROUND SURFACE					0.0	Sand, some gravel, trace to some silt, containing rootlets (FILL)		1	SS	43/0.28	213.7	Dense Brown					0.4	Granite Gneiss (BEDROCK)		1	RC	REC 93%		Bedrock cored from depths of 0.4 m to 3.9 m						For bedrock coring details, refer to Record of Drillhole OHS-4A		2	RC	REC 100%				3	RC	REC 98%	210.2	END OF BOREHOLE					3.9	NOTE: 1. Water level at the ground surface (Elevation 214.1 m) upon completion of drilling.					GROUND WATER CONDITIONS	ELEVATION SCALE		214		213		212		211
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																																																																										
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	212																																																																														
	211																																																																														



PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: OHS-4A

SHEET 2 OF 2

LOCATION: N 5043091.1 ; E 246402.0

DRILLING DATE: October 6, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-50

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	RECOVERY TOTAL CORE %	R.Q.D. % SOLID CORE %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA B Angle DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q AVG.
		Continued from Record of Borehole OHS-4A		213.7										
1	INW Casing October 6, 2010	GRANITE GNEISS Slightly weathered, foliated, coarse grained, strong to very strong, grey to black		0.4	1						.FR,PL,RO .FR,IR,RO .FR,PL,RO .FR,PL,VR .FR,PL,VR .FR,PL,VR			(Diametral) (Axial)
2	NO RC October 6, 2010				2						.FR,PL,VR .FR,PL,VR .FR,PL,VR .FR,PL,VR .FR,PL,VR .FR,PL,VR			(Diametral) (Axial)
3					3						.FR,PL,VR		0.7 0.1	(Diametral) (Diametral)
4		END OF DRILLHOLE		210.2 3.9										
5														
6														
7														
8														
9														
10														

DEPTH SCALE

1 : 50





LOGGED: MR

CHECKED: AH/VA

GTA-RCK 018 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS.GDT 2/24/12 DD/SAC

PROJECT <u>07-1111-0029</u>		<b>RECORD OF BOREHOLE No OHS-4B</b>		1 OF 1 <b>METRIC</b>	
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043075.6 ; E 246389.1</u>		ORIGINATED BY <u>MR</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>165 mm O.D Continuous Flight Solid Stem Auger, NW Casing, Wash Boring</u>		COMPILED BY <u>OK</u>	
DATUM <u>Geodetic</u>		DATE <u>October 6, 2010</u>		CHECKED BY <u>VA</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	w <sub>p</sub>	w	w <sub>L</sub>			
214.2	GROUND SURFACE																
0.0	Sand and gravel, trace silt (FILL) Loose to Compact Brown Moist		1	SS	7	▽	214									50 47 (3)	
			2	SS	26		213										
	Cobbles encountered between depths of 1.2 m to 1.4 m																
212.2		3	SS	8	212												
2.0	Granite Gneiss (BEDROCK)  Bedrock cored from depths of 2.0 m to 4.7 m  For bedrock coring details, refer to Record of Drillhole OHS-4B		1	RC	REC 98%		211										RQD = 60%
			2	RC	REC 100%	210											RQD = 100%
209.5																	
4.7	END OF BOREHOLE  NOTE:  1. Water level encountered in open borehole at a depth of 1.7 m below ground surface (Elevation 212.5 m) during drilling.																

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: OHS-4B

SHEET 2 OF 2

LOCATION: N 5043075.6 ; E 246389.1

DRILLING DATE: October 6, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-50

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	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.	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
				DEPTH								RECOVERY		R.Q.D.	FRACT.	TYPE AND SURFACE DESCRIPTION				Jr Ja Jn			K, cm/sec						N	T	S																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
				(m)								TOTAL CORE %	SOLID CORE %	%	INDEX PER 0.3	B Angle	DIP w.r.t. CORE AXIS						10 <sup>-6</sup>	10 <sup>-5</sup>	10 <sup>-4</sup>							10 <sup>-3</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
				FLUSH								0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000							0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

DEPTH SCALE

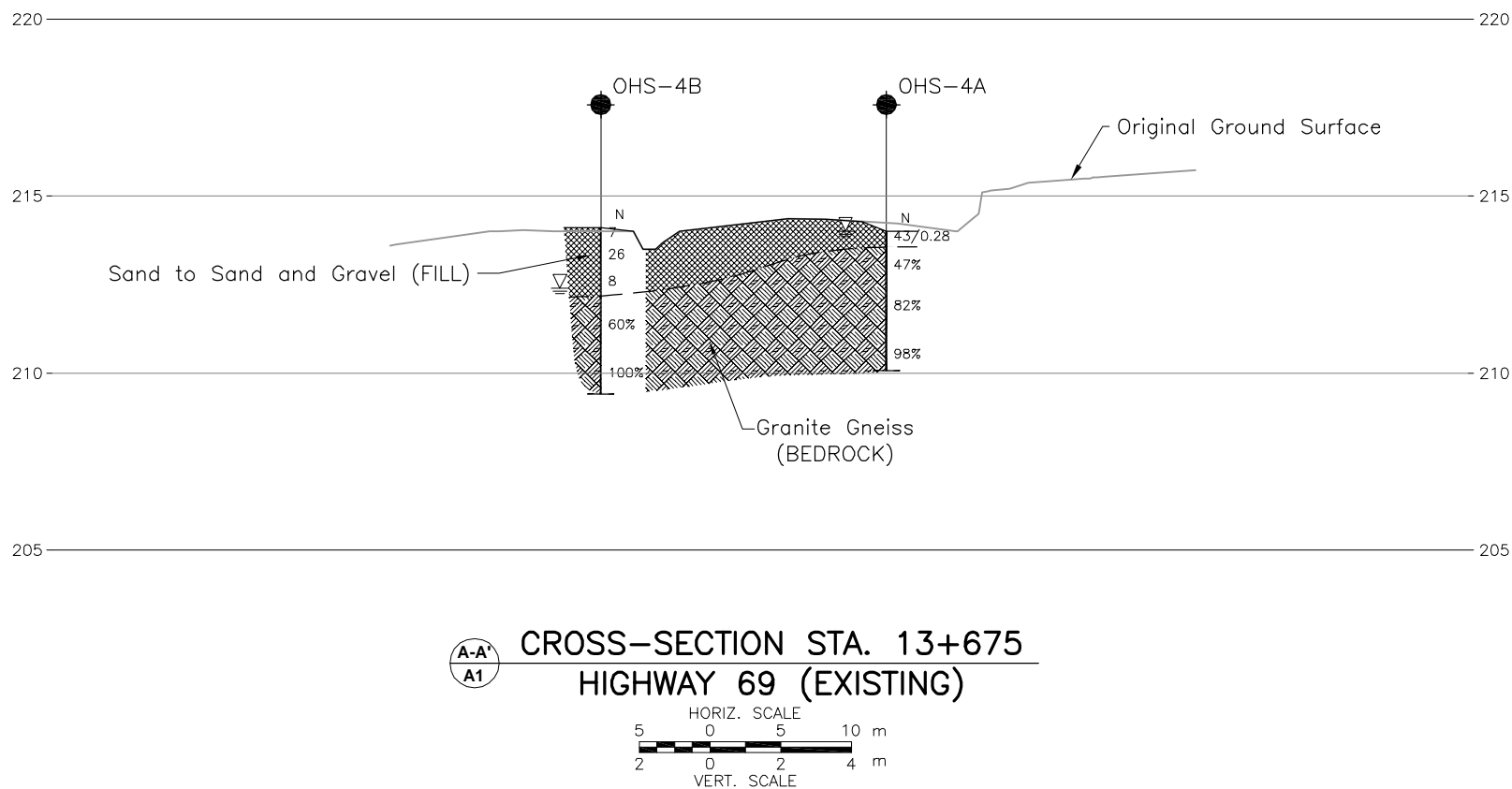
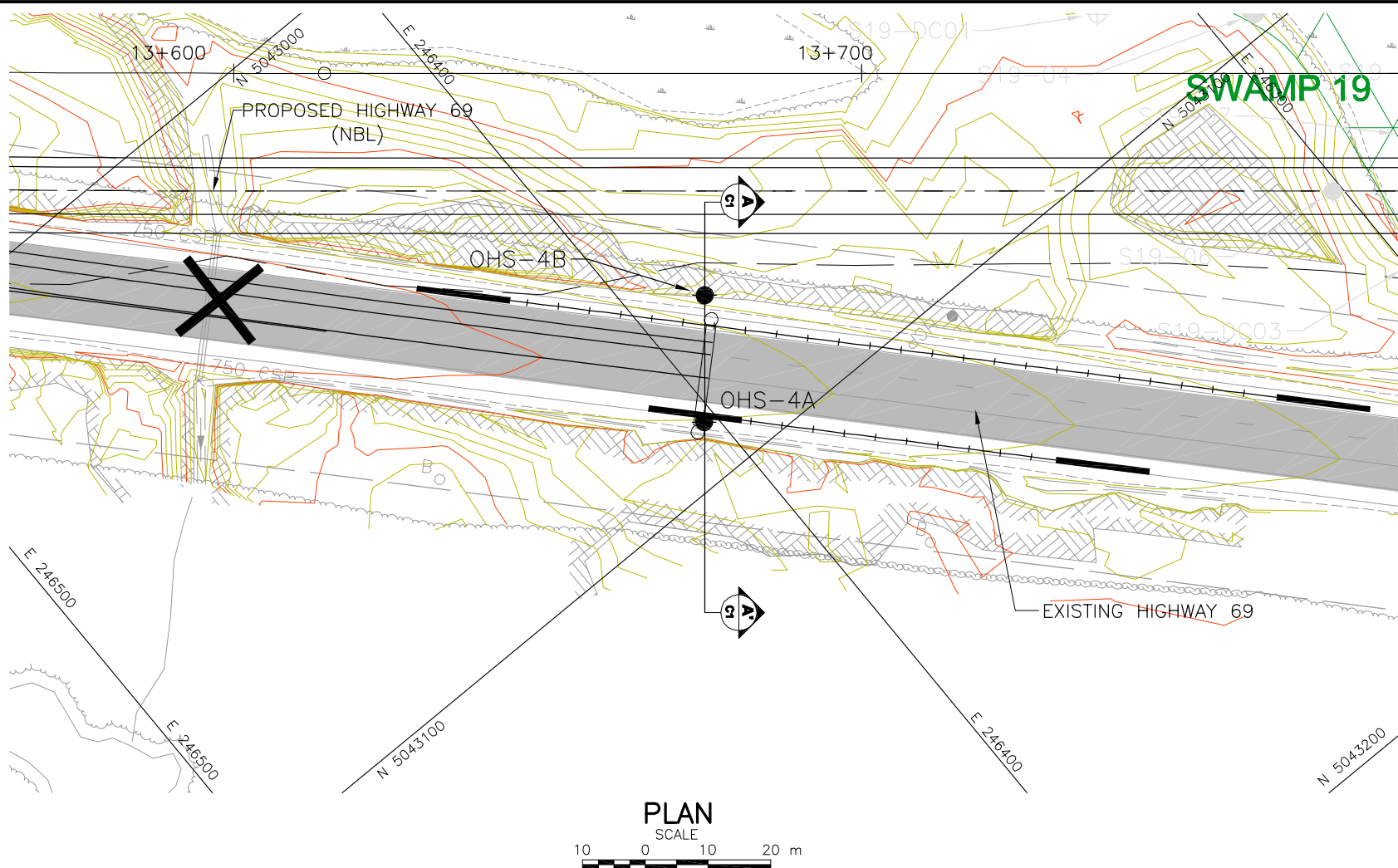
1 : 50



LOGGED: MR

CHECKED: AH/VA

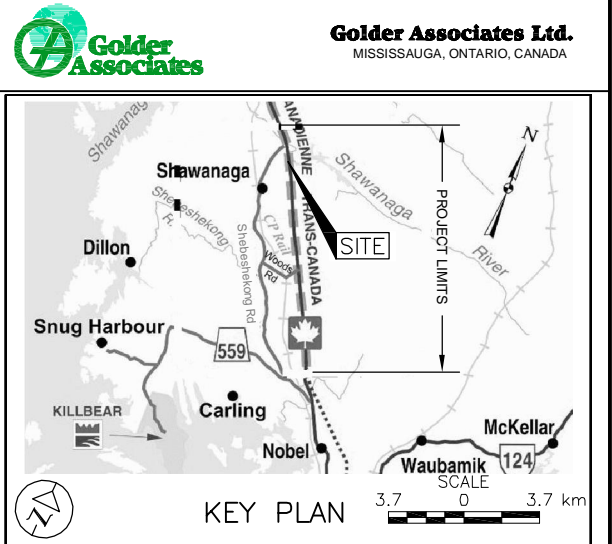
GTA-RCK 018 07-1111-0029-OVERHEAD SIGN-PHASE I-GPJ GAL-MISS.GDT 2/24/12 DD/SAC



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

CONT No.  
GWP No. 5402-05-00

HIGHWAY 69 (EXISTING)  
OVERHEAD SIGN 4, STA 13+675  
BOREHOLE LOCATIONS AND SOIL STRATA



**LEGEND**

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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
OHS-4A	214.1	5043091.1	246402.0
OHS-4B	214.2	5043075.6	246389.1

**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.

**REFERENCE**

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007 and h6878\_PHASE1\_XA1, h6878\_PHASE1\_XN1.dwg, received January 21, 2009 and h6878\_PHASE1\_XN1.dwg, received September 19, 2011.



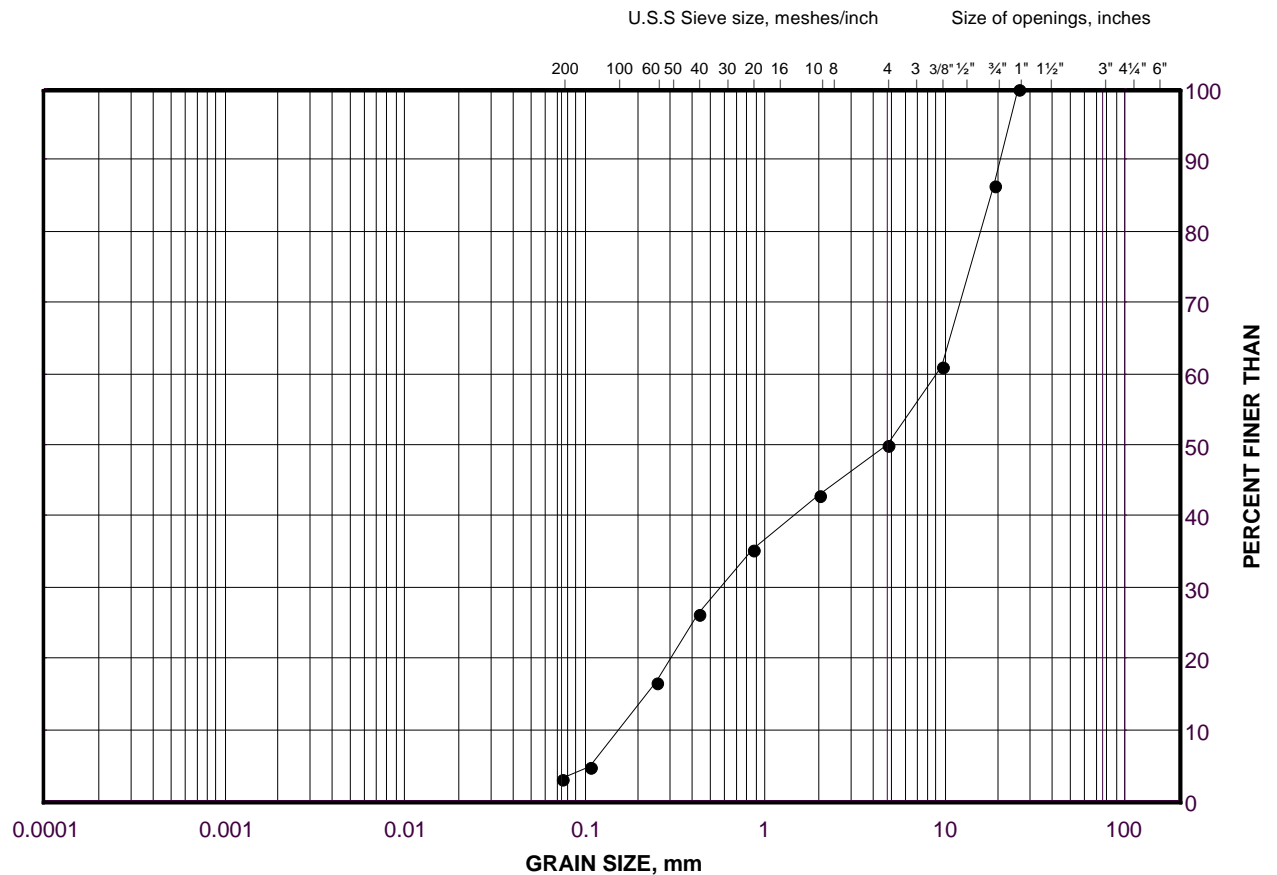
NO.	DATE	BY	REVISION
Geocres No. 41H-112			
HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA	DATE: Feb. 2012	SITE:
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC	DWG. C1

# GRAIN SIZE DISTRIBUTION

Sand and Gravel Fill

Highway 69 Existing STA 13+675 - Overhead Sign 4

FIGURE C1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OHS-4B	1	213.9

Project Number: 07-1111-0029

Checked By: TVA

**Golder Associates**

Date: 28-Jul-11

**TABLE C1**  
**POINT LOAD TEST ON ROCK SAMPLES**

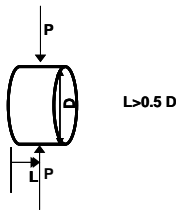
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) <sup>(2)</sup>	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
OHS-4A	1	0.81	213.3	Granite Gneiss	Diametral	102.00	41.30	7.823	141
OHS-4A	1	0.81	213.3	Granite Gneiss	Axial	50.60	44.70	7.945	143
OHS-4A	2	1.95	212.2	Granite Gneiss	Diametral	131.30	42.30	4.148	75
OHS-4A	2	1.95	212.2	Granite Gneiss	Axial	46.20	47.70	9.022	162
OHS-4A	3	3.32	210.8	Granite Gneiss	Diametral	119.60	41.40	9.724	175
OHS-4A	3	3.32	210.8	Granite Gneiss	Diametral	134.80	44.10	10.061	181
OHS-4B	1	2.59	211.6	Granite Gneiss	Diametral	134.00	43.50	4.734	85
OHS-4B	1	2.59	211.6	Granite Gneiss	Axial	50.10	47.20	7.446	134
OHS-4B	2	3.96	210.2	Granite Gneiss	Diametral	96.50	43.30	6.929	125
OHS-4B	2	3.96	210.2	Granite Gneiss	Axial	35.70	47.40	7.302	131

<sup>(1)</sup>  $Is_{50} \times K$ , from ASTM Designation: D 5731-08 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications. A value of  $K = 18$  has been estimated for this site.

<sup>(2)</sup> Actual distance between point load cones at time of failure.

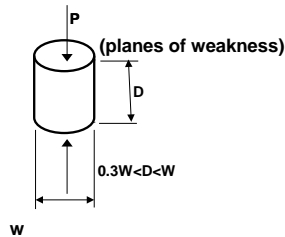
#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



#### AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis



Compiled by: OK  
Reviewed by: TVA/CN



# APPENDIX D

## Non-Standard Special Provisions

**Mass Concrete – Item No.**

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Special Provision

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**Scope of Work**

The scope of work for the above noted tender item includes the supply and placement of mass concrete under the overhead sign spread footings to raise the founding grade to the design level of the underside of the footings.

**Construction**

Concrete shall be the same strength as the footing concrete and placed in accordance with OPSS 904 Concrete Structures.

**Basis of Payment**

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION



## **Dowels Into Rock – Item No.**

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Special Provision

---

### **Scope of Work**

Work under this item is for the placement and field testing of dowels into rock.

### **Construction**

Dowels into rock shall be constructed in accordance with OPSS 904 Concrete Structures. All reinforcing steel supplied shall be in accordance with OPSS 1440 (Steel Reinforcement for Concrete) (dowel bars conforming to CSA Standard CSAG30.18, Grade 400).

For dowels into rock, holes shall be drilled to the required depth and size. Hole diameter shall be two times the nominal diameter of the dowel. Each hole shall be cleaned out, grouted and the dowel set in place. Grout shall be of the same strength as the footing concrete, or at least 25 MPa at 28 days.

If the hole contains water, the Contractor shall remove the water, otherwise, a tremie procedure shall be used to completely fill the hole with grout. The dowel shall be forced into the hole after the grout has been placed and while it is still fresh.

### **Rock Dowel Testing**

All proposed testing procedures shall be in general conformance with ASTM D3689-90 and ASTM D1143M-07. Field testing must be carried out in the presence of, and the results reviewed and approved by, the Contract Administrator.

### **Performance Tests**

The following table summarizes the number of dowels into rock where performance testing shall be carried out to confirm that the design load of the rock dowels can be achieved. The Contract Administrator will select the rock dowels to be tested.

<b>Structure</b>	<b>Number of Dowels for Performance Testing</b>
Overhead Sign OHS-1	2 per spread footing
Overhead Sign OHS-3	2 per spread footing
Overhead Sign OHS-4	2 per spread footing

Performance test shall be by axial tensioning using a hydraulic jack with a capacity of at least 1.5 times the ultimate strength of the dowels.

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

Cycle-Step	1-1	1-2	1-3	2-1	2-2	2-3	2-4
% Design Load	50	75	25	50	75	100	25

Cycle-Step	3-1	3-2	3-3	3-4	3-5
% Design Load	50	75	100	110	25

The design load shall be taken as 360 kN for 35M dowels, 252 kN for 30M dowels, 180 kN for 25M dowels and 108 kN for 20M dowels.

Displacement measurements shall be carried out at each load increment using calibrated displacement gauges capable of measuring movements of 0.025 mm. Measurements shall be referenced to an independent fixed referenced point.

Rock dowels which fail to meet the acceptance criteria shall be replaced at the Contractor's expense and re-tested. If a rock dowel fails, 3 additional rock dowels shall be tested at the same spread footing as directed by the Contract Administrator.

Acceptance criteria for the rock dowels will be in accordance with the Post-Tensioning Institute (1985) as follows:

- The dowels are acceptable if the total elastic movement is greater than 80 percent of the theoretical elastic elongation of the free stressing length and is less than the theoretical elongation of the free stressing length plus 50 percent of the bond length.

#### **Basis of Payment**

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION

**Control of Overburden Soils – Item No.**

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Special Provision

---

**Scope of Work**

Excavations for the overhead sign foundations will be advanced through cohesionless soils, which should be expected to be unstable below the groundwater level. Where cohesionless soil deposits are encountered, appropriate construction equipment and procedures will be required to minimize ground loss during excavation and concrete placement.

**Basis of Payment**

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

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