



January 20, 2014

## FOUNDATION INVESTIGATION REPORT

**CANADIAN PACIFIC RAILWAY OVERHEAD STRUCTURE NBL,  
SITE NO.44-460/1  
HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529  
NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 5404-05-00; WP 5143-08-01**

**Submitted to:**  
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- 1 e-Copy Ministry of Transportation, Ontario, North Bay, Ontario (Northeastern Region)
- 1 e-Copy Ministry of Transportation, Ontario, Downsview, Ontario (Foundations Section)
- 1 e-Copy Golder Associates Ltd., Mississauga, Ontario

REPORT





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# PART A

## FOUNDATION INVESTIGATION REPORT

CANADIAN PACIFIC RAILWAY OVERHEAD STRUCTURE - NBL,  
SITE NO. 44-460/1

HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529  
NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5404-05-00; WP 5143-08-01



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the proposed Highway 69 Northbound Lane (NBL) structure over the Canadian Pacific Railway (CPR), which is within the Contract 3 limits of the new Highway 69 alignment. The proposed work in Contract 3 is part of the four-laning of Highway 69 from 1.7 km north of Highway 529 northerly to 3.9 km north of Highway 522, for a total distance of 19.7 km, which includes: high fill embankments and embankments over swamps; the Canadian National Railway (CNR) re-alignment; the Bekanon Road and Highway 522 interchanges and structures; the Still River, Straight Lake and Key River structures; the Canadian Pacific Railway and Canadian National Railway (CNR) Overhead structures; as well as culvert crossings. The CPR Overhead NBL structure is to be located approximately 1.5 km east of the existing Highway 69 and about 200 m south of Straight Lake. The general location of this proposed bridge along the new Highway 69 four-laning alignment is shown on the Site Location Plan on Drawing 1.

The Terms of Reference (TOR) for the foundation investigation are outlined in MTO's Request for Proposal, dated December 2008. Golder's proposal (Scope of Work) for foundation engineering services associated with the Contract 3 CPR Overhead NBL structure is contained in Section 6.8 of URS's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated April 19, 2010.

This report addresses the investigation carried out for the CPR Overhead NBL structure and the associated approach embankments only (Site No. 44-460/1). A separate report addresses the foundation investigation for the CPR Overhead southbound lane structure.

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

## **2.0 SITE DESCRIPTION**

The proposed Highway 69 alignment is oriented generally in a south-north direction spanning the Township of Wallbridge to the south, the Township of Henvey, and the Township of Mowat to the north. The Contract 3 section of the new four-lane Highway 69 alignment is also oriented generally in a south-north direction within the overall project limits, for a total distance of 5.5 km in the Township of Henvey. The proposed CPR Overhead NBL structure is located within the Contract 3 highway alignment and is located approximately 100 m south of the northern limit of Contract 3, corresponding to approximately 1.5 km east of the existing Highway 69 alignment and about 8.5 km northeast of the junction between existing Highway 69 and Highway 526.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely to densely populated tree covered areas and numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils. The proposed overhead structure and associated approach embankments are to be situated relatively close to an existing rock cut and/or rock outcrop in a sparsely to densely treed area adjacent to the existing CPR track alignment. The existing



ground surface within the limits of the proposed structure and approach embankments varies between about Elevations 200 m and 191 m, referenced to Geodetic datum, and is sloping downward from south to north.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Foundation Investigation**

The field work for the proposed CPR Overhead NBL structure was carried out between February 26 and March 7, 2013 during which time a total of eight (8) boreholes, and four (4) hand shovel excavations were advanced at the locations of the structure foundation footprints and approach embankments. A summary of the respective boreholes and hand shovel excavations advanced at each foundation element and approach embankment is presented below.

<b>Foundation Element/Approach Embankment</b>	<b>Investigation Type</b>	
	<b>Borehole</b>	<b>Hand Shovel Excavation</b>
South Approach Embankment	--	B304-01
South Abutment	B304-03 B304-04 B304-05	B304-02 B304-06
North Abutment	B304-08 B304-09 B304-10 B304-11 B304-12	--
North Approach Embankment	--	B304-07

The Record of Borehole/Drillhole sheets and the results of the laboratory testing are presented in Appendix A and Appendix B, respectively. The locations of the boreholes and hand shovel excavations are shown in plan on Drawing 2.

The field borehole investigation was carried out using a portable drill rig supplied and operated by Landcore of Chelmsford, Ontario. Hand shovel excavation methods were used as appropriate depending on the terrain and to confirm refusal conditions at shallow borehole locations where possible. The boreholes were generally advanced through the overburden using NW casing. Where possible, soil samples were obtained at ground surface and at intervals of depth of about 0.75 m, using a 50 mm outer diameter (O.D.) split-spoon sampler driven by a manual hammer on the drill rig, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test). Samples of the bedrock were obtained using an 'NQ' size rock core barrel.

The boreholes at the locations of the foundation elements were typically advanced to hand shovel, casing and/or sampler refusal (i.e. inferred bedrock) and bedrock was confirmed by coring in selected boreholes. Refusal condition at the boreholes at the south and north approach embankments was confirmed by hand shovel excavation. The boreholes were advanced to depths of up to about 8.7 m below existing ground surface, including coring of bedrock for core lengths between about 3.1 m and 6.0 m in Boreholes B304-03 to B304-05, B304-08, B304-10 and B304-12.



The groundwater conditions and water levels in the open boreholes were observed during the drilling operations. Within the limits of the north abutment, a piezometer was installed in Borehole B304-10 to monitor the ground water level at this location. The piezometer consists of 35 mm diameter PVC pipe, with a slotted screen sealed at a selected depth within the borehole. The borehole and annulus surrounding the piezometer pipe above the screen (and sand pack) were backfilled to the surface with bentonite pellets. Piezometer installation details and a water level reading are described on the Record of Borehole sheet presented in Appendix A. All open boreholes were backfilled with bentonite upon completion and the piezometer was abandoned on March 9, 2013 in accordance with Ontario Regulation 903, Wells (as amended).

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

The perimeter limits of each foundation unit were located in the field by Callon Dietz prior to drilling. The staked borehole locations and ground/ice surface elevations were surveyed by Callon Dietz. The locations given on the Record of Borehole/Drillhole sheets and shown on Drawing 2 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground/ice surface elevations are referenced to Geodetic datum. The borehole locations and ground/ice surface elevations are summarized below.

Borehole No.	Location (MTM NAD 83)		Ground/Ice Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
B304-01	5082691.6	223179.6	198.9	0.5
B304-02	5082705.6	223166.5	197.6	0.3
B304-03	5082710.4	223164.4	197.7	6.1
B304-04	5082711.5	223171.0	197.5	3.7
B304-05	5082712.4	223177.9	200.0	5.8
B304-06	5082717.5	223174.5	196.2	0.1
B304-07	5082765.0	223148.7	194.8	0.4
B304-08	5082745.4	223149.9	191.1	8.7
B304-09	5082740.7	223151.8	191.1	2.6
B304-10	5082746.6	223156.4	191.2	7.3
B304-11	5082752.8	223161.4	191.2	4.1
B304-12	5082748.1	223163.3	191.1	7.0



## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

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

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

The bedrock in the area consists typically of crystalline gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in *Geology of Ontario*, OGS Special Volume 4<sup>2</sup>. Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

### 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock core samples, are presented on the attached Record of Borehole and Drillhole sheets and on the laboratory test figures provided in Appendix A and Appendix B, respectively. The results of the in situ field tests (i.e. SPT 'N'-values) as presented on the Record of Borehole sheets and in Section 4.2 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions in the area of the CPR Overhead NBL structure consist of a layer of organic silt or peat, underlain by thin, discontinuous non-cohesive deposits of silt to sandy silt to silt and sandy gravel, underlain by bedrock. The overburden thickness at the boreholes advanced for the proposed bridge structure ranges from less than about 0.1 m at the northeast area of the south abutment and (exposed bedrock in places) to about 3.9 m at the northeast corner of the north abutment.

A detailed description of the subsurface conditions encountered in the boreholes at the abutments and approach embankments is provided in the following sections.

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

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



#### **4.2.1 Peat/Organic Silt**

An approximately 0.1 m to 1.0 m thick layer of peat and/or organic silt up was encountered at the ground surface in Boreholes B304-01 to B304-04, B304-06 and B304-07, and immediately below ice/water in Boreholes B304-08 to B304-12.

The SPT 'N'-values measured within the peat deposit, across the interface of peat and organic silt layer and within the organic silt layer range from 0 blows (weight of hammer) to 2 blows per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on two (2) samples of the peat deposit is about 734 per cent and 1058 per cent and on three (3) samples of the organic silt deposit is about 72 per cent to 109 per cent.

The organic content measured on two (2) samples of the organic silt deposit is about 5 per cent and 6 per cent.

An Atterberg limits test was carried out on a sample of organic silt deposit and measured a liquid limit of about 63 per cent, a plastic limit of about 42 per cent and plasticity index of about 21 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B1 in Appendix B, and indicates that the material is classified as organic silt of high plasticity.

#### **4.2.2 Silt to Silt and Sand to Sandy Gravel**

A deposit of non-cohesive soils comprised of brown to grey silt, trace to some sand to sandy silt to silt and sand to sandy gravel was encountered below the peat/organic silt layers in Boreholes B304-01, B304-07 to B304-12. The deposit in places contains trace gravel, trace clay and trace organics. The top of this deposit was encountered between about Elevations 198.8 m and 189.8 m and the thickness of the deposit ranges between about 0.3 m and 3.3 m.

The SPT 'N'-values measured within the non-cohesive deposit range from 0 blows (weight of hammer) to 8 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on ten (10) samples of the non-cohesive deposit ranges between about 1 per cent and 26 per cent.

The results of grain size distribution tests completed on seven (7) samples of the silt to sandy silt to silt and sand portion of the deposit are shown on Figure B2 in Appendix B. The result of a grain size distribution test completed on a sample of sandy gravel layer is shown on Figure B3 in Appendix B.

Atterberg limits tests carried out on two (2) samples of the silt to sandy silt portion of deposit and indicate that the fine material is non-plastic.

#### **4.2.3 Bedrock/Refusal**

Bedrock was encountered and core samples were recovered from Boreholes B304-03 to B304-05, B304-08, B304-10 and B304-12. Bedrock outcrops are present in the immediate area of the proposed structure. The bedrock surface was inferred from hand shovel excavation or split-spoon/casing refusal in Boreholes B304-01, B304-2, B304-06, B304-07 and B304-09. The depths to bedrock below ground surface and the corresponding bedrock surface elevation at the investigation locations are summarized below.



**FOUNDATION REPORT – CPR OVERHEAD STRUCTURE NBL – HIGHWAY 69  
FOUR-LANING GWP 5404-05-00; WP 5143-08-01**

Foundation Element / Approach Embankment	Borehole	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
South Approach Embankment	B304-01	0.5	198.4	Hand Shovel Excavation
South Abutment	B304-02	0.3	197.3	Hand Shovel Excavation
	B304-03	0.1	197.6	6.0 m of Bedrock Cored
	B304-04	0.3	197.2	3.4 m of Bedrock Cored
	B304-05	<0.1	200.0	5.8 m of Bedrock Cored
	B304-06	0.1	196.1	Hand Shovel Excavation
	B304-08	3.3 <sup>1</sup>	187.5	5.1 m of Bedrock Cored
North Abutment	B304-09	2.4 <sup>1</sup>	188.5	Split-Spoon and Casing Refusal
	B304-10	3.8 <sup>1</sup>	187.2	3.3 m of Bedrock Cored
	B304-11	3.9 <sup>1</sup>	187.1	Split-Spoon and Casing Refusal
	B304-12	3.6 <sup>1</sup>	187.2	3.1 m of Bedrock Cored
North Approach Embankment	B304-07	0.4	194.4	Hand Shovel Excavation

Note: 1. Depth to Bedrock measured from ground surface below ponded water.

In general, the bedrock surface in the area of the CPR Overhead NBL structure is blocky, with horizontal and vertical fragments and slopes downward from south to north, as shown on the site photographs on Figures B4 and B5. The difference in the bedrock surface elevation at the investigated locations is up to 3.9 m at the south abutment, up to 1.4 m at the north abutment and up to about 13 m between the abutments at the borehole locations.

Based on a review of the bedrock core samples, the bedrock consists of granitic gneiss. In general, the bedrock samples are described as slightly weathered to fresh, thinly laminated to thinly bedded, fine to coarse crystalline, faintly porous, medium strong to very strong, pink, light to dark grey with pink interbeds, as presented on the Record of Drillhole sheets in Appendix A, and shown on the photographs of the recovered core samples on Figures B6 to B11 in Appendix B. The degree of weathering of the bedrock samples (i.e. lightly weathered to fresh – W1 to W2), and the strength classification of the intact rock mass based on field identification (i.e. strong to very strong – R4 to R5) are described in accordance with the International Society for Rock Mechanics (ISRM<sup>3</sup>) standard classification system.

The Rock Quality Designation (RQD) measured on the core samples generally ranges from about 60 per cent to 100 per cent, indicating a rock mass of fair to excellent quality as per Table 3.10 of CFEM (2006<sup>4</sup>). However, portions of core recovered from Boreholes B304-04 and B304-08 contain fractured rock with RQD values of about 36 per cent and 41 per cent, indicating a rock mass of poor quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples recovered are between 90 per cent and 100 per cent and between 44 per cent and 100 per cent, respectively.

<sup>3</sup> International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

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



Point load strength index tests (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification) were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on twenty-three (23) samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from about 3.1 MPa to 12.3 MPa, but generally greater than 6.1 MPa, and the diametral tests carried out on twenty-four (24) samples of the granitic gneiss bedrock core measured  $Is_{50}$  values ranging from about 3.2 MPa to 10.8 MPa, but generally greater than 5.0 MPa.

Two (2) Unconfined Compression (UC) tests (ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens) were carried out on selected core samples of the granitic gneiss bedrock obtained in Boreholes B304-03 and B304-12 and measured uniaxial compressive strengths of about 125 MPa and 106 MPa, respectively, as summarized in Table B2-1 and detailed in Tables B2-2 and B2-3 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength index based on a relationship between  $Is_{50}$  and UCS, which is given by a correlation factor (K) which varies depending on the size of the core sample and the strength of the rock. For this site, the UCS values are based on an estimated average correlation factor (K) of 12.

Based on the laboratory UC and the axial point load index test results, and in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.2.4 Groundwater Conditions**

In general, the overburden samples taken in the boreholes were moist to wet. The water level observed in boreholes upon completion of drilling varied between about Elevations 198.5 m and 191.0 m, measured between 0.3 m above ground surface (i.e. equivalent ponded column of water) and depths up to about 4.8 m below ground surface. Boreholes B304-06 and B304-07 were dry upon completion of hand excavation.

A standpipe piezometer was installed in Borehole B304-10 to allow monitoring of the groundwater level at the site. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A. The groundwater level measured in the piezometer installation is summarized below.

Foundation Element	Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Abutment	B304-10	190.9	191.1	March 9, 2013

It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.



## **5.0 CLOSURE**

Mr. Matt J. Riopelle, field technician with Golder, directed the drilling program. This report was prepared by Mr. Al Varshoi, M.E.Sc., 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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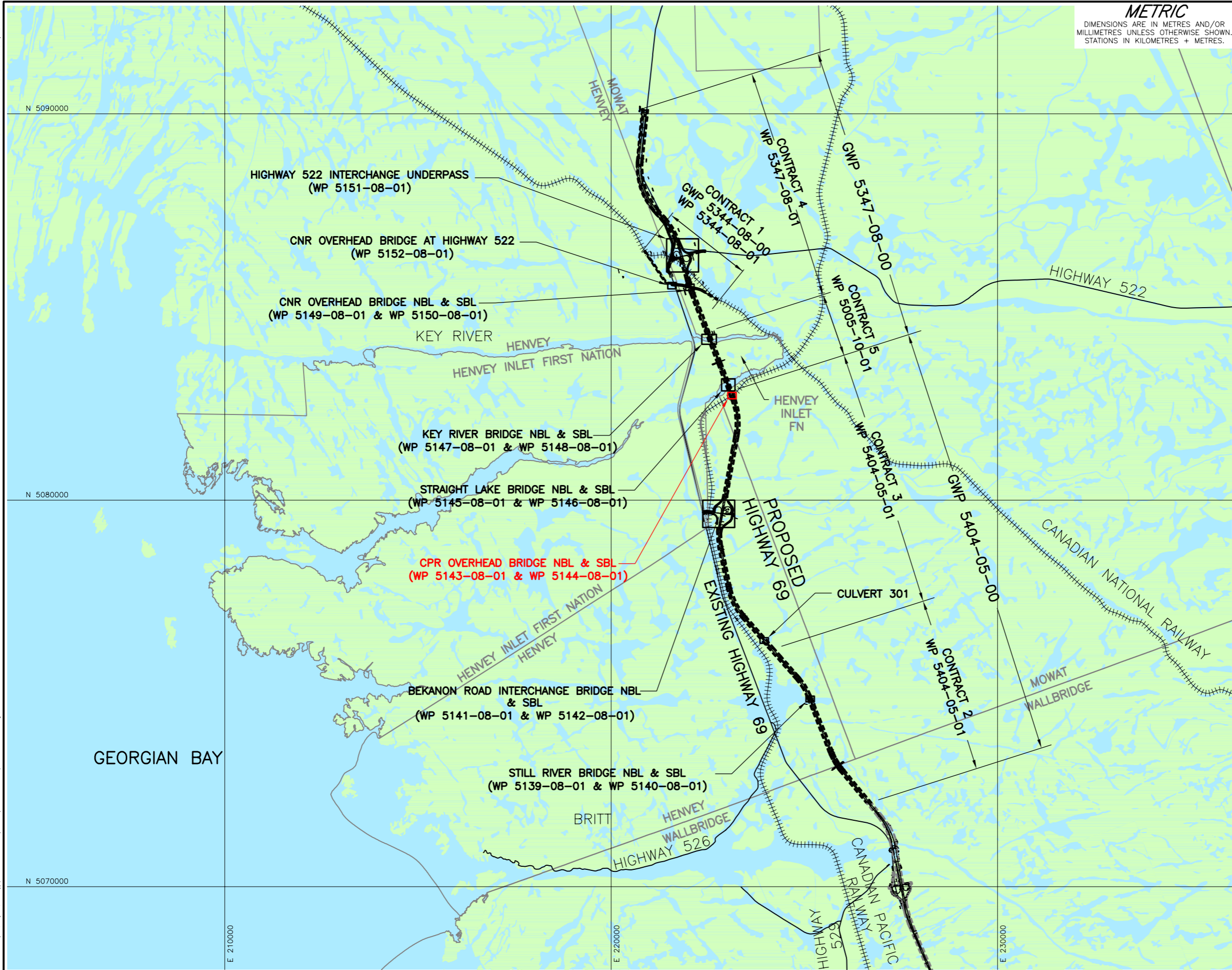


AV/CN/JPD/JMAC/jl

[http://capws/sites/0911116014highway69fourlaning/contract 3/reporting/final/cpr overhead structure nbl/09-1111-6014-3524 rpt 14jan20 cpr overhead structure nbl.docx](http://capws/sites/0911116014highway69fourlaning/contract%203/reporting/final/cpr%20overhead%20structure%20nbl/09-1111-6014-3524%20rpt%2014jan20%20cpr%20overhead%20structure%20nbl.docx)



# DRAWINGS



PLAN



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

CONT No.  
GWP No. 5404-05-00

HIGHWAY 69  
SITE LOCATION PLAN

SHEET

**Golder Associates**

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

KEY PLAN  
NOT TO SCALE

SHEET

REFERENCE				
Base Data - MNR NRVIS, obtained 2004, CANMAP v2008 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008 Datum : NAD 83 Projection : MTM Zone 10				
Geocres No. 41H-138				
NO.	DATE	BY	REVISION	
HWY. 69	PROJECT NO. 09-1111-6014		DIST.	
SUBM'D. TVA	CHKD. TVA	DATE: Oct. 2013	SITE:	
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC	DWG. 1	

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

CONT No.  
WP No. 5143-08-01



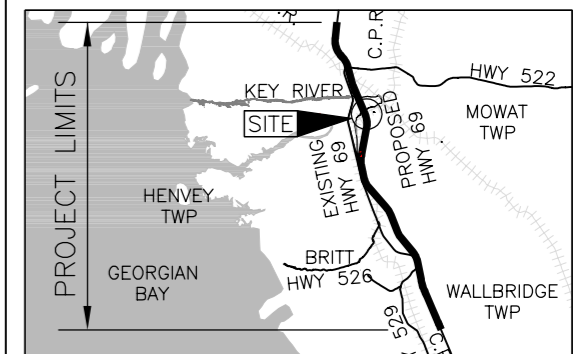
HIGHWAY 69  
CPR OVERHEAD BRIDGE NBL

SHEET

BOREHOLE LOCATIONS AND SOIL STRATA



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



KEY PLAN

SCALE  
5 0 5 10 km

LEGEND

- Borehole - Current Investigation
- ⬮ Seal
- ⬮ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on March 09, 2013
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
B304-01	198.9	5082691.6	223179.6
B304-02	197.6	5082705.6	223166.5
B304-03	197.7	5082710.4	223164.4
B304-04	197.5	5082711.5	223171.0
B304-05	200.0	5082712.4	223177.9
B304-06	196.2	5082717.5	223174.5
B304-07	194.8	5082765.0	223148.7
B304-08	191.1	5082745.4	223149.9
B304-09	191.1	5082740.7	223151.8
B304-10	191.2	5082746.6	223156.4
B304-11	191.2	5082752.8	223161.4
B304-12	191.1	5082748.1	223163.3

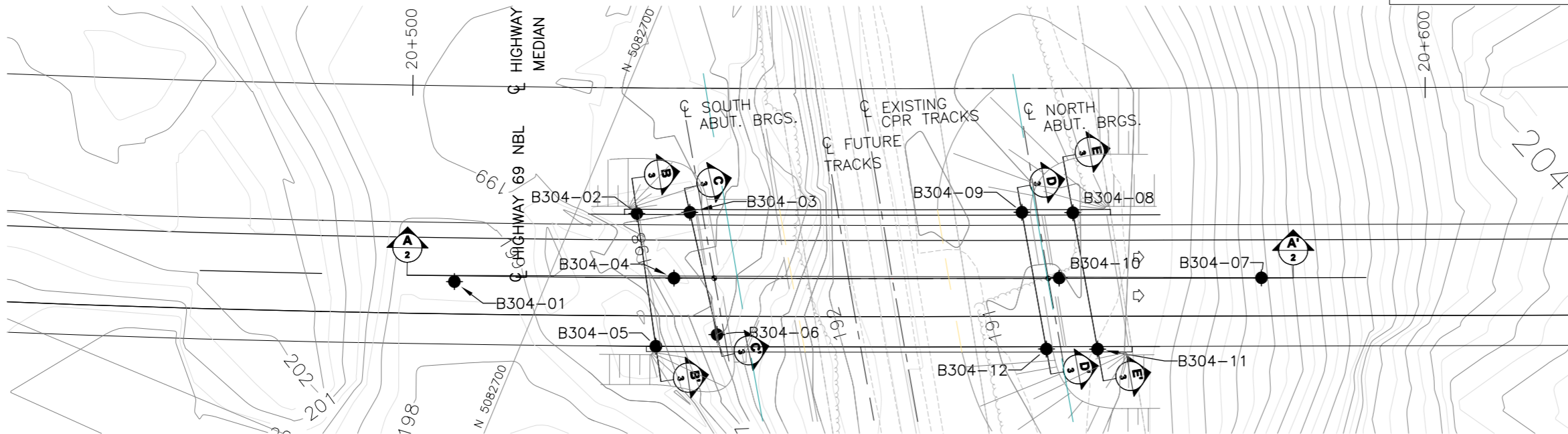
NOTES

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

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

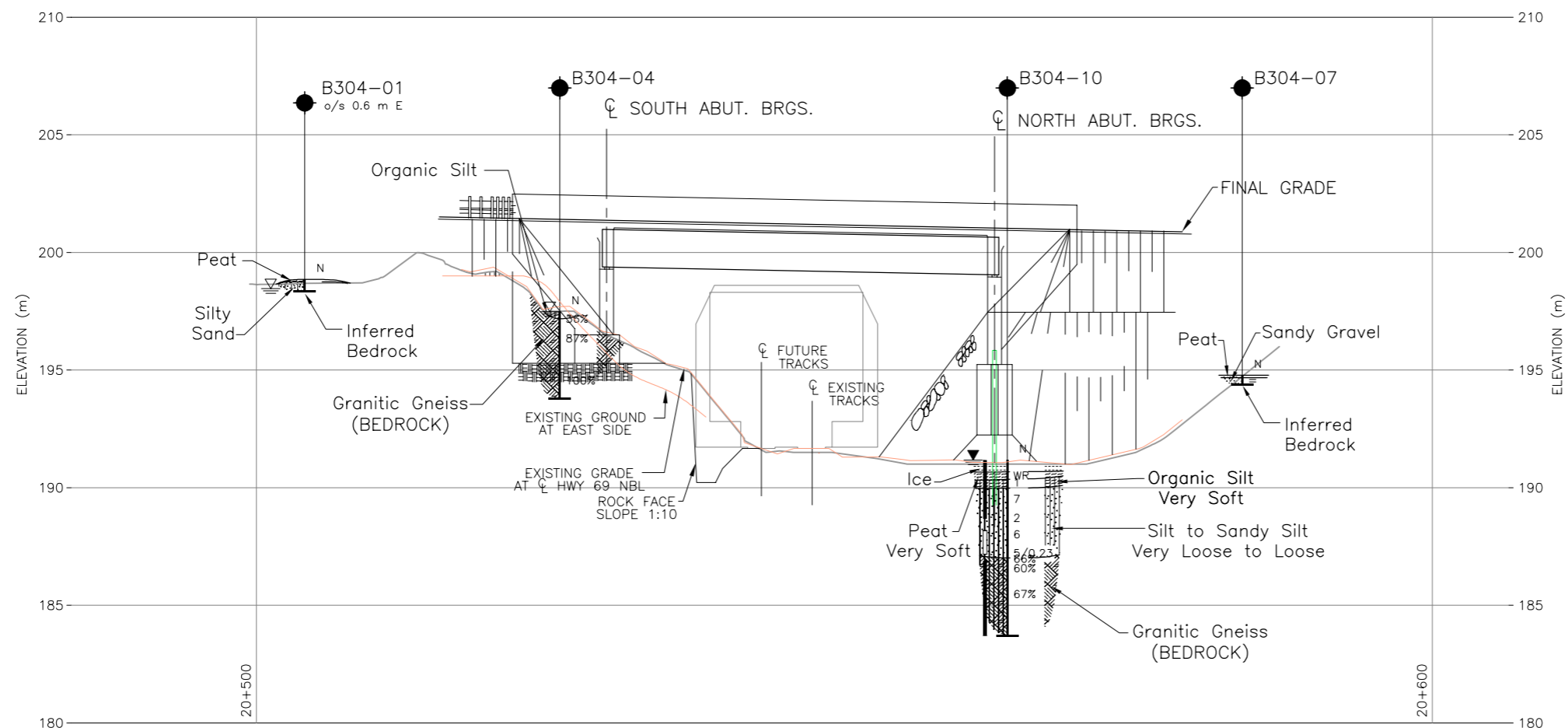
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

NO.	DATE	BY	REVISION
Geocres No. 41H-138			
HWY. 69	PROJECT NO. 09-1111-6014		DIST.
SUBM'D. AV	CHKD. CN	DATE: Oct. 2013	SITE: 44-460/1
DRAWN: MR	CHKD. AV	APPD. JPD/JMAC	DWG. 2



PLAN

SCALE  
5 0 5 10 m



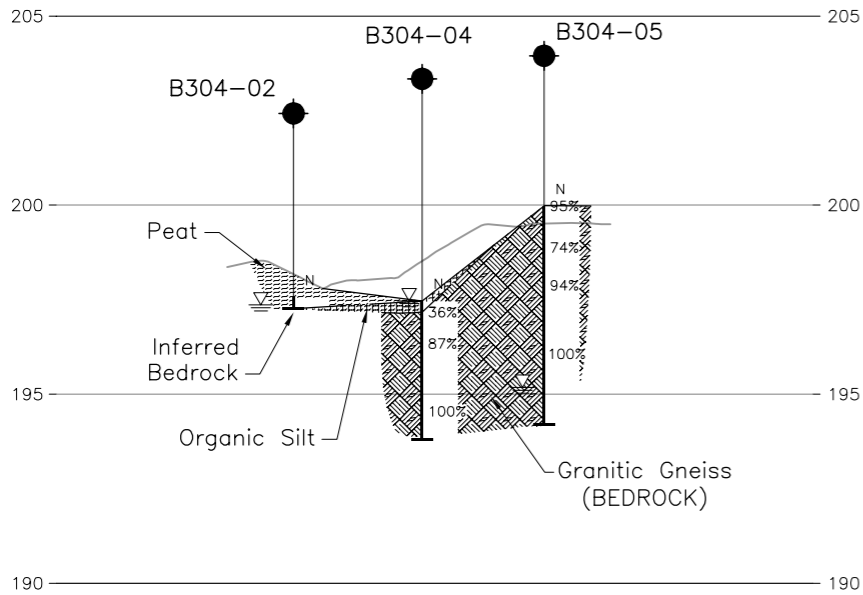
**A-A'**  
CENTRELINE PROFILE  
HIGHWAY 69 (NBL)

HORIZONTAL SCALE  
5 0 5 10 m  
VERTICAL SCALE  
2.5 0 2.5 5 m

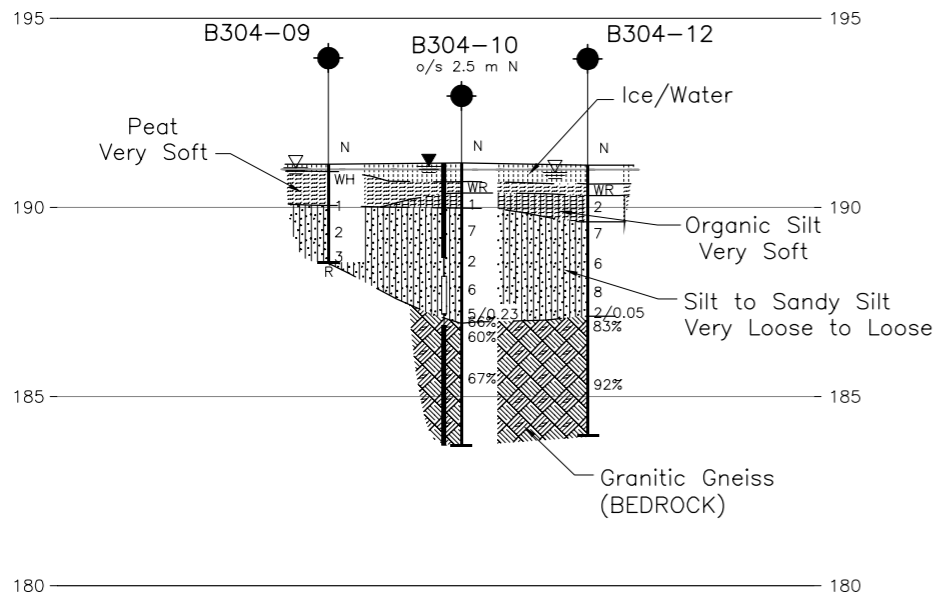
REFERENCE

Base plans provided in digital format by URS, drawing file nos.  
Hwy69\_Contour-Plan\_C3.dwg, Hwy69\_Contour-Plan\_C5.dwg, received April  
23, 2013 and August 31, 2012. CPR NBL Skew\_GA.dwg, received July 11,  
2013.

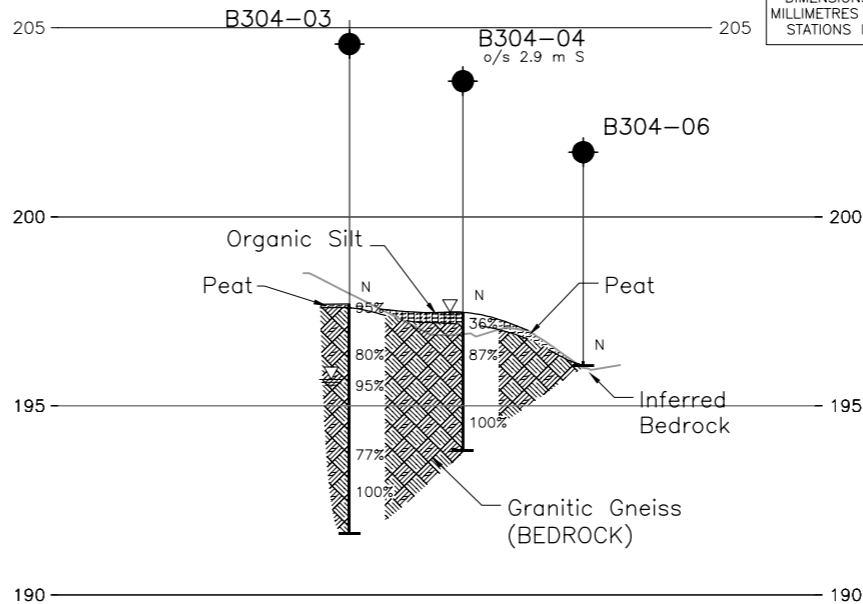




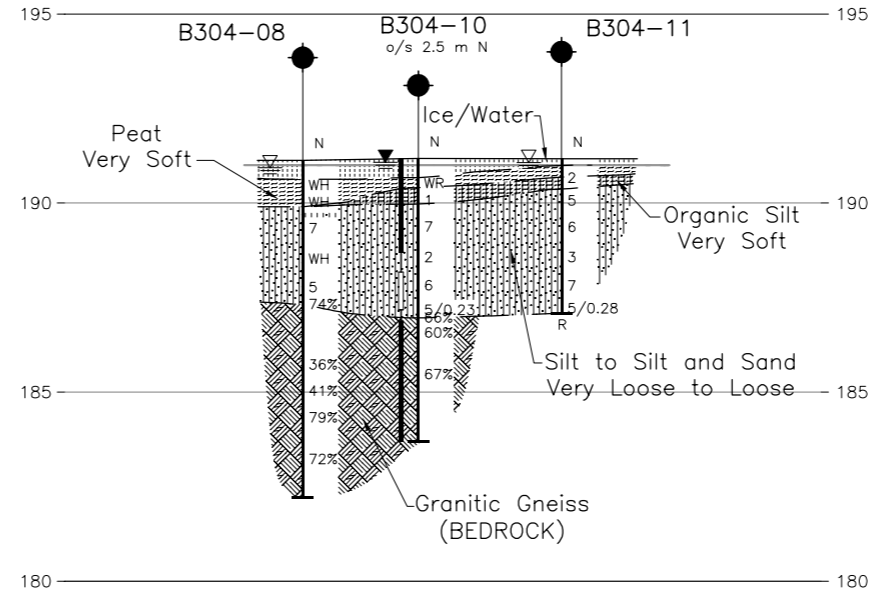
**B-B' 2**  
**SOUTH ABUTMENT**  
**HIGHWAY 69 (NBL)**  
HORIZONTAL SCALE  
4 0 4 8 m  
VERTICAL SCALE  
2 0 2 4 m



**D-D' 2**  
**NORTH ABUTMENT**  
**HIGHWAY 69 (NBL)**  
HORIZONTAL SCALE  
4 0 4 8 m  
VERTICAL SCALE  
2 0 2 4 m



**C-C' 2**  
**SOUTH ABUTMENT**  
**HIGHWAY 69 (NBL)**  
HORIZONTAL SCALE  
4 0 4 8 m  
VERTICAL SCALE  
2 0 2 4 m



**E-E' 2**  
**NORTH ABUTMENT**  
**HIGHWAY 69 (NBL)**  
HORIZONTAL SCALE  
4 0 4 8 m  
VERTICAL SCALE  
2 0 2 4 m

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

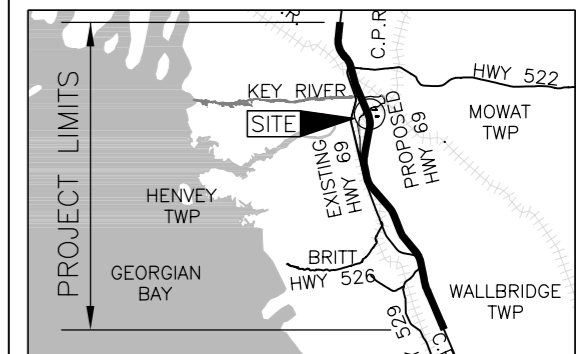
CONT No.  
WP No. 5143-08-01

HIGHWAY 69  
CPR OVERHEAD BRIDGE NBL  
SOIL STRATA

SHEET



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



**KEY PLAN**  
SCALE  
5 0 5 10 km

**LEGEND**

- Borehole - Current Investigation
- ⬮ Seal
- ⬮ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on March 9, 2013
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B304-02	197.6	5082705.6	223166.5
B304-03	197.7	5082710.4	223164.4
B304-04	197.5	5082711.5	223171.0
B304-05	200.0	5082712.4	223177.9
B304-06	196.2	5082717.5	223174.5
B304-08	191.1	5082745.4	223149.9
B304-09	191.1	5082740.7	223151.8
B304-10	191.2	5082746.6	223156.4
B304-11	191.2	5082752.8	223161.4
B304-12	191.1	5082748.1	223163.3

**NOTES**

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NO.	DATE	BY	REVISION
Geocres No. 41H-138			
HWY. 69	PROJECT NO. 09-1111-6014		DIST.
SUBM'D. AV	CHKD. CN	DATE: Oct. 2013	SITE: 44-460/1
DRAWN: MR	CHKD. AV	APPD. JPD/JMAC	DWG. 3



# APPENDIX A

## Record of Borehole and Drillhole Sheets



## LIST OF SYMBOLS

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

### I. GENERAL

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

### II. STRESS AND STRAIN

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

### III. SOIL PROPERTIES

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

### (a) Index Properties (continued)

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

### (b) Hydraulic Properties

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

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

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

### (d) Shear Strength

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

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

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
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.

### V. MINOR SOIL CONSTITUENTS

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

### III. SOIL DESCRIPTION

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

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

#### (b) Cohesive Soils Consistency

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

### IV. SOIL TESTS

w	water content
$w_p$	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 <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

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

Per cent 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 (non-cohesive (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	

PROJECT		RECORD OF BOREHOLE		No B304-01		SHEET 1 OF 1		METRIC									
W.P.		LOCATION		ORIGINATED BY		DIST		BOREHOLE TYPE		COMPILED BY		DATUM		DATE		CHECKED BY	
09-1111-6014		N 5082691.6 ; E 223179.6		MJR		HWY 69		Hand Shovel Excavation		AV		Geodetic		March 1, 2013		JPD	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
							20	40	60	80	100	20	40	60				
198.9	GROUND SURFACE																	
0.0	PEAT (Fibrous) Dark Brown Wet																	
198.4	Silty SAND, some gravel, trace organics Brown Wet																	
0.5	END OF EXCAVATION INFERRED BEDROCK																	
NOTE: 1. Water level in excavation at a depth of 0.4 m below ground surface (Elev. 198.5 m) upon completion.																		

PROJECT		RECORD OF BOREHOLE		No B304-02		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5082705.6 ; E 223166.5		ORIGINATED BY		MJR								
DIST		HWY 69		BOREHOLE TYPE		Hand Shovel Excavation		COMPILED BY								
AV		DATE		March 1, 2013		CHECKED BY		JPD								
DATUM		Geodetic														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ 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								
197.6	GROUND SURFACE															
0.0	PEAT (Fibrous)															
197.3	Dark brown															
0.3	Wet															
	Cobbles															
	END OF EXCAVATION															
	INFERRED BEDROCK															
	NOTE:															
	1. Water level in excavation at a															
	depth of 0.2 m below ground															
	surface (Elev. 197.4 m) upon															
	completion.															

PROJECT		RECORD OF BOREHOLE		No B304-03		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5082710.4 ; E 223164.4		ORIGINATED BY		MJR									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, NQ Coring		COMPILED BY									
AV		DATE		February 27, 2013		CHECKED BY		JPD									
DATUM		Geodetic															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
197.7	GROUND SURFACE							20	40	60	80	100					
0.0	PEAT (Fibrous) Dark brown Wet		1	CS	-												
0.1	Granitic Gneiss (BEDROCK)		1	RC	REC 100%												RQD = 95%
	Bedrock cored from depths of 0.1 m to 6.1 m		2	RC	REC 99%												RQD = 80%
	For bedrock coring details refer to Record of Drillhole B304-03.		3	RC	REC 98%												RQD = 95%
			4	RC	REC 100%												RQD = 77%
			5	RC	REC 100%												RQD = 100%
191.6	END OF BOREHOLE																
6.1	NOTE:  1. Water level in open borehole at a depth of 2.0 m below ground surface (Elev. 195.7 m) upon completion of drilling.																

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: LANDCORE DRILLING

CHECKED: JPD

PROJECT		RECORD OF BOREHOLE		No B304-04		SHEET 1 OF 1		METRIC	
W.P.		LOCATION		ORIGINATED BY		DIST		BOREHOLE TYPE	
DATE		COMPILED BY		CHECKED BY		DATUM		DATE	
09-1111-6014		N 5082711.5 ; E 223171.0		MJR		HWY 69		Portable Equipment, NQ Coring	
Geodetic		February 27, 2013		JPD					

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60			
197.5	GROUND SURFACE																
0.0	ORGANIC SILT		1	CS	-												
197.2	Dark brown																
0.3	Wet																
	Granitic Gneiss (BEDROCK)		1	RC	REC 90%											RQD = 36%	
	Bedrock cored from depths of 0.3 m to 3.7 m																
	For bedrock coring details refer to Record of Drillhole B304-04.		2	RC	REC 99%											RQD = 87%	
			3	RC	REC 100%											RQD = 100%	
193.8	END OF BOREHOLE																
3.7	NOTE: 1. Water level in open borehole at ground surface (Elev. 197.5 m) upon completion of drilling.																

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B304-04**

SHEET 1 OF 1

LOCATION: N 5082711.5 ; E 223171.0

DRILLING DATE: February 27, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG.	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
									TOTAL CORE %	SOLID CORE %	CORRECTION %	B Angle			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 to 20	20 to 30	30 to 40	40 to 50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
		Continued from Record of Borehole B304-04		197.18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

DEPTH SCALE

1 : 50



LOGGED: MJR/CS

CHECKED: JPD

GTA-RCK 018 09-1111-6014.GPJ GAL-MISS.GDT 01/16/14

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B304-05		SHEET 1 OF 1		METRIC										
W.P. 5143-08-01		LOCATION N 5082712.4 ; E 223177.9		ORIGINATED BY MJR												
DIST HWY 69		BOREHOLE TYPE Portable Equipment, NQ Coring		COMPILED BY AV												
DATUM Geodetic		DATE February 26, 2013		CHECKED BY JPD												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
200.0	GROUND SURFACE						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
0.0	Granitic Gneiss (BEDROCK)															
	Bedrock cored from ground surface to a depth of 5.8 m		1	RC	REC 100%											RQD = 95%
	For bedrock coring details refer to Record of Drillhole B304-05.		2	RC	REC 98%											RQD = 74%
			3	RC	REC 100%											RQD = 94%
			4	RC	REC 100%											RQD = 100%
194.2	END OF BOREHOLE															
5.8	NOTE: 1. Water level in open borehole at a depth of 4.8 m below ground surface (Elev. 195.2 m) upon completion of drilling.															

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B304-05**

SHEET 1 OF 1

LOCATION: N 5082712.4 ; E 223177.9

DRILLING DATE: February 26, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
		Continued from Record of Borehole B304-05		199.98									
0		Slightly weathered to fresh, thinly laminated to thinly bedded, light to dark grey with pink interbeds, fine to coarse grained, faintly porous, medium strong to very strong GRANITIC GNEISS		0.00									
1													8.3 MPa (Axial)
2													3.1 MPa (Axial)
3													6.1 MPa (Axial)
4													9.1 MPa 10.2 MPa (Axial)
5													8.1 MPa 9.2 MPa (Axial)
6		END OF DRILLHOLE		194.19 5.79									
7													
8													
9													
10													

DEPTH SCALE

1 : 50



LOGGED: MJR/CS

CHECKED: JPD

GTA-RCK 018 09-1111-6014.GPJ GAL-MISS.GDT 01/16/14

PROJECT 09-1111-6014		<b>RECORD OF BOREHOLE No B304-06</b>		SHEET 1 OF 1		<b>METRIC</b>										
W.P. 5143-08-01		LOCATION N 5082717.5 ; E 223174.5		ORIGINATED BY MJR												
DIST _____ HWY 69		BOREHOLE TYPE Hand Shovel Excavation		COMPILED BY AV												
DATUM Geodetic		DATE March 1, 2013		CHECKED BY JPD												
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								
196.2	GROUND SURFACE															
0.0	PEAT (Fibrous)															
0.1	Dark brown Wet															
	END OF BOREHOLE INFERRED BEDROCK															
	NOTE:  1. Excavation dry upon completion.															

PROJECT		RECORD OF BOREHOLE		No B304-07		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5082765.0 ; E 223148.7		ORIGINATED BY		MJR								
DIST		HWY 69		BOREHOLE TYPE		Hand Shovel Excavation		COMPILED BY								
AV		DATE		March 6, 2013		CHECKED BY		JPD								
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								
194.8	GROUND SURFACE															
0.0	PEAT (Fibrous)		1	CS	-											
194.4	Dark brown		2	CS	-											
0.4	Wet															
	Sandy GRAVEL, trace to some silt, trace clay															
	Brown															
	Wet															
	END OF EXCAVATION INFERRED BEDROCK															
	NOTE:  1. Excavation dry upon completion.															

PROJECT		RECORD OF BOREHOLE		No B304-08		SHEET 1 OF 1		METRIC							
W.P.		LOCATION		ORIGINATED BY		COMPILED BY		CHECKED BY							
DIST		BOREHOLE TYPE		DATE		JPD									
Geodetic		March 1, 2013													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
191.1	ICE SURFACE														
0.0	ICE														
190.8															
0.3	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WH										
			2	SS	WH										
189.9															
1.2	SILT and SAND, trace clay Very loose to loose Grey Wet		3	SS	7										
			4	SS	WH										
			5	SS	5										
187.5															
3.6	Granitic Gneiss (BEDROCK)  Bedrock cored from depths of 3.6 m to 8.7 m  For bedrock coring details refer to Record of Drillhole B304-08.		1	RC	REC 99%										
			2	RC	REC 100%										
			3	RC	REC 97%										
			4	RC	REC 100%										
			5	RC	REC 99%										
182.4															
8.7	END OF BOREHOLE  NOTE:  1. Water level in open borehole at ice surface (Elev. 191.1 m) upon completion of drilling.														

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B304-08**

SHEET 1 OF 1

LOCATION: N 5082745.4 ;E 223149.9

DRILLING DATE: March 1, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: LANDCORE 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.	NOTES	
				DEPTH									
				(m)									
		Continued from Record of Borehole B304-08		187.56									
4	NW Casing	Slightly weathered to fresh, thinly laminated to thinly bedded, light to dark grey with pink interbeds, fine to coarse grained, faintly porous, medium strong to very strong GRANITIC GNEISS		3.57									
	1												
5													
	2												
6	NORQ March 1, 2013												
	3												
7													
	4												
8													
	5												
		END OF DRILLHOLE		182.45									
9				8.68									
10													
11													
12													
13													

DEPTH SCALE

1 : 50



LOGGED: MJR/CS

CHECKED: JPD

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PROJECT		RECORD OF BOREHOLE		No B304-09		SHEET 1 OF 1		METRIC					
W.P.		LOCATION		ORIGINATED BY		COMPILED BY		CHECKED BY					
DIST		BOREHOLE TYPE		DATE		DATE		DATE					
DUM		DATE		DATE		DATE		DATE					
09-1111-6014		N 5082740.7 ; E 223151.8		MJR		AV/GRL		JPD					
5143-08-01		Portable Equipment, NW Casing, Wash Boring		March 7, 2013		March 7, 2013		March 7, 2013					
Geodetic		March 7, 2013		March 7, 2013		March 7, 2013		March 7, 2013					
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
191.1	ICE SURFACE												
0.0	ICE												
0.2	WATER												
	PEAT (Amorphous)		1	SS	WH		191						
	Very soft												
	Dark brown		2A	SS	1		190						
	Wet		2B										
190.0	SILT, some sand, trace clay, trace gravel												
1.1	Very loose												
	Grey		3	SS	2								
	Wet												
188.5	END OF BOREHOLE SPOON AND CASING REFUSAL		4	SS	3		189						
2.6	NOTE: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 191.0 m) upon completion of drilling.												

PROJECT		RECORD OF BOREHOLE		No B304-10		SHEET 1 OF 1		METRIC						
W.P. 5143-08-01		LOCATION		N 5082746.6 ; E 223156.4		ORIGINATED BY		MJR						
DIST _____ HWY 69		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY		AV						
DATUM Geodetic		DATE		March 5, 2013		CHECKED BY		JPD						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
191.2	ICE SURFACE													
190.9	ICE													
190.6	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WR									
190.2	ORGANIC SILT Very soft Dark brown Wet		2A	SS	1									
1.0	SANDY SILT, trace clay Very loose to loose Grey Wet		2B											
			3	SS	7									
			4	SS	2									
188.4	SILT, trace to some sand, trace clay Loose Grey Wet		5	SS	6									0 21 77 2
2.8			6	SS	5/0.23									Non-Plastic
187.2	Granitic Gneiss (BEDROCK)		1	RC	REC 95%									0 11 86 3
4.0	Bedrock cored from depths of 4.0 m to 7.3 m  For bedrock coring details refer to Record of Drillhole B304-10.		2	RC	REC 100%									RQD = 66%
			3	RC	REC 96%									RQD = 60%
														RQD = 67%
184.0	END OF BOREHOLE													
7.3	NOTES:  1. Water level in piezometer at a depth of 0.1 m below ice surface (Elev. 191.1 m) on March 9, 2013.  2. Piezometer decommissioned on March 9, 2013.													

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B304-10**

SHEET 1 OF 1

LOCATION: N 5082746.6 ; E 223156.4

DRILLING DATE: March 5, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate				BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage				PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular				PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough				MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
								RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 10 10 10	10 10 10 10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
4	NW Casing	Continued from Record of Borehole B304-10		187.20 3.98	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									</

DEPTH SCALE

1 : 50



LOGGED: MJR/CS

CHECKED: JPD

GTA-RCK 018 09-1111-6014.GPJ GAL-MISS.GDT 01/16/14

PROJECT		RECORD OF BOREHOLE No B304-11		SHEET 1 OF 1		METRIC												
W.P. 09-1111-6014		LOCATION N 5082752.8 ; E 223161.4		ORIGINATED BY MJR														
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY CC/AV														
DATUM Geodetic		DATE March 7, 2013		CHECKED BY JPD														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)					
191.2	ICE SURFACE							20 40 60 80 100	○ UNCONFINED	+	FIELD VANE	W <sub>p</sub>	W	W <sub>L</sub>				
0.0	ICE							20 40 60 80 100	● QUICK TRIAXIAL	×	REMOULDED							
190.7	WATER		1A	SS	2		191											
190.4	PEAT(Fibrous) Very soft Dark brown Wet		1B	SS	5		190											
0.8	ORGANIC SILT, trace sand Very soft Grey Wet		2	SS	6		189											
	SANDY SILT, trace organics Very loose to loose Grey Wet		3	SS	3		188											
			4	SS	7													
			5	SS	5/0.28													
187.1	END OF BOREHOLE SPOON AND CASING REFUSAL		6	SS														
4.1	NOTE:  1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 191.1 m) upon completion of drilling.																	

PROJECT		RECORD OF BOREHOLE		No B304-12		SHEET 1 OF 1		METRIC					
W.P.		LOCATION		ORIGINATED BY		COMPILED BY		CHECKED BY					
DIST		BOREHOLE TYPE		DATE		DATE		DATE					
Geodetic		March 6, 2013		March 6, 2013		March 6, 2013		March 6, 2013					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)	γ	GR SA SI CL		
191.1	ICE SURFACE												
0.0	ICE												
	WATER												
190.5	PEAT(Fibrous)		1	SS	WR								
0.6	Very soft Dark brown Wet		2	SS	2								
189.8	ORGANIC SILT												
1.3	Very soft Dark brown Wet		3	SS	7								
	SILT, trace to some sand, trace clay Loose Grey Wet		4	SS	6								
188.3	Sandy SILT		5	SS	8								
2.8	Loose Grey Wet		6	SS	2/0.05								
187.2	Granitic Gneiss (BEDROCK)												
3.9	Bedrock cored from depths of 3.9 m to 7.0 m  For bedrock coring details refer to Record of Drillhole B304-12.		1	RC	REC 99%								
			2	RC	REC 98%								
184.1	END OF BOREHOLE												
7.0	NOTE:  1. Water level in open borehole at ice surface (Elev. 191.1 m) upon completion of drilling.												

PROJECT: 09-1111-6014

**RECORD OF DRILLHOLE: B304-12**

SHEET 1 OF 1

LOCATION: N 5082748.1 ;E 223163.3

DRILLING DATE: March 7, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: LANDCORE 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.	NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA			HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn			10 to 20	20 to 30	30 to 40	40 to 50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
4	NW Casing	Continued from Record of Borehole B304-12	187.23																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

DEPTH SCALE

1 : 50



LOGGED: MJR/CS

CHECKED: JPD

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# APPENDIX B

## Laboratory Test Results and Photographs

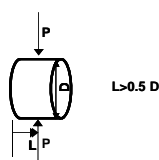
**TABLE B1**  
**POINT LOAD TEST RESULTS ON ROCK SAMPLES**

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm)	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
B304-03	1	0.50	197.2	Granite Gneiss	Axial	38.30	41.40	9.45	113
B304-03	1	1.30	196.4	Granite Gneiss	Axial	31.50	41.50	11.507	138
B304-03	2	2.10	195.6	Granite Gneiss	Axial	30.30	41.90	9.240	111
B304-03	3	3.80	193.9	Granite Gneiss	Axial	31.80	41.60	12.205	146
B304-03	4	4.50	193.2	Granite Gneiss	Axial	28.00	41.60	12.277	147
B304-03	5	5.80	191.9	Granite Gneiss	Axial	31.00	41.60	11.913	143
B304-03	1	0.50	197.2	Granite Gneiss	Diametral	41.40	79.00	3.485	42
B304-03	1	1.30	196.4	Granite Gneiss	Diametral	41.50	87.00	4.829	58
B304-03	2	2.10	195.6	Granite Gneiss	Diametral	41.90	71.00	6.742	81
B304-03	3	3.80	193.9	Granite Gneiss	Diametral	41.60	106.00	6.838	82
B304-03	4	4.50	193.2	Granite Gneiss	Diametral	41.60	78.00	8.744	105
B304-03	5	5.80	191.9	Granite Gneiss	Diametral	41.60	67.00	7.837	94
B304-04	1	0.30	197.2	Granite Gneiss	Axial	51.1	113.00	7.941	95
B304-04	2	1.80	195.7	Granite Gneiss	Axial	51.00	81.00	8.598	103
B304-04	3	3.20	194.3	Granite Gneiss	Axial	51.00	92.00	10.878	131
B304-04	1	0.30	197.2	Granite Gneiss	Diametral	41.0	77.00	6.096	73
B304-04	2	1.80	195.7	Granite Gneiss	Diametral	41.50	101.00	7.431	89
B304-04	3	3.20	194.3	Granite Gneiss	Diametral	41.60	94.00	7.786	93
B304-05	1	0.80	199.2	Granite Gneiss	Axial	34.1	41.40	8.315	100
B304-05	2	1.90	198.1	Granite Gneiss	Axial	28.20	41.60	3.131	38
B304-05	3	3.30	196.7	Granite Gneiss	Axial	28.7	41.60	6.122	73
B304-05	4	4.60	195.4	Granite Gneiss	Axial	33.50	41.50	10.168	122
B304-05	4	5.70	194.3	Granite Gneiss	Axial	33.80	41.60	9.166	110
B304-05	1	0.80	199.2	Granite Gneiss	Diametral	41.40	79.00	6.778	81
B304-05	2	1.90	198.1	Granite Gneiss	Diametral	41.60	63.00	5.023	60
B304-05	3	3.30	196.7	Granite Gneiss	Diametral	41.60	73.00	7.776	93
B304-05	4	4.60	195.4	Granite Gneiss	Diametral	41.50	95.00	9.111	109
B304-05	4	5.70	194.3	Granite Gneiss	Diametral	41.60	96.00	8.058	97
B304-08	1	4.50	186.6	Granite Gneiss	Axial	41.40	79.00	3.485	42
B304-08	3	6.20	184.9	Granite Gneiss	Axial	31.00	41.60	6.219	75
B304-08	4	7.30	183.8	Granite Gneiss	Axial	22.60	41.60	11.018	132
B304-08	5	8.00	183.1	Granite Gneiss	Axial	40.00	41.60	7.518	90
B304-08	1	4.50	186.6	Granite Gneiss	Diametral	41.70	89.00	5.346	64
B304-08	3	6.20	184.9	Granite Gneiss	Diametral	41.60	73.00	3.197	38
B304-08	4	7.30	183.8	Granite Gneiss	Diametral	41.60	104.00	7.010	84
B304-08	5	8.00	183.1	Granite Gneiss	Diametral	41.60	84.00	10.822	130

<sup>(1)</sup>  $I_{s50} \times K$ , from ASTM Designation: D 5731 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications". A value of  $K = 12$  has been used based on 4 UCS tests done for SBL and NBL samples at the bridge location

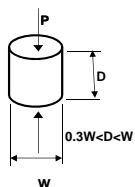
#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



#### AXIAL SPECIMEN SHAPE REQUIREMENTS

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



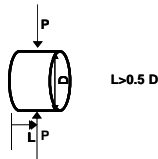
**TABLE B1**  
**POINT LOAD TEST RESULTS ON ROCK SAMPLES**

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm)	Is (50mm) (MPa)	Approx. UCS Value <sup>(1)</sup> (MPa)
B304-10	2	5.00	186.2	Granite Gneiss	Axial	21.50	41.30	8.852	106
B304-10	3	6.10	185.1	Granite Gneiss	Axial	30.50	41.40	11.586	139
B304-10	3	7.00	184.2	Granite Gneiss	Axial	31.20	41.50	10.137	122
B304-10	2	5.00	186.2	Granite Gneiss	Diametral	41.30	112.00	6.783	81
B304-10	3	6.10	185.1	Granite Gneiss	Diametral	41.40	89.00	8.078	97
B304-10	3	7.10	184.1	Granite Gneiss	Diametral	41.50	84.00	7.815	94
B304-12	1	4.90	186.2	Granite Gneiss	Axial	26.90	41.60	11.128	134
B304-12	2	6.00	185.1	Granite Gneiss	Axial	30.70	41.50	10.201	122
B304-12	1	4.90	186.2	Granite Gneiss	Diametral	41.60	101.00	6.314	76
B304-12	2	6.00	185.1	Granite Gneiss	Diametral	41.50	80.00	7.036	84
B304-12	2	6.90	184.2	Granite Gneiss	Diametral	41.50	87.00	6.935	83

<sup>(1)</sup>  $I_{S50} \times K$ , from ASTM Designation: D 5731 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications". A value of  $K = 12$  has been used based on 4 UCS tests done for SBL and NBL samples at the bridge location

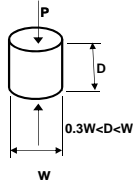
#### DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



#### AXIAL SPECIMEN SHAPE REQUIREMENTS

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



**TABLE B2-1**  
**SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS**  
**CPR OVERHEAD STRUCTURE NBL**  
**HIGHWAY 69 GWP 5404-05-00; WP 5143-08-01**

<b>Borehole Number (Core Run)</b>	<b>Sample Depth (m)</b>	<b>Sample Elevation (m)</b>	<b>Rock Type</b>	<b>Core Diameter (mm)</b>	<b>Uniaxial Compressive Strength (MPa)</b>
B304-03 (1)	1.1	196.6	Granite Gneiss	41.5	125.1
B304-12 (1)	5.1	186.0	Granite Gneiss	41.4	105.7

Compiled By: AVChecked By: CNReviewed By: JPD/JMAC

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

**SAMPLE IDENTIFICATION**

PROJECT NUMBER	09-1111-6014	RUN NUMBER	1
BOREHOLE NUMBER	B304-03	SAMPLE DEPTH, m	1.00-1.10

**TEST CONDITIONS**

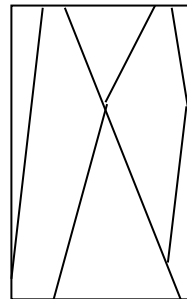
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.20

**SPECIMEN INFORMATION**

SAMPLE HEIGHT, cm	9.14	WATER CONTENT, (specimen) %	0.12
SAMPLE DIAMETER, cm	4.15	UNIT WEIGHT, kN/m <sup>3</sup>	26.61
SAMPLE AREA, cm <sup>2</sup>	13.51	DRY UNIT WT., kN/m <sup>3</sup>	26.58
SAMPLE VOLUME, cm <sup>3</sup>	123.49	SPECIFIC GRAVITY	-
WET WEIGHT, g	335.20	VOID RATIO	-
DRY WEIGHT, g	334.80		

**VISUAL INSPECTION**

**FAILURE SKETCH**



**TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	125.1
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REMARKS:

DATE:

4/8/2013

**TABLE B2-3**  
**UNCONFINED COMPRESSION TEST (UC)**  
**ASTM D 7012-07**

**SAMPLE IDENTIFICATION**

PROJECT NUMBER	09-1111-6014	RUN NUMBER	1
BOREHOLE NUMBER	B304-12	SAMPLE DEPTH, m	5.00-5.10

**TEST CONDITIONS**

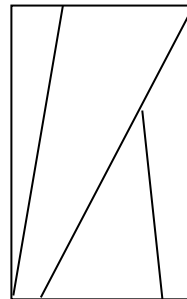
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.24

**SPECIMEN INFORMATION**

SAMPLE HEIGHT, cm	9.28	WATER CONTENT, (specimen) %	0.23
SAMPLE DIAMETER, cm	4.14	UNIT WEIGHT, kN/m <sup>3</sup>	26.34
SAMPLE AREA, cm <sup>2</sup>	13.46	DRY UNIT WT., kN/m <sup>3</sup>	26.28
SAMPLE VOLUME, cm <sup>3</sup>	124.90	SPECIFIC GRAVITY	-
WET WEIGHT, g	335.59	VOID RATIO	-
DRY WEIGHT, g	334.82		

**VISUAL INSPECTION**

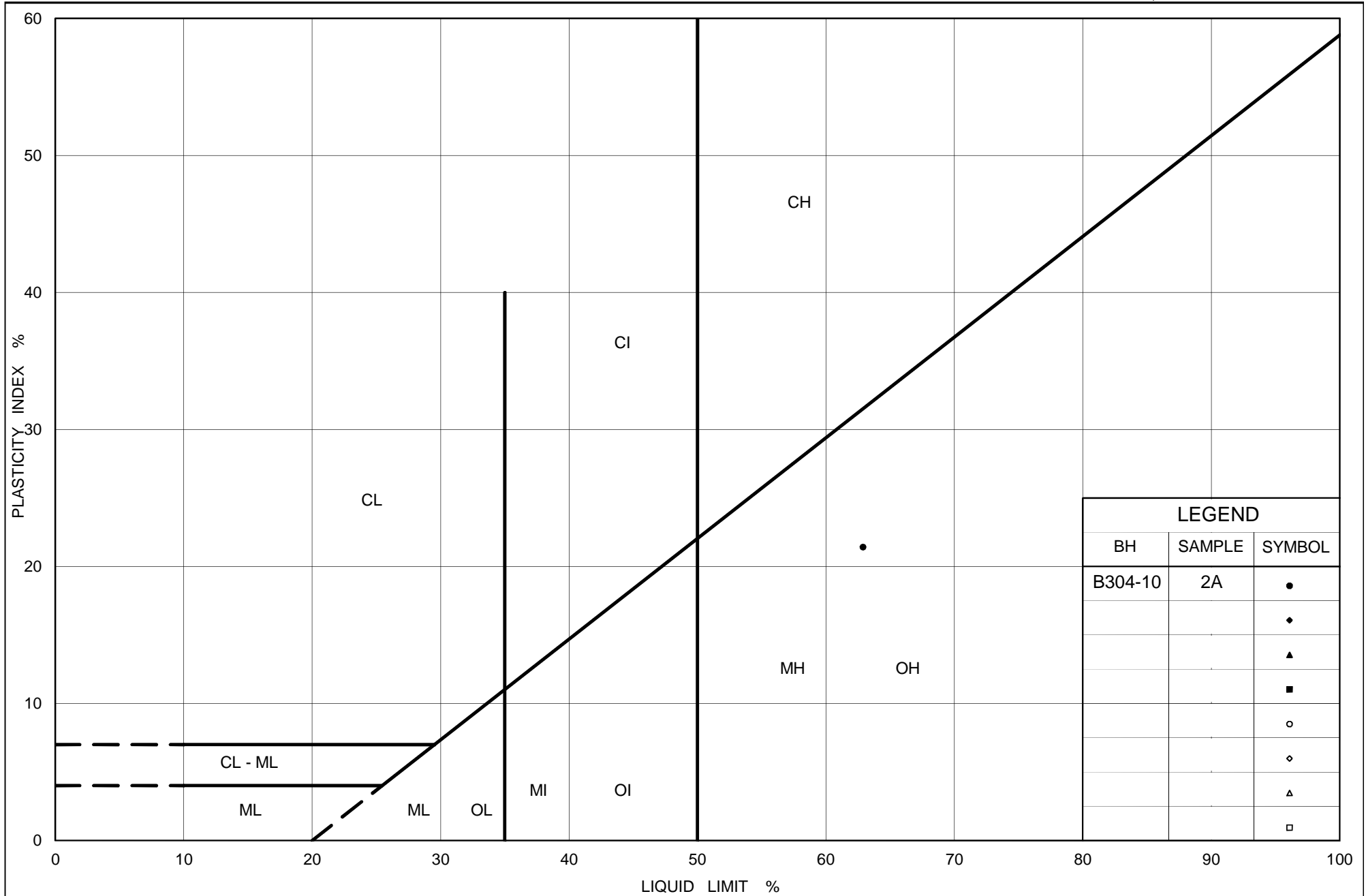
**FAILURE SKETCH**



**TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	105.7
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REMARKS:	DATE: 4/8/2013
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Ministry of Transportation

Ontario

PLASTICITY CHART  
Organic Silt  
CPR Overhead Structure NBL

Figure No. B1

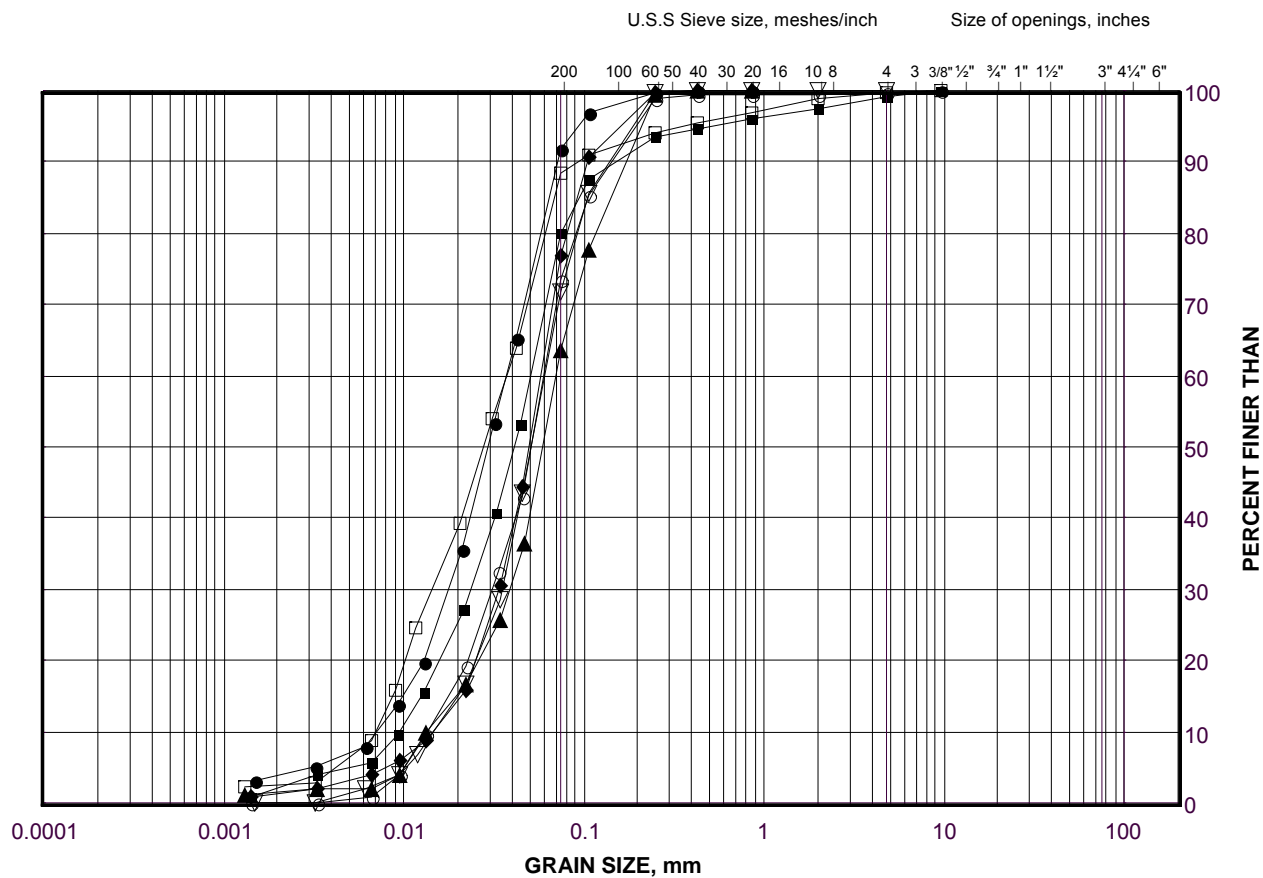
Project No. 09-1111-6014

Checked By: GRL

# GRAIN SIZE DISTRIBUTION

Silt to Silt and Sand  
CPR Overhead Structure NBL

FIGURE B2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B304-12	3	189.5
■	B304-09	3	189.3
◆	B304-10	4	188.6
▲	B304-08	4	188.7
▽	B304-11	4	188.6
○	B304-12	5	187.9
□	B304-10	6	187.3

Project Number: 09-1111-6014

Checked By: GRL

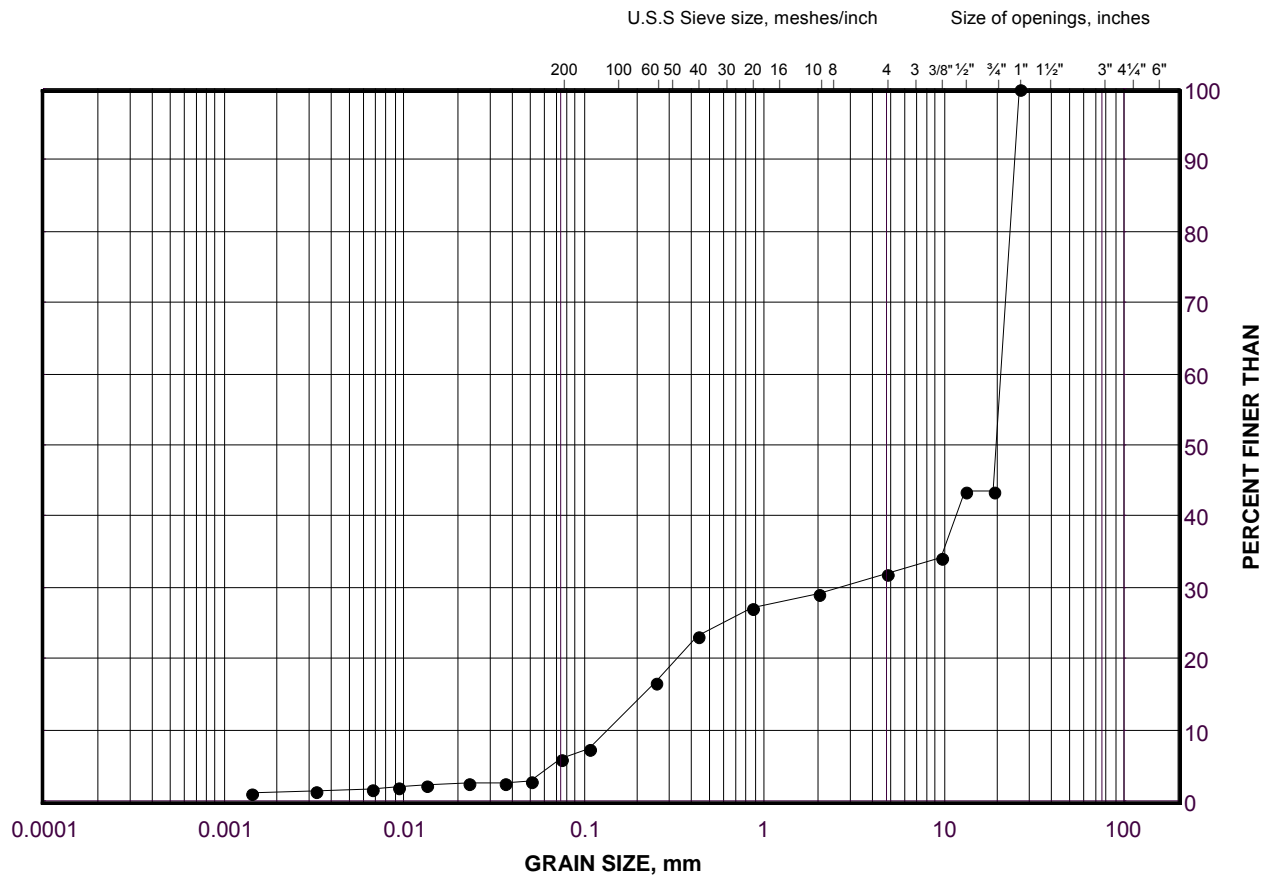
**Golder Associates**

Date: 19-Jun-13


# GRAIN SIZE DISTRIBUTION

Sandy Gravel  
CPR Overhead Structure NBL


FIGURE B3



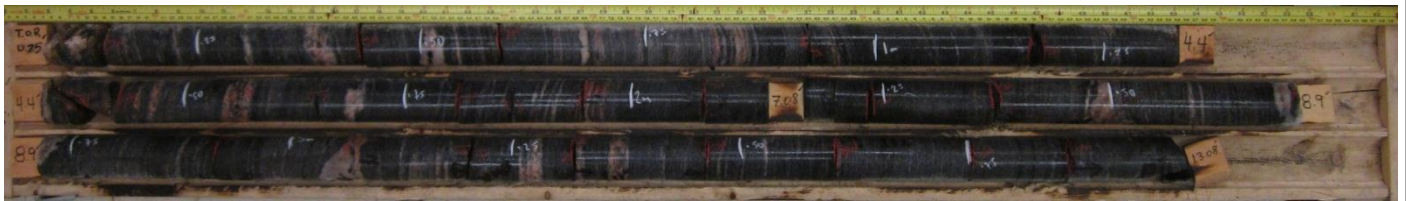


PROJECT	CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01				
	TITLE Rock Surface Photograph Highway 69 (NBL)				
	PROJECT No.	09-1111-6014	FILE No.	----	
	DESIGN	AV	AUG 13	SCALE	NTS
	CADD	--	---		REV
	CHECK	CN	AUG 13	FIGURE B4	
	REVIEW	JPD/JMAC	AUG 13		



PROJECT	<b>CPR OVERHEAD STRUCTURE NBL</b> <b>Highway 69 Four-Laning</b> <b>GWP 5404-05-00; WP 5143-08-01</b>				
TITLE	<b>Rock Surface Photograph</b> <b>Highway 69 (NBL)</b>				
	PROJECT No.	09-1111-6014	FILE No.	----	
	DESIGN	AV	AUG 13	SCALE	NTS
	CADD	--	---		REV
	CHECK	CN	AUG 13	<b>FIGURE B5</b>	
	REVIEW	JPD/JMAC	AUG 13		

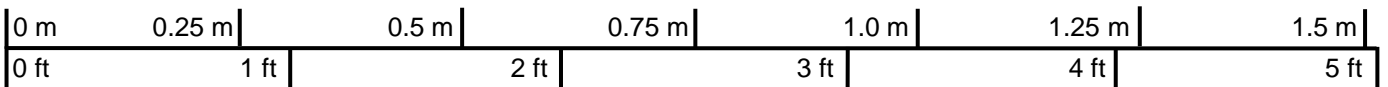
## Borehole B304-03




Box 1: 0.10 m – 4.21 m



Box 2: 4.21 m – 6.07 m



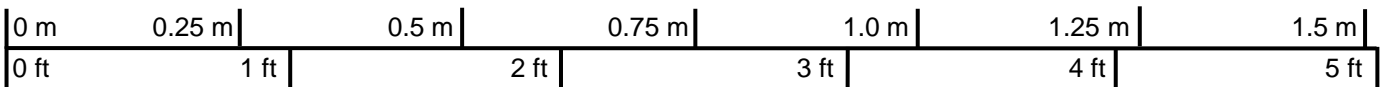
Scale

PROJECT		CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01		
TITLE		Bedrock Core Photograph – B304–03 Highway 69 (NBL)		
		PROJECT No. 09-1111-6014		FILE No. ----
		DESIGN	AV	JUN 13
		CADD	--	--
		CHECK	CN	JUN 13
		REVIEW	JPD/JMAC	AUG13
		SCALE NTS		
		REV.		
		FIGURE B6		

## Borehole B304-04



Box 1: 0.30 m – 3.66 m




Scale

PROJECT		CPR OVERHEAD NBL STRUCTURE Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01			
TITLE		Bedrock Core Photograph – B304–04 Highway 69 (NBL)			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	AV	JUN 13	SCALE NTS
		CADD	-- --		REV.
		CHECK	CN	JUN 13	FIGURE B7
		REVIEW	JPD/JMAC	AUG 13	

12.5 1.25 1.50 1.75 2.00

E.O.H. 190

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

PROJECT		CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01					
TITLE <b>Bedrock Core Photograph – B304–05 Highway 69 (NBL)</b>							
		PROJECT No. 09-1111-6014			FILE No. ----		
		DESIGN	AV	JUN 13	SCALE	NTS	REV.
		CADD	-- --		<b>FIGURE B8</b>		
		CHECK	CN	JUN 13			
		REVIEW	JPD/JMAC	JUN 13			

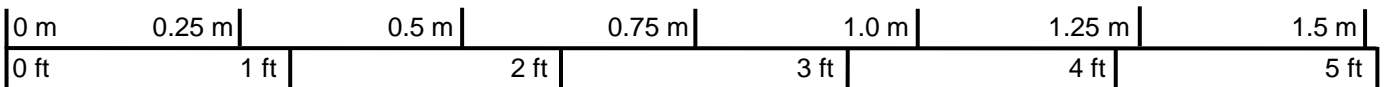
## Borehole B304-08




Box 1: 3.80 m – 7.89 m



Box 2: 7.89 m – 8.93 m



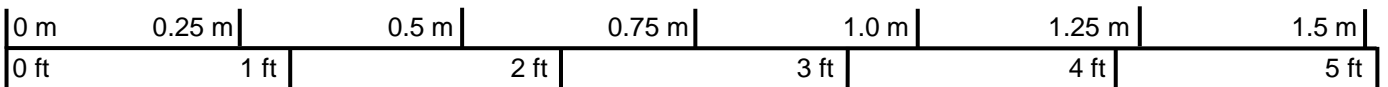
Scale

PROJECT		CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01			
TITLE		Bedrock Core Photograph – B304–08 Highway 69 (NBL)			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	AV	JUN 13	SCALE NTS
		CADD	--	--	REV.
		CHECK	CN	JUN 13	FIGURE B9
		REVIEW	JPD/JMAC	JUN 13	


## Borehole B304-10




Box 1: 4.20 m – 7.47 m



Scale

PROJECT		CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01			
TITLE		Bedrock Core Photograph – B304–10 Highway 69 (NBL)			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	AV	JUN 13	SCALE NTS
		CADD	--	--	REV.
		CHECK	CN	JUN 13	FIGURE B10
		REVIEW	JPD/JMAC	JUN 13	



PROJECT		CPR OVERHEAD STRUCTURE NBL Highway 69 Four-Laning GWP 5404-05-00; WP 5143-08-01					
TITLE  Bedrock Core Photograph – B304–12 Highway 69 (NBL)							
		PROJECT No. 09-1111-6014		FILE No. ----			
		DESIGN	AV	JUN 13	SCALE	NTS	REV.
		CADD	---				
		CHECK	CN	JUN 13	FIGURE B11		
		REVIEW	JPD/JMAC	AUG 13			

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