



SEPTEMBER 2014

FOUNDATION INVESTIGATION REPORT

STILL RIVER SBL BRIDGE STRUCTURE, SITE NO. 44-458/2
HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529
NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5404-05-00; WP 5140-08-01

Submitted to:
URS Canada Inc.
4th Floor, 30 Leek Crescent
Richmond Hill, Ontario
L4B 4N4



REPORT



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PART A

FOUNDATION INVESTIGATION REPORT

STILL RIVER SBL BRIDGE STRUCTURE, SITE NO. 44-458/2

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

NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5404-05-00; WP 5140-08-01



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 southbound lanes (SBL) structure over the Still River (Site No. 44-458/2), which is within the Contract 2 limits of the new Highway 69 alignment to the north of the junction with Highway 529. The proposed work in Contract 2 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. The foundation engineering components within the overall project limits include the engineering of: 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 (CPR) and Canadian National Railway (CNR) structures; as well as culvert crossings. The Still River SBL Bridge structure is located approximately 1.2 km east of the existing Highway 69. The general location of this bridge along the new Highway 69 four-laning alignment is shown on the Site Location Plan on Drawing 1.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated January 2009. Golder's proposal for foundation engineering services associated with the Contract 2 Still River SBL Bridge 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 Quality Control Plan for foundation engineering services for this project, dated April 19, 2010. The General Arrangement (GA) Drawing for the proposed Still River SBL Bridge structure (two-span option) was provided to Golder by URS on April 5, 2011. In addition, a preliminary GA Drawing for the one-span option was provided to Golder by URS on October 1, 2010.

This report addresses the foundation investigation carried out for the Still River SBL Bridge structure and the associated approach embankments only. A two-span bridge structure was proposed in the Environmental Assessment Report. During the initial stage of the detail design assignment one-span and two-span options were evaluated. In September 2011 Golder conducted field investigations and prepared a Technical Memorandum summarizing the findings and provided preliminary recommendations with respect to both a one-span and two-span alternative. Following discussions with the Ministry, a two-span option has been chosen for the Still River crossing. Since the feasibility of a one-span bridge option was being evaluated during the initial design stage, this foundation investigation report has been prepared to address these two options. Separate reports address the foundation investigations for the related swamp crossings and high fill areas, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed bridge 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 proposed Still River SBL Bridge structure is located in the Township of Henvey along the new Highway 69 SBL alignment, approximately 1.2 km east of the existing Highway 69 alignment and about 6.5 km northeast of the junction of



existing Highway 69 and Highway 526. The proposed new four-lane Highway 69 alignment is oriented generally in a south-north direction and parallel to the east side of the existing Highway 69 within the Contract 2 project limits.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely or 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 bridge structure and associated approach embankments are to be situated on a relatively flat and low-lying swamp/open field area on the south side of the Still River and on the moderately to densely tree covered sloping ground and bedrock outcrop on the north side of the River. On the south side of the River, the ground surface within the limits of the proposed structure is relatively flat at about Elevation 181.0 m along the south approach embankment and at the south abutment. On the north side of the river, the ground surface ranges from about Elevations 179.0 m to 178.6 m at the centre pier to about Elevations 185.4 m to 179.5 m at the north abutments (for one- and two-span bridge options) and about Elevation 192.2 m along the north approach embankment (for the two-span bridge option). All elevations are referenced to Geodetic datum.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The field work for the proposed Still River SBL Bridge structure was carried out between February 3 and 8, 2011 and between March 1 and 25, 2011 during which time a total of twelve (12) boreholes, four (4) Dynamic Cone Penetration Tests (DCPTs) and two (2) hand excavations were advanced at the locations of the structure and approach embankments. An additional borehole was (Borehole SP1) was advanced in the vicinity of the south abutment and instrumented with a piezometer to allow for monitoring of the groundwater level.

In addition, one (1) borehole (Borehole S204-09) advanced within the adjacent Swamp 204 as part of the field investigation work carried out by Golder for the Contract 2 swamp crossings and high fill areas¹ was utilized to supplement this investigation at the south approach embankment. The Record of Borehole sheet and the results of the laboratory testing for Borehole S204-09 are presented together with the details of the boreholes advanced for this bridge structures in Appendix A and Appendix B, respectively. The locations of the boreholes and DCPTs are shown on Drawing 2.

A summary of the respective boreholes and DCPTs advanced at each foundation element and approach embankment is presented below.

Foundation Element/ Approach Embankment	Investigation Type		
	Borehole No.	DCPT No.	Hand Excavation
South Approach Embankment (One- or Two-Span Option)	S204-09	-	-

¹ Golder Associates Ltd. 2012. *Foundation Investigation and Design Report, Swamp Crossings and High Fill Areas – Contract 2, Highway 69 Four Lining from 1.7 km North of Highway 529 Northerly to 3.9 km North of Highway 522, Ministry of Transportation, Ontario, G.W.P. 5404 05 00; W.P. 5404 05 01. Geocres No. 41H-115.*



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Foundation Element/ Approach Embankment	Investigation Type		
	Borehole No.	DCPT No.	Hand Excavation
South Abutment (One- or Two-Span Option)	B201-01 SP1 ¹	-	-
Centre Pier (Two-Span Option)	B201-02 B201-13 B201-14	B201-DC03 B201-DC04	-
North Abutment (One-Span Bridge)	B201-03 B201-11 B201-12	B202-DC01 B202-DC02	-
North Approach Embankment (One-Span Option)	B201-04	-	-
North Abutment (Two-Span Option)	B201-05 B201-06 B201-07 B201-08	-	B201-09
North Approach Embankment (Two-Span Option)	-	-	B201-10

Note: 1. Borehole SP1 was advanced in the vicinity of the south abutment to monitor the groundwater level in the area.

The field investigation was carried out using a track-mounted Diedrich D-25 or D-50 Turbo drill rig supplied and operated by Walker Drilling Co. Ltd. of Utopia, Ontario and by portable equipment supplied and operated by OGS Inc. of Almonte, Ontario. Hand excavation methods were used as appropriate depending on the terrain to confirm refusal conditions at shallow borehole locations. The boreholes were advanced through the overburden using 127 mm outer diameter (O.D.) solid-stem augers, tricone and/or 'BW', 'NW' or 'HW' casing with wash boring techniques. In general, soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer on the drill rig, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test). Boreholes advanced by portable equipment employed one-third ($\frac{1}{3}$) weight hammers lifted manually and dropped from the SPT height. The SPT 'N'-value obtained by the use of the lesser weight hammer were then adjusted down by a factor of 3 to correspond to the SPT 'N'-values that would be expected to be obtained had a full-weight hammer been used. Chunk samples were obtained from two (2) boreholes at locations of thin overburden over shallow bedrock. Samples of the cohesive soils were obtained using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587-08, Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using MTO Standard 'N' size vanes and 'B' size vanes in the smaller diameter boreholes advanced by portable equipment. Samples of the bedrock were obtained using a 'NQ' or 'BQ' size rock core barrel.

The boreholes and DCPTs at the locations of the foundation elements were typically advanced to casing and/or split-spoon sampler refusal (i.e. inferred bedrock) and bedrock was confirmed by coring in selected boreholes. The borehole at the north approach embankment for the two-span bridge option is located on a bedrock outcrop and refusal condition was confirmed by hand excavation. The boreholes and DCPTs were advanced to depths of up to about 57.3 m below existing ground surface, including coring of bedrock for core lengths between about



2.5 m and 4.8 m in Boreholes B201-02 to B202-04, B201-06 to B201-08 and B201-11 to B201-14. Photographs of the recovered rock core samples are provided in Appendix B.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations. Within the limits of the centre pier and north abutment foundation elements, a piezometer was installed in each of Boreholes B201-02, B201-03 and B201-07 as well as Borehole SP1 located near the proposed south abutment, to monitor the ground water levels at these locations. No piezometer was installed within the limits of the south abutment foundation element due to the presence of artesian groundwater conditions. The piezometers consist of 35 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the boreholes. The boreholes and annulus surrounding the piezometer pipe above the screen sand pack were backfilled to the surface with bentonite pellets/grout. Piezometer installation details and water level readings are described on the Record of Borehole sheets presented in Appendix A. All boreholes in which standpipe piezometers were not installed were backfilled with bentonite or a bentonite/cement grout mixture using tremie methods upon completion, in accordance with Ontario Regulation 903 (as amended). The piezometer installed in Borehole SP1 was decommissioned once a final water level reading was taken ten (10) days after installation.

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, Atterberg limits and grain size distribution) was carried out on selected samples. A consolidation (oedometer) test was also carried out on a sample of the cohesive deposit. 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.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)². The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W2) and the strength classification of the intact rock mass based on field identification (i.e. strong to extremely strong – R4 to R6) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM, 1985³) standard classification system.

The perimeter limits of each foundation unit were located in the field by Callon Dietz prior to drilling. The as-drilled borehole and DCPT locations and ground surface elevations were surveyed by a member of our technical staff, referenced to the survey stakes put down by Callon Dietz. The borehole locations given in the Record of Borehole/Drillhole sheets and shown on Drawings 2 and 3 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole and DCPT locations and ground surface elevations are summarized below.

²Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

³ 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.



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Borehole / DCPT No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole / DCPT Depth (m)
	Northing	Easting		
B201-01	5074818.7	225139.3	181.1	57.3
B201-02	5074858.6	225123.5	178.6	9.1
B201-03	5074874.5	225117.3	179.5	9.1
B201-04	5074886.1	225112.7	180.6	5.0
B201-05	5074896.5	225100.8	183.9	0.5
B201-06	5074900.4	225099.3	185.4	3.4
B201-07	5074898.7	225107.6	184.4	5.2
B201-08	5074896.9	225115.3	183.4	4.0
B201-09 ¹	5074900.8	225113.7	185.5	0.1
B201-10 ¹	5074917.2	225100.0	192.2	0.1
B201-11	5074876.3	225109.0	179.5	7.1
B201-12	5074872.7	225124.9	179.6	8.8
B201-13	5074856.9	225131.2	178.7	10.8
B201-14	5074860.4	225115.2	179.0	9.7
B201-DC01	5074872.3	225110.6	179.4	5.9
B201-DC02	5074876.7	225123.4	179.8	5.2
B201-DC03	5074860.8	225129.7	178.3	5.4
B201-DC04	5074856.4	225116.8	178.6	9.2
S204-09	5074804.5	225144.9	181.1	45.9
SP1	5074819.8	225159.0	181.1	6.1

Note: 1. B201-09 and B201-10 refer to hand excavations carried out at the north-east corner of the north abutment (two-span option) and at the north approach embankment, respectively, to expose the shallow bedrock surface.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*⁴, 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 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 and 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 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 4⁵.

⁴ 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.

⁵ *Geology of Ontario*, 1991. Ontario Geological Society Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



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

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation (including hand excavations by hand shovel), 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 the laboratory test figures provided in Appendix A and Appendix B, respectively. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4.0 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 and in situ testing. The stratigraphic boundaries shown in Borehole SP1, augered for a piezometer installation, are interpreted based on cuttings and auger samples. All boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. The thickness of the overburden/depth to refusal as inferred from the resistance to DCPT advancement are shown on the Record of Penetration Test sheets in Appendix A. It should be noted that the interpreted stratigraphy shown on Drawings 2 and 3 is a simplification of the subsurface conditions.

In general, the subsurface conditions in the area of the south approach and south abutment (to the south of Still River) consist of a surface layer of topsoil, underlain by alternating deposits of cohesive and non-cohesive soils, underlain by cobbles and boulders. Bedrock was not encountered within the maximum depth of investigation (57.3 m). In the areas of the centre pier, north abutment and north approach (to the north of Still River), the subsurface conditions consists of a surficial layer of topsoil, underlain by deposits of sand to silt and clay, underlain by bedrock at shallow depths. The overburden thickness is variable across the proposed bridge structure, ranging from greater than 57.3 m at the south abutment to no cover at the north approach embankment (i.e. bedrock outcrops exposed at ground surface).

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

4.3 South Abutment and Approach Embankment

One (1) borehole (Borehole B201-01) was advanced at the location of the proposed south abutment as part of this current investigation. At the south approach embankment, one (1) borehole (Borehole S204-09) was advanced on the centreline of the proposed Highway 69 SBL alignment (within Swamp 204) as part of the field investigation for the Contract 2 swamp crossings and high fill areas.

In general, the subsurface conditions consist of topsoil underlain by alternating deposits comprised of clayey silt to silty clay, sand to sandy silt to sand and silt, silty clay to clay, silt to sandy silt, silty clay, silt to sand, and sand and gravel, underlain by cobbles and boulders.



4.3.1 Topsoil

An approximately 0.3 m and 0.2 m thick layer of topsoil was encountered at the ground surface at about Elevation 181.1 m in Boreholes B201-01 and S204-09.

The natural water content measured on a specimen of this layer is about 34 per cent.

4.3.2 Clayey Silt to Silty Clay (Near Surface)

A near surface stratum of brown to grey clayey silt to silty clay, trace to some sand containing rootlets was encountered underlying the topsoil in Boreholes B201-01 and S204-09. The clayey silt to silty clay stratum is intersected by an approximately 0.4 m thick pocket of sandy silt in Borehole B201-01. The top of the cohesive stratum is at about Elevations 180.8 m and 180.9 m and the total thickness of the cohesive stratum is about 2.0 m and 2.7 m in the respective boreholes.

The SPT 'N'-values measured within the clayey silt to silty clay stratum range from 1 blow to 5 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths of about 46 kPa and 50 kPa, and the sensitivity is calculated to be about 4 and 5. It should be noted that in situ filed vanes carried out within the near surface cohesive deposit in Swamp 204, adjacent to the south abutment and south approach embankment, measured undrained shear strengths as low as about 25 kPa. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to firm consistency.

The natural water content measured on five (5) samples of the clayey silt to silty clay stratum ranges from about 24 per cent to 45 per cent.

A grain size distribution of one (1) sample of the silty clay portion of this stratum is shown on Figure B1 in Appendix B.

Atterberg limits tests were carried out on two (2) specimens of the clayey silt to silty clay stratum and indicate liquid limits of about 37 per cent and 29 per cent, plastic limits of about 17 per cent, and corresponding plasticity indices of about 20 per cent and 12 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B and indicate the material to be clayey silt of low plasticity to silty clay of intermediate plasticity.

4.3.3 Sand to Sandy Silt (Upper)

A deposit of non-cohesive soil comprised of brown sand trace silt to sand and silt to sandy silt was encountered underlying the near surface stratum of clayey silt to silty clay in both boreholes. The deposit generally contains trace to some clay, and the upper portion of the deposit in Borehole S204-09 contains organics. The top of this deposit is at about Elevations 178.8 m and 178.2 m and the overall thickness of the deposit is about 6.1 m and 6.8 m in Boreholes B201-01 and S204-09, respectively.

The SPT 'N'-values measured within this deposit range from 1 blow to 21 blows per 0.3 m of penetration, with the higher 'N'-values generally being recorded within the sand portion of this deposit, indicating a very loose to compact relative density.



The natural water content measured on seven (7) samples of this deposit ranges from about 9 per cent to 28 per cent.

The grain size distributions of two (2) samples of the sand and silt to sandy silt portion of this deposit are shown on Figure B3 in Appendix B.

4.3.4 Silty Clay to Clay (Upper)

A stratum of grey silty clay to clay trace silt, trace sand and containing sand lenses was encountered underlying the upper deposit of sand to sandy silt in both boreholes. Within the clay portion of this stratum in Boreholes S204-09 and B201-01, silt to sandy silt interlayers were encountered at varying depths. The top of the silty clay to clay stratum is at about Elevations 172.7 m and 171.4 m and the thickness of the deposit is about 5.0 m and 4.6 m in Boreholes B201-01 and S204-09, respectively.

The SPT 'N'-values recorded within the silty clay to clay deposit range from 1 blow to 5 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 18 kPa to 80 kPa, but generally greater than 50 kPa, and the sensitivity is calculated to range from about 2 to 5. The field vane test results indicate that the silty clay to clay stratum has a soft to stiff consistency, but generally a stiff consistency.

The natural water content measured on four (4) specimens of this stratum ranges from about 29 per cent to 118 per cent, but is generally less than 48 per cent.

Atterberg limits tests were carried out on two (2) specimens of this cohesive stratum and indicate liquid limits of about 50 per cent and 51 per cent, plastic limits of about 20 per cent and 19 per cent and corresponding plasticity indices of about 30 per cent and 32 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B4 in Appendix B and indicate the material to be a silty clay of intermediate plasticity to clay of high plasticity.

4.3.5 Silt to Sandy Silt Interlayer

An interlayer of grey silt some sand to sandy silt, containing trace clay was encountered underlying the silty clay to clay stratum in Boreholes B201-01 and S204-09. The top of this interlayer is at about Elevations 167.7 m and 166.8 m and the thickness of the deposit is about 1.1 m and 2.3 m in the respective boreholes.

Two (2) SPT 'N'-values measured within this deposit are 5 blows and 19 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The natural water content measured on two (2) samples of this interlayer is about 24 per cent and 26 per cent.

The grain size distributions of two (2) samples of this interlayer are shown on Figure B5 in Appendix B.

4.3.6 Silty Clay (Lower)

A stratum of grey silty clay trace sand was encountered underlying the silt to sandy silt interlayer in Boreholes B201-01 and S204-09. The lower silty clay stratum is separated into an upper and lower segment by sand and silt to silt interlayers up to about 4.1 m thick, as described below. The top of the silty clay stratum is at



about Elevations 166.6 m and 164.5 m and the overall thickness of the cohesive stratum is about 23.3 m and 25.8 m in the respective boreholes.

The SPT 'N'-values recorded within the silty clay stratum range from 1 blow to 9 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 55 kPa to greater than 120 kPa, but are typically less than 100 kPa. The sensitivity is calculated to range from about 2 to 4. The field vane tests results indicate that the silty clay stratum has a stiff to very stiff consistency.

The natural water content measured on seven (7) samples of this stratum ranges from about 37 per cent to 53 per cent.

The grain size distributions of two (2) samples of this silty clay stratum are shown on Figure B6 in Appendix B.

Atterberg limits tests were carried out on three (3) specimens of the silty clay stratum and indicate liquid limits ranging from about 45 per cent to 48 per cent, plastic limits between about 17 per cent and 19 per cent and plasticity indices ranging from about 27 per cent to 29 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B7 in Appendix B and indicate the material to be silty clay of intermediate plasticity.

A laboratory consolidation test was carried out on one (1) specimen of the silty clay deposit obtained from a Shelby tube sample in Borehole B201-01. A preconsolidation stress of about 210 kPa was estimated from the void ratio versus logarithmic stress plot and from the total work versus stress plot. A bulk unit weight of about 15.7 kN/m³ and a specific gravity of about 2.81 were measured on the consolidation test specimen. Details of the test results are shown on Figure B8 in Appendix B, and the test results are summarized below.

Borehole Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	C_c	C_r	e_o	c_v^* (cm ² /s)
Borehole B201-01 Sample 17	27.5 m / 153.6 m	218	218	~ 0	~ 1.0	1.12	0.12	1.95	1.81×10^{-3}

Note: * For stress range of between effective overburden stress and final stress due to 7.5 m high approach embankment, that is $215 \text{ kPa} \leq \sigma_v' \leq 360 \text{ kPa}$

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
 σ_p' is the preconsolidation stress in kPa
 σ_v' is the vertical effective stress in kPa
OCR is overconsolidation ratio
 e_o is initial void ratio
 C_c is the compression index
 C_r is the recompression index
 c_v is the coefficient of consolidation in cm²/s

4.3.7 Sand and Silt to Silt Interlayers

An approximately 4.1 m thick interlayer of grey silt, trace sand, trace clay and an approximately 2.7 m thick interlayer of grey sand and silt trace clay were encountered within the silty clay stratum in Boreholes B201-01 and S204-09 at about Elevations 161.0 m and 161.1 m, respectively.

Two SPT 'N'-values measured within the sand and silt to silt interlayers are 4 blows and 6 blows per 0.3 m of penetration, indicating a loose relative density.



The natural water content measured on a specimen of the sand and silt interlayer is about 21 per cent.

4.3.8 Silt to Sand (Lower)

Underlying the lower stratum of silty clay, a non-cohesive soil grading from silt, trace to some sand, trace to some clay, trace gravel to silty sand, trace clay. to sand trace to some silt was encountered in both boreholes. The top of the silty sand to silt to sand deposit is at about Elevations 143.3 m and 138.7 m and the thickness of the deposit is about 15.3 m and greater than 3.5 m in Boreholes B201-01 and S204-09, respectively. Borehole S204-09 was terminated within this deposit.

The SPT 'N'-values recorded within this deposit ranges from 19 blows to 49 blows per 0.3 m of penetration, generally indicating a compact to dense relative density.

The natural water content measured on five (5) samples of this deposit ranges from about 18 per cent to 29 per cent.

The grain size distributions of two (2) samples from the silt portion of this deposit are shown on Figure B9 in Appendix B. An Atterberg limits test on one (1) sample of the silt deposit indicates this material to be non-plastic.

4.3.9 Boulders

Below the silt to sand deposit in Borehole B201-01, an approximately 0.3 m and 0.8 m thick layer of boulders was encountered at about Elevation 128.0 m. An approximately 0.2 m thick layer of sand, trace silt was encountered between the boulder layers. A photograph of the recovered cobbles and boulders samples is shown on Figure B10 in Appendix B.

4.3.10 Sand and Gravel

Underlying the boulder layer in Borehole B201-01, a deposit of sand and gravel containing trace silt and cobbles / boulders at varying depths was encountered. The top of the sand and gravel deposit is at about Elevation 126.7 m and the thickness of the deposit is greater than 2.9 m. The lower portion of the deposit was penetrated by coring through the cobbles and boulders. Borehole B201-01 was terminated within the sand and gravel deposit.

One SPT 'N'-value of 20 blows per 0.3 m of penetration was recorded within the upper portion of the deposit, indicating a compact relative density and about 20 per cent of recovery was obtained within the cored portion of the overburden. The natural water content measured on a specimen of this deposit is about 17 per cent.

4.3.11 Groundwater Conditions

In general, the overburden samples taken in the boreholes were moist to wet. Artesian groundwater conditions were observed in Borehole B201-01 when the drill casing was advanced between about Elevations 133.1 m and 129.3 m; the artesian flow stopped when advancing the casing below Elevation 129.3 m. The series of groundwater levels recorded in the drill casing during and upon completion of drilling range from about



Elevations 183.4 m to 177.0 m, measured at depths ranging from about 2.3 m above ground surface to 4.1 m below ground surface. In Borehole S204-09, the water level observed upon completion of drilling was at about Elevation 177.7 m, measured at a depth of about 3.4 m below ground surface.

A shallow standpipe piezometer was installed in Borehole SP1 located in the area to the east of the south abutment to allow monitoring of the near surface groundwater level in the area. The water level in the piezometer was monitored about ten (10) days after installation and then the piezometer was decommissioned. The details of the piezometer installations and the groundwater levels are shown on the Record of Borehole sheets in Appendix A, and the groundwater levels are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
South Abutment	SP1	181.1	177.1 177.1	February 17, 2011 February 27, 2011

It should be noted that 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.

4.4 Centre Pier (Two-Span Option)

A total of three (3) boreholes (Boreholes B201-02, B201-13 and B201-14) and two (2) Dynamic Cone Penetration Tests (DCPTs B201-DC03 and B201-DC04) were advanced at the location of the proposed centre pier. In general, the subsurface conditions consist of topsoil underlain by a deposit of silty sand to silt, underlain by a stratum of silty clay to clay, underlain by bedrock.

4.4.1 Topsoil

An approximately 0.2 m to 0.3 m thick layer of topsoil was encountered at the ground surface at all borehole locations. The surface of the topsoil ranges from about Elevations 179.0 m to 178.6 m.

4.4.2 Sand to Silt

A deposit of grey silty sand to sand to silt, generally containing trace gravel, trace to some clay was encountered below the topsoil in all the boreholes. In general, the upper portion of the deposit contains rootlets, organics and wood fragments and in Borehole B201-13, the silt portion of this deposit contains silty clay interlayers. The top of the silty sand to sand to silt deposit ranges from about Elevations 178.7 m to 178.4 m and the thickness of this deposit ranges from about 2.0 m to 4.0 m.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 20 per cent to 37 per cent.

The grain size distributions of two (2) samples of the silty sand to sand portion of this deposit and one (1) sample of the silt portion of this deposit are shown on Figures B11A and B11B in Appendix B, respectively.



An Atterberg limits test was carried out on one (1) sample of the silt portion of this deposit and measured a liquid limit of about 21 per cent, a plastic limit of about 18 per cent and a corresponding plasticity index of about 3 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B12 in Appendix B and indicates that the material is classified as silt with slight plasticity.

4.4.3 Silty Clay to Clay

A stratum of grey silty clay to clay some silt, trace sand was encountered underlying the silty sand to sand to silt deposit at all borehole locations. The top of the silty clay to clay stratum ranges from about Elevations 176.7 m to 174.5 m and the thickness of the stratum ranges from about 3.3 m to 4.3 m.

The SPT 'N'-values recorded within the silty clay to clay stratum range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 27 kPa to 55 kPa, but are typically less than 37 kPa. The sensitivity is calculated to be about 3 and 4. The field vane tests results indicate that the silty clay to clay stratum generally has a firm to stiff consistency.

The natural water content measured on samples of this stratum ranges from about 37 per cent to 57 per cent.

The grain size distributions of three (3) samples of this stratum are shown on Figure B13 in Appendix B.

Atterberg limits tests were carried out on three (3) specimens of the silty clay to clay stratum and indicate liquid limits between about 50 per cent and 53 per cent, plastic limits between about 18 per cent and 20 per cent and plasticity indices between about 32 per cent and 35 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B14 in Appendix B and indicate the material to be silty clay of intermediate plasticity to clay of high plasticity.

4.4.4 Bedrock / Refusal

Bedrock was encountered below the silty clay to clay stratum and core samples were recovered at all borehole locations. The bedrock surface is inferred from refusal to dynamic cone penetration in DCPTs B201-DC03 and B201-DC04. The refusal depths at the DCPTs, while they do not confirm bedrock elevations, may be inferred to indicate potential proximity to the bedrock interface at this location. The depth to bedrock below ground surface and corresponding bedrock surface elevation (inferred or actual) is summarised below.

Foundation Element / Approach Embankment	Borehole No.	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
Centre Pier (Two-Span Option)	B201-02	6.2	172.4	Bedrock Cored
	B201-13	7.8	170.9	Bedrock Cored
	B201-14	6.6	172.4	Bedrock Cored
	B201-DC03	5.4	172.9	DCPT Refusal
	B201-DC04	9.2	169.4	DCPT Refusal

In general, the bedrock surface slopes downwards towards the river across the proposed centre pier footprint (up to approximately 1.3H:1V slope or a dip of approximately 37° from the horizontal). Based on the review of



the cored bedrock samples, the bedrock consists of granitic gneiss. The bedrock samples are described as slightly weathered to fresh, foliated, medium crystalline, slightly porous, strong, pink, grey and black, as presented in the Record of Drillhole sheets in Appendix A, and as shown on the photograph on Figure B15 in Appendix B. The degree of weathering of the bedrock samples is slightly weathered to fresh (i.e. W2 to W1) and the strength classification of the intact rock mass based on field identification is very strong to extremely strong (i.e. R5 to R6).

The Rock Quality Designation (RQD) measured on the core samples ranges between 77 per cent and 99 per cent, indicating a rock mass of good to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 97 per cent and 100 per cent and between 60 per cent and 100 per cent, respectively.

Point load strength tests were carried out on selected samples of the rock core and the axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B. The axial tests carried out on three (3) core samples of the granitic gneiss bedrock measured Is_{50} values ranging from about 7.7 MPa to 8.8 MPa and the diametral tests carried out on three (3) core samples of the granitic gneiss bedrock measured Is_{50} values ranging from about 6.9 MPa to 14.4 MPa.

One (1) Unconfined Compression (UC) test (ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens) was carried out on a selected core sample of granitic gneiss bedrock obtained in Borehole B201-02 and measured a compressive strength of about 141 MPa, as summarized in Table B2-1 and detailed in Table B2-2 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between Is_{50} and UCS which is given by a correlation factor (K) (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification), 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 19.

Based on the laboratory UC test and the point load test results, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa).

4.4.5 Groundwater Conditions

In general, the overburden samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling ranged from about Elevations 178.0 m to 177.8 m, measured between about 0.7 m and 1.2 m below ground surface.

A standpipe piezometer was installed in Borehole B201-02 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.



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Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
Centre Pier (Two-Span Option)	B201-02	178.6	177.9 177.9	March 23, 2011 October 3, 2012

It should be noted that 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.

4.5 North Abutment and Approach Embankment (One-Span Option)

A total of three (3) boreholes (Boreholes B201-03, B201-11 and B201-12) and two (2) Dynamic Cone Penetration Tests (DCPTs B201-DC01 and B201-DC02) were advanced at the alternative location of the proposed north abutment and one (1) borehole (Borehole B201-04) was advanced on the centerline of the north approach embankment of the one-span bridge configuration. In general, the subsurface conditions consist of topsoil underlain by a deposit of silty sand to sand, underlain by a stratum of silty clay to clay, which in turn is underlain in places by pockets of either sand and gravel or sandy silt to sand, and/or bedrock.

4.5.1 Topsoil

A layer of topsoil was encountered at the ground surface at all borehole locations. The surface of topsoil ranges from about Elevations 180.6 m to 179.5 m and its thickness ranges from 0.1 m to 0.3 m.

4.5.2 Silty Sand to Sand

A deposit of brown silty sand to sand trace gravel was encountered below the topsoil in Boreholes B201-03, B201-11 and B201-12. The upper portion of the silty sand deposit contains rootlets. The top of this deposit varies between about Elevations 179.4 m and 179.2 m and the thickness of the deposit is between about 0.9 m and 1.2 m.

The SPT 'N'-values measured within this deposit range from 3 blows to 8 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 17 per cent to 25 per cent.

4.5.3 Clayey Silt to Clay

A stratum of cohesive soil comprised of brown to grey clayey silt to silty clay to clay, some silt, trace to some sand was encountered either below the silty sand to sand deposit or topsoil at all borehole locations. In Borehole B201-04, the stratum is interlayered with an approximately 0.3 m thick pocket of sandy silt. The top of the cohesive stratum ranges from about Elevations 180.5 m to 178.1 m and the thickness of the cohesive stratum ranges from about 2.4 m to 4.1 m.

The SPT 'N'-values measured within the clayey silt to clay stratum range from 0 blows (weight of hammer) to 17 blows per 0.3 m of penetration, with the higher 'N'-values generally being recorded in Borehole B201-04



within the clayey silt portion of the deposit and at the interface of the sandy silt pocket below the clayey silt stratum. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 17 kPa to 77 kPa, but are typically less than 27 kPa. The sensitivity is calculated to range from about 2 to 13, but is mostly 3 and 4. The field vane tests results indicate that the clayey silt to clay stratum generally has a soft to stiff consistency.

The natural water content measured on samples of this stratum ranges from about 24 per cent to 75 per cent.

The grain size distributions of three (3) samples of the silty clay to clay portion of this stratum are shown on Figure B16 in Appendix B.

Atterberg limits tests were carried out on three (3) specimens of the silty clay to clay portion of this stratum and indicate liquid limits ranging from about 49 per cent to 51 per cent, plastic limits ranging from about 18 per cent to 20 per cent and plasticity indices ranging from about 29 per cent to 32 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B17 in Appendix B and indicate the material to be silty clay of intermediate plasticity to clay of high plasticity.

4.5.4 Sand and Gravel / Sandy Silt to Sand

In Boreholes B201-03 and B201-12, an approximately 0.7 m and 0.9 m thick deposit of sand and gravel to sandy silt to sand some silt was encountered underlying the clay and silty clay strata at about Elevations 174.2 m and 174.6 m, respectively.

An SPT 'N'-value recorded within the sand and gravel layer is 50 blows per 0.08 m of penetration, indicating a very dense relative density. An SPT 'N'-value recorded within the sandy silt to sand layer is 11 blows per 0.3 m of penetration, indicating a compact relative density, with one SPT 'N'-value of 25 blows per 0.01 m of penetration measured at the contact with the underlying bedrock.

The natural water content measured on a specimen of the sand and gravel layer is 23 per cent.

4.5.5 Bedrock / Refusal

Bedrock was encountered below the clayey silt to clay stratum or below the sand and gravel/sandy silt to sand deposit and core samples were recovered at all borehole locations. The bedrock surface is inferred from refusal to dynamic cone penetration in DCPTs B201-DC01 and B201-DC02. These refusal depths, while they do not confirm bedrock elevations, may be inferred to indicate potential proximity to the bedrock interface. The depth to bedrock below ground surface and corresponding bedrock surface elevation (inferred or actual) is summarised below.

Foundation Element / Approach Embankment	Borehole	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
North Abutment (One-Span Option)	B201-03	6.0	173.5	Bedrock Cored
	B201-11	4.1	175.4	Bedrock Cored
	B201-12	5.9	173.7	Bedrock Cored
	B201-DC01	5.9	173.5	DCPT Refusal
	B201-DC02	5.2	174.6	DCPT Refusal



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North Approach Embankment	B201-04	2.5	178.1	Bedrock Cored
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The bedrock surface slopes downwards towards the Still River from the borehole advanced at the centreline of the north approach embankment (Borehole B201-04) to the borehole advanced at the centreline of the proposed north abutment (Borehole B201-03), with the bedrock elevation decreasing by about 4.5 m towards the river (approximately 2.7H:1V slope or a dip of approximately 21° from the horizontal).

Based on the review of the bedrock core samples, the bedrock consists of granitic gneiss. In general the bedrock samples are described as fresh, foliated, medium crystalline, slightly porous, strong, pink, grey and black, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered samples on Figure B18 in Appendix B. The degree of weathering of the bedrock samples is fresh (i.e. W1) and the strength classification of the intact rock mass based on field identification is very strong to extremely strong (i.e. R5 to R6).

The Rock Quality Designation (RQD) measured on the core samples ranges from 90 per cent to 100 per cent, indicating a rock mass of excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 92 per cent and 100 per cent and between 85 per cent and 100 per cent, respectively.

Point load strength tests 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 test carried out on four (4) core samples of the granitic gneiss bedrock measured Is_{50} values ranging from about 6.2 MPa to 8.8 MPa and the diametral test carried out on three (3) core samples of the granitic gneiss bedrock measured Is_{50} value ranging from about 7.2 MPa to 10.7 MPa.

One (1) Unconfined Compression (UC) test (ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens) was carried out on a selected core sample of granitic gneiss bedrock obtained in Borehole B201-03 and measured a compressive strength of about 127 MPa, as summarized in Table B2-1 and detailed in Table B2-4 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between Is_{50} and UCS which is given by a correlation factor (K) (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification) 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 19.

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

4.5.6 Groundwater Conditions

In general, the overburden samples taken in the boreholes were moist to wet. The water level observed in the boreholes upon completion of drilling was at about Elevation 178.7 m, measured at about 0.8 m and 0.9 m below ground surface, except in Borehole B201-04 where the water level was not recorded.



A standpipe piezometer was installed in Borehole B201-03 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 levels measured in the piezometer installation are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Abutment (One-Span Option)	B201-03	179.5	179.5	March 21, 2011
			179.4	March 24, 2011
			179.0	October 3, 2012

It should be noted that 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.

4.6 North Abutment and Approach Embankment (Two-Span Option)

A total of five (5) boreholes (Boreholes B201-05 to B201-09) were advanced at the location of the proposed north abutment and one (1) borehole (Borehole B201-10) was advanced on the centerline of the proposed Highway 69 alignment at the north approach embankment for the two-span bridge configuration. In general, the subsurface conditions consist of peat or topsoil over cobbles and boulders over bedrock.

4.6.1 Peat / Topsoil

An approximately 0.1 m and 0.2 m thick layer of black amorphous peat was encountered at the ground surface in Boreholes B201-06 and B201-08. A layer of topsoil between about 0.1 m and 0.5 m thick was encountered at the ground surface in Boreholes B201-05, B201-07, B201-09 and B201-10. The topsoil sample retrieved in Borehole B201-05 contains highly weathered schist rock fragments. The top of the peat and topsoil deposits range from about Elevations 192.2 m to 183.4 m.

The natural water content measured on two (2) specimens of the peat is about 478 per cent and 1181 per cent, and the organic content measured on these specimens is about 84 per cent and 25 per cent, respectively.

4.6.2 Cobbles and Boulders

An approximately 0.2 m thick layer of cobbles and 0.3 m thick layer of boulders were encountered below the peat in Boreholes B201-06 and B201-08. The cobbles and boulders were encountered at about Elevations 185.3 m and 183.2 m in the respective boreholes and the layer was cored through to the bedrock. Photographs of the recovered cobbles/boulder core from Boreholes B201-06 and B201-08 are presented on Figure B19 in Appendix B.

4.6.3 Bedrock / Refusal

Bedrock was encountered below the peat/topsoil and/or underlying cobbles and boulders layers, and core samples were recovered in Borehole B201-06 to B201-08. The bedrock surface is inferred from split-spoon refusal in Borehole B201-05, and exposed by shovel (hand) excavation to confirm refusal at the bottom of the



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topsoil layer in Boreholes B201-09 and B201-10. The depth to bedrock below ground surface and corresponding bedrock surface elevation is summarised below.

Foundation Element / Approach Embankment	Borehole	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
North Abutment (Two-Span Option)	B201-05	0.5	183.4	Split-Spoon Refusal
	B201-06	0.3	185.1	Bedrock Cored
	B201-07	0.2	184.2	Bedrock Cored
	B201-08	0.5	182.9	Bedrock Cored
	B201-09	0.1	185.4	Shovel Refusal
North Approach Embankment	B201-10	0.1	192.1	Shovel Refusal

In general, the bedrock surface slopes downwards towards Still River from the borehole advanced at the centreline of the north approach embankment (Borehole B210-10) to the borehole advanced at the centreline of the proposed north abutment (Borehole B201-07), with the bedrock elevation decreasing by about 8.0 m towards the river (approximately 2.4H:1V slope or a dip of approximately 23° from the horizontal).

Based on the review of the bedrock core samples, the bedrock consists of schist to granitic gneiss. In general the bedrock samples are described as fresh to slightly weathered, foliated, medium to coarse crystalline, slightly to moderately porous, strong, pink, grey, brown and black and containing quartzite banding, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered samples on Figure B19 in Appendix B. The degree of weathering of the bedrock samples is fresh to slightly weathered (i.e. W1 to W2) and the strength classification of the intact rock mass based on field identification is very strong to extremely strong (i.e. R5 to R6).

The Rock Quality Designation (RQD) measured on the core samples ranges between 67 per cent and 100 per cent, indicating a rock mass of fair to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 47 per cent and 100 per cent and between 40 per cent and 100 per cent, respectively.

Point load strength tests 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 three (3) core samples of the granitic gneiss bedrock measured Is_{50} values ranging from about 6.7 MPa to 9.0 MPa and the diametral tests carried out on three (3) core samples of the granitic gneiss bedrock measured Is_{50} values ranging from about 7.2 MPa to 12.8 MPa.

One (1) Unconfined Compression (UC) test (ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens) was carried out on a selected core sample of granitic gneiss bedrock obtained in Borehole B201-08 and measured a compressive strength of about 169 MPa, as summarized in Table B2-1 and detailed in Table B2-3 in Appendix B.

Also presented in Table B1 are the estimated Uniaxial Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between Is_{50} and UCS which is given by a correlation factor (K) (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification) 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 19.

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

4.6.4 Groundwater Conditions

In general, the overburden samples taken in the boreholes were moist. The water level observed in Boreholes B201-06 and B201-08 upon completion of drilling was at about Elevations 184.5 m and 182.5 m, measured at about 0.9 m below ground surface.

A standpipe piezometer was installed in Borehole B201-07 to permit 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 No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Abutment (Two-Span Option)	B201-07	184.4	183.9 183.9	March 4, 2011 October 3, 2012

It should be noted that 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 Rhody, senior technician with Golder and Mr. Tony Tomory, E.I.T., directed the drilling program. This report was prepared by Ms. T. Veronica Ayetan, P.Eng., a geotechnical engineer, and reviewed by Mr. J. Paul Dittrich, Ph.D., P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



FOUNDATION REPORT – STILL RIVER SBL BRIDGE STRUCTURE –
HIGHWAY 69 GWP 5404-08-00; WP 5140-08-01

Report Signature Page

T. Veronica Ayetan, P.Eng.
Geotechnical Engineer



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



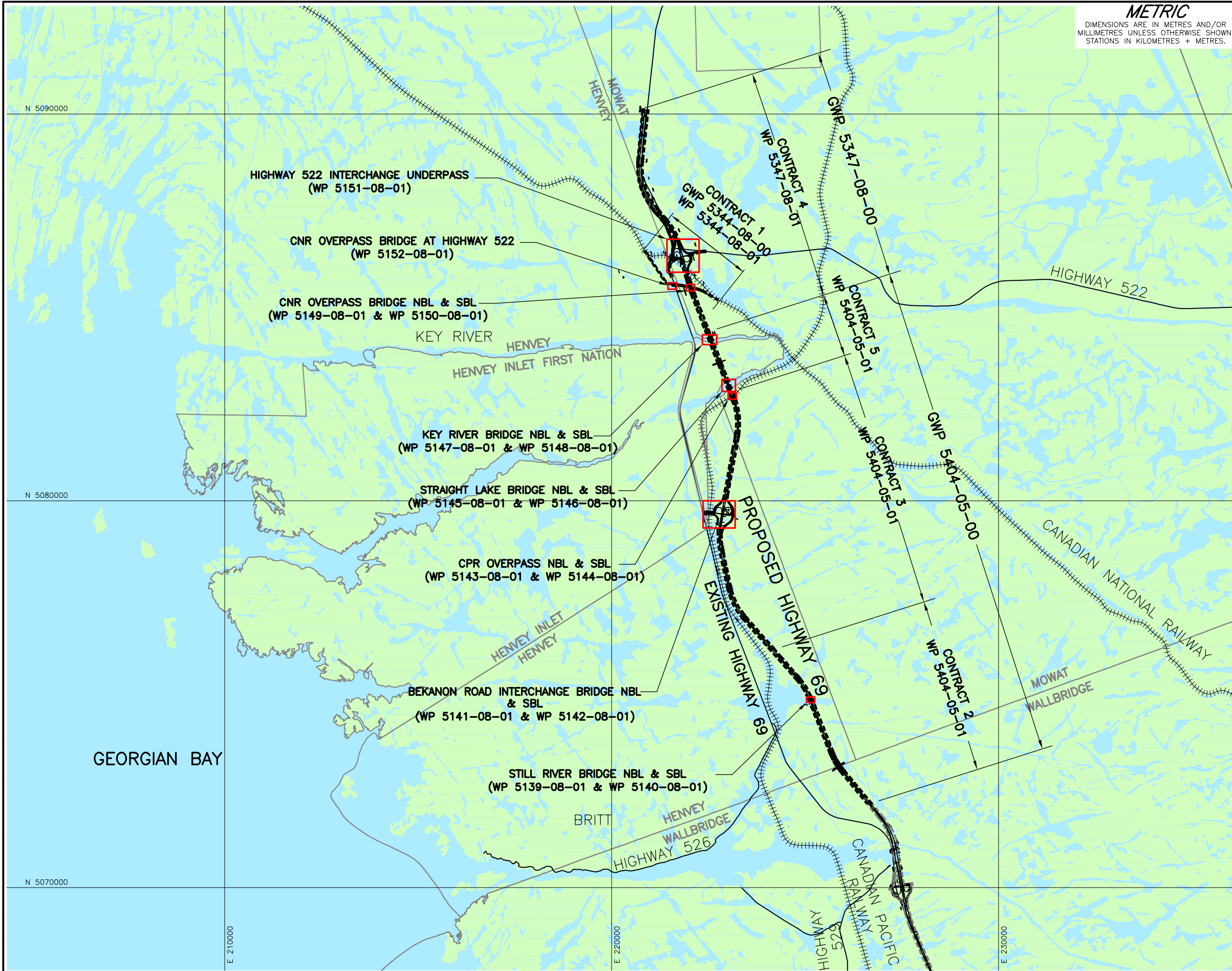
Jorge M. A. Costa, P. Eng.
Designated MTO Contact, Principal

TVA/TZ/CN/JPD/JMAC/jl

[Http://capws/sites/0911116014highway69FourLaning/Contract 2/Reporting/Final/Still River SBL Bridge/09-1111-6014-2523 RPT 14Sep11 Highway 69 Still River SBL Bridge - Part A.docx](http://capws/sites/0911116014highway69FourLaning/Contract%20Reporting/Final/Still%20River%20SBL%20Bridge/09-1111-6014-2523%20RPT%2014Sep11%20Highway%2069%20Still%20River%20SBL%20Bridge%20-%20Part%20A.docx)



DRAWINGS



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



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MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
NOT TO SCALE

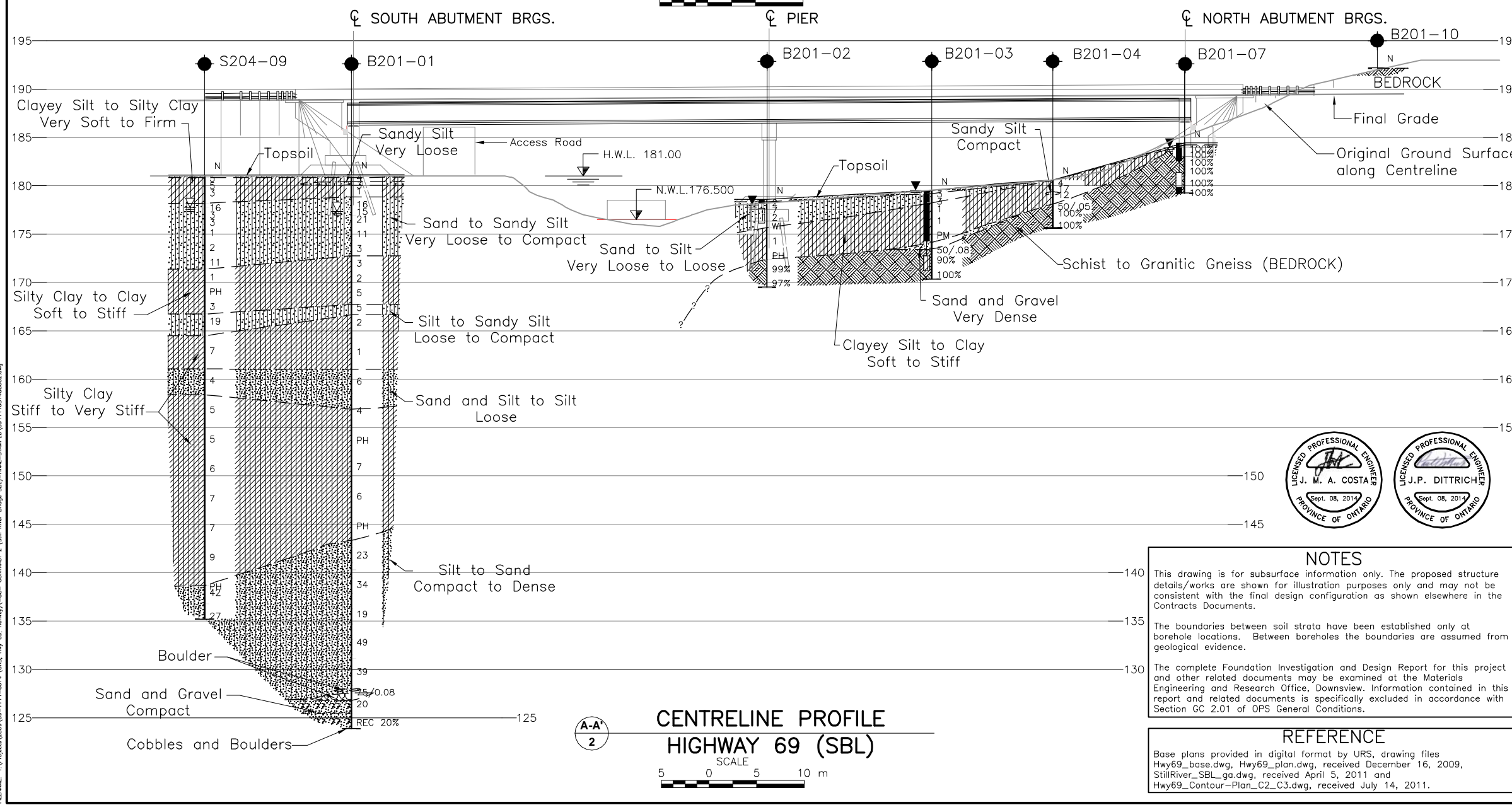
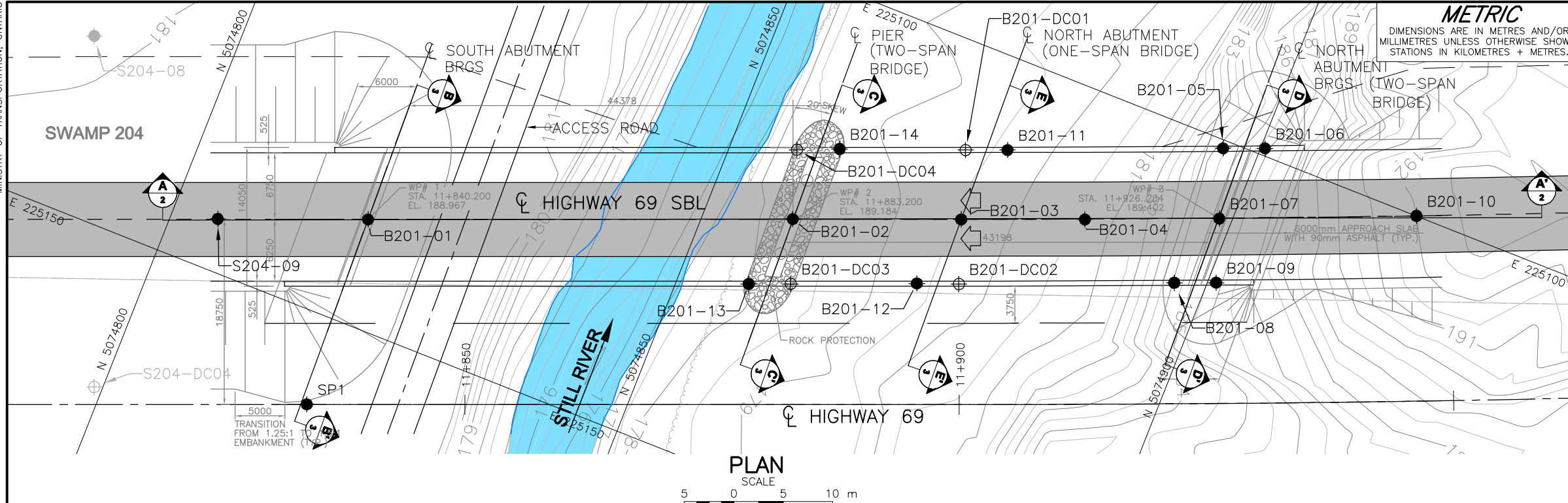
PLAN



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

NO.	DATE	BY	REVISION
Geocres No. 41H-137			
HWY. 69		PROJECT NO. 09-1111-6014	DIST.
SUBM'D. TVA	CHKD. TVA	DATE: June 2011	SITE:
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC	DWG. 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

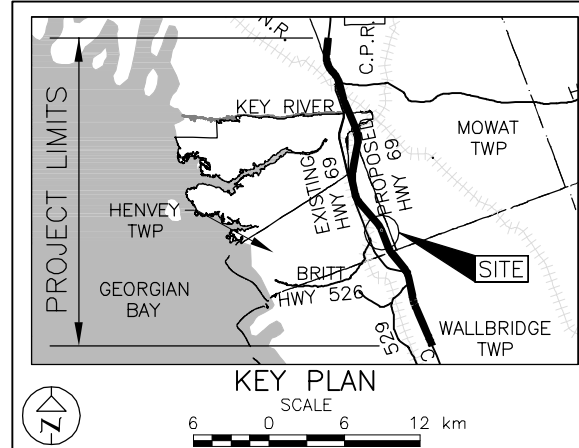
Base plans provided in digital format by URS, drawing files Hwy69_base.dwg, Hwy69_plan.dwg, received December 16, 2009, StillRiver_SBL_ga.dwg, received April 5, 2011 and Hwy69_Contour-Plan_C2_C3.dwg, received July 14, 2011.

CONT No.
WP No. 5140-08-01

HIGHWAY 69
STILL RIVER SBL BRIDGE STRUCTURE
BOREHOLE LOCATIONS AND SOIL STRATA



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



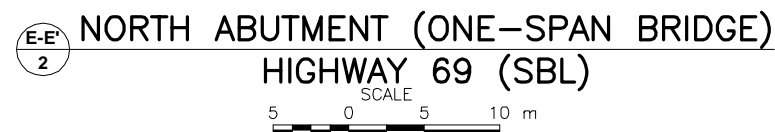
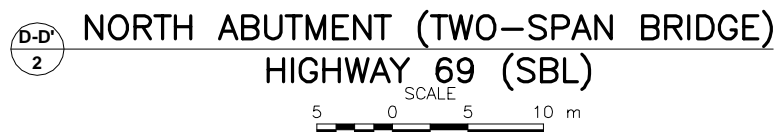
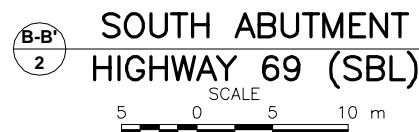
LEGEND

- Borehole - Current Investigation
- Dynamic Cone Penetration Test
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- REC Recovery (%)
- WL in piezometer, measured on March 26, 2011
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
B201-01	181.1	5074818.7	225139.3
B201-02	178.6	5074858.6	225123.5
B201-03	179.5	5074874.5	225117.3
B201-04	180.6	5074886.1	225112.7
B201-05	183.9	5074896.5	225100.8
B201-06	185.4	5074900.4	225099.3
B201-07	184.4	5074898.7	225107.6
B201-08	183.4	5074896.9	225115.3
B201-09	185.5	5074900.8	225113.7
B201-10	192.2	5074917.2	225100.0
B201-11	179.5	5074876.3	225109.0
B201-12	179.6	5074872.7	225124.9
B201-13	178.7	5074856.9	225131.2
B201-14	179.0	5074860.4	225115.2
B201-DC01	179.4	5074872.3	225110.6
B201-DC02	179.8	5074876.7	225123.4
B201-DC03	178.3	5074860.8	225129.7
B201-DC04	178.6	5074856.4	225116.8
S204-09	181.1	5074804.5	225144.9
SP1	181.1	5074819.8	225159.0

NO.	DATE	BY	REVISION
Geocres No. 41H-137			
HWY. 69		PROJECT NO. 09-1111-6014	DIST.
SUBM'D. TVA	CHKD. TVA/TZ	DATE: Dec. 2012	SITE: 44-458/2
DRAWN: JFC/CD	CHKD. CN	APPD. JPD/JMAC	DWG. 2



Ground Surface cut from OG-Survey-Contours C2-3.dwg,
received May 30, 2011.



NO.	DATE	BY	REVISION		
Geocres No. 41H-137					
HWY. 69			PROJECT NO. 09-1111-6014		DIST.
SUBM'D. TVA		CHKD. TVA/TZ	DATE: Dec. 2012		SITE: 44-458/2
DRAWN: JFC		CHKD. CN	APPD. JPD/JMAC		DWG. 3



APPENDIX A

Record of Boreholes, Drillholes, Probeholes and Dynamic Cone Penetration Tests



LIST OF SYMBOLS

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

I. GENERAL

π	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

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	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
γ'	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_α	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
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	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 ρ . Unit weight symbol is γ 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

III. SOIL DESCRIPTION

(a) Non-Cohesive Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

(b) Cohesive Soils Consistency

	kPa	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

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 cm² 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.

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 ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
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)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	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) 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 <u>09-1111-6014</u>		RECORD OF BOREHOLE No B201-01		SHEET 1 OF 5	METRIC
W.P. <u>5140-05-01</u>	LOCATION <u>N 5074818.7 ; E 225139.3</u>	ORIGINATED BY <u>MR</u>			
DIST <u> </u> HWY <u>69</u>	BOREHOLE TYPE <u>127 mm O.D. Continuous Flight Solid Stem Augers, HW Casing, Wash Boring</u>	COMPILED BY <u>MAS</u>			
DATUM <u>Geodetic</u>	DATE <u>February 3 to 8, 2011</u>	CHECKED BY <u>TVA</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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 _p	w	w _L			
181.1	GROUND SURFACE						20 40 60 80 100								
180.8	TOPSOIL		1A	SS	4		181								
180.4	CLAYEY SILT, trace sand, containing rootlets Firm Brown Moist		1B												
180.0			2A	SS	3		180								
1.1	Sandy SILT, trace clay, containing sand layers Very loose Brown and Grey Wet		2B												
			3	SS	1										
178.8	SILTY CLAY, trace sand Very soft to soft Grey Moist						179								
2.3															
	SAND, trace silt, trace clay Compact Brown Moist		4	SS	16		178								
			5	SS	15										
176.9							177								
4.2	SAND and SILT, trace clay Very loose to compact Grey Wet		6	SS	21		176								
			7	SS	11		175								
			8	SS	3	174									
172.7						173									
8.4	SILTY CLAY, containing sand lenses Soft to stiff Grey Moist		9	SS	3	172									
			10	SS	2	171									
			11	SS	5	170									
167.7						169									
13.4	SILT, some sand, trace clay Loose Grey Wet		12	SS	5	168									
166.6						167									
14.5															

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT		RECORD OF BOREHOLE		No B201-01		SHEET 2 OF 5		METRIC						
W.P. 5140-05-01		LOCATION		N 5074818.7 ; E 225139.3		ORIGINATED BY		MR						
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, HW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		February 3 to 8, 2011		CHECKED BY						
								TVA						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
								20 40 60 80 100	20 40 60					
161.0	SILTY CLAY, trace sand Stiff Grey Moist		13	SS	2		166							
							165							
							164							
			14	SS	1		163							0 1 45 54
							162							
161.0	SILT, trace sand, trace clay Loose Grey Wet						161							
20.1							160							
			15	SS	6		159							
							158							
156.9	SILTY CLAY, trace sand Stiff Grey Moist		16A	SS	4		157							
24.2			16B				156							
							155							
							154							
			17	TO	PH		153							
							152							

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT		RECORD OF BOREHOLE		No B201-01		SHEET 3 OF 5		METRIC							
W.P. 09-1111-6014		LOCATION		N 5074818.7 ; E 225139.3		ORIGINATED BY		MR							
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, HW Casing, Wash Boring		COMPILED BY							
DATUM Geodetic		DATE		February 3 to 8, 2011		CHECKED BY		TVA							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100							
	SILTY CLAY, trace sand Stiff Grey Moist		18	SS	7		151								0 2 40 58
							150								
							149								
	Containing silt lenses between depths of 32.9 m and 33.5 m		19	SS	6		148								
							147								
							146								
			20	TO	PH		145								
							144								
143.3 37.8	SILT, some clay, trace sand Compact Grey Wet						143								
			21	SS	23		142								Non-Plastic 0 3 83 14
							141								
140.3 40.8	SAND, trace to some silt Compact to dense Grey Wet						140								
			22	SS	34		139								
							138								
							137								

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B201-01		SHEET 4 OF 5		METRIC						
W.P. 5140-05-01		LOCATION N 5074818.7 ; E 225139.3		ORIGINATED BY MR								
DIST HWY 69		BOREHOLE TYPE 127 mm O.D. Continuous Flight Solid Stem Augers, HW Casing, Wash Boring		COMPILED BY MAS								
DATUM Geodetic		DATE February 3 to 8, 2011		CHECKED BY TVA								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
	--- CONTINUED FROM PREVIOUS PAGE ---											
	SAND, trace to some silt Compact to dense Grey Wet		23	SS	19							
			24	SS	49							
131.1												
50.0	SILT, some sand, trace clay, trace gravel Dense Grey Wet											
			25	SS	39							
127.9												
	Boulder		26	SS	75/0.00							
	SAND, trace silt		1	RC	-							
53.6	Grey Wet Boulders		27	SS	-							
			2	RC	-							
126.7												
54.4	SAND and GRAVEL, trace silt Compact Grey Wet		28	SS	20							
	Containing cobbles and boulders below a depth of 55.3 m											
			3	RC	REC 20%							RQD = 0%
123.8												
57.3	END OF BOREHOLE											

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B201-01				SHEET 5 OF 5		METRIC																																									
W.P. 5140-05-01		LOCATION N 5074818.7 ; E 225139.3				ORIGINATED BY MR																																											
DIST HWY 69		BOREHOLE TYPE 127 mm O.D. Continuous Flight Solid Stem Augers, HW Casing, Wash Boring				COMPILED BY MAS																																											
DATUM Geodetic		DATE February 3 to 8, 2011				CHECKED BY TVA																																											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa																																									
--- CONTINUED FROM PREVIOUS PAGE ---							<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> W_p W W_L </div>					<div style="display: flex; justify-content: space-between;"> 20 40 60 </div> <div style="display: flex; justify-content: space-between;"> WATER CONTENT (%) </div>					<div style="display: flex; justify-content: space-between;"> 20 40 60 </div> <div style="display: flex; justify-content: space-between;"> GR SA SI CL </div>																											
<p>NOTES:</p> <p>1. On February 5, 2011, water was flowing from top of casing when advanced to a depth of 42.0 m below ground surface (Elev. 139.1 m), then stopped after advancing and pulling rods in/out of the borehole up to a depth of 51.8 m - Possible artesian condition.</p> <p>2. Grouted borehole with portland cement to a depth of 51.8 m to continue advancing borehole.</p> <p>3. Water level measurements in casing during and upon completion of drilling:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Date</th> <th>Depth (m) Water/Casing</th> <th>W.L. Elev</th> </tr> </thead> <tbody> <tr> <td>(m)</td> <td></td> <td></td> </tr> <tr> <td>03/02/11</td> <td>4.1/11.9</td> <td>177.0</td> </tr> <tr> <td>04/02/11</td> <td>0.2/36.0</td> <td>180.9</td> </tr> <tr> <td>05/02/11</td> <td>0.9/36.0</td> <td>180.2</td> </tr> <tr> <td>06/02/11</td> <td>-1.1*/48.0</td> <td></td> </tr> <tr> <td></td> <td>182.2*</td> <td></td> </tr> <tr> <td>06/02/11</td> <td>-2.3*/51.8</td> <td>183.4*</td> </tr> <tr> <td>07/02/11</td> <td>3.7/53.2</td> <td>177.4</td> </tr> <tr> <td>08/02/11</td> <td>1.3/54.3</td> <td>179.8</td> </tr> <tr> <td>10/02/11</td> <td>3.8/55.3</td> <td>177.3</td> </tr> </tbody> </table> <p>* Artesian condition</p>		Date	Depth (m) Water/Casing	W.L. Elev	(m)			03/02/11	4.1/11.9	177.0	04/02/11	0.2/36.0	180.9	05/02/11	0.9/36.0	180.2	06/02/11	-1.1*/48.0			182.2*		06/02/11	-2.3*/51.8	183.4*	07/02/11	3.7/53.2	177.4	08/02/11	1.3/54.3	179.8	10/02/11	3.8/55.3	177.3															
Date	Depth (m) Water/Casing	W.L. Elev																																															
(m)																																																	
03/02/11	4.1/11.9	177.0																																															
04/02/11	0.2/36.0	180.9																																															
05/02/11	0.9/36.0	180.2																																															
06/02/11	-1.1*/48.0																																																
	182.2*																																																
06/02/11	-2.3*/51.8	183.4*																																															
07/02/11	3.7/53.2	177.4																																															
08/02/11	1.3/54.3	179.8																																															
10/02/11	3.8/55.3	177.3																																															

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PROJECT		RECORD OF BOREHOLE		No B201-02		SHEET 1 OF 1		METRIC					
W.P.		LOCATION		ORIGINATED BY		DIST		BOREHOLE TYPE					
5140-05-01		N 5074858.6 ; E 225123.5		MR		HWY 69		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring					
DATUM		DATE		CHECKED BY		COMPILED BY		MAS					
Geodetic		March 23, 2011		TVA									
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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
178.6	GROUND SURFACE												
0.0	TOPSOIL												
0.2	Silty SAND, trace clay, containing rootlets, organics and wood fragments Very loose to loose Brown Wet		1A	SS	2		178						
			1B										
			2	SS	7								
			3	SS	2		177						0 74 23 3
176.3	SILT, trace sand, trace clay Very loose Grey Wet		4A	SS	WH		176						
175.7	CLAY, some silt, trace sand Firm Grey Moist		4B										
2.9							175						
			5	SS	1								0 1 39 60
			6	TO	PH		173						
172.4	Granitic Gneiss (BEDROCK)												
6.2	Bedrock cored from depths of 6.2 m to 9.1 m For bedrock coring details refer to Record of Drillhole B201-02		1	RC	REC 100%		172						RQD = 99%
			2	RC	REC 97%		171						RQD = 97%
169.5	END OF BOREHOLE						170						
9.1	NOTES: 1. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 177.9 m), measured during drilling. 2. Water level measurement in Piezometer installed 0.3 m north of Borehole B201-02: Date Depth (m) Elev. (m) 23/03/11 0.7 177.9 03/10/12 0.7 177.9												

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-02

SHEET 1 OF 1

LOCATION: N 5074858.6 ;E 225123.5

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25 Bombardier

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.														NOTES			
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	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	1 °	2 °	3 °				
7	NW Casing March 23, 2011	Continued from Record of Borehole B201-02 Fresh, foliated, pink, grey and black, medium crystalline, slightly porous, very strong GRANITIC GNEISS		172.39 6.19	1																		(Axial)	
8	NQRC March 23, 2011				2																			UCS=141 MPa
9		END OF DRILLHOLE		169.50 9.08																				
10																								
11																								
12																								
13																								
14																								
15																								
16																								

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: MAS/TVA

PROJECT		RECORD OF BOREHOLE		No B201-03		SHEET 1 OF 1		METRIC														
W.P. 5140-05-01		LOCATION		N 5074874.5 ; E 225117.3		ORIGINATED BY		MR														
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY														
DATUM		Geodetic		DATE		March 21, 2011		CHECKED BY														
								TVA														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
179.5		GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L 20 40 60			kN/m ³			GR SA SI CL		
179.2		TOPSOIL		1A	SS	3		179														
0.3		Silty SAND, containing rootlets to a depth of 0.7 m Very loose Brown Wet		1B																		
178.3				2A	SS	3																
1.2		CLAY, some silt, trace sand Soft Brown to grey Moist		2B				178														
				3	SS	1																
		Becoming grey at a depth of 2.4 m						177														
				4	SS	1																
								176														
				5	SS	PM																
								175														
174.2																						
5.3		SAND and GRAVEL, some silt Very dense Grey Wet		6	SS	50/0.08		174														
173.5																						
6.0		Granitic Gneiss (BEDROCK)						173														
		Bedrock cored from depths of 6.0 m to 9.1 m		1	RC	REC 92%																
		For bedrock coring details refer to Record of Drillhole B201-03						172														
				2	RC	REC 100%		171														
170.4																						
9.1		END OF BOREHOLE																				
		NOTES: 1. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 178.7 m) upon completion of drilling. 2. Water level measurements in Piezometer: Date Depth (m) Elev. (m) 21/03/11 0.0 179.5 24/03/11 0.1 179.4 03/10/12 0.5 179.0																				

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PROJECT		RECORD OF BOREHOLE		No B201-04		SHEET 1 OF 1		METRIC						
W.P. 09-1111-6014		LOCATION		N 5074886.1 ; E 225112.7		ORIGINATED BY		TT						
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing,, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		March 3 and 4, 2011		CHECKED BY						
								TVA						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
180.6	GROUND SURFACE							20 40 60 80 100	20 40 60					
180.9	TOPSOIL													
	CLAYEY SILT, trace to some sand, containing rootlets		1	SS	4			7						
	Stiff							13						
	Brown and grey		2	SS	17									
	Moist													
179.4	Sandy SILT													
179.1	Compact		3A	SS	12			3						
1.5	Brown		3B											
	Moist													
	Silty Clay, trace sand							2						
	Firm to stiff							2						
178.1	Grey													
2.5	Moist													
	Granitic Gneiss (BEDROCK)													
	Bedrock cored from depths of 2.5 m to 5.0 m.		2	RC	REC 100%									RQD = 100%
	For bedrock coring details refer to Record of Drillhole B201-04													
			3	RC	REC 100%									RQD = 100%
175.6	END OF BOREHOLE													
5.0	NOTES:													
	1. Water level in open borehole not measured upon completion of drilling.													
	2. Additional boreholes were advanced 1.5 m south and 0.5 m east of Borehole B201-04 to carry out in-situ vane tests between depths of 0.5 m and 2.6 m.													


SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS Inc

CHECKED: MAS/TVA

GTARCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 09/02/14

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B201-05				SHEET 1 OF 1		METRIC			
W.P. 5140-05-01		LOCATION N 5074896.5 ; E 225100.8				ORIGINATED BY TT					
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY MAS					
DATUM Geodetic		DATE March 2, 2011				CHECKED BY TVA					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			
183.9 0.0	GROUND SURFACE TOPSOIL		1	SS	8			<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div>	<div style="display: flex; justify-content: space-between;"> 20 40 60 </div>		
183.4 0.5	END OF BOREHOLE SPOON REFUSAL NOTES: 1. Borehole advanced using Portable drilling equipment with a one-third weight hammer. SPT N value shown has been adjusted to reflect value that would be obtained with standard weight hammer. 2. Highly weathered Schist fragments were encountered within the Topsoil. 3. Water level in borehole not noted upon completion of drilling.										

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PROJECT		RECORD OF BOREHOLE		No B201-06		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5074900.4 ; E 225099.3		ORIGINATED BY		TT									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY									
AM		DATE		March 2, 2011		CHECKED BY		TVA									
DATUM		Geodetic															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
185.4	GROUND SURFACE																
0.0	PEAT (Amorphous)		1	RC	REC 85%												
0.3	Black Moist Cobbles		2	RC	REC 100%												
	Granitic Gneiss (BEDROCK)																
	Bedrock cored from depths of 0.3 m to 3.4 m.																
	For bedrock coring details, refer to Record of Drillhole B201-06.																
			3	RC	REC 100%												
			4	RC	REC 68%												
182.0	END OF BOREHOLE																
3.4	NOTE: 1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 184.5 m) upon completion of drilling.																

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PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-06

SHEET 1 OF 1

LOCATION: N 5074900.4 ;E 225099.3

DRILLING DATE:











DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS Inc

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

1	BQRC March 2, 2011	Continued from Record of Borehole B201-06		185.19	1																	
		COBBLES		0.20																		
		Fresh, foliated, pink, grey and black, medium crystalline, slightly porous, very strong GRANITIC GNEISS		0.29																		
2	BQRC March 2, 2011				2																	
3	BQRC March 2, 2011				3																	
4	BQRC March 2, 2011				4																	
5	BQRC March 2, 2011				5																	
6	BQRC March 2, 2011				6																	
7	BQRC March 2, 2011				7																	
8	BQRC March 2, 2011				8																	
9	BQRC March 2, 2011				9																	
10	BQRC March 2, 2011				10																	

		END OF DRILLHOLE		182.01																	
4				3.38																	
5																					
6																					
7																					
8																					
9																					
10																					

DEPTH SCALE

1 : 50



LOGGED: TT

CHECKED: MAS/TVA

PROJECT		RECORD OF BOREHOLE		No B201-07		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5074898.7 ; E 225107.6		ORIGINATED BY		TT									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY									
DATUM		Geodetic		DATE		March 1, 2011		CHECKED BY									
								TVA									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	20 40 60	W _p	W	W _L				
184.4	GROUND SURFACE																
0.0	TOPSOIL		1	CS	REC 100%												
	Schist (BEDROCK)		1	RC	REC 100%												RQD = 100%
0.4	Granitic Gneiss (BEDROCK)																
	Bedrock cored from depths of 0.2 m to 5.2 m		2	RC	REC 100%												RQD = 100%
	For bedrock coring details refer to Record of Drillhole B201-07.		3	RC	REC 100%												RQD = 100%
			4	RC	REC 100%												RQD = 100%
			5	RC	REC 100%												RQD = 100%
			6	RC	REC 100%												RQD = 100%
179.2	END OF BOREHOLE																
5.2	NOTE:																
	1. Water level measurement in Piezometer:																
	Date Depth (m) Elev. (m)																
	04/03/11 0.5 183.9																
	03/10/12 0.5 183.9																

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PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-07

SHEET 1 OF 1

LOCATION: N 5074898.7 ;E 225107.6

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS Inc

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate				BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage				PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular				PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough				MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.				NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								RECOVERY		R.Q.D. %	FRACT INDEX PER 0.25	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 °	10 °			10 °	10 °																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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1	BQRC March 1, 2011	Continued from Record of Borehole B201-07		184.23																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

DEPTH SCALE

1 : 50



LOGGED: TT

CHECKED: MAS/AM

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 09/02/14

PROJECT		RECORD OF BOREHOLE		No B201-08		SHEET 1 OF 1		METRIC							
W.P. 09-1111-6014		LOCATION		N 5074896.9 ; E 225115.3		ORIGINATED BY		TT							
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY							
DATUM		Geodetic		DATE		March 3, 2011		CHECKED BY							
								TVA							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
183.4	GROUND SURFACE														
0.0	PEAT, trace sand (Amorphous)		1	SS	20/0.15										
182.9	Black Moist		1	RC	REC 42%										
0.5	Boulders														
	Granitic Gneiss (BEDROCK)														
	Bedrock cored from depths of 0.2 m to 4.0 m.		2	RC	REC 100%										RQD = 71%
	For bedrock coring details, refer to Record of Drillhole B201-08.		3	RC	REC 100%										RQD = 100%
			4	RC	REC 100%										RQD = 97%
179.4	END OF BOREHOLE														
4.0	NOTES:														
	1. Borehole advanced using Portable drilling equipment with a one-third weight hammer. SPT N value shown has been adjusted to reflect value that would be obtained with standard weight hammer.														
	2. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 182.5 m) upon completion of drilling.														

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

CHECKED: MAS/TVA

PROJECT		RECORD OF BOREHOLE		No B201-09		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5074900.8 ; E 225113.7		ORIGINATED BY		TT								
DIST		HWY 69		BOREHOLE TYPE		Hand Excavation		COMPILED BY								
MAS		DATE		March 1, 2011		CHECKED BY		TVA								
DATUM		Geodetic														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
185.5	GROUND SURFACE															
8.9	TOPSOIL															
	END OF EXCAVATION - BEDROCK															
	NOTE: 1. Hand digging carried out at proposed borehole location to expose bedrock.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No B201-10		SHEET 1 OF 1		METRIC											
W.P. <u>5140-05-01</u>		LOCATION <u>N 5074917.2 ; E 225100.0</u>		ORIGINATED BY <u>TT</u>													
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Hand Excavation</u>		COMPILED BY <u>MAS</u>													
DATUM <u>Geodetic</u>		DATE <u>March 1, 2011</u>		CHECKED BY <u>TVA</u>													
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
192.2	GROUND SURFACE																
8.9	TOPSOIL																
	END OF EXCAVATION - BEDROCK																
	NOTE: 1. Hand digging carried out at proposed borehole location to expose bedrock.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14

PROJECT		RECORD OF BOREHOLE		No B201-11		SHEET 1 OF 1		METRIC												
W.P.		LOCATION		ORIGINATED BY		DIST		BOREHOLE TYPE												
DATE		DATE		COMPILED BY		CHECKED BY														
09-1111-6014		N 5074876.3 ; E 225109.0		MR		HWY 69		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring												
Geodetic		March 21 and 22, 2011		MAS		TVA														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ				
179.5	GROUND SURFACE							20 40 60 80 100					20 40 60							
0.0	TOPSOIL		1A	SS	3		179													
0.2	Silty SAND Very loose Brown Wet		1B																	
178.6			2A																	
0.9	SAND, trace gravel Loose Brown Wet		2B	SS	7		178													
178.1																				
1.4	CLAY Soft Brown to grey Moist Becoming grey at a depth 2.4 m		3	SS	WH		177	3												
			4	SS	WH		176	3 4												
175.4							175													
4.1	Granitic Gneiss (BEDROCK)		1	RC	REC 97%		174													
	Bedrock cored from depths of 4.1 m to 7.1 m For bedrock coring details refer to Record of Drillhole B201-11		2	RC	REC 93%		173													
172.4																				
7.1	END OF BOREHOLE																			
NOTE: 1. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 178.7 m) upon completion of drilling.																				

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-11

SHEET 1 OF 1

LOCATION: N 5074876.3 ;E 225109.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25 Bombardier

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES			
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG	
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja				Ja
								80 60 40 20 0	80 60 40 20 0					80 60 40 20 0	80 60 40 20 0						
	NW Casing March 21, 2011	Continued from Record of Borehole B201-11		175.44																	
		GRANITE GNEISS Fresh, foliated, medium crystalline, slightly porous, very strong, pink, grey and black		4.10	1									JN,PL,SM	1	1					
5														JN,PL,RO	1.5	1				(Axial)	
6	NORC March 22, 2011													JN,PL,RO	1.5	1				10.7 MPa	
7					2									JN,UN,RO	2	1					
		END OF DRILLHOLE		172.44																	
8				7.10																	
9																					
10																					
11																					
12																					
13																					
14																					

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: MAS/TVA

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 09/02/14

PROJECT		RECORD OF BOREHOLE		No B201-12		SHEET 1 OF 1		METRIC						
W.P. 09-1111-6014		LOCATION		N 5074872.7 ; E 225124.9		ORIGINATED BY		MR						
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		March 22 and 23, 2011		CHECKED BY						
								TVA						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
179.6	GROUND SURFACE													
0.0	TOPSOIL		1A											
0.2	Silty SAND, containing rootlets to a depth of 0.5 m Very loose to loose Brown Wet		1B	SS	3									
			2	SS	8									
178.2														
1.4	SILTY CLAY, trace sand Soft Brown to grey Moist Becoming grey at a depth 2.3 m		3	SS	1									
			4	TO	PM									
			5	SS	WH									
174.6														
5.0	Sandy SILT Compact Grey Wet		6	SS	11									
173.8														
			7	SS	25/0.0									
5.9	SAND, some silt Compact Grey Wet Granitic Gneiss (BEDROCK) Bedrock cored from depths of 5.9 m to 8.8 m For bedrock coring details, refer to Record of Drillhole B201-12		1	RC	REC 96%									RQD = 96%
			2	RC	REC 100%									RQD = 100%
170.8														
8.8	END OF BOREHOLE													
	NOTE: 1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 178.7 m) upon completion of drilling.													

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-12

SHEET 1 OF 1

LOCATION: N 5074872.7 ;E 225124.9

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25 Bombardier

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES			
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q AVG		
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja	Jn			
6	NW Casing March 22, 2011	Continued from Record of Borehole B201-12		173.63 5.94																	
7		Fresh, foliated, pink, grey and black, medium crystalline, slightly porous, very strong GRANITIC GNEISS			1									JN,W,SM		15	1				
8	NQRC March 23, 2011				2									JN,PL,RO		15	1				(Axial)
9		END OF DRILLHOLE		170.77 8.80										JN,UN,SM		2	1				
10																					
11																					
12																					
13																					
14																					
15																					

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: MAS/TVA

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B201-13				SHEET 1 OF 1		METRIC								
W.P. 5140-05-01		LOCATION N 5074856.9 ; E 225131.2				ORIGINATED BY MR										
DIST HWY 69		BOREHOLE TYPE 127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring				COMPILED BY MAS										
DATUM Geodetic		DATE March 24, 2011				CHECKED BY TVA										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
178.7	GROUND SURFACE															
0.0	TOPSOIL		1A	SS	2											
0.2	Silty SAND, containing rootlets, organics and wood fragments Very loose to loose Brown Moist to wet Becoming wet below a depth of 0.8 m		1B	SS												
			2	SS	8											
			3	SS	9											
176.5	SAND, trace gravel, containing wood fragments Loose Grey Wet		4	SS	4											
			5	SS	5											
175.3	SILT, some clay, trace sand, containing silty clay interlayers Very loose Grey Wet		6	SS	2											
174.5	CLAY, some silt, trace sand Firm to stiff Grey Moist		7	SS	WH											
4.2			8	SS	1											
			9	SS	3											
170.9	Granitic Gneiss (BEDROCK)		1	RC	REC 99%											
7.8	Bedrock cored from depths of 7.8 m to 10.8 m For Bedrock coring details refer to Record of Drillhole B201-13		2	RC	REC 97%											
167.9	END OF BOREHOLE															
10.8	NOTES: 1. Unable to push N vane past a depth of 6.9 m below ground surface (Elev. 171.8 m). 2. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 178.0 m) upon completion of drilling.															

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-13

SHEET 1 OF 1

LOCATION: N 5074856.9 ;E 225131.2

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25 Bombardier

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
								RECOVERY		R.Q.D. %	FRACT INDEX PER 0.25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja					Jn																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
8	NW Casing March 24, 2011	Continued from Record of Borehole B201-13 Fresh, foliated, pink, grey and black, medium crystalline, slightly porous, very strong to extremely strong GRANITIC GNEISS		170.87 7.80	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: MAS/TVA

PROJECT		RECORD OF BOREHOLE		No B201-14		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5074860.4 ; E 225115.2		ORIGINATED BY		MR									
DIST		HWY 69		BOREHOLE TYPE		127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY									
DATUM		Geodetic		DATE		March 25, 2011		CHECKED BY									
								TVA									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
179.0	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	4												
178.7			1B														
0.3	Silty SAND, containing rootlets and organics Loose Brown to grey Wet		2	SS	9												
177.6																	
1.4	SAND, trace to some silt, trace clay Loose Brown Wet		3	SS	5												
176.7																	
2.3	SILTY CLAY, trace sand Firm Grey Moist		4	SS	WH												
			5	TO	PM												
			6	SS	1												
172.4																	
6.6	Granitic Gneiss (BEDROCK)																
	Bedrock cored from depths of 6.6 m to 9.7 m		1	NQ RC	REC 100%												
	For bedrock coring details refer to Record of Drillhole B201-14																
			2	NQ RC	REC 98%												
169.3																	
9.7	END OF BOREHOLE																
	NOTE: 1. Water level in open borehole at a depth of 1.2 m below ground surface (Elev. 177.8 m) upon completion of drilling.																

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B201-14

SHEET 1 OF 1

LOCATION: N 5074860.4 ;E 225115.2

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25 Bombardier

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.	NOTES
		Continued from Record of Borehole B201-14		172.38									
7	NW Casing March 25, 2011	Slightly weathered, foliated, pink, grey and black, medium crystalline, slightly porous, very strong GRANITIC GNEISS		6.61	1								12.7 MPa
8	NQRC March 25, 2011												
9					2								8.8 MPa (Axial)
10		END OF DRILLHOLE		169.33									
11				9.66									
12													
13													
14													
15													
16													

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: MAS/TVA

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 09/02/14



PROJECT <u>09-1111-6014</u>	RECORD OF BOREHOLE No S204-09	SHEET 1 OF 4	METRIC
W.P. <u>5404-05-01</u>	LOCATION <u>N 5074804.5 ;E 225144.9</u>	ORIGINATED BY <u>MR</u>	
DIST <u> </u> HWY <u>69</u>	BOREHOLE TYPE <u>127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring</u>	COMPILED BY <u>OK</u>	
DATUM <u>Geodetic</u>	DATE <u>February 3 and 4, 2010</u>	CHECKED BY <u>TVA</u>	

[illegible]

GT-A-MTO 001 09-1111-6014.GPJ GAL-MISS.GDT 7/25/12 SAC/DD



Continued Next Page

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

Continued Next Page

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

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S204-09		SHEET 3 OF 4		METRIC	
W.P. <u>5404-05-01</u>		LOCATION <u>N 5074804.5 ; E 225144.9</u>		ORIGINATED BY <u>MR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring</u>		COMPILED BY <u>OK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 3 and 4, 2010</u>		CHECKED BY <u>TVA</u>			


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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							
								20 40 60 80 100	20 40 60						
--- CONTINUED FROM PREVIOUS PAGE ---															
	SILTY CLAY Stiff to very stiff Grey Moist		18	SS	6		151								
							150								
							149								
							148								
							147								
							146								
							145								
							144								
							143								
							142								
			20	SS	7		145								
							144								
							143								
							142								
							141								
							140								
							139								
138.7							138								
42.4	SILT, trace to some clay, trace sand Dense Grey Wet		22	TO	PH		137								
			23	SS	42		138								
							137								
136.8															
44.3															

Continued Next Page

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

GTA-MTO 001 09-1111-6014.GPJ GAL-MISS.GDT 7/25/12 SAC/DD

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S204-09		SHEET 4 OF 4		METRIC	
W.P. <u>5404-05-01</u>		LOCATION <u>N 5074804.5 ; E 225144.9</u>		ORIGINATED BY <u>MR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>127 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring</u>		COMPILED BY <u>OK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 3 and 4, 2010</u>		CHECKED BY <u>TVA</u>			

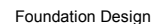
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W		
							20	40	60	80	100					
	--- CONTINUED FROM PREVIOUS PAGE ---															
135.2	Silty SAND, trace clay Compact Grey Wet		24	SS	27	136										
45.9	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 3.4 m below ground surface (Elev. 177.7 m) upon completion of drilling.															

GTA-MTO 001 09-1111-6014.GPJ GAL-MISS.GDT 7/25/12 SAC/DD

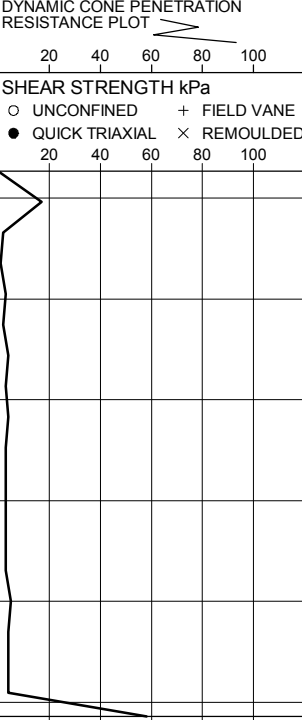
PROJECT 09-1111-6014				RECORD OF BOREHOLE No SP1				SHEET 1 OF 1				METRIC														
W.P. 5139-08-01				LOCATION N 5074819.8 ; E 225159.0				ORIGINATED BY MR																		
DIST HWY 69				BOREHOLE TYPE 213 mm O.D. Continuous Flight Hollow Stem Augers				COMPILED BY TVA																		
DATUM Geodetic				DATE February 17, 2011				CHECKED BY TVA																		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)													
181.1	GROUND SURFACE							20	40	60	80	100														
0.0	TOPSOIL																									
180.8																										
0.3	Sandy SILT, some clay Brown																									
180.2																										
0.9	SILTY CLAY Grey																									
178.7																										
2.4	SAND to Silty SAND Brown to grey																									
175.0																										
6.1	END OF BOREHOLE																									
NOTES: 1. General stratigraphy interpretations are based on cuttings and auger samples only. Soil types and boundaries shown between soil types are approximate. 2. Water level measurement in Piezometer: <table style="margin-left: 40px;"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>17/02/11</td> <td>4.0</td> <td>177.1</td> </tr> <tr> <td>27/02/11</td> <td>4.0</td> <td>177.1</td> </tr> </table>																		Date	Depth (m)	Elev. (m)	17/02/11	4.0	177.1	27/02/11	4.0	177.1
Date	Depth (m)	Elev. (m)																								
17/02/11	4.0	177.1																								
27/02/11	4.0	177.1																								

PROJECT <u>09-1111-6014</u>										RECORD OF DCPT No B201-DC01 SHEET 1 OF 1										METRIC															
W.P. <u>5140-05-01</u>					LOCATION <u>N 5074872.3 ; E 225110.6</u>					ORIGINATED BY <u>MR</u>																									
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>					COMPILED BY <u>MAS</u>																									
DATUM <u>Geodetic</u>					DATE <u>March 22, 2011</u>					CHECKED BY <u>TVA</u>																									
SOIL PROFILE					SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT					UNIT WEIGHT					REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION				STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					W _p W W _L					WATER CONTENT (%)					γ					GR SA SI CL				
179.4 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)									179	20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60						
173.5 5.9	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)									174	20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60					

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14



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

PROJECT <u>09-1111-6014</u>				RECORD OF DCPT No B201-DC03				SHEET 1 OF 1				METRIC				
W.P. <u>5140-05-01</u>				LOCATION <u>N 5074860.8 ; E 225129.7</u>				ORIGINATED BY <u>MR</u>								
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>				COMPILED BY <u>MAS</u>								
DATUM <u>Geodetic</u>				DATE <u>March 25, 2011</u>				CHECKED BY <u>TVA</u>								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W		
178.3 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)					178										
172.9 5.4	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)					173										

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 09/02/14



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



APPENDIX B

Laboratory Test Results and Cobbles/Boulders and Bedrock Core Photographs

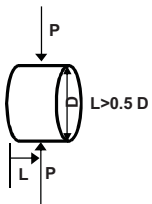
TABLE B1
POINT LOAD TEST RESULTS ON ROCK SAMPLES

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core ⁽²⁾ Diameter (mm)	Is (50mm) (MPa)	Approx. UCS Value ⁽¹⁾ (MPa)
B201-02	1	6.8	171.8	Granite Gneiss	Axial	44.44	47.41	7.677	146
B201-02	2	8.0	170.6	Granite Gneiss	Diametral	52.86	44.64	6.926	132
B201-03	2	7.7	171.8	Granite Gneiss	Axial	43.64	47.49	8.837	168
B201-03	2	8.5	171.0	Granite Gneiss	Diametral	51.63	43.74	7.213	137
B201-04	2	3.0	177.6	Granite Gneiss	Diametral	61.38	48.20	7.209	137
B201-04	3	4.2	176.4	Granite Gneiss	Axial	45.55	50.72	6.238	119
B201-06	3	1.5	183.9	Granite Gneiss	Diametral	51.15	45.75	8.277	157
B201-07	2	1.0	183.4	Granite Gneiss	Axial	37.85	50.83	6.703	127
B201-07	4	2.5	181.9	Granite Gneiss	Diametral	46.13	41.21	12.844	244
B201-07	6	4.5	179.9	Granite Gneiss	Axial	50.58	50.70	8.954	170
B201-08	3	2.0	181.4	Granite Gneiss	Diametral	54.13	46.64	7.206	137
B201-08	4	3.5	179.9	Granite Gneiss	Axial	44.89	51.11	7.025	133
B201-11	1	5.0	174.5	Granite Gneiss	Axial	40.81	47.37	7.676	146
B201-11	2	6.0	173.5	Granite Gneiss	Diametral	61.06	41.61	10.677	203
B201-12	2	8.0	171.6	Granite Gneiss	Axial	26.570	47.420	8.022	152
B201-13	1	8.5	170.2	Granite Gneiss	Axial	54.17	47.44	8.490	161
B201-13	2	9.9	168.8	Granite Gneiss	Diametral	61.31	43.36	14.433	274
B201-14	1	7.2	171.8	Granite Gneiss	Diametral	72.65	38.29	12.650	240
B201-14	2	8.9	170.1	Granite Gneiss	Axial	37.90	46.90	8.848	168

⁽¹⁾ $I_{S50} \times K$, 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 $K = 19$ has been used and is based on the average of six (6) I_{S50} tests and the average of 3 UCS tests, for similar bedrock core zones.

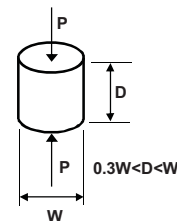
DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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



AXIAL SPECIMEN SHAPE REQUIREMENTS

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



Compiled by: TVA
Reviewed by: JPD/JMAC

TABLE B2-1
SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS
STILL RIVER BRIDGE (SBL) STRUCTURE
HIGHWAY 69 GWP 5404-05-00; WP 5140-08-01

Borehole Number (Core Run)	Sample Depth (m)	Sample Elevation (m)	Rock Type	Core Diameter (mm)	Uniaxial Compressive Strength (MPa)
B201-02 (2)	8.2	170.4	Granitic Gneiss	47.5	140.6
B201-03 (2)	8.7	170.8	Granitic Gneiss	47.3	126.6
B201-08 (3)	1.8	181.6	Granitic Gneiss	50.5	168.8

Compiled By: TVA

Reviewed By: JPD/JMAC

TABLE B2-2
UNCONFINED COMPRESSION (UC) TEST
ASTM D 7012-10

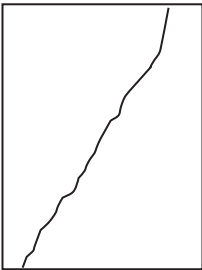
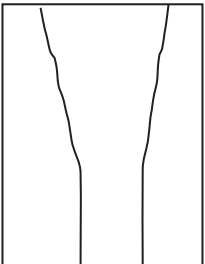
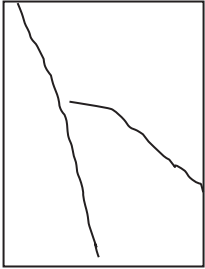
SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	RUN NUMBER	2
BOREHOLE NUMBER	B201-02	SAMPLE DEPTH, m	8.10-8.25
TEST CONDITIONS			
MACHINE SPEED, mm/min	0.00	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.41
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.46	WATER CONTENT, (specimen) %	0.09
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m ³	26.76
SAMPLE AREA, cm ²	17.72	DRY UNIT WT., kN/m ³	26.74
SAMPLE VOLUME, cm ³	203.08	SPECIFIC GRAVITY, assumed	2.75
WET WEIGHT, g	554.40	VOID RATIO	0.01
DRY WEIGHT, g	553.90		
VISUAL INSPECTION		FAILURE SKETCH	
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	140.6
REMARKS:	N/A	DATE:	2011-07-14
CHECKED BY:	TVA	REVIEWED BY:	JPD/JMAC

TABLE B2-3
UNCONFINED COMPRESSION (UC) TEST
ASTM D 7012-10

SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	RUN NUMBER	2
BOREHOLE NUMBER	B201-03	SAMPLE DEPTH, m	8.60-8.75
TEST CONDITIONS			
MACHINE SPEED, mm/min	0.00	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.28
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.80	WATER CONTENT, (specimen) %	0.12
SAMPLE DIAMETER, cm	4.73	UNIT WEIGHT, kN/m ³	27.08
SAMPLE AREA, cm ²	17.57	DRY UNIT WT., kN/m ³	27.05
SAMPLE VOLUME, cm ³	189.77	SPECIFIC GRAVITY, assumed	2.75
WET WEIGHT, g	524.30	VOID RATIO	0.00
DRY WEIGHT, g	523.67		
VISUAL INSPECTION		FAILURE SKETCH	
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	126.6
REMARKS:	N/A	DATE:	2011-07-14
CHECKED BY:	TVA	REVIEWED BY:	JPD/JMAC

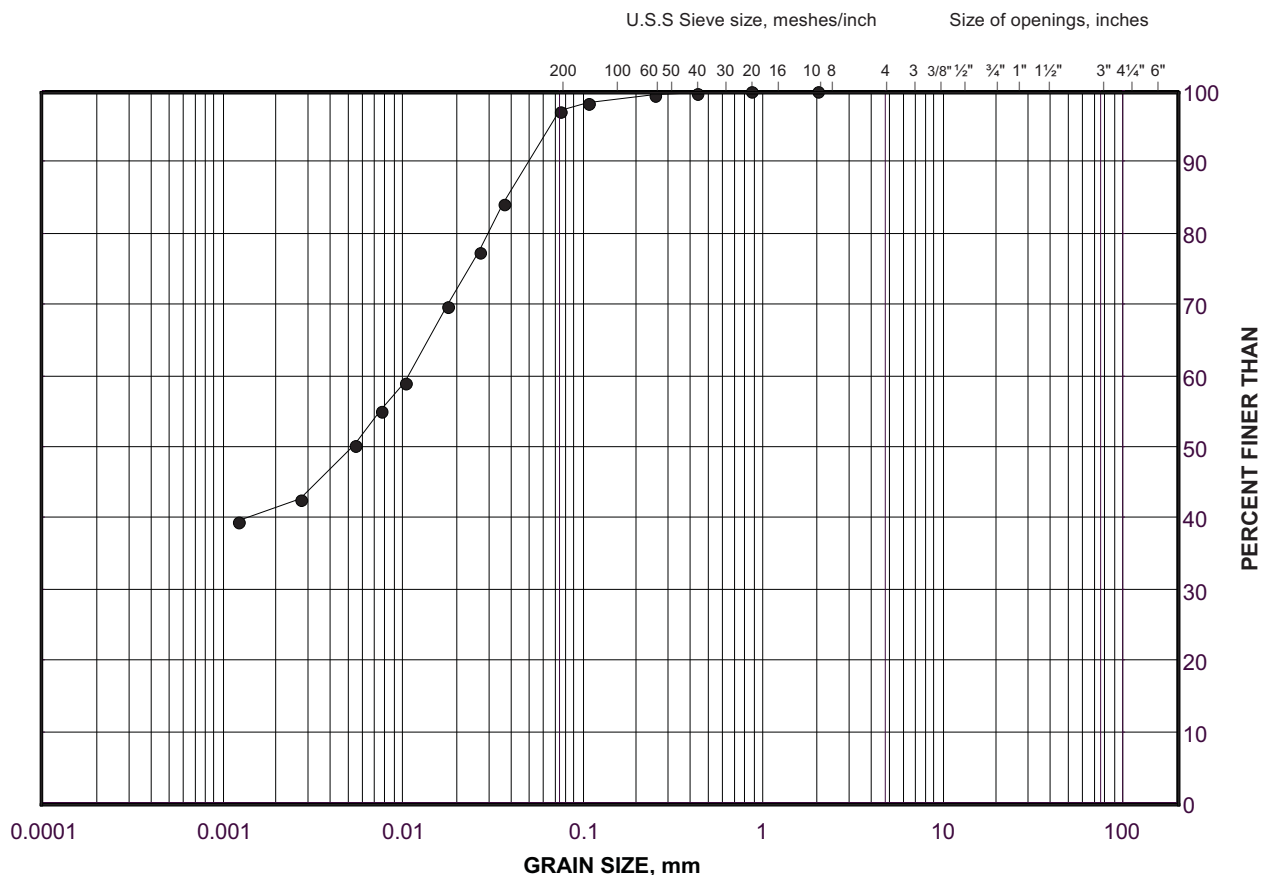
**TABLE B2-4
UNCONFINED COMPRESSION (UC) TEST
ASTM D 7012-10**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	09-1111-6014	RUN NUMBER	3
BOREHOLE NUMBER	B201-08	SAMPLE DEPTH, m	1.75-1.90
TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.31
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.65	WATER CONTENT, (specimen) %	0.10
SAMPLE DIAMETER, cm	5.05	UNIT WEIGHT, kN/m ³	27.42
SAMPLE AREA, cm ²	20.03	DRY UNIT WT., kN/m ³	27.39
SAMPLE VOLUME, cm ³	233.35	SPECIFIC GRAVITY, assumed	2.80
WET WEIGHT, g	652.75	VOID RATIO	0.00
DRY WEIGHT, g	652.09		
VISUAL INSPECTION		FAILURE SKETCH	
			
TEST RESULTS			
STRAIN AT FAILURE, %		COMPRESSIVE STRESS, MPa	
-		168.8	
REMARKS:	N/A	DATE:	2011-08-04
CHECKED BY:	TVA	REVIEWED BY:	JPD/JMAC

GRAIN SIZE DISTRIBUTION

Silty Clay (Near Surface)
South Abutment - Still River Bridge (SBL)

FIGURE B1



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

LEGEND

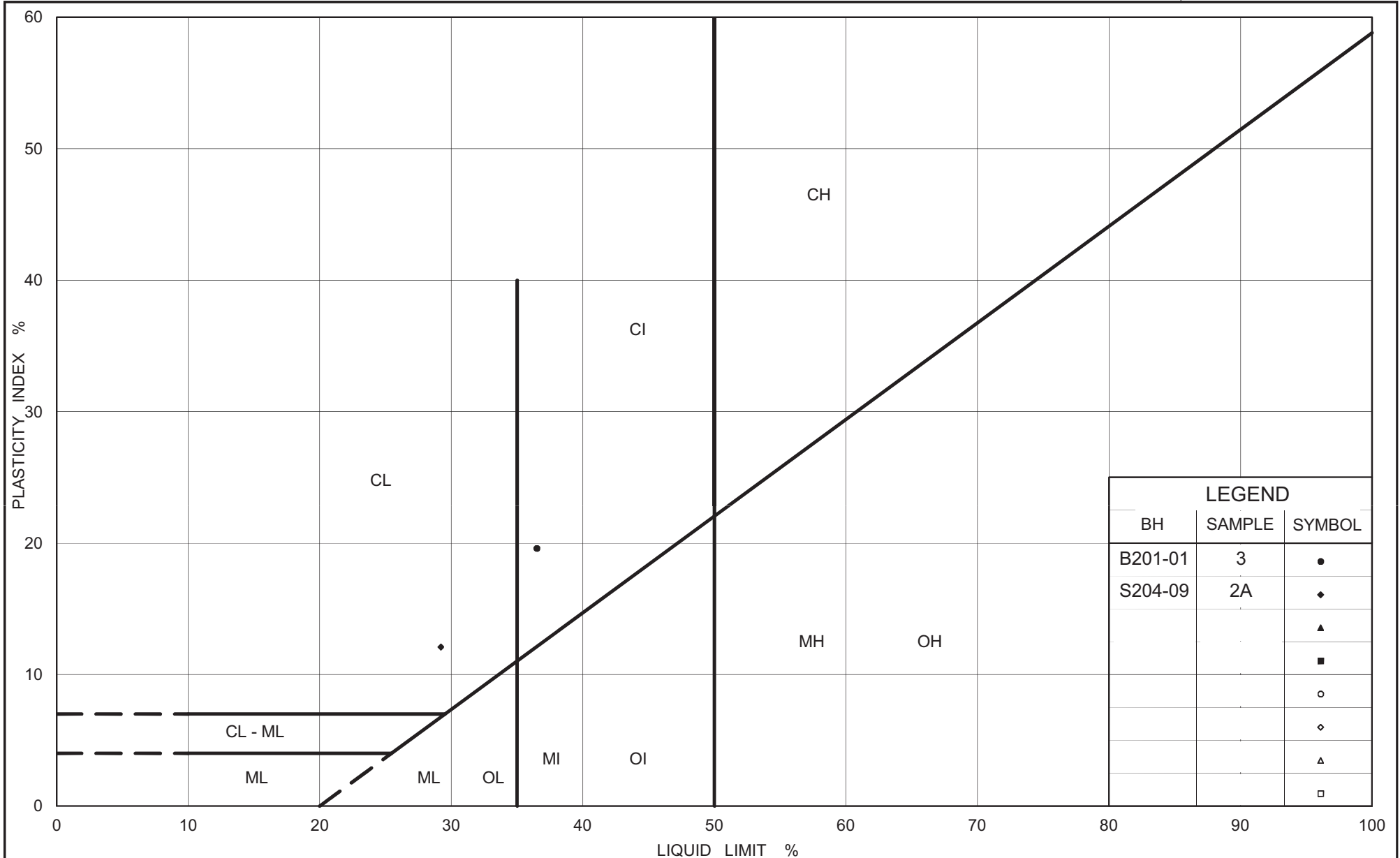
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	B201-01	3	179.4

Project Number: 09-1111-6014

Checked By: TZ

Golder Associates

Date: 13-Oct-11



Ministry of Transportation

Ontario

PLASTICITY CHART
 Clayey Silt to Silty Clay (Near Surface)
 South Abutment and Approach - Still River Bridge (SBL)

Figure No. B2

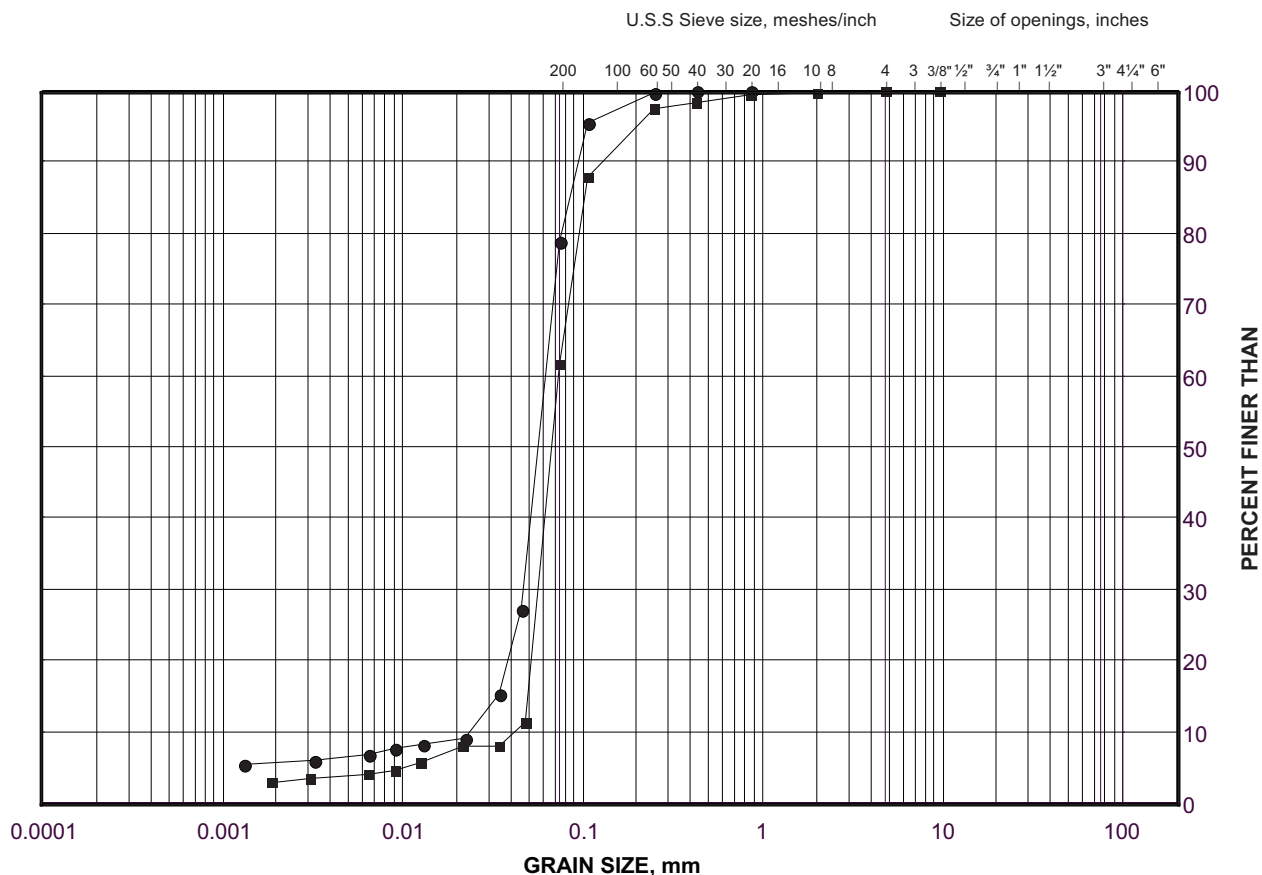
Project No. 09-1111-6014

Checked By: TZ

GRAIN SIZE DISTRIBUTION

Sand and Silt to Sandy Silt (Upper)
South Abutment and Approach - Still River Bridge (SBL)

FIGURE B3



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

LEGEND

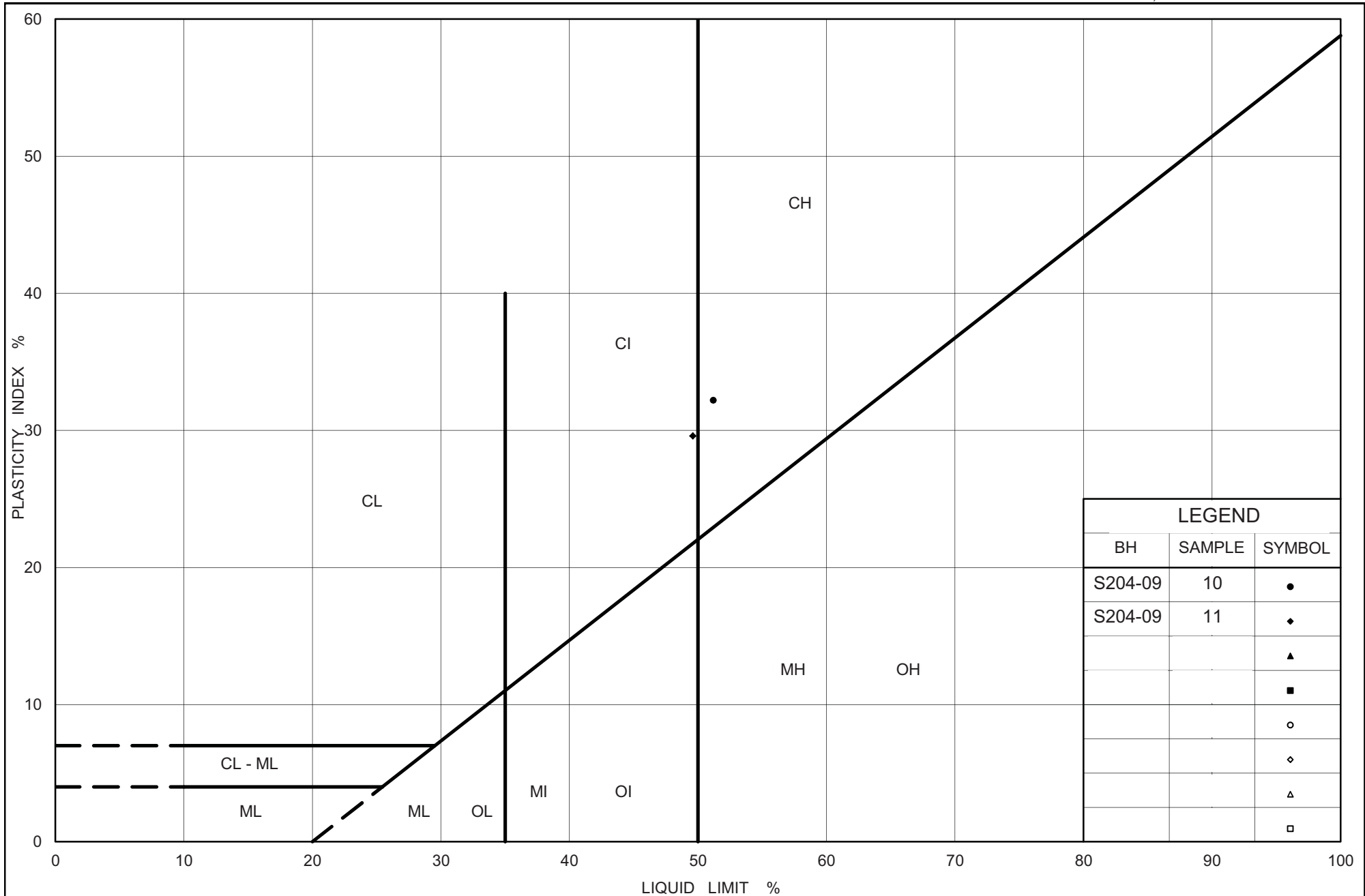
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S204-09	5	177.0
■	B201-01	7	175.0

Project Number: 09-1111-6014

Checked By: TZ

Golder Associates

Date: 13-Oct-11



Ministry of Transportation

Ontario

PLASTICITY CHART
Silty Clay to Clay (Upper)
South Approach - Still River Bridge (SBL)

Figure No. B4

Project No. 09-1111-6014

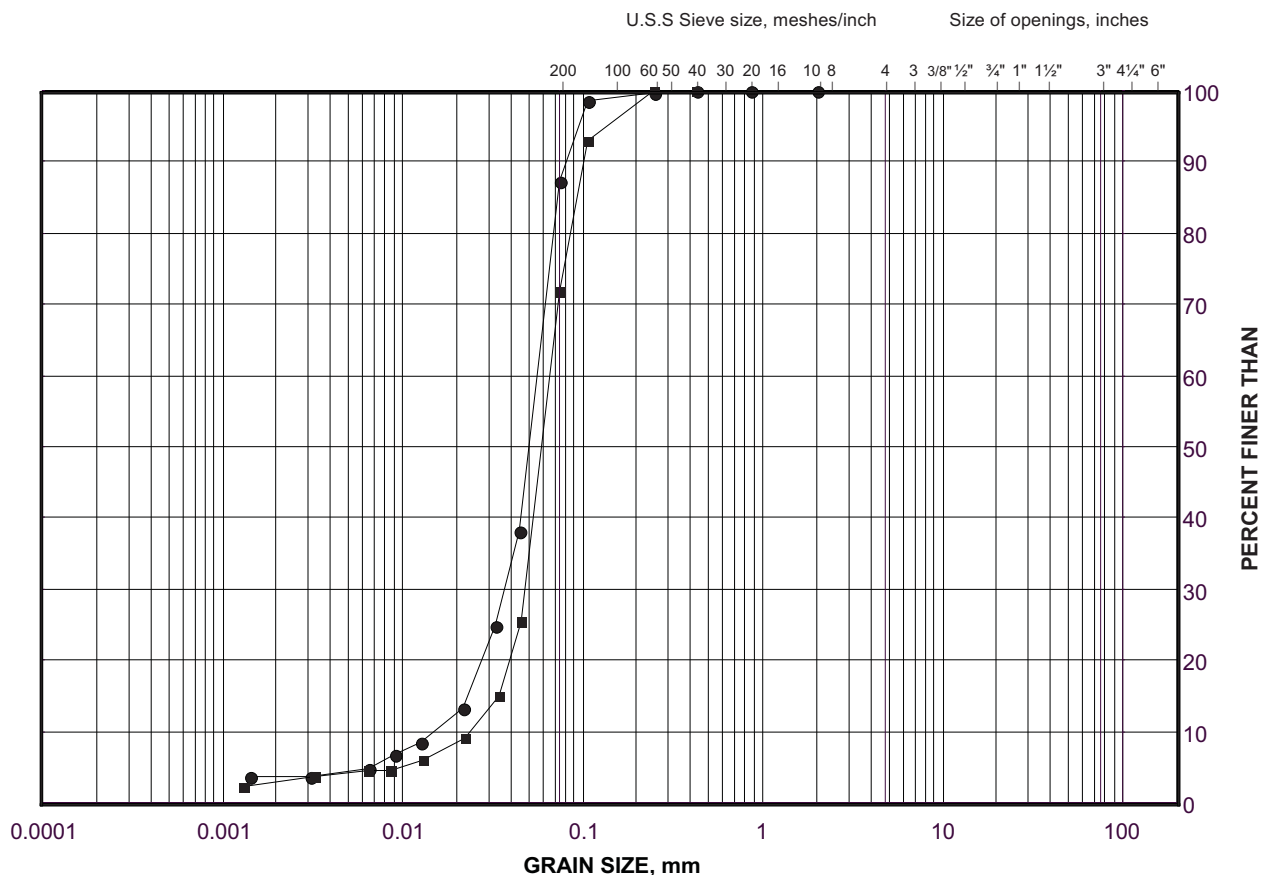
Checked By: TZ

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt

South Abutment and Approach - Still River Bridge (SBL)

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-01	12	167.4
■	S204-09	13	166.0

Project Number: 09-1111-6014

Checked By: TZ

Golder Associates

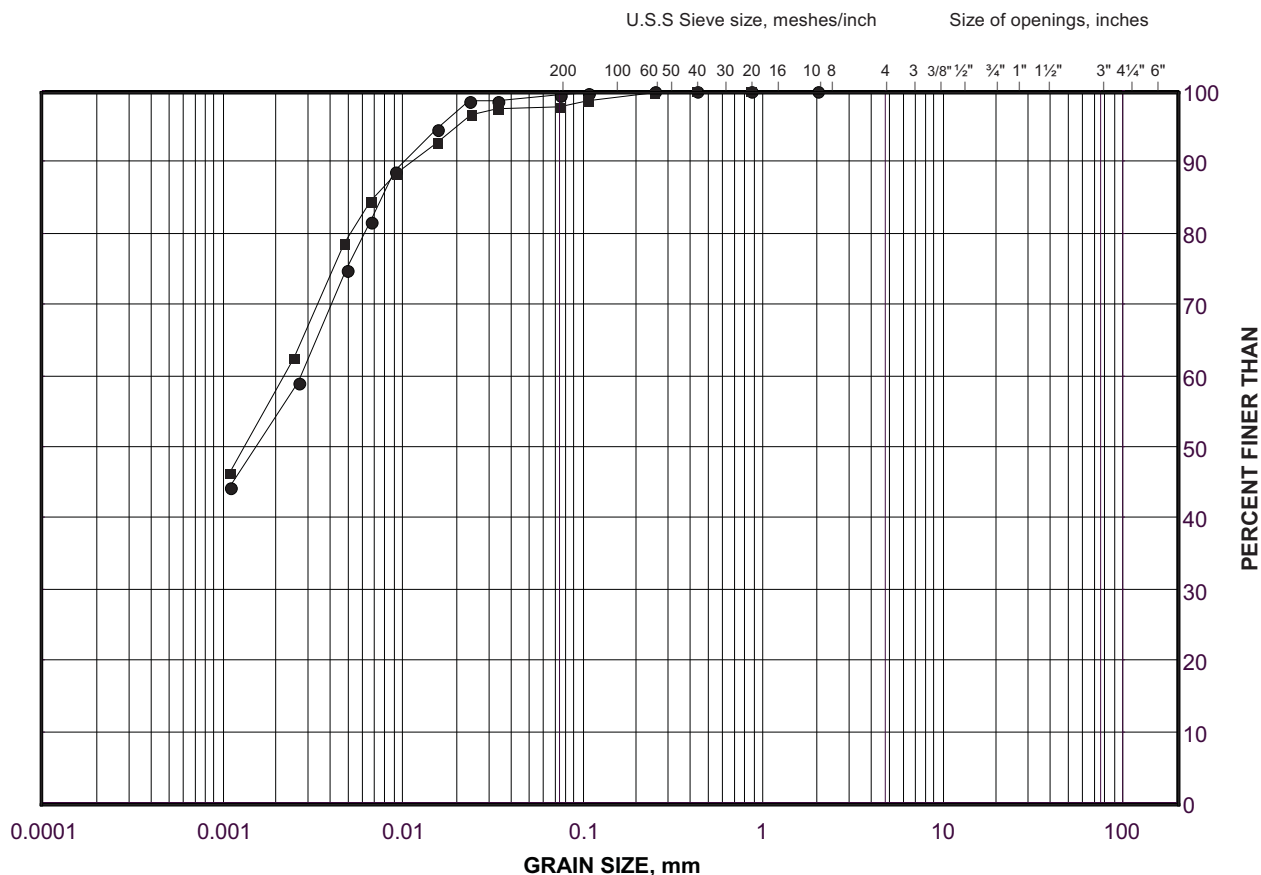
Date: 13-Oct-11

GRAIN SIZE DISTRIBUTION

Silty Clay (Lower)

South Abutment and Approach - Still River Bridge (SBL)

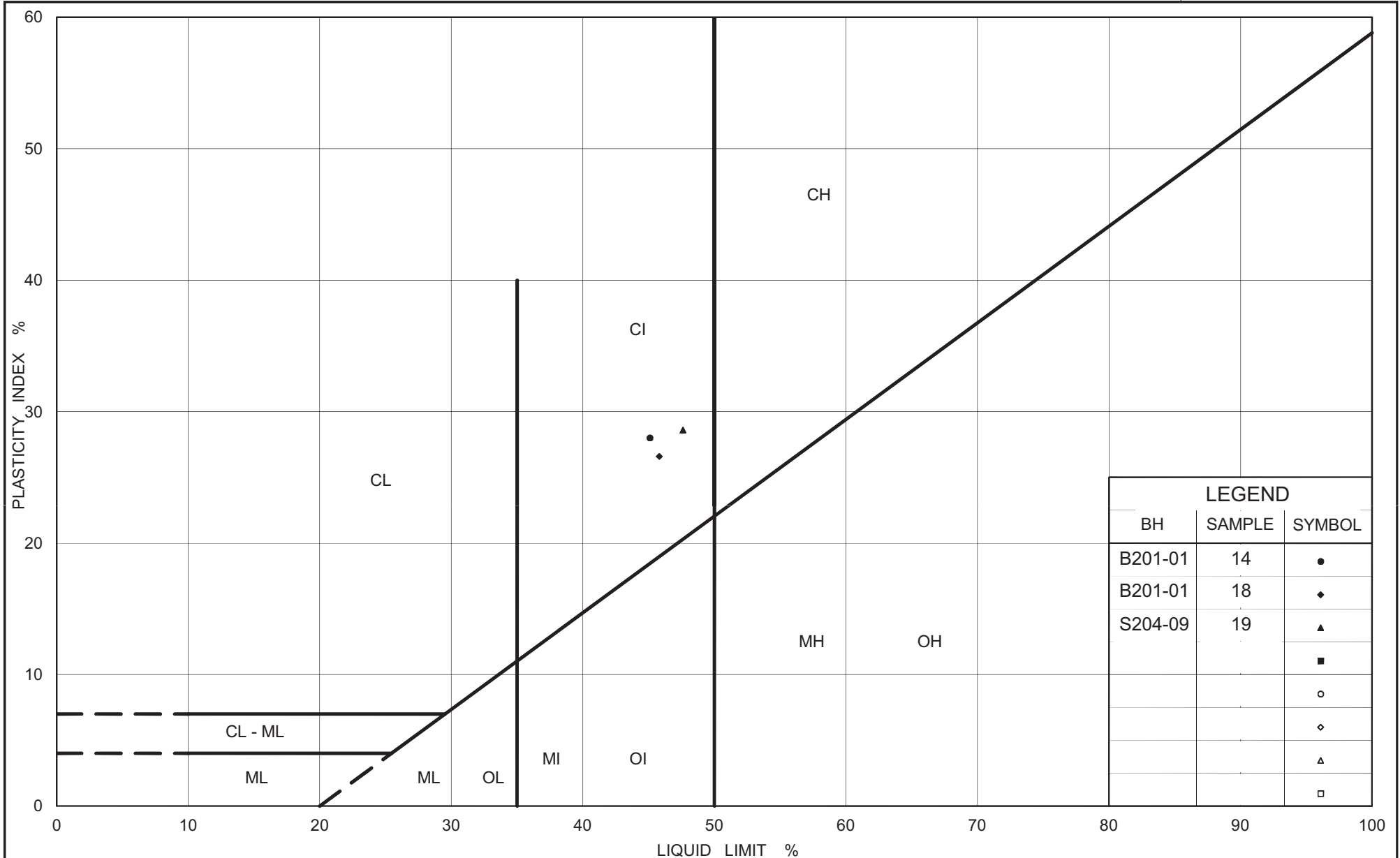
FIGURE B6



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-01	14	162.8
■	B201-01	18	150.9



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay (Lower)

South Abutment and Approach - Still River Bridge (SBL)

Figure No. B7

Project No. 09-1111-6014

Checked By: TZ

CONSOLIDATION TEST SUMMARY**FIGURE B8****Sheet 1 of 4****SAMPLE IDENTIFICATION**

Project Number	09-1111-6014	Sample Number	17
Borehole Number	B201-01	Sample Depth, m	27.1-27.6

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	12/18/2012		
Date Completed	01/02/2013		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.53	Unit Weight, kN/m ³	15.69
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	9.34
Area, cm ²	31.68	Specific Gravity, measured	2.81
Volume, cm ³	80.28	Solids Height, cm	0.859
Water Content, %	67.93	Volume of Solids, cm ³	27.22
Wet Mass, g	128.43	Volume of Voids, cm ³	53.06
Dry Mass, g	76.48	Degree of Saturation, %	97.9

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	2.534	1.949	2.534				
6.00	2.532	1.947	2.533	2	6.80E-01	1.25E-04	8.33E-06
10.63	2.531	1.946	2.531	290	4.68E-03	1.11E-04	5.09E-08
20.65	2.526	1.940	2.528	265	5.11E-03	2.01E-04	1.01E-07
40.04	2.505	1.916	2.516	540	2.48E-03	4.13E-04	1.01E-07
78.65	2.467	1.871	2.486	437	3.00E-03	3.98E-04	1.17E-07
155.81	2.403	1.796	2.435	463	2.71E-03	3.27E-04	8.71E-08
310.26	2.232	1.598	2.317	1009	1.13E-03	4.36E-04	4.82E-08
619.36	1.953	1.273	2.093	1779	5.22E-04	3.56E-04	1.82E-08
1237.41	1.756	1.044	1.855	1109	6.57E-04	1.26E-04	8.11E-09
2474.60	1.598	0.860	1.677	913	6.53E-04	5.04E-05	3.22E-09
1237.41	1.607	0.870	1.602				
310.26	1.662	0.935	1.635				
78.65	1.734	1.018	1.698				
20.65	1.794	1.088	1.764				
6.00	1.838	1.140	1.816				

Note:

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

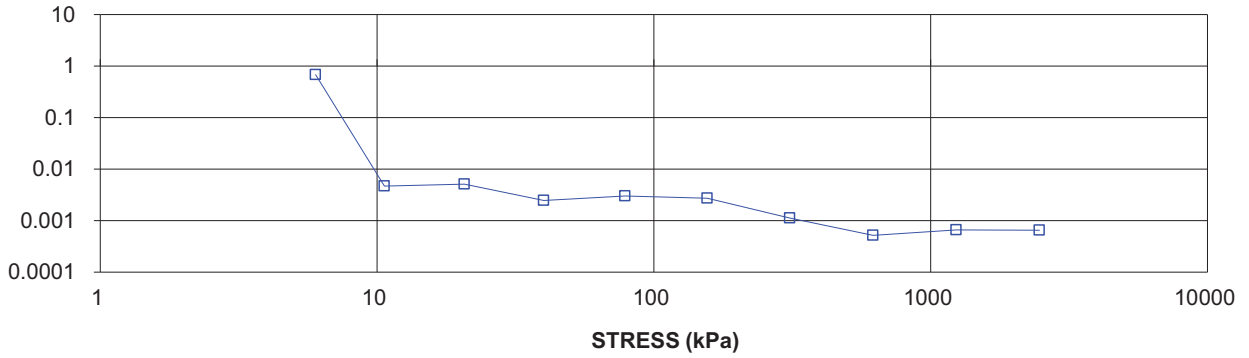
Sample Height, cm	1.84	Unit Weight, kN/m ³	18.24
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	12.88
Area, cm ²	31.68	Specific Gravity, measured	2.81
Volume, cm ³	58.24	Solids Height, cm	0.859
Water Content, %	41.64	Volume of Solids, cm ³	27.22
Wet Mass, g	108.33	Volume of Voids, cm ³	31.02
Dry Mass, g	76.48		

CONSOLIDATION TEST SUMMARY

FIGURE B8
Sheet 2 of 4

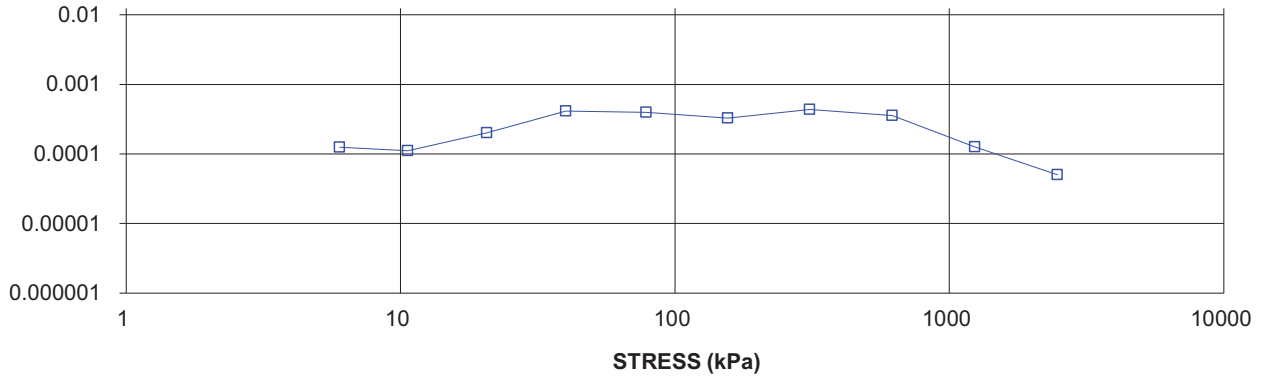
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH B201-01 SA 17



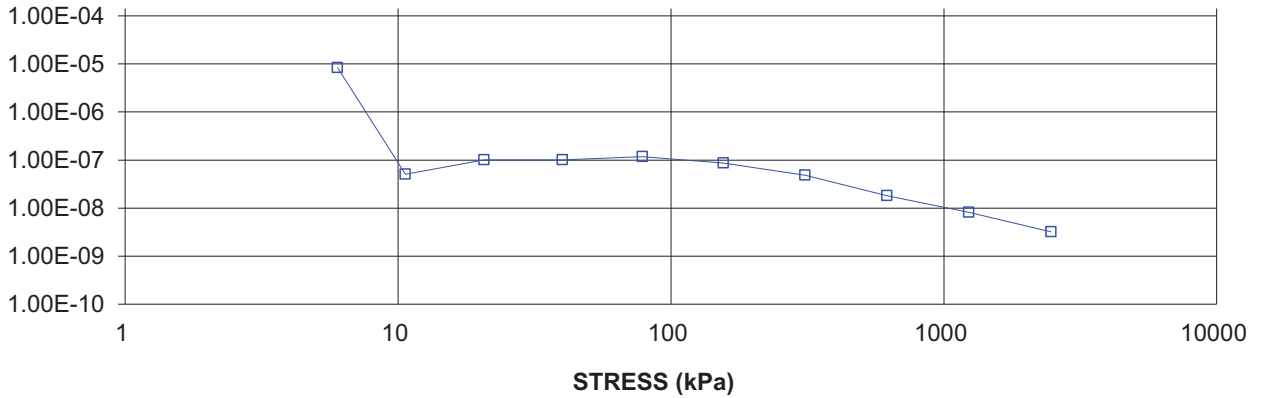
VOLUME COMPRESSIBILITY, m²/kN

CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH B201-01 SA 17



HYDRAULIC CONDUCTIVITY,
cm/s

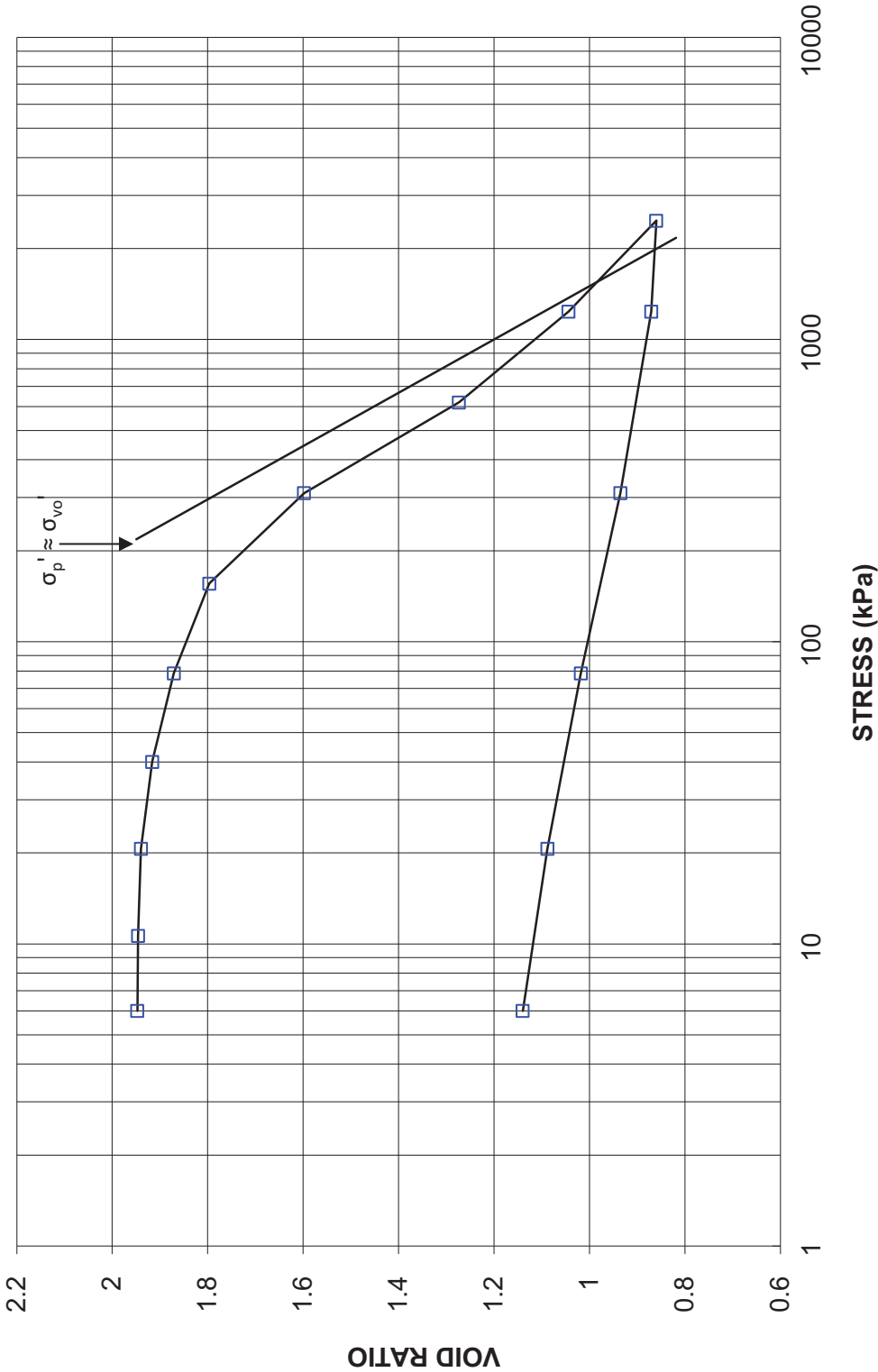
CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH B201-01 SA 17

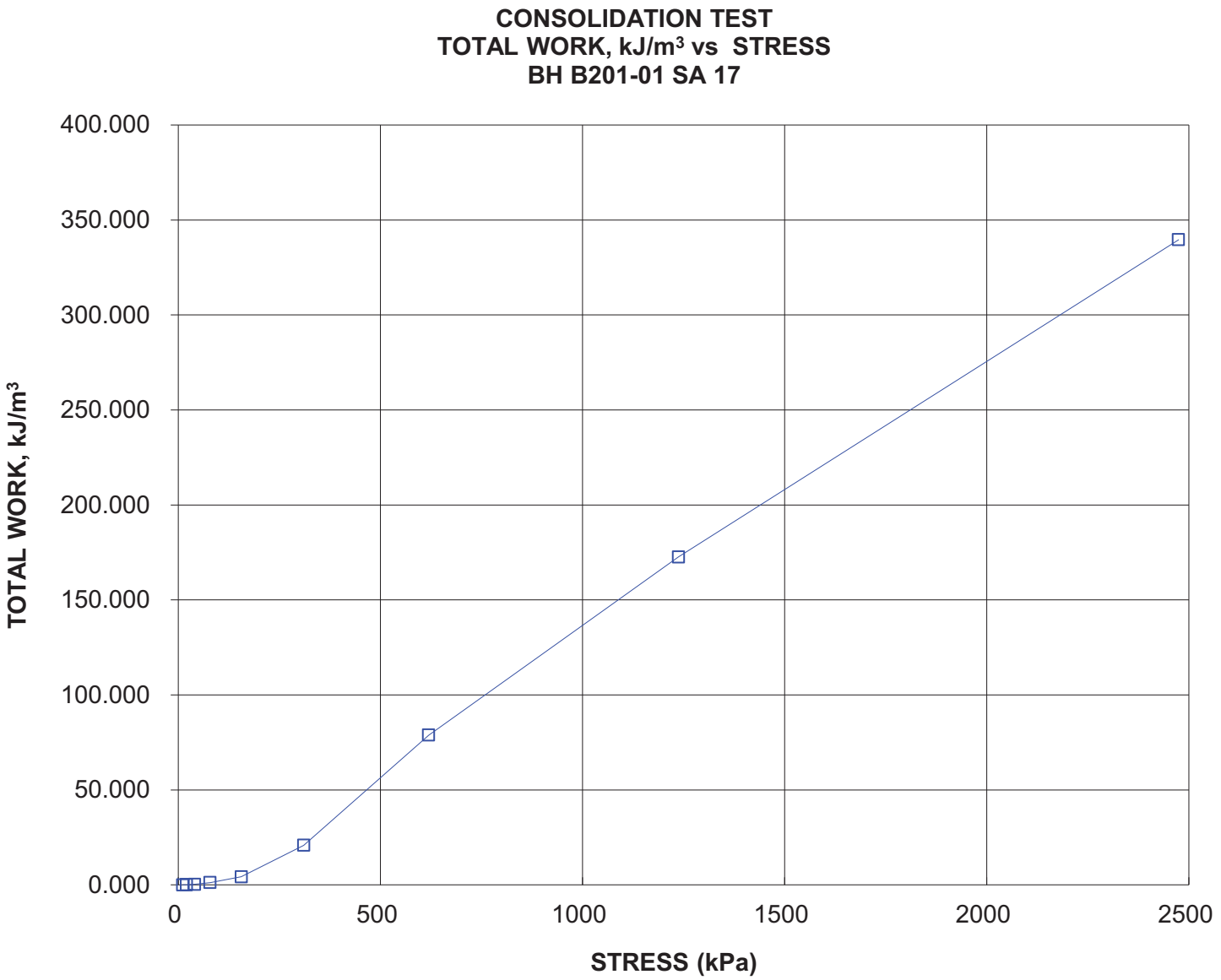


CONSOLIDATION TEST
VOID RATIO VS LOG STRESS

FIGURE B8
Sheet 3 of 4

CONSOLIDATION TEST
VOID RATIO vs STRESS
BH B201-01 SA 17



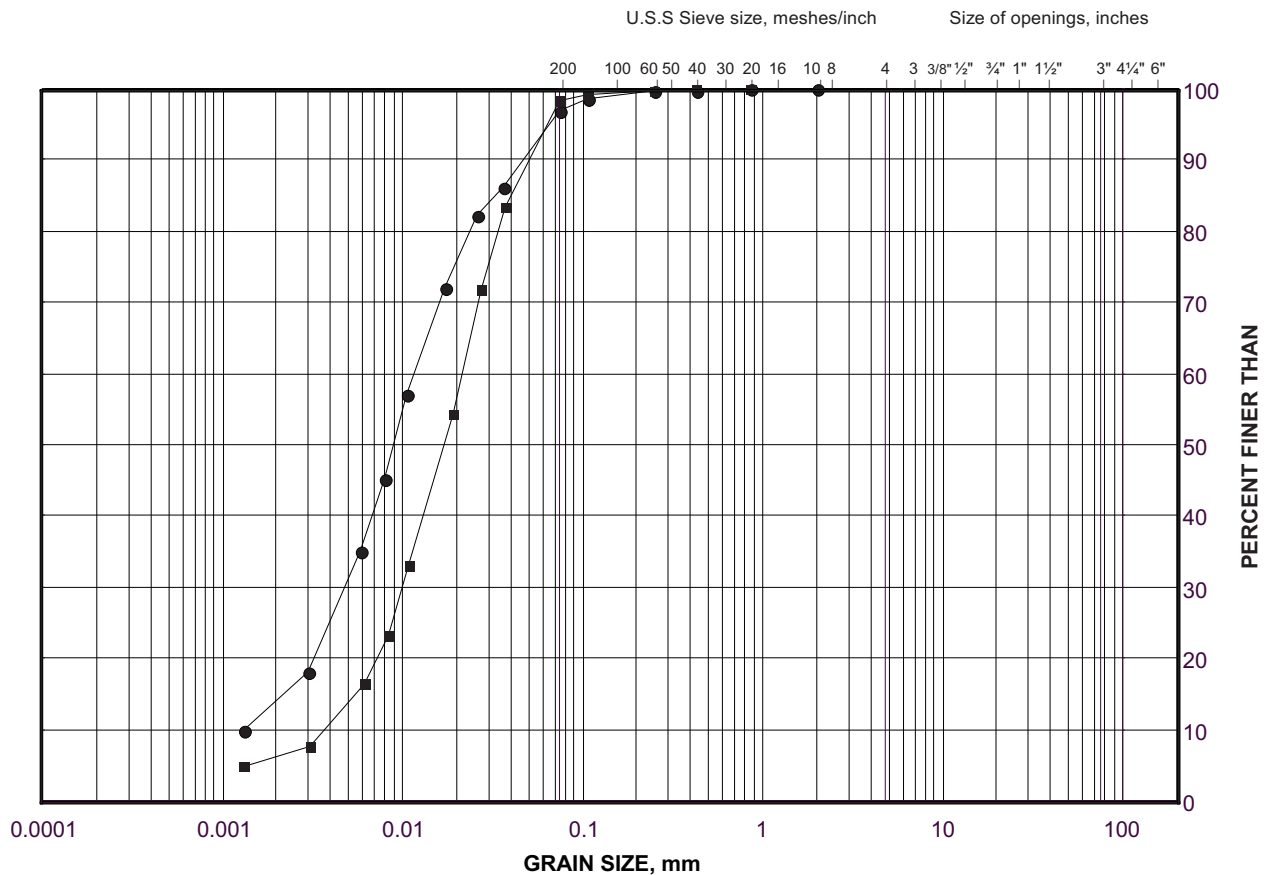


GRAIN SIZE DISTRIBUTION

Silt

South Abutment and Approach - Still River Bridge (SBL)

FIGURE B9



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-01	21	141.8
■	S204-09	23	138.0

Project Number: 09-1111-6014

Checked By: TZ

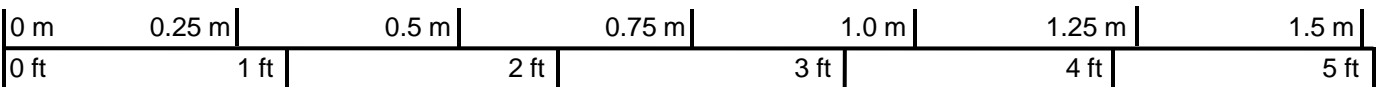
Golder Associates

Date: 13-Oct-11


Borehole B201-01



Box 1: 53.2 m – 57.3 m



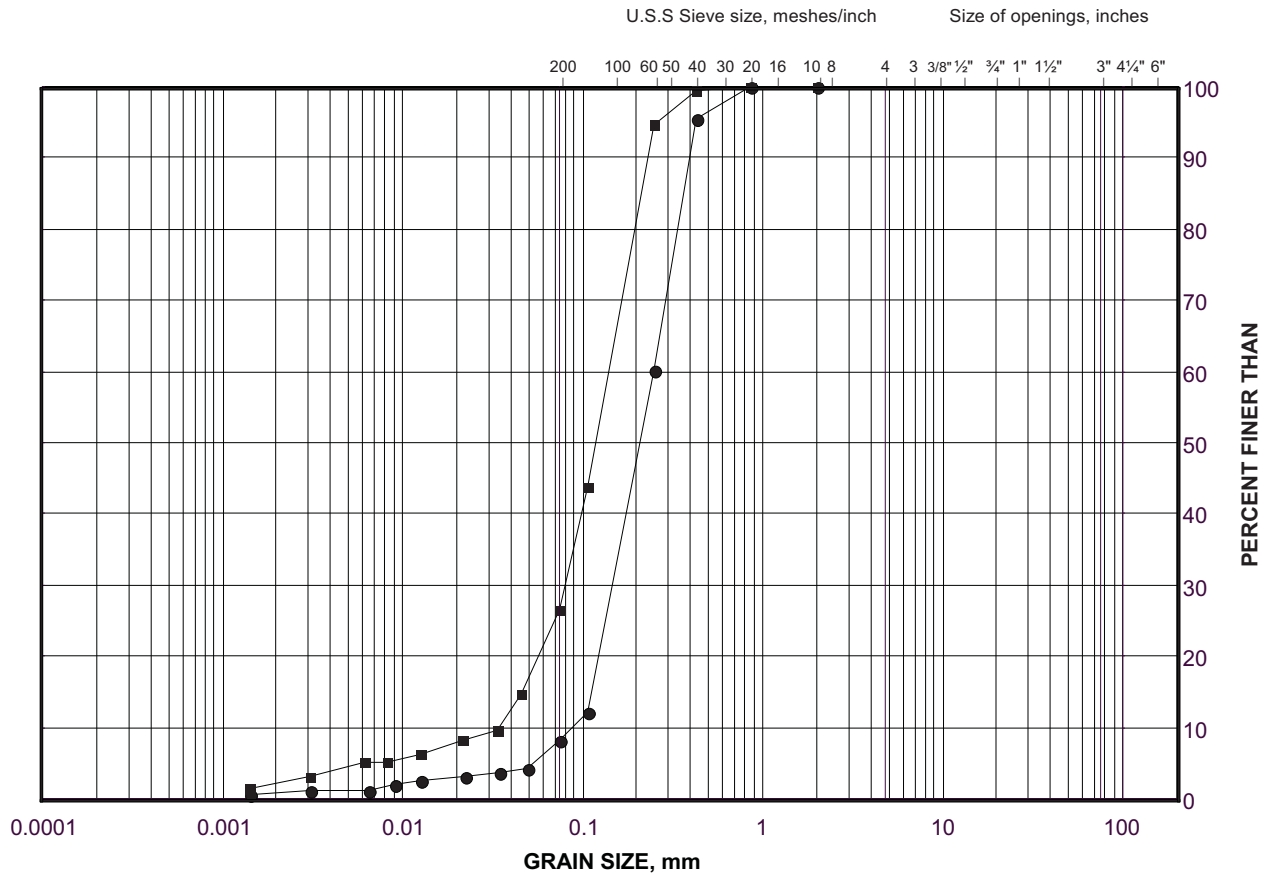
Scale

PROJECT				Still River Bridge SBL Structure Highway 69 Four-Laning GWP 5404-05-00; WP 5140-05-01			
TITLE				Cobbles and Boulder Rock Core Photograph – South Abutment			
				PROJECT No. 09-1111-6014		FILE No. ----	
				DESIGN	AT		SCALE NTS REV.
				CADD	--		
				CHECK	TVA		
				REVIEW	TVA		
FIGURE B10							

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand
Centre Pier - Still River Bridge (SBL)

FIGURE B11A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-14	3	177.2
■	B201-02	3	176.8

Project Number: 09-1111-6014

Checked By: TZ

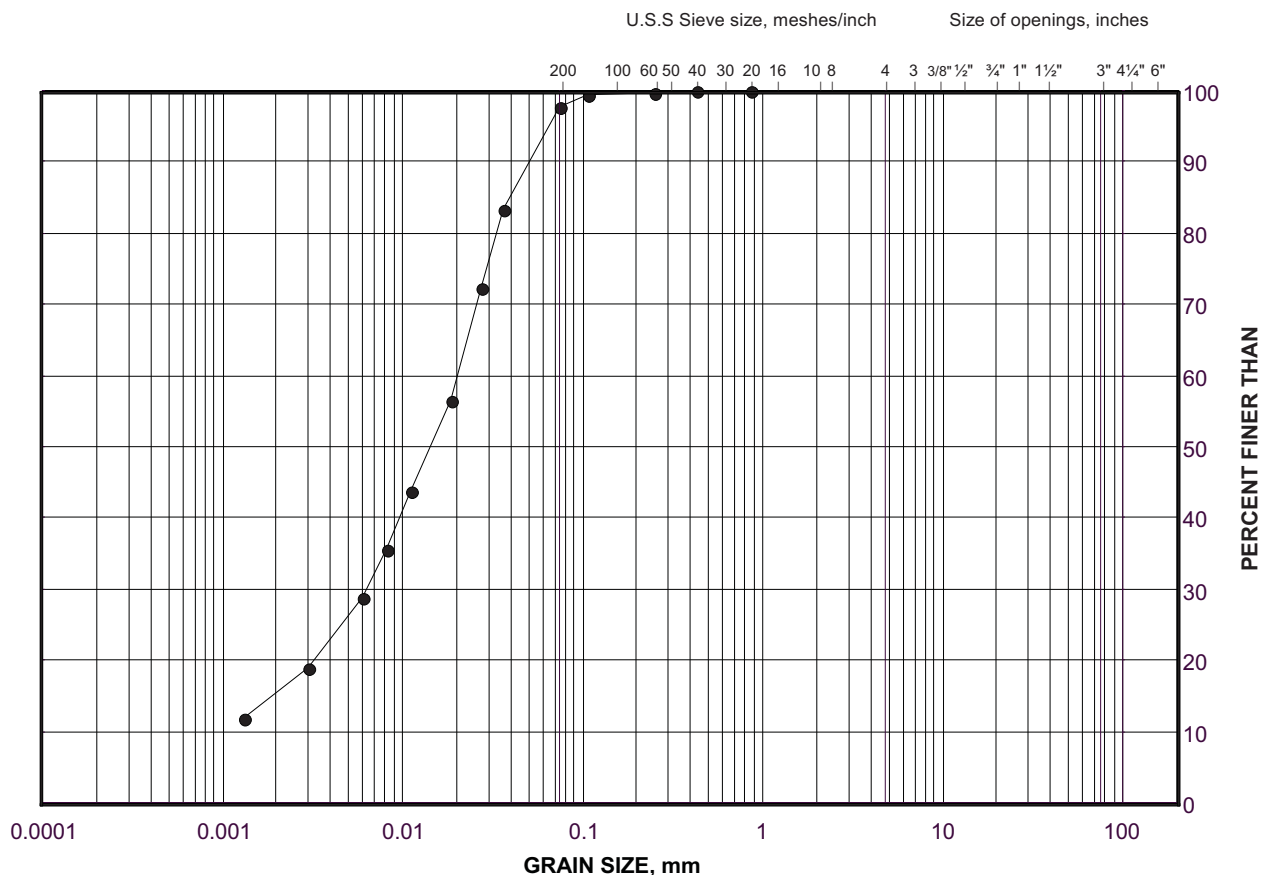
Golder Associates

Date: 13-Oct-11

GRAIN SIZE DISTRIBUTION

Silt
Centre Pier - Still River Bridge (SBL)

FIGURE B11B



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

LEGEND

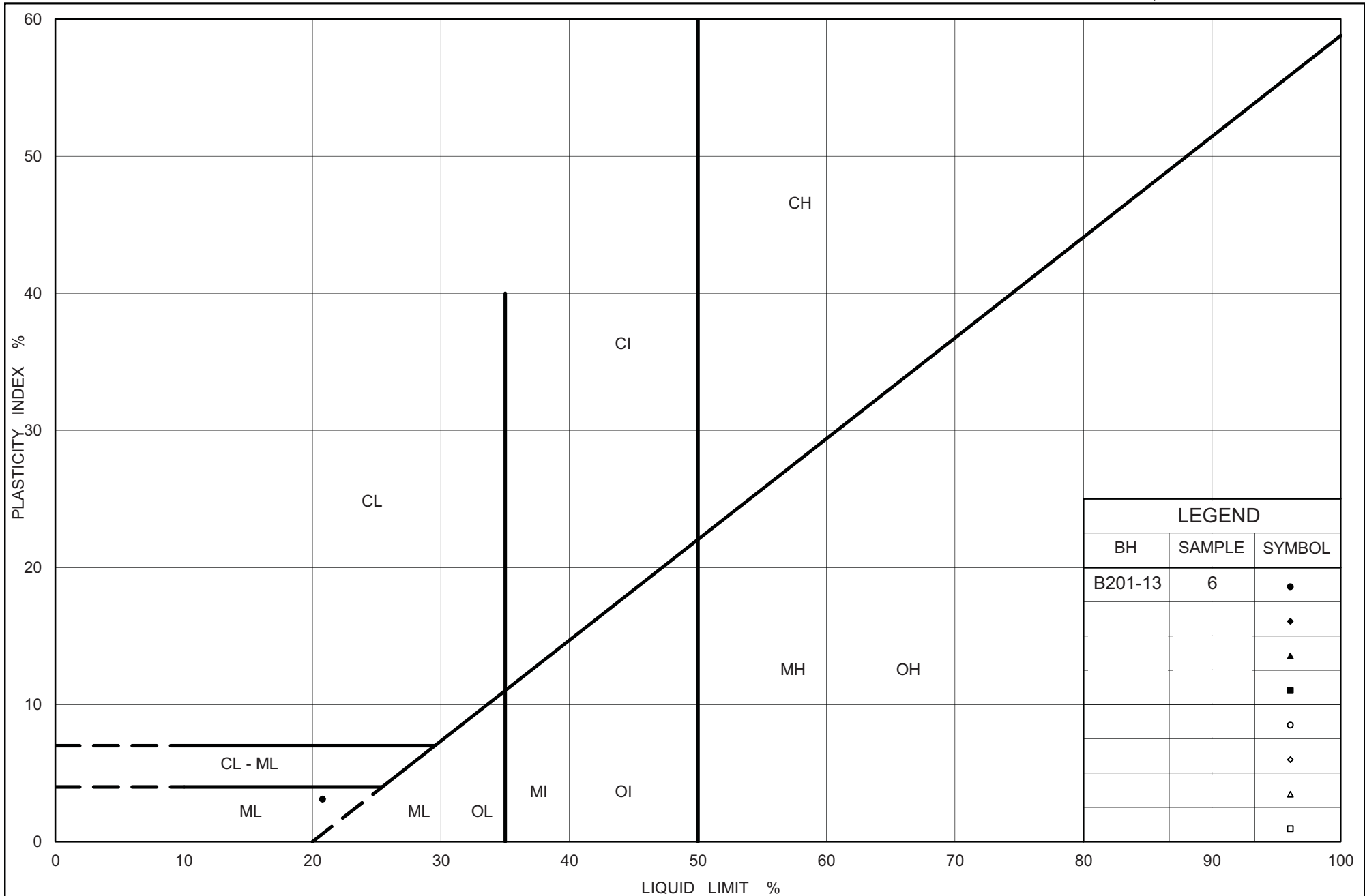
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	B201-13	6	174.9

Project Number: 09-1111-6014

Checked By: TZ

Golder Associates

Date: 13-Oct-11



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt (Slight Plasticity)
Centre Pier - Still River Bridge (SBL)

Figure No. B12

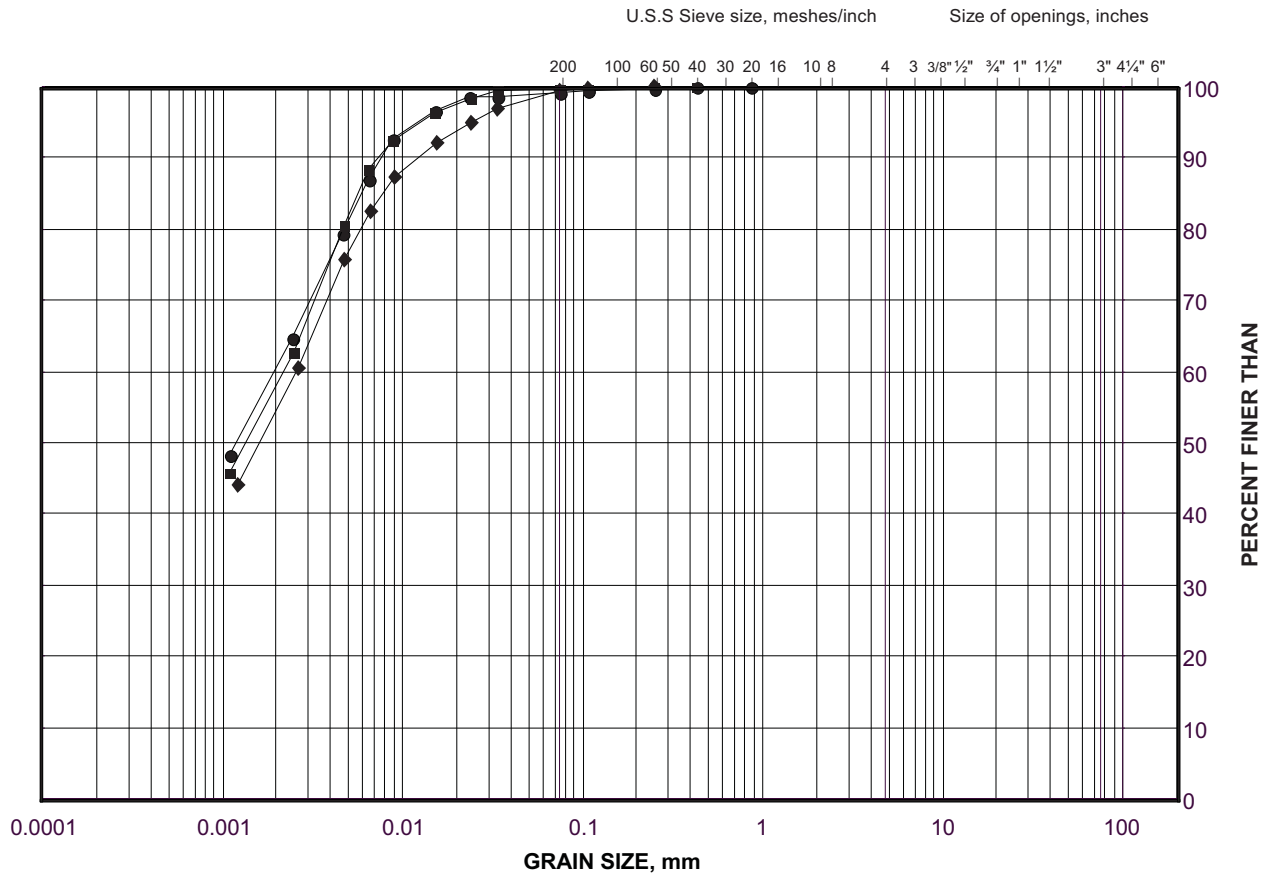
Project No. 09-1111-6014

Checked By: TZ

GRAIN SIZE DISTRIBUTION

Silty Clay to Clay
Centre Pier - Still River Bridge (SBL)

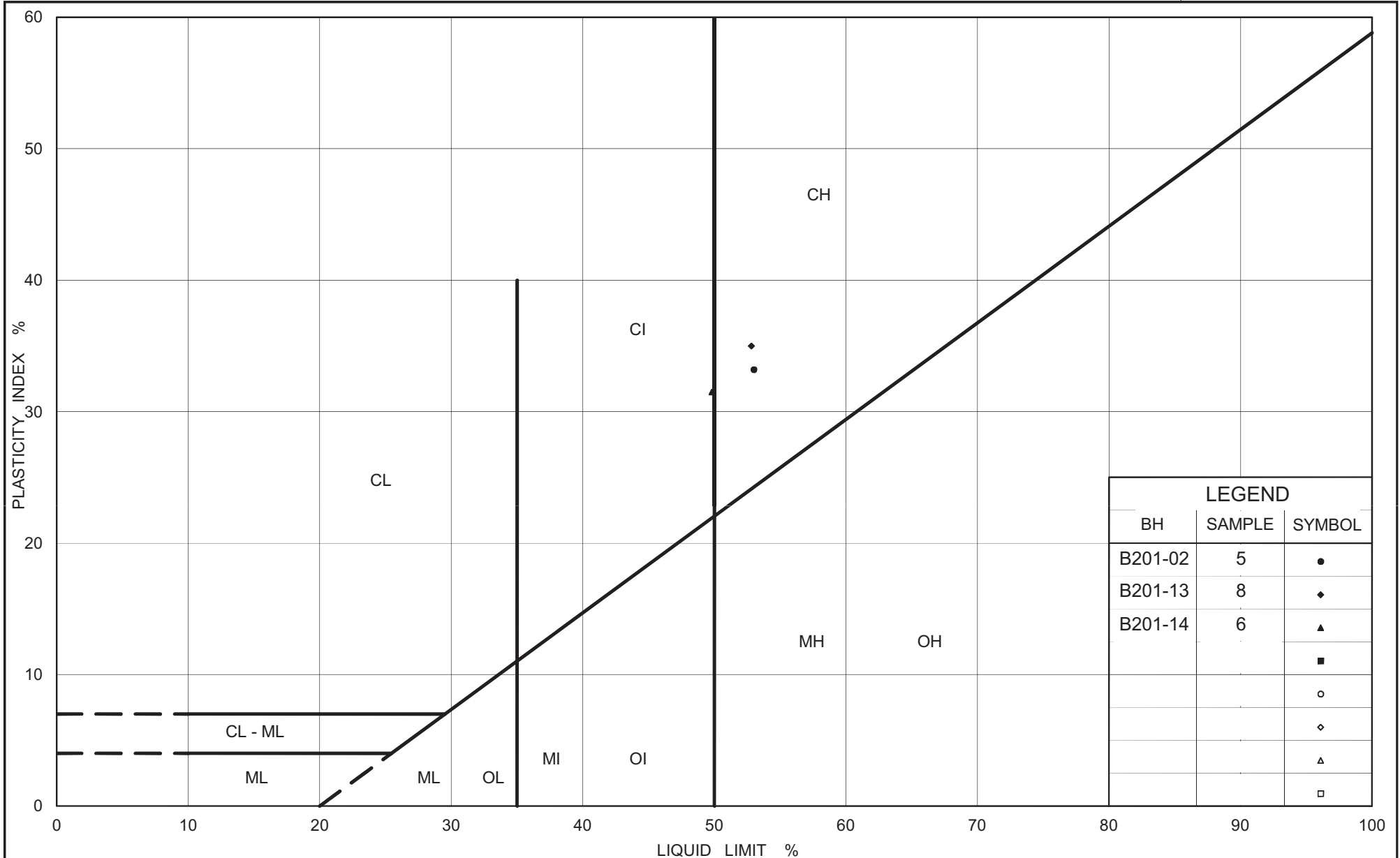
FIGURE B13



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-02	5	174.3
■	B201-14	6	173.4
◆	B201-13	8	172.6



Ministry of Transportation

Ontario

PLASTICITY CHART
 Silty Clay to Clay
 Centre Pier - Still River Bridge (SBL)

Figure No. B14

Project No. 09-1111-6014

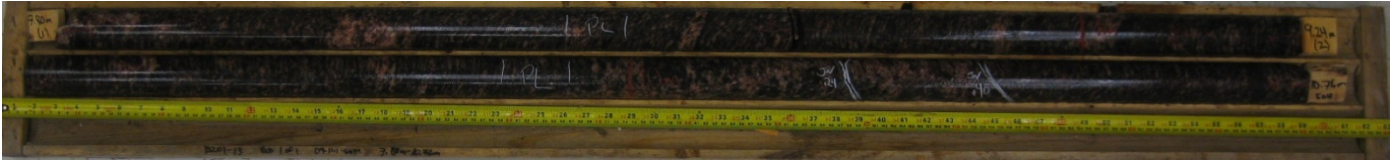
Checked By: TZ

Borehole B201-02



Box 1: 6.2 m – 9.1 m

Borehole B201-13

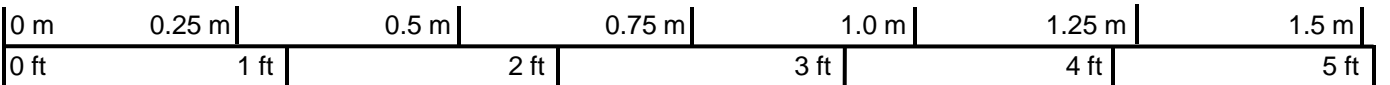


Box 1: 7.8 m – 10.8 m


Borehole B201-14



Box 1: 6.6 m – 9.7 m



Scale

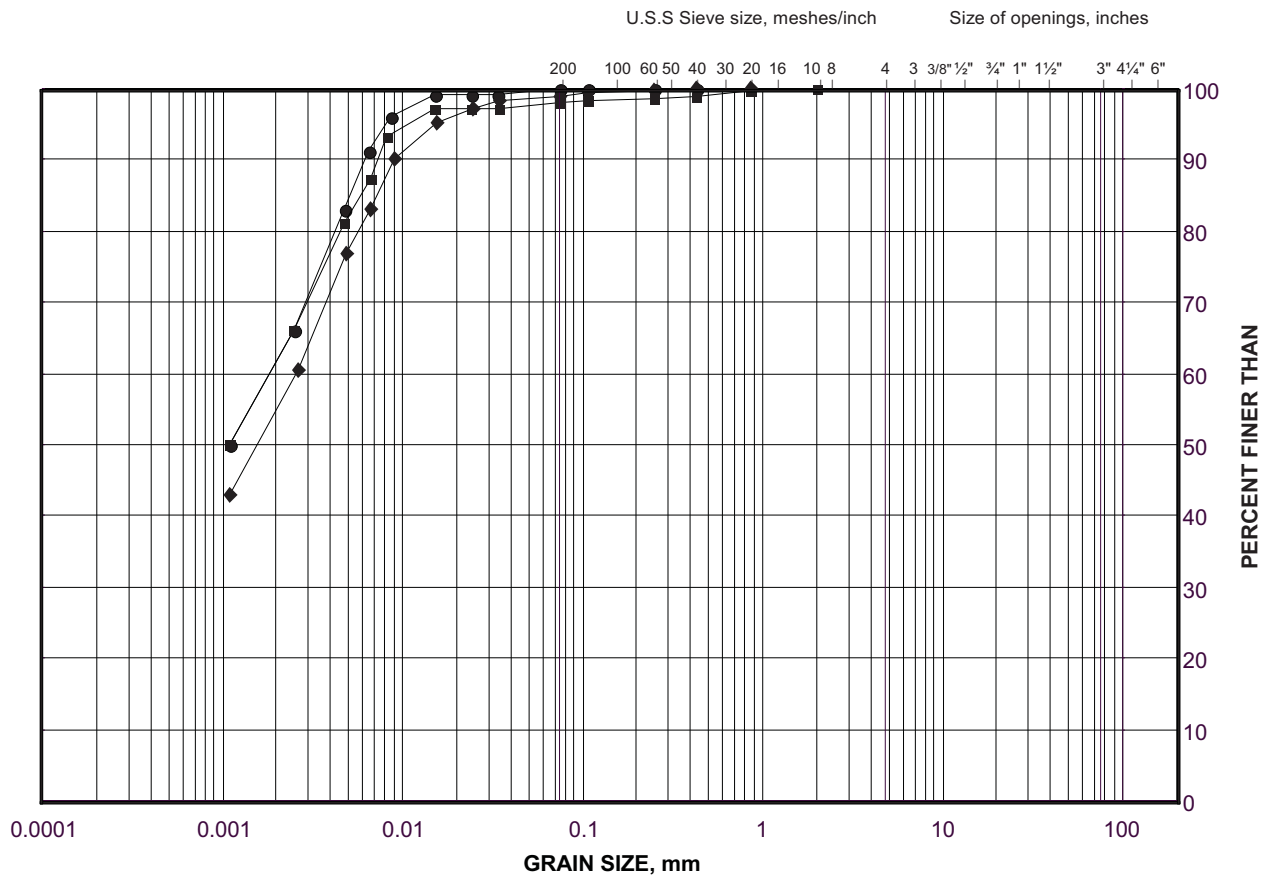
PROJECT		Still River Bridge SBL Structure Highway 69 Four-Laning GWP 5404-05-00; WP 5140-05-01		
TITLE		Bedrock Core Photographs – Centre Pier		
		PROJECT No. 09-1111-6014		FILE No. ----
		DESIGN	AT	SCALE NTS
		CADD	--	REV.
		CHECK	TVA	FIGURE B15
		REVIEW	TVA	

GRAIN SIZE DISTRIBUTION

Silty Clay to Clay

North Abutment (One-Span Option) - Still River Bridge (SBL)

FIGURE B16



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

LEGEND

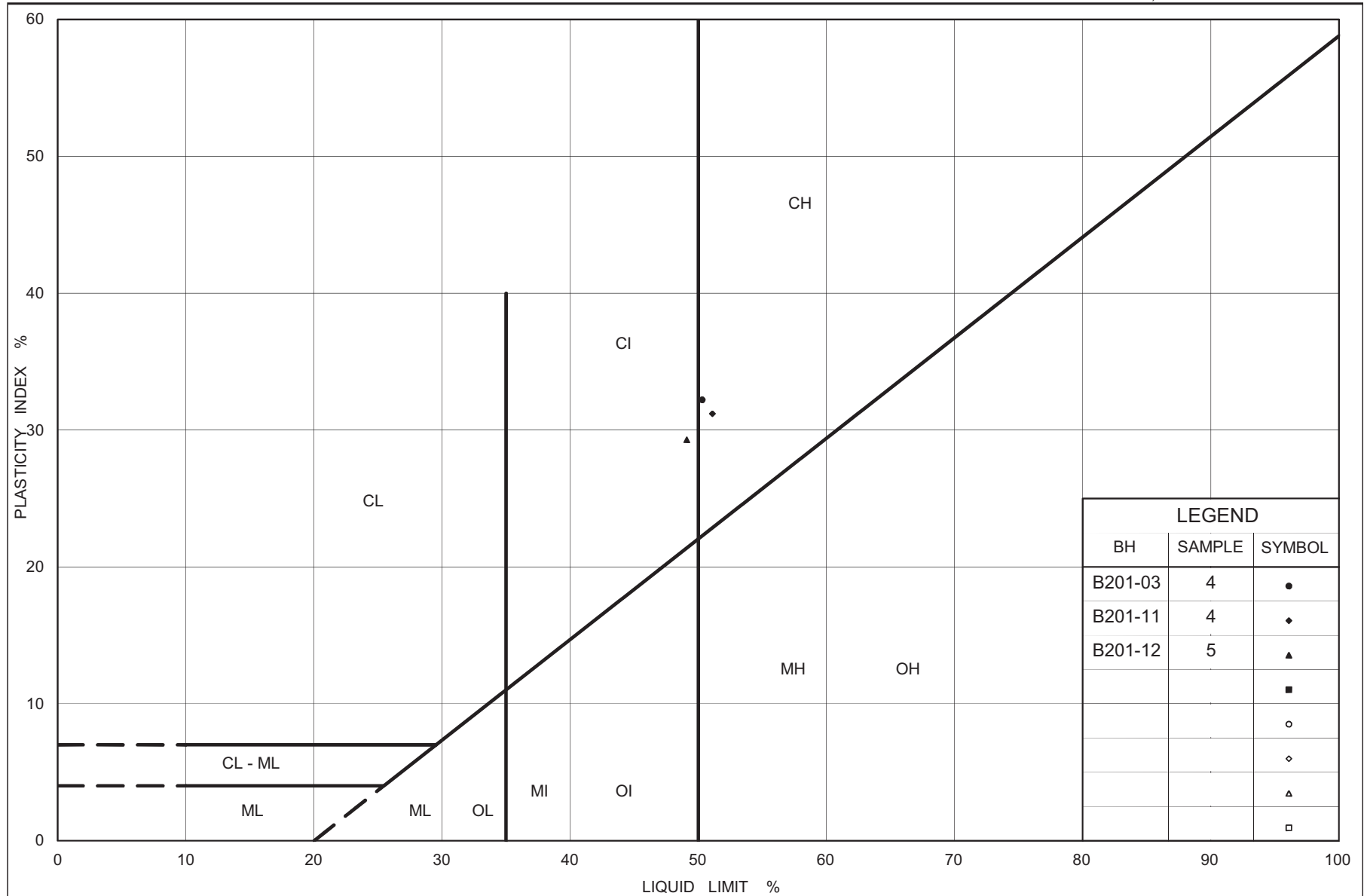
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B201-11	4	176.7
■	B201-03	4	176.4
◆	B201-12	5	175.5

Project Number: 09-1111-6014

Checked By: TZ

Golder Associates

Date: 13-Oct-11



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay to Clay

North Abutment (One-Span Option) - Still River Bridge (SBL)

Figure No. B17

Project No. 09-1111-6014

Checked By: TZ

Borehole B201-03



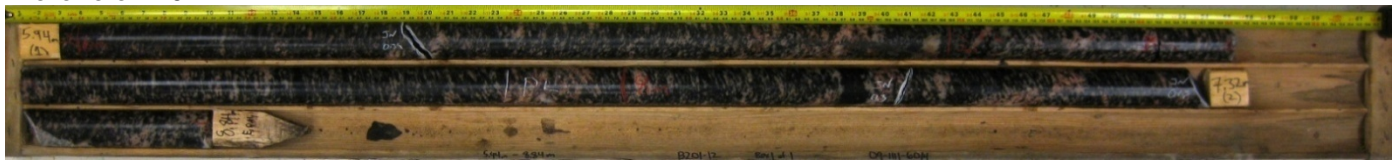
Box 1: 6.0 m – 9.1 m

Borehole B201-11

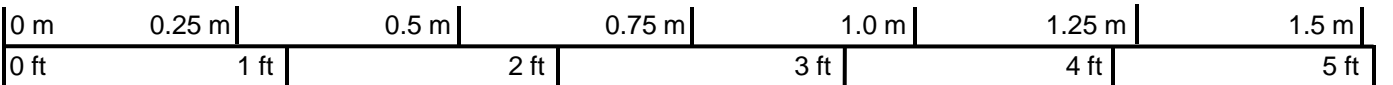


Box 1: 4.1 m – 7.1 m


Borehole B201-12



Box 1: 5.9 m – 8.8 m



Scale

PROJECT				Still River Bridge SBL Structure Highway 69 Four-Laning GWP 5404-05-00; WP 5139&40-05-01		
TITLE				Bedrock Core Photographs – North Abutment (One-Span Option)		
				PROJECT No. 09-1111-6014		FILE No. ----
				DESIGN	AT	
				CADD	--	
				CHECK	TVA	
				REVIEW	TVA	
				SCALE	NTS	REV.
FIGURE B18						

Borehole B201-06



Box 1: 0.1 m – 3.4 m

Borehole B201-07



Box 1: 0.2 m – 3.2 m

Borehole B201-07

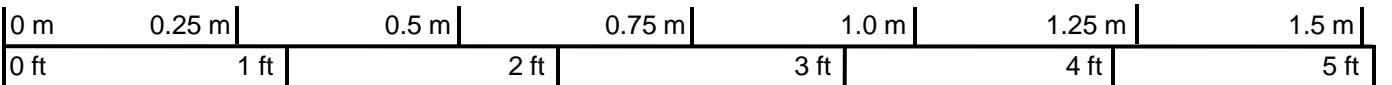


Box 2: 3.2 m – 5.2 m


Borehole B201-08



Box 1: 0.2 m – 4.0 m



Scale

PROJECT		Still River Bridge SBL Structure Highway 69 Four-Laning GWP 5404-05-00; WP 5140-05-01			
TITLE		Cobbles/Boulder and Bedrock Core Photographs – North Abutment and Approach (Two-Span Option)			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	AT	SCALE	NTS
		CADD	--		REV.
		CHECK	TVA		
		REVIEW	TVA		
FIGURE B19					

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. 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 who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario, L5N 7K2
Canada
T: +1 (905) 567 4444

