



April 11, 2016

FOUNDATION INVESTIGATION AND DESIGN REPORT

**CULVERTS - PHASE 2
HIGHWAY 69 FOUR-LANING
FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559
INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF
HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 5111-07-00 (PHASE 2 OF G.W.P. 5402-05-00)**

Submitted to:

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REPORT


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LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY



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Non-Standard Special Provisions

– Item No.



PART A

FOUNDATION INVESTIGATION REPORT

CULVERTS – PHASE 2

HIGHWAY 69 FOUR-LANING

FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559

INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF

HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM

MINISTRY OF TRANSPORTATION, ONTARIO

G.W.P. 5111-07-00 (PHASE 2 OF G.W.P. 5402-05-00)



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin (MRC), a member of MMM Group Limited on behalf of Ministry of Transportation, Ontario (MTO) to provide detailed engineering services for twenty (20) culverts within the Phase 2 limits of the new Highway 69 alignment. The proposed work is part of the detail design for the four-laning of Highway 69 from 1.0 km north of the new Highway 559 Interchange northerly to 1.5 km north of Highway 7182 (Shebeshekong Road), which involves high fill embankments and embankments over swamps, the New Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, the Shebeshekong Road Overpass structures, as well as culvert crossings. The Phase 2 limits of the project extend from 3 km north of the existing Woods Road to 6.1 km north of Highway 7182 (Shebeshekong Road). The general location of this section of the Highway 69 four-laning alignment is shown on Drawing 1.

The Terms of Reference and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated January 2007. Golder's original proposal for foundation engineering services associated with the Phase 2 culverts is contained in Section 6.8 of MRC's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated July 4, 2007. Foundation engineering services for the culverts, the majority of which were not addressed in MTO's original Request for Proposal, are outlined in Golder's Addenda No. 2 and No. 5 dated, March 26, 2009 and April 07, 2011, and were approved by MTO on April 29, 2009 and August 8, 2011, respectively. The foundation engineering services for the additional culverts, some associated with Species At Risk (SAR) requirements, are outlined in Golder Addendum No.7 dated February 14, 2013, and was approved by MTO on July 11, 2013. The General Arrangement (GA) drawings for the proposed culvert alignments were provided to Golder by MRC on January 21, 2009 and May 15, 2015, and the updated GA drawings were provided to Golder on May 29, 2015.

This report addresses the investigation carried out for the twenty (20) Phase 2 culvert crossings only. A detailed list of the Phase 2 culverts investigated is presented in Table 1. Separate reports address the foundation investigations for the Phase 1 culvert crossings, as well as for the swamp crossings and high fill areas and the bridge structures for Phase 1 and 2 components of the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed culverts associated with the existing and the new Highway 69 by borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The culverts were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The investigation areas are shown in plan on Drawing 2. In general, the culverts are typically located within or adjacent to the swamp crossings which were investigated by Golder Associates Ltd. as documented in:

- Foundation Investigation and Design Report, Swamp Crossings – Phase 2, Highway 69 Four-Laning from 1.0 km North of the New Highway 559 Interchange Northerly to 1.5 km North of Highway 7182 (Shebeshekong Road) for 17 km, Ministry of Transportation, Ontario, G.W.P. 5111-07-00, Geocres No. 41H-161 report dated April 11, 2016.

2.0 SITE DESCRIPTION

The proposed culvert alignments addressed in this report are located within the existing and new Phase 2 highway alignment for the section from about 1.5 km north of Nobel, Ontario, northerly for about 17 km. Re-aligned and/or newly proposed highways and access / service roads associated with the four-laning of the new Highway 69 in this phase of the project include Shebeshekong Road, the adjoining ramps for the proposed Shebeshekong Road underpass (interchange) and overpass structures and Site No. 9 Road northerly from the interchange. The new four-lane Highway 69 alignment is oriented generally in a southeast-northwest direction with the Phase 2 project limits located within the Shawanaga Township.



In general, the topography in the area of the overall project limits consists of rolling terrain, including densely treed areas and numerous bedrock outcrops, separated by low-lying swamps containing areas of standing water and various vegetation types and organic soils. The ground surface within the investigated limits of the Phase 2 culvert crossings varies between about Elevation 201.8 m and Elevation 215.2 m, referenced to Geodetic datum, and is gently sloping downward from northeast to southwest towards Georgian Bay. A detailed description of each investigated culvert alignment is presented in Section 4.0. The locations of these culverts relative to the Highway 69 (NBL and SBL) alignments are shown on Drawing 2.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The field work for the Phase 2 culvert crossings investigation was carried out in two periods to cover the additional scope of work, between March 9 and July 14, 2009 and January 30 and June 17, 2015 during which time a total of forty-two (42) boreholes and twenty-nine (29) Dynamic Cone Penetration Tests (DCPTs) were advanced at or near the culvert locations. In addition, twenty-five (25) boreholes and three (3) DCPTs advanced as part of the field investigation work carried out by Golder Associates Ltd. for the Phase 1 and 2 swamp crossings and high fill areas were used to supplement this investigation, and the methods of investigation of this field work are included in the Swamp Crossings Report referenced in Section 1.0. The locations of the boreholes and DCPTs utilized for the culverts are shown on Drawings A1 to K1, and are summarized in Table 1.

The field investigation was carried out using: portable equipment supplied and operated by Walker Drilling Ltd. of Utopia, Ontario, Landcore Drilling of Sudbury, Ontario and OGS Inc. of Almonte, Ontario; track-mounted CME 55 and CME 550 drill rigs supplied and operated by Landcore Drilling of Sudbury, Ontario. The boreholes were advanced through the overburden using hollow-stem augers, or 'NW' or 'BW' casing with wash boring techniques. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler, performed in accordance with Standard Penetration Test (SPT) procedures ASTM D1586 (Standard Test Method for Standard Penetration Test), where driven by full weight (automatic) hammers. Where half weight or one-third weight hammers were used, the 'N'-values were corrected for the lower energy drive. Select samples of the cohesive soils were obtained using 50 mm or 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587 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 Shear Test) using the MTO Standard 'N'-size vane supplemented with a 'B'-size vane in the boreholes advanced by the smaller diameter 'BW' casing. Samples of the bedrock were obtained using 'NQ' and 'BQ' size rock core barrels. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The boreholes and DCPTs were advanced to depths up to 15.1 m below existing ground surface and were terminated on refusal to further split-spoon and/or casing advancement. The depths to refusal do not confirm bedrock surface elevations, but may be inferred to indicate potential proximity to the bedrock surface. In twenty-three (23) boreholes, bedrock was cored for depths ranging from about 1.4 m to 4.4 m below the surface of the bedrock.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to K, inclusive. It should be noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability.

The field work was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were



identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, organic content, Atterberg limits and grain size distribution) was carried out on selected samples.

Classification of the bedrock rock mass quality with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)¹. Point load strength index tests, both perpendicular to the core axis (diametral test) and along the core axis (axial test) were performed on selected samples of the rock core to provide an indication of the point load strength index (Is_{50})² of the rock. Laboratory Unconfined Compression (UC) Tests were also carried out on select sections of the bedrock core to assess the uniaxial compressive strength (UCS) of the bedrock. The bedrock was then classified with respect to strength based on the Is_{50} and UCS values as suggested in Table 3.5 of the CFEM (2006)¹. The results of the laboratory testing for each of the culvert crossing are included in the associated appendices.

The proposed centreline of the highway was staked in the field by Callon Dietz prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured by Golder in reference to the centreline alignment and were subsequently converted into MTM NAD 83 (Zone 10) coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the centreline median which were indicated on the stakes. The borehole locations shown on Drawings A1 to K1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in The Physiography of Southern Ontario³, this section of Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

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

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4⁴. Deposition of Paleozoic strata 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, together with the results of the laboratory tests carried out on selected soil samples, are presented

¹Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

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

³Chapman, 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.

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



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on the attached Record of Borehole and Drillhole sheets in Appendices A to K. The detailed results of the laboratory testing are also provided in Appendices A to K. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from the filed vanes) as presented on the Record of Borehole sheets and in Sections 4.3 through 4.22 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 Standard Penetration Tests (SPTs), Dynamic Cone Penetration Test (DCPT) and in situ field vane tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. Where applicable, the thickness of the overburden in the investigated areas as inferred from the resistance to DCPT results are shown on the Record of DCPT sheets in Appendices A to K.

The inferred soil stratigraphy as encountered in the boreholes and DCPTs advanced for the proposed Phase 2 culverts is shown on Drawings A1 to K1. It should be noted that the orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north (along the proposed Highway 69 alignment) and therefore may differ from that shown on the drawings which represents magnetic north.

In general, the stratigraphy encountered at the various culvert areas investigated is similar, however, the thickness of the overburden (soil materials) is variable, ranging from about 0 (i.e. bedrock present at ground surface) to about 16.1 m below ground surface. The stratigraphy from ground surface to refusal generally consists of:

- Surficial layers of root mat / peat, organic silty sand to sand, and/or sand and gravel fill and rock fill associated with the existing Highway 69 embankment;
- Relatively thin deposits of silt and sand to sand;
- Deposits of clay interbedded with silt in some areas; and,
- Deep deposits of silt and sand to sand to sand and gravel, and sand and silt till in places.

Detailed descriptions of the subsurface conditions at each investigated culvert alignment are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.



4.3 Highway 69 SBL – STA 13+380 (Culvert C45)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+380 in the Township of Shawanaga are shown on Drawing A1 in Appendix A. The culvert will extend across a swamp area and the proposed Highway 69 SBL embankment which will be up to about 3.5 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C45-S1 to C45-S3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. In addition, a total of six (6) Dynamic Cone Penetration Tests (DCPTs C45-DC01 to C45-DC06, inclusive) were advanced near the west and east ends of the culvert to further confirm the depth to refusal in these areas. The topography in the area is relatively flat with ground cover consisting of grassy and swampy areas located within the confines of tree covered valley slopes to the north and south sides of the culvert.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of silty peat / organic silty sand, underlain in places by a non-cohesive deposit of sand. The deposit of sand or organic silty sand is underlain by granite gneiss bedrock. Bedrock outcrops are present to the north and south of the culvert.

Silty Peat / Organic Silty Sand

A deposit of dark brown, moist to wet, silty peat and/or organic silty sand was encountered at the ground surface in all the boreholes advanced at this culvert location. The organic silty sand deposit contains trace to some clay, trace gravel, rootlets and oxidation zones. The top of the organic deposit is between Elevation 210.7 and 210.4 m and the deposit thickness varies from 0.2 m to 1.2 m. The bottom of this deposit was defined by bedrock in Borehole C45-S2.

The Standard Penetration Test (SPT) 'N'-values measured within the silty peat are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration, indicating a very soft consistency. Within the organic silty sand deposit, SPT 'N'-values of 2 blows per 0.2 m of penetration and 3 blows per 0.3 m of penetration were recorded, indicating a very loose relative density.

The natural water content measured on one (1) sample of the silty peat and one (1) sample of the organic silty sand is about 707 per cent and 46 per cent, respectively.

Sand

A non-cohesive deposit of brown and grey sand, trace to some silt, trace gravel and trace clay was encountered below the silty peat and organic silty sand deposits in Boreholes C45-S1 and C45-S3. The top of the sand deposit is at Elevation 209.2 m and 209.5 m, and its thickness is 0.7 m and 0.2 m in the respective boreholes. The bottom of this deposit was defined by bedrock.

The SPT 'N'-values recorded within the sand deposit are 3 blows and 12 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit is about 23 per cent and 24 per cent.

A grain size distribution of one (1) sample from this deposit is shown on Figure A.C45-1 in Appendix A.

Bedrock / Refusal

Bedrock outcrops are present to the north and south of the culvert. The bedrock surface was encountered at depths between 0.2 m and 1.9 m in the boreholes, and refusal to further cone penetration was encountered at



depths between 1.1 m and 2.7 m below ground surface in DCPTs C45-DC01 to C45-DC06, ranging between Elevation 209.3 m and 207.7 m.

Bedrock core samples were recovered from all the boreholes (Boreholes C45-S1 to C45-S3) drilled at this culvert location. The bedrock generally consists of granite gneiss and the core samples are described as fresh, non to moderately foliated, black, pink, green and grey, fine to coarse grained, faintly to moderately porous, and very strong to extremely strong,. The Rock Quality Designation (RQD) measured on the core samples are between 64 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 99 per cent and 100 per cent, and between 40 per cent and 97 per cent, respectively.

Diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table A1 in Appendix A. The point load index (Is_{50}) results from the diametral laboratory tests carried out on eleven (11) samples of the granitic bedrock range from approximately 6.6 MPa to 13.8 MPa, but were typically greater than 8.2 MPa and average about 9.8 MPa.

Based on point load tests in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in Boreholes C45-S1 and C45-S3 upon completion of drilling were at Elevation 210.4 m, measured at the ground surface, while Borehole C45-S2 was observed to be dry upon completion of drilling.



4.4 Highway 69 NBL – STA 13+380 (Culvert C45)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+380 in the Township of Shawanaga are shown on Drawing A1 in Appendix A. The culvert alignment extends across the existing Highway 69 roadway embankment and the embankment height at the proposed culvert location will be about 5.0 m above the existing ground surface. A total of three (3) boreholes (Boreholes C45-N1 to C45-N3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. In addition, two (2) Dynamic Cone Penetration Tests (DCPTs C45-DC07 and C45-DC08) were advanced near the west and east ends of the culvert to further confirm the depth to refusal in this area. The topography in the area is relatively flat to low-lying with ground cover consisting of occasional bedrock knobs and swampy areas located within the confines of tree valley slopes to the north and south of the proposed culvert.

In general, the subsurface soils along the culvert alignment consist of a deposit of fill associated with the existing Highway 69 embankment and surficial deposit of sandy peat / organic silty sand beyond the toes of the embankment, underlain by a non-cohesive deposit of silty sand to sand containing a localized pocket of clay. The silty sand to sand deposit or the organic silty sand deposit is underlain by granite gneiss bedrock. Bedrock was observed to outcrop to the north and south sides of the culvert, as well as along the toes of the existing highway embankment.

Embankment Fill

A deposit of granular fill comprised of brown and grey sand, trace gravel, trace silt to sand and gravel, and rock fill was encountered below an 0.1 m thick layer of asphalt in Borehole C45-N2 drilled through the west shoulder of the existing highway. The top of the embankment fill is at Elevation 214.8 m and its thickness is 5.5 m, comprised of an upper 0.4 m thick layer of sand and gravel, a middle 2.3 m thick layer of rock fill, a lower 0.3 m thick layer of sand and a lower 2.5 m thick layer of rock fill.

The Standard Penetration Test (SPT) 'N'-values recorded within the fill deposit are 8 blows and 12 blows per 0.3 m of penetration, typically indicating a loose relative density.

Sandy Peat / Organic Sandy Silt

A deposit of brown, wet, sandy peat to brown and grey, wet, organic silty sand was encountered at the ground surface in Boreholes C45-N1 and C45-N3 drilled at the toes of the existing highway embankment. The organic deposit contains trace gravel, trace silt and wood fragments near the upper portion. The top of the sandy peat / organic silty sand deposit is at Elevation 211.0 m and 210.9 m, and its thickness is 1.2 m and 1.5 m in Boreholes C45-N1 and C45-N3, respectively. The bottom of this deposit is defined by bedrock in Borehole C45-N1.

The natural water content measured on two (2) samples of the organic silty sand is about 57 per cent and 175 per cent.

Silty Sand to Sand

A non-cohesive deposit of grey to dark brown silty sand to sand, trace to some gravel, trace to some silt and trace clay was encountered below the embankment rock fill and organic silty sand deposits in Boreholes C45-N2 and C45-N3. The upper portion of this deposit was noted to be slightly organic and contains a localized pocket of silty clay. The top of the silty sand to sand deposit is at Elevation 209.3 m and 209.4 m, and the thickness is 0.7 m and 2.0 m in Boreholes C45-N2 and C45-N3, respectively. The localized pocket of silty clay is 0.2 m thick.



and was encountered at Elevation 208.2 m. The bottom of silty sand to sand deposit was defined by bedrock in both boreholes.

The SPT 'N'-values measured within the silty sand to sand deposit range from 2 blows to 11 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit is 22 per cent and 26 per cent.

The grain size distributions of two (2) samples from the sand portion of this deposit are shown on Figure A.C45-2 in Appendix A.

The natural water content measured on a sample of the silty clay pocket is about 67 per cent. An Atterberg limits test carried out on this specimen measured a liquid limit of about 50 per cent and a plastic limit of about 18 per cent, corresponding to a plasticity index of about 32 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure A.C45-3 in Appendix A and indicate that the material is silty clay of intermediate plasticity.

Bedrock / Refusal

Bedrock outcrops are present to the north and south of the culvert and along the toes of the existing highway embankment. The bedrock surface was encountered at depths between 1.2 m and 7.9 m in the boreholes and refusal to further cone penetration was encountered at depths of 1.1 m and 3.7 m below ground surface in DCPTs C45-DC07 and C45-DC08 ranging between Elevation 209.9 m and 207.0 m.

Bedrock core samples were recovered from all the boreholes (Boreholes C45-N1 to C45-N3) advanced at this culvert location. The bedrock generally consists of granite gneiss and the core samples are described as fresh to slightly weathered, moderately to strongly foliated, black, pink, green and grey, medium to coarse grained, moderately to faintly porous, and strong to very strong. The Rock Quality Designation (RQD) measured on the core samples are between 85 per cent and 100 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 99 per cent and 100 per cent, and between 85 per cent and 96 per cent, respectively.

Diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table A1 in Appendix A. The point load index (Is_{50}) results from the diametral laboratory tests carried out on ten (10) samples of the granitic bedrock range from approximately 2.5 MPa to 9.1 MPa, but were typically greater than 4.2 MPa and average about 6.1 MPa.

Based on point load tests in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range from Elevation 212.3 m to 206.9 m, measured at a depth of 0.3 m and 2.6 m below ground surface.



4.5 Highway 69 SBL – STA 13+778 (Culvert C47 – Site No. 44-616/C2)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+778 in the Township of Shawanaga are shown on Drawing B1 in Appendix B. The culvert will extend across a swamp area and the proposed Highway 69 SBL embankment which will be up to about 3.5 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C47-S1 and C47-S2) were completed specifically to investigate the subsurface conditions along the culvert alignment, and augmented with Borehole S19-05 advanced for the proposed Highway 69 SBL embankment. In addition, three (3) Dynamic Cone Penetration Tests (DCPTs C47-DC01 to C47-DC03, inclusive) were advanced near the west end of the culvert to further confirm the depth to refusal in this area. The topography in the culvert area is relatively flat to low-lying consisting of occasional bedrock knobs, grassy and moderately treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat, underlain in places by a non-cohesive deposit of sand and silt to sand or granite gneiss bedrock. Bedrock outcrop was observed to the northwest and northeast of the culvert.

Ice / Water

Ice or water to depths of 0.2 m and 0.3 m was encountered in Boreholes S19-05 and C47-S2.

Peat

A deposit of dark brown to black, wet, fibrous/amorphous peat containing trace sand and trace silt was encountered at the ground surface in Borehole C47-S1 and under the ice/water in Boreholes S19-05 and C47-S2. The top of the peat deposit ranges from Elevation 210.7 m to 210.3 m and the thickness of the deposit ranges from 1.2 m to 2.1 m. The bottom of this deposit was defined by bedrock in Borehole C47-S1.

The Standard Penetration Test 'N'-values measured within the peat deposit range between 0 blows (weight of hammer) per 0.3 m of penetration and 1 blow per 0.23 m of penetration, indicating a very soft consistency.

The natural water content measured on samples of the peat deposit range from about 1162 per cent to 1694 per cent, and the organic content measured on a sample of the peat is about 87 per cent.

Silt and Sand to Sand

A non-cohesive deposit of brown to grey silt and sand to sand, some silt, trace gravel and trace clay was encountered below the peat deposit in Boreholes S19-05 and C47-S2 and the upper portion of the sand deposit encountered in Borehole S19-05 contains silt layers and wood fragments. The silt and sand deposit encountered in Borehole C47-S2 is intersected by a localized pocket of clay. The top of the silt and sand to sand deposit is at Elevation 209.1 m and 208.6 m, and its thickness is between 1.4 m and 2.8 m. The bottom of this deposit was defined by refusal to further split-spoon and auger/casing advancement.

The SPT 'N'-values recorded within the silt and sand to sand deposit typically range from 1 blow to 28 blows per 0.3 m of penetration, indicating a very loose to compact relative density. A SPT 'N'-value of 38 blows per 0.23 m of penetration was recorded prior to split-spoon and casing refusal on inferred bedrock, indicating a compact relative density.

The natural water content measured on samples of this deposit range from about 23 per cent to 26 per cent.

The grain size distributions of two (2) samples from this deposit are shown on Figure B.C47-1 in Appendix B.



Within the silt and sand to sand deposit in Borehole C47-S2, an 0.2 m thick layer of brown clay containing some silt and trace sand was encountered at Elevation 207.4 m. The natural water content measured on the clay specimen is about 75 per cent. An Atterberg limits test carried out on this specimen measured a liquid limit of about 51 per cent and a plastic limit of about 19 per cent, corresponding to a plasticity index of about 32 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure B.C47-2 in Appendix B and indicate that the material is clay of high plasticity.

Bedrock / Refusal

Bedrock outcropping was observed to the northeast and northwest of the culvert. In Boreholes S19-05 and C47-S2, and DCPTs C47-DC01 to C47-DC03, refusal to further auger/split-spoon and casing advancement or cone penetration was encountered between depths of 1.1 m and 5.3 m below ground surface corresponding to between Elevation 209.6 m and 205.3 m.

Bedrock was encountered at a depth of 1.6 m (Elevation 209.0 m) and cored for a depth of 1.5 m in Borehole C47-S1. The bedrock generally consists of granite gneiss and the core samples are described as fresh, moderately foliated, black, grey and white, medium to coarse grained, moderately porous, and strong to very strong,. The Rock Quality Designation (RQD) measured on the core sample is 100 per cent, indicating a rock mass of excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the sample recovered are 100 per cent and 98 per cent, respectively.

Diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table B1 in Appendix B. The point load index (Is_{50}) results from the diametral laboratory tests carried out on three (3) samples of the granitic bedrock range from approximately 3.5 MPa to 5.7 MPa and average about 4.8 MPa.

Based on point load tests in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range between Elevation 210.9 m and 210.6 m, measured either at the ground or ice/water surface.



4.6 Highway 69 NBL –STA 13+791 (Culvert C47 – Site No. 44-616/C1)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+791 in the Township of Shawanaga are shown on Drawing B1 in Appendix B. The culvert will extend across a swamp area and the proposed Highway 69 NBL embankment which will be up to about 4 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C47-N1 to C47-N3) were advanced along the culvert length to investigate the subsurface conditions at this culvert location. The topography in the area is low-lying to undulating, consisting of bedrock knobs surrounded by grassy and moderately treed ground with areas of shallow open water. Rock fill was observed on the side slopes of the existing highway embankment traversing the area to the east.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat/organic sand, underlain by a deposit of silt and sand. The silt and sand deposit is underlain by granite gneiss bedrock. Bedrock was observed to outcrop to the north and in isolated areas to the south of the culvert alignment, as well as along the toes of the existing Highway 69.

Water

Water to depths of 0.2 m and 0.3 m was encountered in all the boreholes advanced at this culvert location.

Peat / Organic Sand

A deposit of dark brown, wet, silty/fibrous peat to dark brown, wet, organic sand containing rootlets was encountered under the water in all the boreholes. The top of the peat/organic sand deposit varies between Elevation 210.4 and 210.3 m, and its thickness is 1.2 m in all boreholes.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat/organic sand deposit are 0 blows (weight of hammer) per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on two (2) samples of the peat deposit is about 535 per cent and 628 per cent, and water content measured on a sample of the organic sand is about 46 per cent. The organic content measured on a sample of the silty peat is about 56 per cent.

Silt and Sand

A deposit of grey silt and sand, trace gravel and trace clay was encountered below the peat/organic sand deposit in all the boreholes. The silt and sand deposit encountered in Borehole C47-N3 contains an 50 mm thick layer of silty clay. The top of the silt and sand deposit varies between Elevation 209.2 m and 209.1 m, and the thickness ranges from 1.1 m to 2.3 m. The bottom of this deposit was defined by bedrock in Boreholes C47-N1 and C47-N2, and by refusal to further split-spoon and casing advancement in Borehole C47-N3.

The SPT 'N'-values measured within this deposit range from 8 blows to 27 blows per 0.3 m of penetration, indicating a loose to compact relative density. A SPT 'N'-value of 15 blows per 0.15 m of penetration was recorded immediately above the bedrock surface in Borehole C47-N2, indicating a compact relative density.

The natural water content measured on samples of this deposit range from about 20 per cent to 26 per cent.

The grain size distributions of three (3) samples from this deposit are shown on Figure B.C47-3 in Appendix B.



Bedrock / Refusal

Bedrock outcropping was observed to the north and south sides of the culvert and along the toes of the existing highway. Borehole C47-N3 encountered refusal to further split-spoon and casing advancement at a depth of 3.7 m below ground surface, Elevation 206.9 m.

Bedrock was encountered and core samples were recovered from Boreholes C47-N1 and C47-N2. The depth to the surface of the bedrock is 2.6 m and 3.4 m below ground surface, corresponding to Elevation 208.0 m and 207.3 m. The bedrock generally consists of granite gneiss and the core samples are described as fresh, moderately to strongly foliated, black, pink, green and white, medium to coarse grained, moderately porous, and strong to very strong,. The Rock Quality Designation (RQD) measured on the core samples are between 62 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 100 per cent, and between 71 per cent and 100 per cent, respectively.

Diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table B1 in Appendix B. The point load index (Is_{50}) results from the diametral laboratory tests carried out on six (6) samples of the granitic bedrock range from approximately 2.3 MPa to 6.8 MPa, but were typically greater than about 5.2 MPa, and average about 4.9 MPa.

Based on point load tests in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were wet. The ponded water level noted at the boreholes location was at Elevation 210.6 m.



4.7 Highway 69 SBL – STA 14+315 (Culvert C48.1 – Site No. 44-617/C2)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 14+315 in the Township of Shawanaga are shown on Drawing C1 in Appendix C. The culvert will extend across a swamp area and the proposed Highway 69 SBL embankment which will be up to about 3 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C48.1-S1 and C48.1-S2) were completed specifically to investigate the subsurface conditions along the culvert alignment, and augmented with Borehole S20-02 advanced for the proposed Highway 69 SBL embankment. In addition, three (3) Dynamic Cone Penetration Tests (DCPTs C48.1-DC01 to C48.1-DC03, inclusive) were advanced near the east end of the culvert to further confirm the depth to refusal in this area. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, and the area is located within the confines of tree covered valley slopes at the north and south limits of the proposed culvert.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of silty peat, underlain by a non-cohesive deposit of silt and sand to sand. Bedrock outcrops are present to the north and south of the culvert.

Snow / Ice

Snow or ice to depths of 0.6 m and 0.8 m was encountered in Boreholes C48.1-S1 and C48.1-S2.

Silty Peat

A deposit of black, wet, silty peat containing rootlets was encountered at the ground surface in Borehole S20-02 and under the snow/ice in Boreholes C48.1-S1 and C48.1-S2. The top of the silty peat deposit range from Elevation 213.2 m to 212.4 and its thickness varies between 0.3 m and 0.8 m.

The Standard Penetration Test 'N'-values recorded within the silty peat deposit are 1 blow and 3 blows per 0.3 m of penetration, indicating a very soft to soft consistency.

The natural water content measured on samples of the silty peat deposit is 177 per cent and 369 per cent, and the organic content measured on a sample of this deposit is about 38 per cent.

Silt and Sand to Sand

A non-cohesive deposit of dark brown to grey silt and sand to sand, trace to some silt, trace to some clay and trace gravel was encountered below the silty peat deposit in all the boreholes. In Boreholes S20-02 and C48.1-S2, the silt and sand deposit contains organics and rootlets. The top of the silt and sand to sand deposit ranges from Elevation 212.4 m to 211.8 m, and its thickness ranges from 0.5 m to 2.3 m. The bottom of the deposit was defined by refusal to further auger or casing advancement.

The SPT 'N'-values recorded within the silt and sand to sand deposit range from 2 blows to 21 blows per 0.3 m of penetration, indicating a very loose to compact relative density, although a SPT 'N'-value of 84 blows per 0.3 m of penetration was recorded within this deposit at the interface between the silt and sand and sand layers, indicating a very dense relative density.

The natural water content measured on samples of this deposit is about 16 per cent.

The grain size distributions of two (2) samples from the silt and sand portion of this deposit are shown on Figure C.C48.1-1 in Appendix C.



Bedrock / Refusal

Bedrock outcrops are present to the north and south of the culvert alignment. In Boreholes C48.1-S1, C48.1-S2 and S20-02; and DCPTs C48.1-DC01 to C48.1-DC03, refusal to further auger or casing advancement or cone penetration was encountered at depths between 1.5 m and 3.7 m below ground/snow surface, corresponding to between Elevation 211.7 m and 209.5 m.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range between Elevation 213.2 m and 212.7 m, measured either at the ground surface or up to a depth of 0.5 m below the snow surface.



4.8 Highway 69 NBL –STA 14+325 (Culvert C48.1 – Site No. 44-617/C1)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 14+325 in the Township of Shawanaga are shown on Drawing C1 in Appendix C. The culvert will extend across a swamp area and the proposed Highway 69 NBL embankment which will be up to about 2.5 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C48.1-N1 and C48.1-N2) were completed specifically to investigate the subsurface conditions along the culvert alignment, and augmented with Boreholes S20-12 and S20-12A advanced for the proposed Highway 69 NBL embankment. In addition, three (3) Dynamic Cone Penetration Tests (DCPTs C48.1-DC04 to C48.1-DC06, inclusive) were advanced near the west end of the culvert to further confirm the depth to refusal in this area. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, and located within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of silty peat, underlain by a deposit of silty clay or silt. The silty clay or silt deposit is in turn underlain by a silt and sand till deposit. Bedrock outcrops are present immediately to the north and south of the culvert alignment, and also further to the northeast of the culvert.

Silty Peat

A deposit of black to brown, wet, silty peat containing rootlets was encountered at the ground surface in all the boreholes. The top of the silty peat deposit ranges from Elevation 213.4 to 213.1 m and the thickness of the deposit ranges from 0.2 m to 0.8 m. Borehole C48.1-N1 was terminated within this deposit upon split-spoon refusal.

The Standard Penetration Test 'N'-value recorded within the silty peat deposit is 1 blow per 0.15 m of penetration, indicating a very soft consistency.

Silty Clay

A deposit of brown silty clay, trace sand, was encountered beneath the silty peat in Borehole S20-12. The top of the silty clay deposit is at Elevation 212.4 m and its thickness is 0.9 m.

The SPT 'N'-value recorded within the silty clay deposit is 3 blows per 0.3 m of penetration, indicating soft consistency.

The natural water content measured on a sample of this deposit is about 32 per cent.

An Atterberg limits test carried out on a specimen of the silty clay deposit measured a liquid limit of about 44 per cent and a plastic limit of about 17 per cent, corresponding to a plasticity index of about 27 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure C.C48.1-2 in Appendix C and indicate that the material is silty clay of intermediate plasticity.

Silt

Immediately underlying the silty peat layer in Borehole C48.1-N2 is a deposit of grey silt, trace to some clay, trace to some sand and containing rootlets. The top of the silt deposit is at Elevation 212.9 m and its thickness is 1.2 m.

The SPT 'N'-values recorded within this deposit are 3 blows and 6 blows per 0.3 m of penetration, indicating that the silt has a very loose to loose relative density.



The natural water content measured on a sample of this deposit is about 20 per cent.

An Atterberg limits test carried out on a sample of the silt deposit measured a liquid limit of about 19 per cent and a plastic limit of about 16 per cent corresponding to a plasticity index of about 3 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure C.C48.1-3 in Appendix C and indicate the material to be a silt of low plasticity.

Silt and Sand Till

A deposit of non-cohesive till consisting of brown and grey silt and sand, trace to some clay, trace gravel and containing sandy silt seams was encountered below the silty clay deposit and silt deposit in Boreholes S20-12 and C48.1-N2. The top of the till deposit is at Elevation 211.7 m and 211.5 m, and its thickness is 1.0 m and 1.2 m in both boreholes. The bottom of this deposit was defined by refusal to further split-spoon and auger/casing advancement.

The SPT 'N'-values measured within this deposit are 13 blows per 0.25 m of penetration, 34 blows per 0.3 m of penetration and 82 blows per 0.15 m of penetration, generally indicating a compact to very dense relative density.

The natural water content measured on two samples of the silt and sand till deposit is about 20 per cent and 32 per cent.

The grain size distributions of two (2) samples from this till deposit are shown on Figure C.C48.1-4 in Appendix C.

Bedrock / Refusal

Bedrock outcrops are present to the north and south of the culvert alignment. In Boreholes C48.1-N1, C48.1-N2 and S20-12 and DCPTs C48.1-DC04 to C48.1-DC06, refusal to further split-spoon and auger/casing advancement or cone penetration was encountered at depths between 0.2 m and 2.7 m, corresponding to between Elevation 213.2 m and 210.5 m.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range from Elevation 213.4 m to 213.1 m, measured at the ground surface.



4.9 Highway 69 SBL – STA 14+649 (Culvert C49A – Site No. 44-618/C2)

The plan and profiles along the length of the culvert showing the borehole locations and interpreted stratigraphy at approximately STA 14+649 in the Township of Shawanaga are shown on Drawings D1 and D2 in Appendix D. The culvert will extend across the proposed Highway 69 SBL embankment which will be up to about 5 m high above the existing grade at the proposed culvert location. A total of four (4) boreholes (Boreholes C49A-S1A, C49A-S1B, C49A-S2 and C49A-S3) were advanced specifically to investigate the subsurface conditions along the culvert, supplemented with Borehole H9-01 advanced for the proposed Highway 69 SBL embankment for High Fill 9. In addition, two (2) Dynamic Cone Penetration Tests (DCPTs C49A-DC01 and C49A-DC02, inclusive) were advanced near the centre and east end of the culvert to further confirm the depth to refusal in these areas. The topography in the area is low-lying encompassing wet grassy areas, shallow open water and bedrock knobs, confined by moderately tree covered slopes immediately to the south as well as to the north of the adjacent swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil or peat underlain by a deposit of sandy silt to sand which in turn is generally underlain by granite gneiss bedrock. At the west end of the culvert the deposit of silty sand is underlain by a deposit of silty sand and gravel which in turn is also underlain by granite gneiss bedrock.

Topsoil / Peat

A 0.1 m to 0.2 m thick layer of topsoil was encountered at the ground surface in Boreholes C49A-S1A, C49A-S2 and C49A-S3. A 0.2 m thick layer of amorphous peat was encountered at the ground surface in Borehole H9-01.

Sandy Silt to Sand

A non-cohesive deposit of brown to grey sandy silt, trace clay, trace organic to silt and sand to silty sand, trace organics to sand, some silt, trace organics was encountered below the topsoil in Boreholes C49A-S1A, C49A-S2 and C49A-S3 and below the peat in Borehole H9-01. The top of the deposit varies between Elevations 208.3 m and 207.7 m, and the thickness of the deposit ranges from 0.6 m to 3.7 m, and potentially may be up to about 6.4 m as inferred in DCPT C49A-DC02. The bottom of this deposit is defined by granite gneiss bedrock in Borehole C49A-S2 and C49A-S3, and by refusal to casing advancement in Borehole H9-01.

The SPT 'N'-values recorded within the non-cohesive deposit range between 1 blow and 36 blows per 0.3 m of penetration, indicating a very loose to dense relative density. Two SPT 'N'-values of 47 blows per 0.13 m of penetration and 25 blows per 0.08 m of penetration were measured within Boreholes C49A-S2 and C49A-S3, on refusal on bedrock.

The natural water content measured on samples of this deposit range from about 19 per cent and 29 per cent.

The grain size distributions of three (3) samples from this deposit are shown on Figure D.C49A-1 in Appendix D.

Silty Sand and Gravel

A deposit of brown, moist to wet, silty sand and gravel, trace clay was encountered below the deposit of silty sand in Borehole C49A-S1A and confirmed upon re-drilling in Borehole C49A-S1B. The top of the granular deposit was encountered at Elevations 207.2 m and 206.4 m and the thickness of this deposit was 0.3 m in both boreholes. The bottom of this deposit is defined by split-spoon refusal and bedrock.



Two SPT 'N'-values measured within the silty sand and gravel deposit are 27 blows for 0.08 m of penetration, and 20 blows for 0.15 m of penetration prior to split-spoon refusal on bedrock.

The natural water content measured on one (1) sample of the silty sand and gravel is about 10 per cent.

Bedrock / Refusal

In Boreholes C49A-S1A and H9-01 and DCPTs C49A-DC01 and C49A-DC02, refusal to further split-spoon or casing advancement or cone penetration was encountered between depths of 1.0 m and 6.4 m below ground surface corresponding to between Elevations 206.9 m and 201.4 m.

Bedrock was encountered and core samples were recovered from Boreholes C49A-S1B, C49A-S2 and C49A-S3. The depth to the surface of the bedrock ranges between 1.8 m and 3.9 m below ground surface, corresponding to between Elevations 206.1 m and 203.8 m. The bedrock consists of granite gneiss and the core samples are described as slightly weathered to fresh, foliated, grey, green, pink, and black, medium to coarse grained, and medium strong to strong, . The Rock Quality Designation (RQD) measured on the core samples ranges between 74 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 the samples recovered are between 96 per cent and 100 per cent and 74 per cent and 100 per cent, respectively.

Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table D1 in Appendix D. The point load index (Is_{50}) results from the axial laboratory tests carried out on six (6) samples of the granite gneiss bedrock range from approximately 1.6 MPa to 8.5 MPa, but are typically greater than 5.0 MPa. The point load index (Is_{50}) results from the diametral laboratory tests carried out on five (5) samples of the granite gneiss bedrock range from approximately 3.8 MPa to 9.2 MPa, but are typically greater than 4.9 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7012 (Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens), on a selected core sample of the granite gneiss bedrock from Borehole C49A-S1B and measured a compressive strength of about 84 MPa, as detailed in Table D2 in Appendix D.

Based on a laboratory UC tests and point load tests, in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in Boreholes C49A-S1B, C49A-S2, C49A-S3 and H9-01 upon completion of drilling rang between Elevations 207.6 m and 207.3 m, measured at a depth between 0.4 m and 0.7 m below the ground surface.



4.10 Highway 69 NBL – STA 14+656 (Culvert C49A – Site No. 44-618/C1)

The plan and profiles along the length of the culvert showing the borehole locations and interpreted stratigraphy at approximately STA 14+656 in the Township of Shawanaga are shown on Drawings D1 and D2 in Appendix D. The culvert will extend across the proposed Highway 69 NBL embankment which will be up to about 5 m high above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C49A-N1 to C49A-N3, inclusive) were advanced specifically to investigate the subsurface conditions along the culvert. In addition, two (2) Dynamic Cone Penetration Tests (DCPTs C49A-DC03 and C49A-DC04, inclusive) were advanced near the centre and east end of the culvert to further confirm the depth to refusal in these areas. The topography in the area is low-lying encompassing wet grassy areas, shallow open water and bedrock knobs, confined by moderately tree covered slopes immediately to the south as well as to the north of the adjacent swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil/organic silty sand underlain by a deposit of silt and sand to sand which in turn is generally underlain by a sand and gravel deposit over granite gneiss bedrock. At one location a boulder was encountered between the silt and sand to sand deposit and the deposit of sand and gravel.

Topsoil

A 0.1 m to 0.3 m thick layer of topsoil was encountered at the ground surface in Boreholes C49A-N1 to C49A-N3.

The natural water content measured on one (1) sample of the topsoil from Borehole C49A-N3 is about 59 per cent.

Organic Silty Sand

A 0.5 m thick deposit of red to dark brown, moist, organic silty sand was encountered underlying the topsoil in Borehole C49A-N2 at Elevation 208.3 m.

A SPT 'N'-value recorded within the organic deposit is 8 blows per 0.3 m of penetration, indicating a loose relative density.

The natural water content measured on a sample of the organic deposit is about 29 per cent and the organic content measured on this sample is about 7 per cent.

Silt and Sand to Sand

A non-cohesive deposit of brown/reddish brown to grey, silt and sand, trace clay to silty sand, trace organics to silty sand to sand, some silt, trace gravel was encountered below the topsoil in Boreholes C49A-N1 and C49A-N3 and below the organic silty sand in Borehole C49A-N2. A 0.3 m thick boulder was encountered below the deposit of silt and sand in Borehole C49A-N2 at Elevation 206.2 m. The top of the deposit varies between Elevations 208.2 m and 207.8 m, and the thickness of the deposit ranges from 1.6 m to 4.8 m. The bottom of this deposit is defined by bedrock in Borehole C49A-N3.

The SPT 'N'-values recorded within the non-cohesive deposit range between 2 blows and 36 blows per 0.3 m of penetration, indicating a very loose to dense relative density. One SPT 'N'-value of 27 blows per 0.15 m of penetration was measured within Boreholes C49A-N1 prior to split-spoon refusal on cobbles.

The natural water content measured on samples of this deposit range from about 17 per cent and 27 per cent.



The grain size distributions of three (3) samples from this deposit are shown on Figure D.C49A-2 in Appendix D.

Sand and Gravel

A deposit of brown, wet, sand and gravel, some silt to silty, was encountered below the boulder in Borehole C49A-N2. The top of the granular deposit is at Elevation 205.9 m and the deposit is 1.7 m thick. The bottom of this deposit is defined by bedrock.

Two SPT 'N'-values measured within the sand and gravel deposit are 36 blows and 51 blows per 0.3 m of penetration, indicating a dense to very dense relative density. One SPT 'N'-value measured within the bottom portion of the granular deposit is 36 blows per 0.15 m of penetration prior to split-spoon refusal on bedrock.

The natural water content measured on one (1) sample of the sand and gravel is about 12 per cent.

A grain size distribution of one (1) sample from this deposit is shown on Figure D.C49A-3.

Cobbles

A deposit of cobbles was encountered below the silty sand deposit in Borehole C49A-N1. The top of the cobbles deposit is at Elevation 205.9 m and the deposit is 1.6 m thick. The bottom of this deposit is defined by bedrock.

Bedrock / Refusal

In DCPTs C49A-DC03 and C49A-DC04, refusal to further cone penetration was encountered at depths of 3.2 m and 5.1 m below ground surface, respectively, corresponding to Elevations 205.7 m and 202.4 m.

Bedrock was encountered and core samples were recovered from Boreholes C49A-N1 to C49A-N3. The depth to the surface of the bedrock ranges between 4.0 m and 5.1 m below ground surface, corresponding to between Elevations 204.3 m and 203.2 m. The bedrock consists of granite gneiss and the core samples are described as fresh, foliated, black, grey and pink, medium to coarse grained, and very strong. The Rock Quality Designation (RQD) measured on the core samples ranges between 86 per cent and 100 per cent, indicating a rock mass of good to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the sample recovered are between 86 per cent and 100 per cent and between 76 per cent and 100 per cent, respectively.

Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table D1 in Appendix D. The point load index (Is_{50}) results from the axial laboratory tests carried out on three (3) samples of the granite gneiss bedrock range from approximately 4.1 MPa to 6.7 MPa. The point load index (Is_{50}) results from the diametral laboratory tests carried out on three (3) samples of the granite gneiss bedrock range from approximately 5.3 MPa to 8.1 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7012, on a selected core sample of the granite gneiss bedrock from Borehole C49A-N2 and measured a compressive strength of about 48 MPa, as detailed in Table D3 in Appendix D.

Based on a laboratory UC tests and point load tests in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).



Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in Boreholes C49A-N1 to C49A-N3 upon completion of drilling rang between Elevations 207.6 m and 206.9 m, measured at depths between 0.7 m and 1.5 m below the ground surface.



4.11 Highway 69 SBL – STA 14+706 (Culvert C50 – Site No. 44-619/C2)

The plan and profile along the length of the culvert showing the borehole locations and interpreted stratigraphy at approximately STA 14+706 in the Township of Shawanaga are shown on Drawing E1 in Appendix E. The culvert will extend across the proposed Highway 69 SBL embankment which will be up to about 5.5 m high above the existing grade at the proposed culvert location. One (1) borehole (Borehole C50-S1) was advanced to specifically investigate the subsurface conditions at the west end of the culvert, supplemented with Boreholes S21-01 and S21-02 advanced for the proposed Highway 69 SBL embankment for Swamp 21 crossing. The topography is relatively flat and low low-lying encompassing a wet grassy area, shallow open water and bedrock knobs; located within the confines of moderately tree covered valley slopes to the north and south.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat and organic sand, underlain by interlayered deposits of silty sand and silt and sand. The non-cohesive deposits are underlain by granite gneiss bedrock. At one location inferred bedrock was encountered immediately below ponded water which covers the entire culvert site.

Ice / Water

Ice and/or water to depths ranging between 0.7 m and 0.9 m was encountered in all boreholes. Refusal to casing advancement was encountered below the water in Borehole S21-01 at a depth of 0.7 m, corresponding to Elevation 206.6 m.

Peat

A 0.4 m thick layer of dark brown, wet, fibrous peat was encountered underlying the water in Borehole C50-S1 at Elevation 206.7 m.

A SPT 'N'-value recorded within the peat is 1 blow per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on a sample of the organic deposit is about 80 per cent.

Organic Sand

A 1 m thick deposit of dark brown, wet, organic sand containing some silt was encountered underlying the peat in Borehole C50-S1 at Elevation 206.3 m.

A SPT 'N'-value recorded within the organic deposit is 3 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on a sample of the organic deposit is about 40 per cent.

A grain size distribution of one (1) sample from this deposit is shown on Figure E.C50-1.

Silt and Sand to Silty Sand

A non-cohesive deposit of dark brown to grey, silt and sand, trace to some clay to silty sand, trace gravel, organics and rootlets, was encountered below the water in Borehole S21-02 and below the organic sand in Borehole C50-S1. The top of the deposit was encountered at Elevations 206.6 m and 205.3 m, and the thickness of the deposit is 0.4 m and 1.4 m. The bottom of this deposit is defined by refusal to further split-spoon advancement.



The SPT 'N'-values recorded within the non-cohesive deposit in Borehole S21-02 are 1 blow and 9 blows per 0.3 m of penetration, indicating a very loose to loose relative density. Two SPT 'N'-values of 16 blows per 0.13 m and 0.15 m of penetration were measured within Boreholes S21-02 and C50-S1, respectively, on split-spoon refusal on bedrock.

The natural water content measured on samples of this deposit are about 20 per cent and 36 per cent. An organic content measured on a sample of the silty sand recovered from Borehole S21-02 is about 2 per cent.

An Atterberg limits test carried out on a specimen of silt and sand deposit measured a liquid limit of about 16 per cent and a plastic limit of about 13 per cent, corresponding to a plasticity index of about 3 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure E.C50-2 in Appendix E and indicates that the fines component of the material is a silt of slight plasticity.

Bedrock / Refusal

In Boreholes S21-01 and S21-02, refusal to further split-spoon advancement was encountered at a depth of 0.7 m and 2.3 m, respectively, corresponding to Elevation 206.7 m and 205.2 m.

Bedrock was encountered and core samples were recovered from Borehole C50-S1. The depth to the surface of the bedrock is 2.6 m below ground surface, corresponding to Elevation 204.9 m. The bedrock consists of granite gneiss and the core samples are described as slightly weathered to fresh, foliated, medium grained, green, grey and pink, and medium strong. The Rock Quality Designation (RQD) measured on the core samples is 73 per cent and 97 per cent, indicating a rock mass of fair to excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the sample recovered are 97 per cent and between 73 per cent and 97 per cent, respectively.

Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table E1 in Appendix E. The point load index (Is_{50}) result from the axial laboratory test carried out on one (1) sample of the granite gneiss bedrock is approximately 5.1 MPa. The point load index (Is_{50}) result from the diametral laboratory test carried out on one (1) sample of the granite gneiss bedrock is approximately 4.8 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7012, on a selected core sample of the granite gneiss bedrock from Borehole C50-S1 and measured a compressive strength of about 46 MPa, as detailed in Table E2 in Appendix E.

Based on the laboratory UC test and point load tests, in accordance with Table 3.5, CFEM 2006³, the granite gneiss bedrock is classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in Boreholes C49A-N1 to C49A-N3 upon completion of drilling are at Elevation 207.5 m in open water and between Elevations 207.5 m and 207.3 m, measured at the ice surface.



4.12 Highway 69 NBL – STA 14+726 (Culvert C50 – Site No. 44-619/C1)

The plan and profile along the length of the culvert showing the borehole locations and interpreted stratigraphy at approximately STA 14+726 in the Township of Shawanaga are shown on Drawing E1 in Appendix E. The culvert will extend across the proposed Highway 69 NBL embankment which will be up to about 5 m high above the existing grade at the proposed culvert location. Four (4) boreholes (Boreholes S21-10, S21-10A, S21-11 and S21-19) advanced for the proposed Highway 69 NBL embankment crossing of Swamp 21, but located in close proximity to the proposed culvert, were utilized to investigate the subsurface conditions along the culvert alignment. In addition, one (1) Dynamic Cone Penetration Test (DCPT C50-DC01) was advanced near the west end of the culvert to further confirm the depth to refusal in this area. The topography is relatively flat and low lying encompassing a wet grassy area, shallow open water and bedrock knobs located within the confines of moderately tree covered valley slopes to the north and south.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat and organic sand underlain by a non-cohesive deposit comprised of various layers of silt to silty sand, in places overlain by a deposit containing layers/pockets of clayey silt to clay. At some locations, the silt to silty sand deposit is underlain by a granular deposit comprised of sand and gravel prior to refusal.

Ice / Water

Ice and water at one location, was encountered in all boreholes to depths ranging between 0.5 m and 0.6 m.

Peat

A 0.4 m and 0.3 m thick layer of peat was encountered below the ice in Borehole S21-11 and below the water in Borehole S21-19, at Elevations 207 m and 206.9 m, respectively.

The natural water content measured on one (1) sample of the peat recovered from Borehole S21-11 is about 68 per cent.

Organic Sand

A 0.3 m thick deposit of dark brown, wet, organic sand was encountered underlying the peat in Borehole S21-19 at Elevation 206.6 m.

A SPT 'N'-value recorded within the organic deposit is 1 blow per 0.3 m of penetration, indicating a very loose relative density.

Clayey Silt

A 0.8 m thick near-surface deposit of grey, wet, clayey silt was encountered below the organic sand in Borehole S21-19 at Elevation 206.3 m.

One SPT 'N'-values recorded within the cohesive deposit is 3 blows per 0.3 m of penetration, suggesting a soft consistency.

The natural water content measured on one (1) sample of the clayey silt is about 23 per cent.

An Atterberg limits test carried out on a specimen of the cohesive layer measured a liquid limit of about 19 per cent and a plastic limit of about 13 per cent, corresponding to a plasticity index of about 6 per cent. The



result of the Atterberg limits test is shown on the plasticity chart on Figure E.C50-3 in Appendix E and indicates that the material is a clayey silt of low plasticity.

Silt to Sand

An interlayered deposit of dark brown to grey, silt to sandy silt to silt and sand to silty sand to sand was encountered below the ice in Boreholes S21-10 and S21-10A, below the peat in Borehole S21-11, and below the clayey silt layer in Borehole S21-19. The upper portion the deposit in Boreholes S21-10 and S21-11 has trace organics and contains rootlets to a depth of 1.6 m. Pockets of silt clay to clay were encountered within the silt to silty sand portions of the deposit in Boreholes S21-10, S21-10A and S21-19. The top of the deposit ranges between Elevation 207 m and 205.5 m, and the overall thickness of the deposit ranges from 7.2 m to 9.8 m, but may inferred to be only 3.3 m thick (or less) in DCPT C50-DC01. In Borehole S21-29 and DCPT C50-DC01 the bottom of this deposit is defined by refusal to further casing advancement and cone penetration, respectively.

The SPT 'N'-values recorded within the non-cohesive deposit range between 1 blow and 17 blows per 0.3 m of penetration, indicating a very loose to compact relative density. A SPT 'N'-value of 4 blows per 0.07 m of penetration was recorded at split-spoon refusal in Borehole S21-10A.

The natural water content measured on samples of this deposit ranges between about 14 per cent and 28 per cent. The natural water content measured on one (1) sample recovered from the upper portion of the silty sand deposit immediately below the ice cover in Borehole S21-10 is about 150 per cent.

The grain size distributions of six (6) samples of the silt to silt and sand portion of this deposit are shown on Figure E.C50-4 in Appendix E.

An Atterberg limits test carried out on a specimen of the silt deposit measured a liquid limit of about 19 per cent and a plastic limit of about 16 per cent, corresponding to a plasticity index of about 3 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure E.C50-5 in Appendix E and indicates that the material is a silt of slight plasticity. An Atterberg limits test on one (1) sample of this deposit from Borehole S21-10A indicates this material to be non-plastic.

Silt Clay to Clay (Pockets)

Pockets of light brown/grey, wet, silty clay to clay were encountered within the silt to sand deposit in Boreholes S21-10, S21-10A and S21-19 at Elevations 202.8 m and 200 m, and were penetrated for thicknesses of 2 m and 0.5 m.

Two SPT 'N'-values measured within the silty clay to clay pocket encountered in Borehole S21-10 are 2 blows and 11 blows per 0.3 m of penetration, suggesting a very soft and stiff consistency. An in situ field vane test carried out within this deposit measured an undrained shear strength of about 23 kPa and a sensitivity is calculated to be about 3. The field vane test results indicate that the clay pocket has a soft consistency.

The natural water content measured on samples of this deposit generally ranges between about 52 per cent and 63 per cent.

The grain size distribution of one (1) sample of the silty clay pocket is shown on Figure E.C50-6 in Appendix E.

Atterberg limits tests were carried out on three (3) specimens of the silty clay to clay pockets. The liquid limits range between about 44 per cent and 53 per cent, the plastic limits range between about 18 per cent and 20 per cent, and the plasticity indices range between about 26 per cent and 33 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure E.C50-7 in Appendix E and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.



Sand and Gravel

A deposit of brown to grey, wet, sand and gravel, trace to some silt, was encountered below the silt to silty sand deposit in Boreholes S21-10 and S21-11. The top of the granular deposit was encountered at Elevations 200 m and 196.8 m and the thickness of the deposit is 0.2 m and 0.1 m in the respective boreholes. The bottom of this deposit is defined by refusal to further split-spoon advancement.

Two SPT 'N'-values measured within the sand and gravel deposit are 22 blows per 0.15 m of penetration and 54 blows per 0.03 m of penetration prior to split-spoon refusal.

The natural water content measured on one (1) sample of the sand and gravel is about 20 per cent.

Bedrock / Refusal

In Boreholes S21-10, S21-10A, S21-11 and S21-19 and DCPT C50-DC01, refusal to further split-spoon or casing advancement or cone penetration was encountered at depths ranging between 3.9 m and 10.8 m below ice or water surface, corresponding to between Elevations 203.6 m and 196.7 m.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in Boreholes S21-10, S21-11 and S21-19 upon completion of drilling are at Elevation 207.5 m, measured at the ice surface, or corresponding to the surface of the open water.



4.13 Highway 69 SBL – STA 15+710 (Culvert C55 – Site No. 44-620/C2)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 15+710 in the Township of Shawanaga are shown on Drawing F1 in Appendix F. The culvert alignment will extend across the proposed Highway 69 SBL and Shebeshekong Road North to East-West Ramp embankment which will be up to about 6.5 m high above the existing grade at the proposed culvert location. Three (3) boreholes (Boreholes S23-03A, S23-04 and S23-06) and one (1) DCPT (S23-DCPT02) advanced for the proposed highway embankment crossing of Swamp 23, but located in close proximity to the culvert, were utilized to investigate the subsurface conditions along the culvert alignment. The topography in the culvert area is relatively flat, with ground cover consisting of shrubs and wet grassy areas, and is located within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat (where present) underlain by a predominant deposit of sand which extends to the refusal depth. Bedrock outcrops are present to the south of the culvert.

Ice / Water

Ice or ice and water to depths of between 0.8 m and 0.9 m was encountered in all the boreholes.

Peat

A deposit of dark brown, wet, amorphous peat containing trace roots and wood fragments was encountered underlying the ice/water cover in Boreholes S23-03A and S23-04. The top of the peat deposit is at Elevations 208.1 m and 208.0 m and the thickness of this deposit is 1.8 m and 0.9 m at the respective borehole.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit range from 1 blow to 13 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency.

The natural water content measured on two (2) samples of the peat deposit is about 353 per cent and 357 per cent and the organic content measured on one (1) sample of the peat deposit is about 56 per cent.

Sand

A deposit of brown to grey sand, trace to some silt, trace to some gravel and trace clay was encountered underlying the peat deposit or ice cover in the boreholes. The upper portion of the sand deposit in Boreholes S23-04 and S23-06 contains trace organics, and in Borehole S23-06, clay seams were present near the top of the deposit between Elevations 207.8 m and 207.0 m. The top of the sand deposit ranges from Elevation 208.5 m to 206.2 m and the thickness of the deposit ranges from 3.4 m to 6 m, and potentially may be up to about 7.5 m thick as inferred in DCPT S23-DC02. The bottom of this deposit is defined by refusal to further split-spoon and casing advancement or cone penetration.

The SPT 'N'-values measured within this deposit typically range from 1 blow to 22 blows per 0.3 m of penetration, with 'N'-values between 54 blows and 106 blows per 0.3 m of penetration and up to 68 blows per 0.15 m of penetration recorded within the lower portion of the deposit in Borehole S23-04, indicating an overall very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 14 per cent to 42 per cent but is typically less than 30 per cent. The organic content measured on two (2) samples of the upper portion of the sand deposit containing trace organics is about 2 per cent and 4 per cent.



The grain size distributions of five (5) samples of this deposit are shown on Figure F.C55-1 in Appendix F.

Bedrock / Refusal

Bedrock outcrops are present to the south of the proposed culvert alignment. In Boreholes S23-03A, S23-04 and S23-06 and DCPT S23-DC02, refusal to further split-spoon and casing advancement or cone penetration was encountered at depths between 4.2 m and 9.6 m below ice or ground surface, corresponding to between Elevations 205.1 m and 199.3 m.

Groundwater Conditions

The samples taken in the boreholes were wet with free water noted in a number of the sand samples. Water levels observed in the boreholes upon completion of drilling range between Elevation 208.9 m and 208.7 m, measured to a depth of 0.6 m below the ice surface.



4.14 Highway 69 NBL – STA 15+717 (Culvert C55 – Site No. 44-620/C1)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at about STA 15+717 in the Township of Shawanaga are shown on Drawing F1 in Appendix F. The culvert alignment will extend across the proposed Highway 69 NBL embankment which will be up to about 6.5 m high above the existing grade at the proposed culvert location. Three (3) boreholes (Boreholes S23-08 to S23-10, inclusive) advanced for the proposed highway embankment crossing of Swamp 23, but located in close proximity to the culvert, were utilized to investigate the subsurface conditions along the culvert alignment. The topography in the culvert area is relatively flat, with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat (where present) underlain by a predominant deposit of silty sand to sand which extends to the refusal depth. Bedrock outcrops are present to the south of the culvert.

Ice / Water

Ice or ice and water to depths of between 0.7 m and 0.9 m was encountered in all the boreholes.

Peat

A 0.8 m thick deposit of brown, wet, fibrous peat containing trace wood fragments was encountered underlying the ice/water cover in Boreholes S23-08 at Elevation 208.2 m.

A Standard Penetration Test (SPT) 'N'-value recorded within the peat deposit is 1 blow per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on a sample of the peat deposit is about 326 per cent and an organic content measured on this sample is about 64 per cent.

Silty Sand to Sand

A deposit of brown and grey silty sand to sand, containing trace to some gravel and trace clay was encountered underlying the peat deposit or ice/water cover in the boreholes. The upper portion of the sand deposit in Boreholes S23-09 and S23-10 contains trace organics and clay seams. In Borehole S23-09 a 0.7 m thick layer of brown and grey organic sand, trace to some silt, trace clay, was encountered within the sand deposit at Elevation 207.4 m. The top of the silty sand to sand deposit ranges from Elevation 208.6 m to 207.5 m and the overall thickness of the deposit, including the organic sand pocket, ranges from 7.5 m to 10.2 m. Boreholes S23-08 to S23-10 were terminated within this deposit upon refusal to further split-spoon and/or casing advancement.

The SPT 'N'-values measured within this deposit typically range from 1 blow to 30 blows per 0.3 m of penetration, with values of 53 blows to 89 blows per 0.3 m of penetration recorded at varying depths in Borehole S23-08, indicating an overall very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 12 per cent to 24 per cent. The grain size distributions of five (5) samples of this deposit are shown on Figure F.C55-2 in Appendix F.

A SPT 'N'-value recorded within the layer is 6 blows per 0.3 m of penetration, indicating a loose relative density. The natural water content measured on a sample of this layer is about 58 per cent.



Bedrock / Refusal

Bedrock outcrops are present to the south of the proposed culvert alignment. In Boreholes S23-08 to S23-10, refusal to further split-spoon and/or casing advancement was encountered at depths between 8.4 m and 11.0 m below ice surface, corresponding to between Elevations 200.5 m and 198.4 m.

Groundwater Conditions

The samples taken in the boreholes were wet with free water noted in a number of sand samples. Water levels observed in the boreholes upon completion of drilling range from Elevation 208.9 m to 208.6 m, measured to a depth of 0.6 m below the ice surface.



4.15 Highway 69 SBL – STA 16+345 (Culvert C57.1 – Site No. 44-621/C2)

The plan and profile along the length of the culvert showing the borehole locations and interpreted stratigraphy at about STA 16+345 in the Township of Shawanaga are shown on Drawing G1 in Appendix G. The culvert will extend across the proposed Highway 69 SBL embankment which will be up to about 4.5 m high above existing grade at the proposed culvert location. Five (5) boreholes (Boreholes C57.1-S1 to C57.1-S5, inclusive) were advanced to specifically investigate the subsurface conditions along the culvert. In addition, three (3) Dynamic Cone Penetration Tests (DCPTs C57.1-DC01 to C57.1-DC03, inclusive) were advanced near the culvert to further confirm the depth to refusal in this area. The topography in the culvert area is relatively flat with ground cover consisting of relatively densely treed areas. In general, the ground surface slopes down relatively gently towards the north towards a low-lying swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil, underlain by a non-cohesive deposit ranging in composition from silt to sand with pockets of gravelly silty sand to sand and gravel, containing some cobbles, which is underlain by a silty sand and gravel to gravelly silt and sand deposit in places, in turn underlain by granite gneiss bedrock.

Topsoil

A 0.1 m to 0.3 m thick layer of topsoil was encountered at the ground surface in all boreholes.

The natural water content measured on one (1) sample of the topsoil is about 28 per cent.

Silt to Sand

A non-cohesive deposit of brown to grey, silt, some sand to silt and sand to silty sand to sand was encountered below the topsoil in all boreholes. The silty sand deposit and silt deposit encountered in Boreholes C57.1-S4 and C57.1-S5, respectively, contain trace organics. Pockets of gravelly silty sand, and sand and gravel are encountered within the silt to sand deposit in Boreholes C57.1-S3 and C57.1-S5, respectively. The top of the deposit varies between Elevation 208.7 m and 207 m, and its thickness ranges from 2.1 m to 4.6 m. In Boreholes C57.1-S1, the bottom of this deposit was defined by bedrock. Auger grinding was observed in Boreholes C57.1-S1 and C57.1-S2 at a depth of 1.4 m, corresponding to Elevations 205.9 m and 207.3 m, respectively.

The SPT 'N'-values recorded within the non-cohesive deposit range between 3 blows and 52 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit range from about 12 per cent and 28 per cent.

The grain size distributions of six (6) samples from this deposit are shown on Figure G.57.1-1 in Appendix G.

Gravelly Silty Sand and Sand and Gravel (Pockets)

Pockets of gravelly silty sand and sand and gravel, containing some cobbles, were encountered within the silt to sand deposit in Boreholes C57.1-S3 and C57.1-S5 at Elevations 208.2 m and 207.2 m, respectively and are approximately 0.7 m thick.

The SPT 'N'-values recorded within the gravelly silty sand and sand and gravel are 44 blows and 28 blows per 0.3 m of penetration, respectively, indicating a dense and compact relative density.

The natural water content measured on a sample of the gravelly silty sand, and sand and gravel is about 13 per cent and 11 per cent.



The grain size distribution of one (1) sample of the gravelly silty sand is shown on Figure G.57.1-2 in Appendix G.

Gravelly Silt and Sand to Sand and Gravel

A non-cohesive deposit of grey, wet, gravelly silt and sand to silty sand and gravel to sand and gravel was encountered below the silt to sand deposit in all boreholes except in Borehole C57.1-S1. The top of the granular deposit varies between Elevation 205 m and 204.1 m, and its thickness ranges from 0.3 m to 1.9 m. In Borehole C57.1-S2, the bottom of this deposit is defined by bedrock and in Boreholes C57.1-S3 to C57.1-S5, the bottom of the deposit is defined by refusal to split-spoon and casing advancement.

The SPT 'N'-values recorded within this granular deposit range between 16 blows and 41 blows per 0.3 m of penetration, indicating a compact to dense relative density. SPT 'N'-values measured within the bottom portion of the granular deposit in Boreholes C57.1-S4 and C57.1-S5 are 15 blows per 0.08 m of penetration and 35 blows per 0 m of penetration, respectively, prior to split-spoon refusal.

The natural water content measured on two samples of this deposit is about 1 per cent and 14 per cent.

The grain size distributions of two (2) samples from this deposit are shown on Figure G.C57.1-3.

Bedrock / Refusal

In Boreholes C57.1-S3 to C57.1-S5 and DCPTs C57.1-DC01 to C57.1-DC03, refusal to further split-spoon/casing advancement or cone penetration was encountered between depths of 3.0 m and 5.9 m, between Elevations 205.4 m and 203.1 m.

Bedrock was encountered and core samples were recovered from Boreholes C57.1-S1 and C57.1-S2. The depth to the bedrock is 2.4 m and 5.2 m below ground surface, corresponding to Elevation 204.9 m and 203.5 m in the respective boreholes. The bedrock consists of granite gneiss and the core samples are described as slightly weathered, grey, pink white and black, coarse to very coarse grained, foliated, non-porous, and strong to very strong. The Rock Quality Designation (RQD) measured on the core samples ranges between 92 per cent and 100 per cent, indicating a rock mass of excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the samples recovered are 100 per cent, and between 92 per cent and 100 per cent, respectively.

Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table G1 in Appendix G. The point load index (Is_{50}) results from the axial laboratory tests carried out on four (4) samples of the granite gneiss bedrock range from approximately 4.9 MPa to 8.8 MPa. The point load index (Is_{50}) results from the diametral laboratory tests carried out on four (4) samples of the granite gneiss bedrock range from approximately 4.5 MPa to 7.4 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7012, on a selected core sample of the granite gneiss bedrock from Borehole C57.1-S1 and measured a compressive strength of about 60 MPa, as detailed in Table G2 in Appendix G.

Based on a laboratory UC tests and point load tests in accordance with Table 3.5 of CFEM (2006)³, the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) and very strong (R5, 100 MPa < UCS < 250 MPa).



Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in Boreholes C57.1-S1 to C57.1-S5 upon completion of drilling range between Elevations 207.8 m and 207.1 m, between depths of 0.2 m and 1.5 m below ground surface.



4.16 Highway 69 NBL – STA 16+345 (Culvert C57.1 – Site No. 44-621/C1)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at about STA 16+345 in the Township of Shawanaga are shown on Drawing G1 in Appendix G. The culvert alignment will extend across the proposed Highway 69 NBL embankment which will be up to about 5 m high above existing grade at the proposed culvert location. Five (5) boreholes (Boreholes C57.1-N1 to C57.1-N5, inclusive) were advanced to specifically investigate the subsurface conditions along the culvert. In addition, four (4) Dynamic Cone Penetration Tests (DCPTs C57.1-DC04 to C57.1-DC07, inclusive) were advanced near the culvert to further confirm the depth to refusal in this area. The topography in the culvert area is relatively flat with ground cover consisting of relatively densely treed areas. In general, the ground surface slopes down relatively gently towards the north where a low-lying swamp is located.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil underlain in places by a near-surface deposit of silt of high plasticity or sandy clayey silt. The topsoil and the near-surface cohesive deposit are underlain by a non-cohesive deposit ranging in composition from silt to sand inferred to contain some cobbles at the west end of the culvert, which in turn is underlain by a deposit of gravelly silt and sand to sand and gravel, underlain by granite gneiss and schist bedrock.

Topsoil

A 0.1 m to 0.2 m thick layer of topsoil was encountered at the ground surface in all boreholes.

Silt / Sandy Clayey Silt

A near-surface cohesive deposit of light brown/brown, moist, silt, some sand, trace organics to sandy clayey silt, trace organics, was encountered below the topsoil in Borehole C57.1-N2 and C57.1-N4, respectively. The top of the deposit is at Elevation 207.7 m and 208.5 m, and the thickness of the deposit is 0.7 m and 0.6 m, at the respective boreholes.

Two SPT 'N'-values recorded within the cohesive deposit were 8 blows and 10 blows per 0.3 m of penetration, indicating a firm to stiff consistency.

The natural water content measured on two (2) samples of this deposit is about 24 per cent and 71 per cent.

An Atterberg limits test carried out on a specimen of the silt deposit measured a liquid limit of about 55 per cent and a plastic limit of about 43 per cent, corresponding to a plasticity index of about 12 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure G.C57.1-4 in Appendix G and indicates that the material is a silt of high plasticity.

Sandy Silt to Sand

A non-cohesive deposit of brown to grey, moist to wet, sandy silt to silty sand to sand was encountered in all boreholes either below the topsoil or below the silt / sandy clayey silt deposit. The upper portion of the sandy silt to sand deposit in places contains trace to some organics. A pocket of sand and gravel was encountered within the sandy silt to sand deposit in Borehole C57.1-N1. The top of the deposit varies between Elevation 208.9 m and 207.0 m, and the overall thickness of the deposit ranges from 0.6 m to 2.7 m. Inferred cobbles, indicated by auger grinding, were encountered at the west end of the culvert in Borehole C57.1-N1 at a depth of 0.6 m, corresponding to Elevation 207.6 m.

The SPT 'N'-values recorded within the non-cohesive deposit range between 3 blows and 27 blows per 0.3 m of penetration, indicating a very loose to compact relative density.



The natural water content measured on samples of this deposit range from about 18 per cent and 33 per cent.

The grain size distributions of two (2) samples from this deposit are shown on Figure G.57.1-5 in Appendix G.

Sand and Gravel (Pocket)

A 0.7 m thick granular pocket of sand and gravel containing trace to some silt was encountered within the sand to sandy silt deposit in Boreholes C57.1-N1 at Elevation 207.4 m. Inferred cobbles, indicated by auger grinding, were encountered within this pocket at a depth of 1.4 m, corresponding to Elevation 206.8 m.

One (1) SPT 'N'-value recorded within the sand and gravel was 54 blows per 0.3 m of penetration, indicating a very dense relative density.

The natural water content measured on a sample of the sand and gravel is about 10 per cent.

A grain size distribution of one (1) sample of the sand and gravel is shown on Figure G.57.1-6 in Appendix G.

Gravelly Silt and Sand to Sand and Gravel

A non-cohesive deposit of brown to grey, moist to wet, gravelly silt and sand to sand and gravel was encountered below the sandy silt to sand deposit in all boreholes. At the west end of the culvert the deposit is inferred to contain cobbles below a depth of 2.3 m to 2.4 m below ground surface, below Elevations 205.8 m to 205.3 m. The top of the granular deposit varies between Elevations 208.2 m and 205.2 m, and the thickness of the deposit ranges from 0.2 m to 2.1 m. The bottom of this deposit is defined by bedrock in four boreholes and by refusal to split-spoon and casing advancement in Borehole C57.1-N4.

The SPT 'N'-values recorded within this granular deposit range between 16 blows per 0.3 m of penetration and 50 blows per 0.07 m of penetration, indicating a compact to very dense relative density. SPT 'N'-values measured within the bottom portion of the granular deposit in Boreholes C57.1-N4 and C57.1-N5 are 15 blows per 0 m of penetration and 22 blows per 15 m of penetration, respectively, prior to split-spoon and casing refusal on bedrock.

The natural water content measured on four (4) samples of this deposit range between about 9 per cent and 18 per cent.

The grain size distribution of two (2) samples from this deposit are shown on Figure G.C57.1-7.

Bedrock / Refusal

In Borehole C57.1-N4 and DCPTs C57.1-DC04 to C57.1-DC07, refusal to further split-spoon/casing advancement or cone penetration was encountered at depths between 1.0 m and 5.2 m below ground surface, corresponding to between Elevation 208.0 m and 203.4 m.

Bedrock was encountered and core samples were recovered from Boreholes C57.1-N1 to C57.1-N3 and C57.1-N5. The depth to the surface of the bedrock varies between 0.9 m and 2.9 m below ground surface, between Elevations 207.3 m and 205.0 m. The bedrock generally consists of granite gneiss in places consisting of granite gneiss and migmatite or granite gneiss and schist. The core samples are described as fresh, medium to coarse grained, moderately foliated, moderately porous, medium strong, black, grey and white. The Rock Quality Designation (RQD) measured on the core samples generally ranges between 69 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 the sample recovered are 100 per cent, and between 82 per cent and 100 per cent, respectively.



Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheets and in Table G1 in Appendix G. The point load index (Is_{50}) results from the axial laboratory tests carried out on eleven (11) samples of the granite gneiss bedrock range from approximately 2.6 MPa to 7.9 MPa. The point load index (Is_{50}) results from the diametral laboratory tests carried out on eleven (11) samples of the granite gneiss and one (1) sample of the granite gneiss and schist bedrock range from approximately 4.5 MPa to 9.3 MPa.

Three (3) Unconfined Compression (UC) tests were carried out in accordance to ASTM D7012, on selected core samples of the granite gneiss bedrock from Boreholes C57.1-N2, C57.1-N3 and C57.1-N5, and measured compressive strengths between about 73 MPa and 107 MPa, as detailed in Table G3 to G5 in Appendix G.

Based on the laboratory UC tests and point load tests, in accordance with Table 3.5, CFEM (2006)³, the granite gneiss / granite gneiss and migmatite / granite gneiss and schist bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in Boreholes C57.1-N1 to C57.1-N5 upon completion of drilling range between about Elevations 208.0 m and 207.3 m, at depths between 0.5 m and 1.0 m below ground surface.



4.17 Highway 69 SBL – STA 16+499 (Culvert C57 – Site No. 44-622/C2)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at about STA 16+499 in the Township of Shawanaga are shown on Drawing H1 in Appendix H. The culvert alignment will extend across the proposed Highway 69 SBL embankment which will be up to about 9 m high above existing grade at the proposed culvert location. Three (3) boreholes (Boreholes S24-03, S24-04 and S23-06) and one (1) DCPT (S24-DC01), advanced for the proposed highway embankment crossing of Swamp 24, but located in close proximity to the culvert, were utilized to investigate the subsurface conditions along the culvert alignment. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/peat underlain by a non-cohesive deposit generally grading from sandy silt to sand, underlain in places by a deposit of sand and gravel. Bedrock outcrops are present to the south of the proposed culvert alignment.

Ice / Water

Ice and water to a depth of 0.2 m was encountered in Borehole S24-06.

Root Mat / Peat

A deposit of dark brown, wet, root mat or amorphous peat containing rootlets was encountered either at the ground surface or below the ice/water cover in all the boreholes. The top of the root mat/peat deposit is between Elevation 203.1 m and 202.7 m and the thickness of the peat deposit is between 0.2 m and 0.4 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are 3 blows and 4 blows per 0.3 m of penetration, suggesting a soft consistency.

Silt

A 0.1 m to 0.2 m thick layer of brown to grey, wet silt, trace to some sand, trace clay was encountered in Boreholes S24-03 and S24-04 at surface, Elevations 202.4 m and 202.7 m, respectively.

Silt and Sand to Sand

A deposit of brown to grey non-cohesive soil grading from silt and sand to sand was encountered below the silt layer or peat deposit in all boreholes. The deposit generally contains trace gravel, trace clay, trace organics and root mat/rootlets near the surface. The top of this deposit ranges between Elevations 202.6 m and 202.2 m and the thickness of the deposit ranges between 9.0 m and 11.7 m. Boreholes S24-04 and S24-06 were terminated within this deposit upon refusal to further split-spoon and/or casing/auger advancement.

The SPT 'N'-values measured within this deposit range from 3 blows to 21 blows per 0.3 m of penetration, with 100 blows per 0.02 m and 0.25 m of penetrations recorded at the bottom of the deposit prior to split-spoon and casing refusal, indicating a very loose to compact relative density.

The natural water content measured on sixteen (16) samples of this deposit ranges from about 19 per cent to 28 per cent. The organic content measured on one (1) sample of the near surface of this deposit is about 1 per cent.



The grain size distributions of nine (9) samples of the silt and sand to sand portion of this deposit are shown on Figures H.C57-1A and H.C57-1B in Appendix H. An Atterberg limits test on one (1) sample of this deposit indicates this material to be non-plastic.

Sand and Gravel

A non-cohesive deposit of grey sand and gravel, trace silt was encountered below the sand deposit in Borehole 24-03, and extends to refusal at a depth of 12.7 m below ground surface. The top of the sand and gravel deposit is at Elevation 191.6 m and the thickness of the deposit is 1.6 m.

An SPT 'N'-value measured within the sand and gravel is 16 blows per 0.3 m of penetration, indicating a compact relative density.

Bedrock / Refusal

Bedrock outcrops are present to the south of the proposed culvert alignment. In Boreholes S24-03, S24-04, S24-06 and DCPT S24-DC01, refusal to further split-spoon, casing and/or auger advancement or cone penetration was encountered at depths between 9.5 m and 14.4 m below ice or ground surface, corresponding to between Elevations 193.6 m and 188.3 m.

Groundwater Conditions

The samples taken in the boreholes were wet with free water noted in a number of silt and sand and sand samples. Water levels observed in the boreholes upon completion of drilling range between Elevation 202.8 m and 202.7 m, measured at the ice and peat surface and at a depth of 0.3 m below the peat surface.



4.18 Highway 69 NBL – STA 16+485 (Culvert C57 – Site No. 44-622/C1)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at about STA 16+485 in the Township of Shawanaga are shown on Drawing H1 in Appendix H. The culvert alignment will extend across the proposed Highway 69 NBL embankment which will be up to about 9 m high above existing grade at the proposed culvert location. Three (3) boreholes (Boreholes S24-06, S24-10 and S24-11) and one (1) DCPT (DCPT S24-DC01), advanced for the proposed highway embankment crossing of Swamp 24, but located in close proximity to the culvert, were utilized to investigate the subsurface conditions along the culvert alignment. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/peat underlain by a deposit of sandy silt to sand, which in turn is underlain by a deposit of sand and gravel. The sand and gravel deposit is underlain by a lower deposit of silt and sand that extends to the refusal depth. Resistance to dynamic cone penetration and borehole advancement was encountered at greatest depth at about STA 16+475. Bedrock outcrops are present along the southern limit of the swamp.

Ice / Water

Ice and water to depths between 0.2 m and 0.3 m were encountered in all the boreholes.

Root Mat / Peat

A deposit of dark brown, wet, root mat and/or amorphous peat containing sand lenses was encountered below the ice/water cover in all the boreholes. The top of the root mat/peat deposit ranges between Elevation 202.5 m and 201.9 m and the thickness of the peat deposit is between 0.2 m and 1.1 m.

An SPT 'N'-value recorded within the peat was 1 blow per 0.3 m of penetration, suggesting a very soft consistency.

Silt

In Borehole S24-10, a 0.1 m thick layer of grey, wet silt was encountered underlying the peat deposit at Elevation 201.9 m; and a 0.6 m thick pocket of grey, wet silt was encountered within the silt and sand deposit (described below) at Elevation 190.2 m.

Sandy Silt to Sand

A non-cohesive deposit of brown to grey soil grading from sandy silt to silt and sand to silty sand to sand was encountered below the root mat/peat deposit or silt layer in all boreholes. The deposit generally contains trace gravel, trace clay, trace organics and root mat/rootlets near the surface. The sandy silt to silt deposit is interlayered with a 1.4 m thick deposit of sand and gravel (described below) and 0.6 m thick pocket of silt (described above). The top of this deposit ranges between Elevation 202.3 m and 200.8 m and the overall thickness of the deposit ranges between 5.4 m and 13.9 m, including the sand and gravel layer and the silt pocket. Boreholes S24-06 and S24-11 were terminated within this deposit upon refusal to further split-spoon and/or auger/casing refusal.

The SPT 'N'-values measured within the sandy silt to sand deposit range from 2 blows to 49 blows per 0.3 m of penetration but are typically greater than 10 blows, and an SPT 'N'-value of 100 blows per 0.25 m of penetration



was recorded at the bottom of the deposit prior to split-spoon and auger refusal in Borehole S24-06. The SPT 'N'-values measured in this deposit indicate a very loose to dense relative density.

The natural water content measured on seventeen (17) samples of this deposit ranges from about 14 per cent to 46 per cent. The organic content measured on two (2) samples of the near surface of this deposit is about 0.5 per cent and 1 per cent.

The grain size distributions of nine (9) samples from this deposit are shown on Figures H.C57-2A and H.C57-2B in Appendix H.

Sand and Gravel

A deposit of grey sand and gravel trace silt containing some cobbles and a boulder was in Borehole S24-10 interlayered with the sand / silt and sand and underlying the silt and sand portions of the sandy silt to sand deposit. The sand and gravel interlayer is 1.4 m thick and was encountered at Elevation 192.5 m; and the lower sand and gravel deposit is 1.6 m thick and was encountered at Elevation 187.9 m. The bottom of the lower deposit of the sand and gravel deposit is defined by refusal to further split-spoon and casing advancement.

The SPT 'N'-values measured within the sand and gravel interlayer and deposit are 17 blows and 33 blows per 0.3 m of penetration, indicating a compact to dense relative density.

Bedrock / Refusal

Bedrock outcrops are present to the south of the proposed culvert alignment. In Boreholes S24-06, S24-10 and S24-11, refusal to further split-spoon and/or auger/casing advancement was encountered at depths ranging between 6.8 m and 16.1 m below ice surface, corresponding to between Elevation 195.4 m and 186.3 m.

Groundwater Conditions

The samples taken in the boreholes were wet with free water noted. Water levels observed in the boreholes upon completion of drilling range from Elevation 202.7 m to 202.2 m, measured at the ice surface.



4.19 Highway 69 SBL – STA 17+272 (Culvert C60)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 17+272 in the Township of Shawanaga are shown on Drawing I1 in Appendix I. The culvert will extend across a swamp area (Swamp 25) and the proposed Highway 69 SBL embankment, which will be up to about 8.5 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C60-S1 to C60-S3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography in the area is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat underlain by a deposit of silty sand, over a deposit of clay. The clay deposit is in turn underlain by a deposit of silt in places, underlain by a deposit of sand which extends to the refusal depth. Bedrock outcrops are present to the north and south of the swamp in which the culvert is located.

Ice / Water

Ice and water to depths between 0.8 m and 1.2 m was encountered in Boreholes C60-S1 to C60-S3.

Peat

A 0.1 m to 0.2 m thick layer of dark brown, wet, fibrous peat was encountered underlying the ice/water cover in all boreholes drilled at this culvert location. The top of the peat varies between Elevation 201.8 m and 201.5 m.

A SPT 'N'-value recorded within this layer is 0 blows (weight of hammer) per 0.3 m of penetration, indicating a very soft consistency.

Silty Sand

A deposit of brown to grey silty sand, trace clay containing organics was encountered below the peat in all boreholes. The top of the silty sand deposit ranges from Elevation 201.7 m to 201.2 m and its thickness ranges from 1.5 m to 2.2 m.

The SPT 'N'-values measured within this deposit range from 6 blows to 14 blows per 0.3 m of penetration, but are typically less than 9 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The natural water content measured on samples of this deposit ranges between about 25 per cent and 27 per cent. The upper portion of the silty sand deposit was visually noted to be slightly organic. Laboratory testing on one (1) sample of the silty sand measured an organic content of about 1 per cent.

A grain size distribution of one (1) sample of the silty sand deposit is shown on Figure I.C60-1 in Appendix I.

Clay

A deposit of brown and grey clay, some silt and trace sand was encountered below the deposit of silty sand in all boreholes advanced at this culvert location. The top of the clay deposit is at between Elevation 199.7 m and 199.6 m and its thickness ranges from 0.7 m to 2.8 m.

The SPT 'N'-values recorded within the cohesive deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths



between about 14 kPa and 20 kPa and the sensitivity is calculated to range from about 5 to 8. The field vane tests results together with the SPT 'N'-values indicate that the clay deposit has a very soft to soft consistency.

The natural water content measured on two (2) samples of this deposit is about 45 per cent and 74 per cent.

An Atterberg limits test carried out on one (1) sample of the clay deposit measured a liquid limit of about 60 per cent, a plastic limit of about 20 per cent and a corresponding plasticity index of about 40 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure I.C60-2 in Appendix I and indicate that the material is classified as clay of high plasticity.

Silt

Underlying the clay deposit in Boreholes C60-S1 and C60-S2 is a deposit of grey silt, some sand and trace clay. The top of the silt deposit is at Elevation 198.8 and 197.6 m and its thickness is 0.8 m and 0.3 m in Boreholes C60-S1 and C60-S2, respectively.

The SPT 'N'-values recorded within this deposit are 0 blows (weight of hammer) and 3 blows per 0.3 m of penetration, indicating that the silt has a very loose relative density.

The natural water content measured on a sample of this deposit is about 23 per cent.

An Atterberg limits test carried out on a sample of the silt deposit measured a liquid limit of about 17 per cent and a plastic limit of about 14 per cent, corresponding to a plasticity index of about 3 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure I.C60-3 in Appendix I and indicate the material to be a silt of low plasticity.

Sand

A deposit of grey to brown sand, trace to some gravel and trace to some silt was encountered below the deposit of silt in Boreholes C60-S1 and C60-S2 and below the clay deposit in Borehole C60-S3. The top of the sand deposit ranges from Elevation 198 m to 196.9 m and its thickness ranges from 0.1 m to 9.3 m. The bottom of this deposit was defined by refusal to further split-spoon and/or casing advancement.

The SPT 'N'-values recorded within this deposit typically range from 3 blows to 21 blows per 0.3 m of penetration, but are typically greater than 6 blows per 0.3 m of penetration, indicating a generally loose to compact relative density. A SPT 'N'-value of 4 blows per 0.13 m of penetration was recorded prior to split-spoon refusal in Borehole C60-S1 and a SPT 'N'-value of 150 blows per 0.15 m of penetration was recorded prior to casing refusal.

The natural water content measured on samples of the sand deposit ranges from about 11 per cent to 36 per cent.

The grain size distributions of two (2) samples from this deposit are shown on Figure I.C60-4 in Appendix I.

Bedrock / Refusal

Bedrock outcrops are present to the north and south of the swamp area in which the culvert is located. In Boreholes C60-S1 to C60-S3, refusal to further split-spoon and/or casing advancement was encountered at depths between 4.7 m and 15.1 m, corresponding to Elevation 197.9 m and 187.6 m.



Groundwater Conditions

In general, the samples taken in the boreholes were wet with free water noted in select sand samples. The water levels observed in the boreholes upon completion of drilling were at Elevation 202.6 m and 202.5 m, measured at a depth of 0.1 m below the ice surface.



4.20 Highway 69 NBL – STA 17+276 (Culvert C60)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 17+276 in the Township of Shawanaga are shown on Drawing I1 in Appendix I. The culvert will extend across a swamp area (Swamp 25) and the proposed Highway 69 NBL embankment which will be up to about 8 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C60-N1 to C60-N3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography in the area is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat underlain by a deposit of silt and sand to sand, underlain by a deposit of silty clay. The silty clay deposit is underlain by deposits of silt and/or silty sand in places, which in turn is underlain by a deposit of silt and sand to sand. Bedrock outcrops are present to the north and south of the swamp in which the culvert is located.

Ice / Water

Ice and water to a depth of 0.8 m was encountered in Borehole C60-N3.

Peat

A deposit of dark brown, wet, fibrous peat containing rootlets was encountered at the ground surface in Boreholes C60-N1 and C60-N2 and below the ice/water cover in Borehole C60-N3. The top of the peat ranges from Elevation 203.2 m to 201.8 m and its thickness varies between 0.1 m and 0.6 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are 0 blows (weight of hammer) and 4 blows per 0.3 m of penetration, indicating a very soft to soft consistency.

Silt and Sand to Sand (Upper Deposit)

A deposit of non-cohesive soil comprised of brown to grey silt and sand, silty sand and sand some silt was encountered below the peat in all boreholes. The deposit generally contains trace clay and the near surface portion of the deposit contains organics and wood fragments. The top of the silt and sand to sand deposit ranges from Elevation 202.6 m to 201.6 m and its thickness ranges from 1.6 m to 3.1 m.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 18 blows per 0.3 m of penetration, but are typically greater than 6 blows per 0.3 m of penetration, indicating a generally loose to compact relative density.

The natural water content measured on samples of this deposit ranges from about 24 per cent to 35 per cent. The upper portion of the silt and sand to sand deposit was visually noted to be slightly organic. Laboratory testing on one (1) sample of the silty sand measured an organic content of about 2 per cent.

The grain size distributions of three (3) samples of the silt and sand to sand deposit are shown on Figure I.C60-5 in Appendix I.



Silty Clay

A deposit of brown to grey silty clay trace sand was encountered below the deposit of silt and sand to sand in all boreholes advanced in this area. The top of the silty clay deposit ranges from Elevation 200 m to 199.2 m and its thickness ranges from 0.8 m to 3.1 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer) to 4 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths of about 19 kPa and 20 kPa and the sensitivity is calculated to be about 6. The field vane tests results together with the SPT 'N'-values indicate that the silty clay deposit has a very soft to soft consistency.

The natural water content measured on samples of this deposit ranges from about 32 per cent to 67 per cent.

Atterberg limits tests carried out on two (2) samples of the silty clay deposit measured liquid limits of about 38 per cent and 49 per cent, plastic limits of about 17 per cent and 18 per cent, corresponding to plasticity indices of about 21 per cent and 31 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure I.C60-6 in Appendix I and indicate that the material is classified as silty clay of intermediate plasticity.

Silty Sand

Underlying the silty clay deposit in Borehole C60-N2 is a deposit of grey silty sand, trace gravel and trace clay. The top of the silty sand deposit is at Elevation 198.7 m and its thickness is 1.4 m.

A SPT 'N'-value recorded within this deposit is about 5 blows per 0.3 m of penetration, indicating a loose relative density.

Silt

A deposit of grey and reddish brown silt, some sand and trace clay was encountered underlying the silty clay deposit in Borehole C60-N1 and below the deposit of silty sand in Borehole C60-N2. The top of the silt deposit is at Elevation 196.9 and 197.3 m and its thickness is 0.7 m and 1.3 m in Boreholes C60-N1 and C60-N2, respectively.

The SPT 'N'-values recorded within this deposit are 5 blows and 6 blows per 0.3 m of penetration, indicating a loose relative density.

The natural water content measured on two (2) samples of this deposit is about 22 per cent and 30 per cent.

A grain size distribution of one (1) sample from the silt deposit is shown on Figure I.C60-7 in Appendix I.

An Atterberg limits test carried out on a sample of the silt deposit measured a liquid limit of about 19 per cent and a plastic limit of about 17 per cent, corresponding to a plasticity index of about 2 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure I.C60-8 in Appendix I and indicate the material to be a silt of low plasticity.

Silt and Sand to Sand (Lower Deposit)

A deposit of grey to brown silt and sand to sand, trace to some silt and trace to some gravel was encountered below the silt deposit in Boreholes C60-N1 and C60-N2 and below the silty clay deposit in Borehole C60-N3. The top of the silt and sand to sand deposit ranges from Elevation 196.8 m to 196 m and its thickness ranges



from 4.6 m to 9.1 m. The bottom of this deposit was defined by refusal to further split-spoon and/or casing advancement.

The SPT 'N'-values measured within this deposit range from 4 blows to 22 blows per 0.3 m of penetration, indicating a loose to compact relative density. The natural water content measured on samples of this deposit ranges between about 21 per cent and 25 per cent.

A grain size distribution of one (1) sample of the silt and sand deposit is shown on Figure I.C60-9 in Appendix I.

Bedrock / Refusal

Bedrock outcrops are present to the north and south of the swamp area in which the culvert is located. In Boreholes C60-N1 to C60-N3, refusal to further casing advancement was encountered at depths between 10.6 m and 14.9 m, corresponding to Elevation 191.6 m and 187.7 m.

Groundwater Conditions

In general, the samples taken in the boreholes were wet with free water noted in select sand samples. Water levels observed in the boreholes upon completion of drilling range from Elevation 202.9 m and 202.2 m, measured at the ground surface and up to a depth of 0.3 m below the ice or ground surface.



4.21 Shebeshekong Road S-E/W Ramp – STA 14+990 (Culvert C51)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 14+990 in the Township of Shawanaga are shown on Drawing J1 in Appendix J. The culvert will extend across the proposed Shebeshekong Road S-E/W Ramp embankment which will be up to about 5.5 m high above the existing grade at the proposed culvert location. One (1) borehole (Borehole C51-R1) was advanced to specifically investigate the subsurface conditions at the east end of the culvert and is supplemented with Boreholes S22-02 and S22-03 advanced for the proposed Shebeshekong Road S-E/W Ramp embankment crossing of Swamp 22. In addition, one (1) Dynamic Cone Penetration Test (DCPT S22-DC03) was advanced near the culvert to further confirm the depth of refusal in this area. The topography in the area is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil (where present) and a deposit of sandy silt to sand which in turn is underlain by a stratum of clayey silt. The clayey silt stratum is underlain by an upper deposit of silt and sand which is underlain in places by a clay stratum. The clay stratum or silt and sand deposit in turn is underlain by a lower deposit of silt and sand to sand and refusal conditions.

Topsoil

A 0.2 m thick layer of topsoil was encountered in Borehole C51-R1.

Sandy Silt to Sand

A non-cohesive deposit of light/dark brown to grey, moist to wet, sandy silt to sand, trace to some silt, trace organics was encountered below the topsoil in Borehole C51-R1 and at the ground surface in Boreholes S22-02 and S22-03. The top of the sandy silt to sand deposit ranges from Elevation 207.7 m to 207.0 m, and the thickness of this deposit ranges from 2.5 m to 3.2 m.

The SPT 'N'-values measured within this deposit range from 1 blow to 32 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The natural water content measured on samples of this deposit ranges from about 23 per cent to 37 per cent and the organic content of one (1) sample of the sandy silt deposit recovered from Borehole S22-03 is about 3 per cent.

The grain size distributions of two (2) samples of this deposit are shown on Figure J.C51-1 in Appendix J.

Clayey Silt

A stratum of grey/reddish brown, wet, clayey silt containing trace sand was encountered below the deposit of sandy silt to sand in all boreholes. The top of the clayey silt deposit ranges from Elevation 204.5 m to 204.2 m, and the thickness of this deposit ranges between 1.0 m and 1.2 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration. Two in situ field vane tests carried out in Boreholes C51-R1 and S22-02 within this stratum measured undrained shear strengths of about 25 kPa and 36 kPa and sensitivities of 7 and 4, respectively. The field vane test results indicate that the clayey silt stratum has a firm consistency.

The natural water content measured on samples of this deposit ranges from about 39 per cent to 51 per cent.

Atterberg limits tests carried out on two (2) samples of the clayey silt deposit measured liquid limits of about 27 per cent and 33 per cent, plastic limits of about 14 per cent, corresponding to plasticity indices of about



13 per cent and 18 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure J.C51-2 in Appendix J and indicate that the material is classified as clayey silt of low plasticity.

Silt and Sand (Upper Deposit)

A non-cohesive upper deposit of grey, wet, silt and sand containing trace to some clay and trace gravel was encountered below the clayey silt stratum in all boreholes. The top of the silt and sand deposit ranges from Elevation 203.4 m to 203.1 m, and the thickness of the deposit ranges from 2.8 m to 3.4 m.

The SPT 'N'-values measured within this deposit range from 1 blow 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 20 per cent to 22 per cent.

The grain size distributions of two (2) samples of the silt and sand deposit are shown on Figure J.C51-3 in Appendix J.

Clay

A stratum of reddish brown, wet, clay containing some silt, trace sand, was encountered below the upper silt and sand deposit in Boreholes S22-02 and S22-03. The top of the clay deposit is at Elevation 200.3 m and 200.1 m, and the thickness of this deposit is 1.5 m.

An SPT 'N'-value measured within the cohesive deposit is 2 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths of about 35 kPa and 36 kPa. The sensitivity is calculated to be about 4 and 6. The field vane tests results together with the SPT 'N'-values suggest that the clay deposit has a soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 56 per cent to 73 per cent.

Atterberg limits tests carried out on two (2) samples of the clay deposit measured liquid limits of about 59 per cent and 62 per cent, plastic limits of about 20 per cent and 21 per cent, corresponding to plasticity indices of about 39 per cent and 41 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure J.C57-4 in Appendix J and indicate that the material is classified as clay of high plasticity.

Silt and Sand to Sand (Lower Deposit)

A lower non-cohesive deposit of grey/reddish brown, wet, silt and sand to silty sand to sand, containing trace to some clay, trace gravel, was encountered below the clay stratum in Boreholes S22-02 and S22-03 and below the upper deposit of silt and sand in Borehole C51-R1. The top of silt and sand to sand lower deposit ranges from Elevation 200.0 m to 198.6 m, and the thickness of this deposit ranges from 1.8 m to 4.7 m.

The SPT 'N'-values measured within this deposit range from 4 blows to 18 blows per 0.3 m of penetration, indicating a loose to compact relative density. SPT 'N'-values measured within the bottom portion of the non-cohesive deposit in Boreholes S22-02 and S22-03 are 50 blows per 0.05 m of penetration and 2 blows per 0.08 m of penetration, respectively, prior to split-spoon refusal.

The natural water content measured on samples of this deposit ranges from about 16 per cent to 24 per cent.

The grain size distributions of two (2) samples of the silt and sand portion of the deposit are shown on Figure J.C51-5 in Appendix J.



Bedrock / Refusal

Boreholes C51-1R, S22-02 and S22-03 and DCPT S22-DC03 (including a DCPT advanced about 0.5 m east of Borehole C51-R1) encountered refusal to further split-spoon or casing advancement or cone penetration at depths between 9.0 m and 13.8 m below ground surface, corresponding to between Elevation 198.3 m and 193.9 m; however, the DCPT advanced near Borehole C51-R1 penetrated to a depth of 13.0 m below ground surface, inferred due to sliding along a sloping bedrock surface.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels were measured in the Boreholes C51-R1 and S22-03 upon completion of drilling at Elevation 206.8 m and 207.0 m, respectively, at depths of 0.4 m and 0.7 m below the ground surface. In Borehole S22-02, the water level was measured at 0.6 m above the ground surface, corresponding to Elevation 207.8 m, indicating artesian conditions.



4.22 Site No. 9 Road – STA 10+235 (Culvert C53)

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 10+235 in the Township of Shawanaga are shown on Drawing K1 in Appendix K. The culvert will extend across the proposed Site No. 9 Road which will be up to about 4 m high above the existing grade at the proposed culvert location. A total of two (2) borehole (Boreholes C53-01 and C53-02) were advanced to specifically investigate the subsurface conditions along the culvert and are supplemented with Borehole S26-03 advanced for the proposed Site No. 9 Road embankment crossing of Swamp 26. The topography in the area is relatively flat, with ground cover consisting of shrubs, sparse trees and wet grassy areas, located within the confines of a relatively higher ground and densely treed area and bounded to the east by the existing Highway 69. Bedrock outcrops are present along the southern limit of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of sandy organic silt (where present) underlain by a non-cohesive deposit of silt to sand which is underlain by granite gneiss bedrock.

Sandy Organic Silt

A 0.3 m thick, non-cohesive deposit of brown, wet, sandy organic silt was encountered at the ground surface in Boreholes C53-01 and C53-02.

The SPT 'N'-values measured within the sandy organic silt are 2 blows and 4 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on one (1) sample of the sandy organic silt from Borehole C53-02 is about 539 per cent.

Silt to Sand

A non-cohesive deposit of brown to grey, moist to wet, silt, some sand to sandy silt to silt and sand to silty sand to sand was encountered below the sandy organic silt in Boreholes C53-01 and C53-02 and at the ground surface in Borehole S26-03. The upper portion of the non-cohesive deposit (up to a depth of 2.2 m below ground surface) contains trace organics. A pocket of silty clay was encountered between the silt and sand and the silt portions of the overall deposit in Borehole C53-01. The top of the silt and sand deposit ranges between Elevation 210.9 m and 210.5 m, and the overall thickness of the deposit ranges from 5.1 m to 7.1 m. In Borehole C53-02 the bottom of this deposit is defined by bedrock, and in Boreholes C53-01 and S26-03 the bottom of the deposit is defined by refusal to further split-spoon/casing advancement.

The SPT 'N'-values recorded within the non-cohesive deposit range between 0 blows (weight of hammer) and 15 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit range between about 19 per cent and 26 per cent.

The grain size distributions of seven (7) samples of this deposit are shown on Figure K.C53-1 in Appendix K.

Silty Clay (Pocket)

A 0.5 m thick pocket of grey, wet, silty clay was encountered between the silt to sand / silt portions of the non-cohesive deposit in Borehole C53-01 at Elevation 202.8 m.

One (1) SPT 'N'-value measured within the silty clay pocket is 7 blows per 0.3 m of penetration, suggesting a firm consistency.



The natural water content measured on one (1) sample of the silty clay pocket is about 55 per cent.

An Atterberg limits test carried out on a specimen of the silt clay measured a liquid limit of about 41 per cent and a plastic limit of about 17 per cent, corresponding to a plasticity index of about 24 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure K.C53-2 in Appendix K and indicates that the material is a silty clay of intermediate plasticity.

Bedrock / Refusal

In Boreholes C53-01 and S26-03, refusal to further split-spoon/casing advancement was encountered at a depth of 7.4 m and 6.1 m below ground surface, respectively, corresponding to Elevations 203.6 m and 204.8 m.

Bedrock was encountered and core samples were recovered from Borehole C53-02. The depth to bedrock is 5.4 m below ground surface, corresponding to Elevation 205.4 m. The bedrock consists of granite gneiss and the core samples are described as fresh, foliated, grey, white and pink, coarse to fine grained containing garnet porphyries, non-porous, and strong to extremely strong. The Rock Quality Designation (RQD) measured on the core samples is 100 per cent, indicating a rock mass of excellent quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the samples recovered are 100 per cent and between 78 per cent and 100 per cent, respectively.

Axial and diametral point load strength index values for selected samples of rock core are shown on the Record of Drillhole Sheet and in Table K1 in Appendix K. The point load index (Is_{50}) results from the axial laboratory tests carried out on four (4) samples of the granite gneiss bedrock range from approximately 3.7 MPa to 10.5 MPa. The point load index (Is_{50}) results from the diametral laboratory tests carried out on two (2) samples of the granite gneiss bedrock are approximately 4.3 MPa and 4.5 MPa.

Based on laboratory point load tests, in accordance with Table 3.5, CFEM (2006)³, the granite gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to extremely strong (R6, UCS >250 MPa).

Groundwater Conditions

In general, the samples taken in the boreholes were wet. The depth to the water levels measured in the boreholes upon completion of drilling range from ground surface to 0.3 m below the ground surface, ranging from Elevation 210.8 m to 210.6 m.



5.0 CLOSURE

The field technicians directing the drilling program were Messrs. Matt Rhody, Indulis Dumpis and Mathew Riopelle. This report was prepared by Mr. Tomaz Zalucki, P. Eng., Ms. Veronica T. Ayetan, P. Eng., and Mr. Alex Szot and was reviewed by Mr. Christopher Ng, P.Eng., a Senior Geotechnical Engineer and Associate of Golder. Mr. Jorge M. A. Costa, P. Eng., Golder's Designated MTO Contact for this project and Principal of Golder, conducted an independent quality control review of the report.



FOUNDATION REPORT – CULVERTS – PHASE 2
HIGHWAY 69 G.W.P. 5111-07-00

Report Signature Page

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69 culverts - phase 2.docx



PART B

FOUNDATION DESIGN REPORT

CULVERTS – PHASE 2

HIGHWAY 69 FOUR-LANING

FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559

INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF

HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM

MINISTRY OF TRANSPORTATION, ONTARIO

G.W.P. 5111-07-00 (PHASE 2 OF G.W.P. 5402-05-00)



6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides an interpretation of the factual geotechnical data obtained during the subsurface investigation and recommendations on the foundation aspects of design of the proposed works. The recommendations provided are intended for the guidance of the design engineer. Where comments are made on construction, they are provided to highlight aspects of construction that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the subsurface information provided as it affects their proposed construction methods, costs, equipment selection, scheduling and the like.

6.1 General

Golder Associates Ltd. (Golder) was retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation design recommendations for the proposed culverts at various locations along the proposed Phase 2 – Highway 69 alignment within the current project limits. The scope of work includes carrying out stability and settlement analyses, assessments of preferred mitigation options to minimize total and differential settlements for the individual culverts and recommendations of the preferred option, provision of geotechnical resistances and estimating horizontal and vertical strains and maximum joint opening allowances along the culverts. The work also includes addressing foundation aspects for the final design and construction of head walls and wing walls associated with the culverts (where applicable), identifying construction concerns and potential geotechnical problems associated with the culverts, including requirements for full sub-excavation of soft / organic materials and placement of new fill, as well as requirements for erosion protection and bedding materials.

The overall project involves the design of a 17 km section of the new Highway 69 four-laning alignment north of Nobel, Ontario, including high fill embankments and embankments over swamps, the Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, as well as culvert crossings. As part of this work, foundation recommendations are required for twenty (20) culverts between the new Shebeshekong Road interchange and the Shawanaga River (Phase 2 project limits). The details of the proposed culverts currently investigated within the Phase 2 project limits, including the culvert locations, dimensions and invert elevations are summarized in Table 1.

6.2 Culvert Types

Based on the proposed culvert details provided in a CAD file by MRC on November 11, 2014, the analyses and recommendations in this report assume that pre-cast and cast-in-place concrete box culverts will be constructed for this section of the proposed Highway 69 alignment.

6.3 Culvert Construction Options

In general, the foundation strata at the culvert crossings will undergo settlement as a result of loading from new embankment construction in the Phase 2 area. Therefore, the timing of culvert construction is an essential factor in determining the preferred mitigation option. The following alternatives for culvert construction can be considered (where applicable, giving due consideration to the recommended foundation mitigation option for the accompanying embankment):

- concurrent with embankment construction;
- following the preload period of embankment construction; or,



- following full sub-excavation of unsuitable subsoils along the culvert alignment and concurrent with embankment construction.

Where relatively small settlements are estimated to occur due to relatively thin, compressible foundation strata at the culvert locations, culvert construction can commence immediately following excavation of the existing embankment fill and/or surficial organic soils and concurrently with the proposed new embankments so long as any requirements for maintaining embankment stability are addressed. If required, the culvert design could include a camber.

Where relatively large settlements are estimated to occur, it is recommended that the culverts be constructed subsequent to the embankment preload period, or following full sub-excavation of cohesive deposits, to provide an adequate long-term performance of the culvert and the associated overlying and adjacent roadway. The following sections provide a more detailed discussion on the possible alternatives for culvert construction to mitigate settlements and improve long-term performance.

6.3.1 Culvert Construction Concurrent with Embankment Construction

Culverts which are constructed concurrently with the new embankments will experience settlement (both short-term and long-term) as well as lateral spreading (or horizontal strain in the longitudinal direction) as a result of the embankment loading. The analyses of settlement and horizontal strain are discussed in Section 6.4.2 and Section 6.4.3, respectively. If the culvert is capable of tolerating the estimated total and differential settlements and associated strains, the culvert could be constructed with a camber (if necessary), such that once the settlement has occurred, the hydraulic flow will be maintained as originally designed. However, culvert designs which include a camber may have a relatively high risk of poor performance (depending on the estimated settlements) resulting in unfavourable drainage/surface flow conditions at some locations. It is important to note that it is inherently difficult to predict settlements for the variable subsurface conditions along the culvert alignments with such a degree of accuracy to allow a successful camber design. If the actual settlements are smaller than predicted, the culvert may not achieve the design grade or slope which could impede the flow of water. If actual settlements are larger than expected, the culvert may sag below the design invert elevation and as a result become filled with sediment which could impede the flow of water. The incorporation of expansion joints along the length of the culvert should also be considered in the design to accommodate horizontal strain which will occur in conjunction with the vertical settlement. If the culvert cannot tolerate the estimated settlement and horizontal strain, consideration should be given to constructing the culvert following the preload period of the embankment (see Section 6.3.2) or following full sub-excavation of the compressible, cohesive deposits (see Section 6.3.3).

It should be noted that where this option is adopted as the preferred alternative for construction of any of the culverts, it is still necessary that all organic material be sub-excavated prior to placement of any fill or bedding material due to the highly compressible nature of organic soils which can undergo significant secondary (creep) settlement.

6.3.2 Culvert Construction Following Embankment Preload Period

At locations where the magnitudes of estimated total and differential settlements and horizontal strains cannot be tolerated and/or where removal of localized clayey deposits and replacement with rock fill is not considered practical, the culverts should be constructed after a preload period. Preloading refers to the placement of fill to the proposed height of embankment (possibly in stages), in advance of construction of the permanent culvert, in order to consolidate the underlying compressible soils. If preloading of the embankment at the culvert location is completed prior to construction of the permanent culvert, the magnitude of total and differential settlement beneath the culvert and horizontal strain along the culvert will be reduced. However, this mitigation option requires excavation through the new embankment fill to the culvert founding elevation at the end of the preload



period in order to construct the permanent culvert. Provided that the final fill above the culvert is properly placed and compacted, the magnitude of differential settlement between the fill embankment (that has been compressed under its self-weight for the entire preload period) and the final backfill above the culvert should be acceptable.

In addition, it may be more practical to construct a temporary granular fill core within the embankment in the proximity of the culvert location to allow for ease of sub-excavation of the embankment fill in this area following the preload period. Details regarding the temporary granular fill core are provided in Section 6.9.1.

It should be noted that with preloading, it is still required that all organic material be sub-excavated prior to placement of any fill and bedding material due to the highly compressible nature of organic soils which can undergo significant secondary (creep) settlement.

6.3.3 Culvert Construction Following Full Sub-Excavation

Depending on the depth and thickness of the soft, compressible deposit(s), the magnitude of total and differential settlement and horizontal strain could also be reduced by means of full sub-excavation and replacement along the culvert alignment to allow for permanent culvert construction prior to embankment loading (i.e. concurrent with embankment construction). At culvert locations where the compressible deposits are thick, the resulting magnitude of settlements as well as the associated horizontal strains, even with full sub-excavation, may still be too large, as a result of compression of the underlying fill itself, to accommodate standard culvert construction. However, where there is a limited thickness and depth of soft, compressible soils underlying the proposed culvert, full sub-excavation and replacement is a feasible option to reduce the settlement and allow for culvert construction in conjunction with the new embankment. The costs of full sub-excavation and backfilling would have to be assessed in the cost/benefit analysis when choosing the preferred mitigation option.

Although full sub-excavation will improve the settlement performance of the culverts and embankment in close proximity of the sub-excavation, adjacent areas of the embankment may not experience the same improvements in settlement performance depending on the mitigation measures adopted for the adjacent swamp crossing. As a result, the overlying embankment may experience some differential settlements depending on the timing of embankment construction/culvert construction, type of backfill and timing of final earthwork and paving.

It should also be noted that settlement of the replacement rock fill beneath the culvert base will occur and could constitute a significant portion of the expected settlements, depending on the depth of sub-excavation required.

Where full sub-excavation is adopted, the additional rock fill below the base of the culvert should be constructed with the same side slope profile as that of the above-grade embankment (i.e. 1.25H:1V) since this is the natural slope of rock fill and should not be affected by underwater placement. In addition, the necessity to develop stable side slopes and back slopes within the excavation may result in cut slope geometries ranging from 1H:1V to as flat as 3H:1V, especially where excavations are carried out 'in-the-dry'. Recommendations with respect to excavations and unwatering are given in Section 6.8. It should be noted that full sub-excavation at the culvert locations will produce extra volumes of spoil material for disposal.

6.4 Stability, Settlement and Horizontal Strain

The following sections summarize the methods utilized to carry out analyses of stability and settlement of the culverts and methods utilized to evaluate horizontal strains along the culverts beneath the zone of influence of the proposed embankment loading.



6.4.1 Stability

The methodology used to evaluate embankment stability at the culvert locations is described below. In addition, the parameters used in the analyses for each culvert location are also presented. The results of the analyses for each culvert location are discussed in Section 6.6.

6.4.1.1 Methodology

Embankment stability analyses were performed at each culvert location. In all areas where cohesive deposits were encountered, the stability of the proposed new embankment section(s) was analyzed using limit equilibrium methods.

All limit equilibrium slope stability analyses were performed using the commercially available program Slide (Version 5.0), produced by Rocscience Inc., employing the Morgenstern-Price method of analysis. For the analyses, the factor of safety of numerous potential failure surfaces was computed in order to establish the minimum Factor of Safety. The Factor of Safety is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. A target minimum Factor of Safety of 1.3 is normally adopted for the design of embankment slopes under static conditions. This Factor of Safety is considered adequate for the embankments at these sites considering the design requirements and the field data available and is based on deep-seated, global failure surfaces that would affect the operation of the roadway. The stability analyses were performed to check that the target minimum Factor of Safety was achieved for the embankment heights and geometries at the culvert locations.

The stability analyses assume that all organic soils beneath the culvert alignment will be removed prior to construction and that rock fill will be used for replacement of sub-excavated material (as discussed in Section 6.8.1.1). The piezometric conditions required in the analyses were based on the groundwater levels observed during drilling, which were generally located at about the level of the natural ground surface.

6.4.1.2 Parameter Selection

The simplified stratigraphy together with the associated strength and unit weight values assigned to the different native soil types at the culvert locations are summarized in Table 2. The rock fill modeled in the analyses is assumed to have a unit weight of 19 kN/m³ and an effective friction angle of 40° and the embankments constructed with 1.25H:1V side slopes.

The subsoils encountered in the culvert areas are composed of combination of granular soils (silts, sands and sandy silt/silty sand) and cohesive deposits (silty clay and clay). For granular soils, effective stress parameters were employed in the analyses assuming drained conditions. The effective stress parameters (effective friction angle and effective cohesion) for the granular soils were estimated from empirical correlations using the results of the in situ Standard Penetration Tests (SPT), in conjunction with engineering judgement based on experience in similar soil conditions.

For cohesive deposits, total stress parameters were employed in the analyses assuming undrained conditions. The total stress parameters (i.e. average mobilized undrained shear strength – s_u) for the cohesive soils were assessed based primarily on the results of in situ field vane shear tests and inferred from the laboratory consolidation tests results (where available), and also estimated from correlations with the SPT results and other laboratory test data (natural water content). From the consolidation tests, the following correlation proposed by Mesri (1975) was employed to estimate the undrained shear strength:

$$s_u = 0.22\sigma_p'$$



where: S_u = average mobilized undrained shear strength (kPa)
 σ_p' = preconsolidation stress (kPa)

Where appropriate, Bjerrum's correction factor was employed to estimate the average mobilized undrained shear strength from the results of the in situ field vane tests as follows:

$$S_{u(mob)} = \mu S_{u(FV)} \quad (\text{after Bjerrum, 1973})$$

where: $S_{u(mob)}$ = average mobilized undrained shear strength (kPa)
 $S_{u(FV)}$ = undrained shear strength from field vane test (kPa)
 μ = Bjerrum's correction factor based on Plasticity Index

When developing the culvert area-specific correlations of engineering parameters based on laboratory or field test data, the results from the culvert crossings as well as the associated swamp crossing were combined to provide a larger set of parameters to evaluate where applicable. It is considered that the culvert crossings and the swamp crossing in the area exhibit sufficiently similar soil mineralogy and geology that correlations based on all of the data are justified.

6.4.2 Settlement

The following sections outline the methods used to conduct the settlement analyses at the culvert locations. The results of the analyses for each culvert location are discussed in Section 6.6.

6.4.2.1 Methodology

To estimate the magnitude of the expected settlements, analyses were carried out along the individual culvert alignments using the commercially available program Settle3D (Version 3.0) produced by Rocscience Inc. and/or hand/spreadsheet calculations. The rate of settlement/consolidation of the cohesive foundation soils was assessed using Terzaghi's one-dimensional consolidation theory.

The sources of settlement were considered to include:

- primary time-dependent consolidation of the cohesive deposits;
- secondary time-dependent (creep) consolidation of the cohesive deposits (long-term);
- immediate settlement of the native granular soils; and,
- self-weight compression of the embankment fill materials beneath the culvert.

The thickness of the compressible foundation soils and the height of the embankment vary along the proposed culvert crossings and as such the settlements along the length of a given culvert will similarly vary. As such, settlements have been assessed at the inlet, mid-point, and outlet of each culvert alignment.

The settlement analyses assume that all organic soils beneath the culvert alignment will be removed prior to construction and that rock fill will be used for replacement of sub-excavated material (as discussed in Section 6.8.1.1). The piezometric conditions required in the analyses are based on the groundwater levels observed during drilling and are generally located at about the level of the natural ground surface.



6.4.2.2 Parameter Selection

The simplified stratigraphy together with the associated deformation and time-rate consolidation parameters employed for the different native soil types at the culvert locations within the swamp crossing are given in Table 2.

The immediate compression of the very loose to compact silt, sand, and sandy silt/silty sand layers was modeled by estimating an elastic modulus of deformation based on the SPT 'N'-values and using correlations proposed by Bowles (1984) and Kulhawy and Mayne (1990). These estimated values were compared with the typical range of expected values for similar soil types, as outlined in Canadian Highway Bridge Design Code, CHBDC (2006) and adjusted, if necessary.

The consolidation settlement of the cohesive deposits was assessed using the results of the laboratory consolidation tests (where available) and in situ field vane tests to estimate the stress history and deformation parameters for the clayey foundation soils. In addition, the results of the consolidation tests were supplemented with estimates of deformation parameters (i.e. recompression and compression indices) using empirical correlations proposed in literature by Koppula (1986), Terzaghi and Peck (1967), Kulhawy and Mayne (1990) and Azzouz et al. (1976). The correlation by Koppula (1986) relating the natural water content and liquid limit to the compression index was found to be the most consistent with the results of laboratory consolidation tests for the clayey soils at this site.

The following correlation relating in situ undrained shear strength to preconsolidation stress proposed by Mesri (1975) was employed:

$$\sigma_p' = \frac{s_{u(mob)}}{0.22}$$

where :

$$s_{u(mob)} = \mu s_{u(FV)} \quad (\text{after Bjerrum, 1973})$$

$$\sigma_p' = \text{preconsolidation stress (kPa)}$$

$$s_{u(mob)} = \text{average mobilized undrained shear strength (kPa)}$$

$$s_{u(FV)} = \text{undrained shear strength from field vane test (kPa)}$$

$$\mu = \text{Bjerrum's correction factor based on Plasticity Index}$$

The coefficient of consolidation, c_v (cm²/s), required in the time-rate analysis was established using the results of the consolidation tests (based on t_{90}) and/or estimated from the U.S. Navy (NAVFAC, 1986) correlation with liquid limits assuming normally-consolidated soils.

In addition to primary consolidation within clays, secondary compression may also occur. Secondary compression is referred to as creep settlement and occurs over a long period of time, after full dissipation of excess pore pressure under a constant stress. The following relationships have been employed for estimating the magnitude of creep settlement over the design life following the completion of primary settlement at each location.

$$S_c = HC_{\alpha\epsilon} \log \left(\frac{t}{t_{EOP}} \right)$$

$$C_{\alpha\epsilon} \approx \frac{w_n}{10,000} \quad (\text{after Mesri, 1973})$$



where :	S_c	=	secondary (creep) settlement (mm)
	$C_{\alpha\epsilon}$	=	modified secondary compression index
	H	=	initial thickness of normally consolidated portion of compressible clay deposit (mm)
	t	=	post-construction period of interest (10 years for this project)
	t_{EoP}	=	time to reach end of primary consolidation (years)
	w_n	=	natural water content (%)

The values of modified secondary compression index ($C_{\alpha\epsilon}$) from the correlation noted above were also compared with the values of $C_{\alpha\epsilon}$ calculated from the results of the laboratory consolidation tests, where available.

6.4.2.3 Settlement of Rock Fill Beneath Culvert

Where rock fill is used for the construction of the proposed embankments and/or sub-excavation and replacement below culvert alignments, there will be settlement due to compression of the rock fill itself under self-weight, in addition to the settlement of the underlying foundation soils as described above. The magnitude of settlement of the rock fill depends on the following factors:

- type of rock/strength of particles;
- size and shape of rock particles;
- gradation of rock fill;
- total height/thickness of rock fill (stress level); and,
- method of construction and sequence of placement (including lift thickness, compactive effort and state of packing).

The settlement of rock fill occurs as a result of re-arrangement of rock particles under load and wetting and as a result of localized crushing of rock particles at point contacts. The magnitude of both the short-term and long-term post-construction settlement of the rock fill is a function of the height of fill as well as the method of fill placement (i.e. compacted versus dumped rock fill) as outlined in MTO Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates, dated September 2010.

Rock fill should be placed, whenever possible, in a controlled manner (i.e. not end dumped) in accordance with OPSS.PROV 206 (Grading). Blading, dozing and 'chinking' the rock fill to form a dense, compact mass is required to minimize voids and bridging and reduce settlements and should be used to construct rock fill embankments above the existing groundwater table. Where rock fill cannot be placed in a controlled manner (i.e. below the groundwater table), the post-construction settlement of the rock fill is expected to be greater.

Short-Term Rock Fill Settlement

The magnitude of short-term post-construction settlement associated with compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (September 2010), as follows:



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Total Height of Rock Fill, H	Short-Term Rock Fill Settlement (m)	
	Compacted Rock Fill	Dumped Rock Fill
Up to 5 m	0.5% H	1.0% H
>5 m to 10 m	0.75% H	1.5% H
>10 m to 15 m	1.0% H	2.0% H

It should be noted that approximately 90 per cent of the short-term settlement may be expected to occur within the first six (6) months following completion of rock fill placement and construction of the embankment to full height. The short-term settlement is expected to be fully completed within one (1) year following the completion of rock fill placement and embankment construction to full height.

Long-Term Rock Fill Settlement

The magnitude of long-term post-construction settlement for compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (September 2010), as follows:

Total Height of Rock Fill, H	Long-Term Rock Fill Settlement (m)	
	Compacted Rock Fill	Dumped Rock Fill
Up to 15 m	0.1% H	0.2% H

The long-term rock fill settlement is expected to occur from one (1) year following the completion of construction to over the life of the embankment.

6.4.3 Horizontal Strain

The following sections outline the method used to estimate the horizontal strain along the culvert locations. The results of the estimated horizontal strain for each individual culvert are presented in Section 6.6.

6.4.3.1 Parameter Selection

As a result of the two-dimensional nature of the proposed embankment geometry, shear stresses will be mobilized in the foundation soils (upon completion of preload embankment construction and during the preload period) causing lateral spreading of the foundation soils and new embankment fill. This, in conjunction with the non-uniform vertical settlement of the foundation soils along the proposed culvert alignment, will generate horizontal straining along the newly constructed culvert. In order to maintain structural integrity of the culvert, the culvert design must incorporate a suitable allowance for extension at the joints/couplings of the culvert segments to prevent the culvert from cracking and/or failing in tension.

The research work by Rutledge and Gould (1973) on the movements on articulated conduits under earth dams on compressible foundations can be used to estimate the magnitude of the horizontal strain likely to occur as a result of the proposed embankment construction at the culvert sites. The following equations have been used to



obtain a relationship between vertical settlement, vertical strain, horizontal strain and maximum joint opening as a result of settlement of the foundation soils:

$$\epsilon_v = \frac{\delta_v}{d}$$

$$\epsilon_h = \epsilon_v \frac{\epsilon_h}{\epsilon_v}$$

$$\Delta L = \epsilon_h L$$

where :

ΔL = maximum joint opening (m)

ϵ_v = maximum vertical strain

ϵ_h = maximum horizontal strain

$\frac{\epsilon_h}{\epsilon_v}$ = estimated ratio of maximum horizontal strain to maximum vertical strain
 (from Rutledge and Gould, 1973 – Figure 2)

L = length of culvert (m)

δ_v = maximum vertical settlement of culvert as a result of immediate and post-construction settlement of foundation soils and rock fill / bedding material (m)

d = thickness of compressible foundation strata at culvert location (m)

6.5 Geotechnical Axial Resistance

Section 6.6 outlines the recommended factored geotechnical axial resistance at Ultimate Limit States (ULS) and geotechnical axial resistance at Serviceability Limit States (SLS) for 25 mm of settlement for design of each pre-cast and cast-in-place concrete box culvert founded on a properly prepared subgrade/granular bedding material (as discussed in Section 6.8.1). The geotechnical resistances provided assume that the loads will be applied perpendicular to the surface of the base of the culverts. Where loads are not applied perpendicular to the base of the culvert, inclination of the loads should be taken into account in accordance with Section 6.7.4 and Section C6.7.4 of *CHBDC* and its *Commentary*.

6.5.1 Resistance to Lateral Loads/Sliding Resistance

Resistance to lateral forces/sliding resistance between the base of the pre-cast and the cast-in-place concrete box culverts and the granular fill/bedding placed following sub-excavation should be calculated in accordance with Section 6.7.5 of the *CHBDC*. The following summarizes the coefficient of friction, $\tan \delta$, for the interface materials.

Interface Materials	Coefficient of Friction ($\tan \delta$)
Pre-Cast Concrete Box Culvert on Compacted Granular 'A'	0.45
Cast-in-Place Concrete Box Culvert on Compacted Granular 'A'	0.55
Cast-in-Place Concrete Culvert on Bedrock	0.70



The above represent unfactored values.

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

6.6 Results of Analysis

The results of the stability and settlement analyses, estimated maximum vertical and horizontal strains and factored geotechnical axial resistance at Ultimate Limit States (ULS) and geotechnical resistances at Serviceability Limit States (SLS) are provided for each of the culvert sites in the following sections. In addition, the options and recommendations for achieving the target factor of safety for the stability of the required embankment geometry, if necessary, and for minimizing the time dependent, post-construction settlements are also discussed. These options take into consideration the foundation mitigation recommendations for the swamp areas in which some of the culverts are located, as provided in the Phase 2 Swamp Crossings and High Fill Areas Foundation Investigation and Design Report dated April 11, 2016. The results of analysis/foundation recommendations for the culverts are also summarized in Table 3 and Table 4.

For the stability and settlement analyses performed, it has been assumed that all organics (topsoil, peat and/or organic soils) have been stripped and removed from within the footprint of the proposed culverts.

If the expected settlements, vertical strain and horizontal strain are relatively small, the preferred option is typically to construct the culvert concurrently with the embankment construction. Due to variations in the subsurface conditions along the length of the culverts, the settlements and horizontal strains may differ at different points along the culvert and this should be considered when choosing an appropriate design and construction methodology to be employed.

Where the expected settlements, vertical strain and horizontal strain are relatively large, the preferred option is to either install a temporary culvert (if necessary) and then construct the permanent culvert following the embankment preload period, or to construct the culvert following full sub-excavation of compressible deposit(s) along the culvert alignment.

Where full sub-excavation is recommended, the depth of the compressible cohesive deposits is typically on the order of about 1 m deep, however, it is up to about 5.3 m deep along the C60 culvert alignment in Swamp 25. For Culvert C60, the expected settlements, vertical strain and horizontal strain are relatively large and in order to be consistent with the foundation mitigation strategy recommended for the embankment construction in Swamp 25, the preferred option is to construct the culvert following full sub-excavation of the compressible deposit(s) along the culvert alignment.

It is noted that at some culvert locations, up to about 2.5 m of bedrock excavation is required to expose the design founding level.



6.6.1 Highway 69 SBL – STA 13+380 (Culvert C45)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 18 at about STA 13+380 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 4 m high. The topography in this area is relatively flat with ground cover consisting of grassy and swampy areas located within the confines of tree covered valley slopes to the north and south sides of the proposed culvert alignment.

The subsoils along the culvert alignment generally consist of a surficial deposit of silty peat / organic silty sand, underlain in places by a deposit of sand. The deposit of sand or organic silty sand is underlain by granite gneiss bedrock. A bedrock outcrop was observed to the north and south of the proposed culvert alignment.

Details of the subsurface conditions along this culvert are presented in Section 4.3 and shown on Drawing A1 in Appendix A.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 2.4 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granite gneiss bedrock, or granular fill and sand overlying granite gneiss bedrock at this location is estimated to be 300 kPa and 125 kPa, respectively. It should be noted that sub-excavation of bedrock (up to about 1.0 m deep) will be required near the centre of the culvert.

Given the absence of cohesive deposits and presence of bedrock at shallow depth, the total settlement along the new culvert is estimated to range from less than about 5 mm to about 10 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 29.1 m long culvert associated with these total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlements and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.2 Highway 69 NBL – STA 13+380 (Culvert C45)

The culvert crossing will extend across the existing Highway 69 roadway embankment within Swamp 18 at about STA 13+380 in the Township of Shawanaga. The existing embankment at the culvert location is approximately 5 m high. The topography in the area adjacent to the existing highway is relatively flat to low-lying with ground cover consisting of occasional bedrock outcrops and swampy areas located within the confines of tree valley slopes further to the north and south of the proposed culvert alignment.

In general, the subsurface soils along the culvert alignment consist of a deposit of fill associated with the existing Highway 69 embankment and surficial deposit of sandy peat / organic silty sand beyond the toes of the embankment, underlain by a non-cohesive deposit of silty sand to sand containing a localized pocket of clay. The silty sand to sand deposit or the organic silty sand deposit is underlain by granite gneiss bedrock. Bedrock was observed to outcrop to the north and south sides of the culvert, as well as along the toes of the existing highway embankment.

Details of the subsurface conditions along this culvert are presented in Section 4.4 and shown on Drawing A1 in Appendix A.

The proposed Highway 69 NBL alignment at the new culvert location requires a widening of about 1 m and a grade raise of about 0.5 m of the existing highway embankment. Given that there is no stability issues associated with the existing highway embankment at this location, no stability issues are anticipated upon the completion of the new culvert construction, embankment widening and grade raise so long as all organics present within the footprint of the proposed culvert alignment are removed during construction.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 2.4 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying gravel fill, silty sand to sand and granite gneiss bedrock granite gneiss bedrock at this location is estimated to be 300 kPa and 80 kPa, respectively

Given the general absence of cohesive deposits and presence of bedrock at shallow depth, the total settlement along the new culvert is estimated to be less than about 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 34.4 m long culvert associated with this total settlement is estimated to be less than 0.05 per cent of the culvert length. As a result, culvert construction may commence following the excavation of the existing embankment fill without the need for any additional special foundation mitigation measures (other than removal and replacement of organics, where encountered), so long as the structural design of the culvert can accommodate the estimated settlements and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.3 Highway 69 SBL – STA 13+778 (Culvert C47– Site No. 44-616/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 19 at about STA 13+778 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography in this area is relatively flat to low-lying consisting of occasional bedrock outcrops, grassy and moderately treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a deposit of peat, underlain in places by a non-cohesive deposit of sand and silt to sand and/or granite gneiss bedrock. Bedrock outcrops are present to the northwest and northeast of the culvert.

Details of the subsurface conditions along this culvert are presented in Section 4.5 and shown on Drawing B1 in Appendix B.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 3 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granular fill, sand or granite gneiss bedrock at this location is estimated to be 300 kPa and 100 kPa, respectively.

Given the absence of cohesive deposits and the presence of relatively thin, non-cohesive deposits overlying bedrock, the total settlement along the new culvert is estimated to range from about 5 mm to 15 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 35.3 m long culvert associated with the total settlements is estimated to be up to about 0.15 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.4 Highway 69 NBL – STA 13+791 (Culvert C47– Site No. 44-616/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment within Swamp 19 at about STA 13+791 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 4 m high. The topography in this area is low-lying to undulating, consisting of bedrock outcrops surrounded by grassy and moderately treed ground with areas of shallow open water. Rock fill was observed on the side slopes of the existing highway embankment traversing the area to the east.

In general, the subsurface soils along the culvert alignment consist of a deposit of peat/organic sand, underlain by a deposit of silt and sand. The silt and sand deposit is underlain by granite gneiss bedrock. Bedrock was observed to outcrop to the north and in isolated areas to the south of the culvert alignment, as well as along the toes of the existing Highway 69.

Details of the subsurface conditions along this culvert are presented in Section 4.6 and shown on Drawing B1 in Appendix B.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 3 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granular fill, silty sand to sand and granite gneiss bedrock at this location is estimated to be 300 kPa and 125 kPa, respectively.

Given absence of cohesive deposits and the presence of relatively thin, non-cohesive deposits overlying bedrock, the total settlements along the new culvert are estimated to range from about 5 mm to 10 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 32.4 m long culvert associated with the total settlements is estimated to be up to about 0.05 per cent of the culvert length. As a result, culvert construction concurrent with embankment construction can be carried out without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.5 Highway 69 SBL – STA 14+315 (Culvert C48.1 – Site No. 44-617/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 20 at about STA 14+315 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 3 m high. The topography in this area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of silty peat, underlain by a non-cohesive deposit of silt and sand to sand. Bedrock outcrops are present to the north and south of the culvert.

Details of the subsurface conditions along this culvert are presented in Section 4.7 and shown on Drawing C1 in Appendix C.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granular fill and sand to sand and silt at this location is estimated to be 300 kPa and 80 kPa, respectively..

Given the absence of cohesive deposits and the presence of relatively thin, non-cohesive deposits, the total settlement along the new culvert is estimated to range from about less than 5 mm to 15 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 19.1 m long culvert associated with the total settlements is estimated to be up to about 0.10 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.6 Highway 69 NBL – STA 14+325 (Culvert C48.1 – Site No. 44-617/C1)

The culvert crossing will extend across the proposed Highway 69 Northbound lanes (NBL) embankment within Swamp 20 at about STA 14+325 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 3.0 m high. The topography in this area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of silty peat, underlain by a deposit of silty clay or silt. The silty clay or silt deposit is in turn underlain by a silt and sand till deposit. Bedrock outcrops are present immediately to the north and south of the culvert alignment, and also further to the northeast of the culvert.

Details of the subsurface conditions along this culvert are presented in Section 4.8 and shown on Drawing C1 in Appendix C.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granite gneiss bedrock or granular fill, silty clay and/or silt and sand and silt till at this location is estimated to be 75 kPa and 75 kPa, respectively. It should be noted that sub-excavation of bedrock (up to about 0.5 m deep) will be required near the west end of the culvert.

Given the relatively thin, cohesive deposit overlying shallow, non-cohesive deposits, the total settlement along the new culvert is estimated to range from less than about 5 mm to 25 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 17.7 m long culvert associated with the estimated total settlements is estimated to be up to about 0.20 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

If localized sub-excavation of the thin cohesive foundation soils and replacement with granular fill is carried out (up to about 0.9 m below the culvert invert), the total settlement along the new culvert is estimated to range from less than about 5 mm to 10 mm over a 10-year period following completion of construction. As such, this alternative offers little advantage over culvert construction concurrent with embankment construction.

For a preload period of 10 days (which is consistent with the foundation mitigation recommendations provided for Swamp 20), the total settlement along the new culvert is estimated to range from less than about 5 mm to 10 mm over a 10-year period following completion of construction. Although this option would require excavation of up to 3 m through the preload embankment fill (at the end of the preload period) prior to culvert construction, this alternative offers little advantage over culvert construction concurrent with embankment construction.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.7 Highway 69 SBL – STA 14+649 (Culvert C49A – Site No. 44-618/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment at about STA 14+649 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography in the area is low-lying encompassing wet grassy areas, shallow open water and bedrock outcrops, confined by moderately tree covered slopes immediately to the south as well as to the north of the adjacent swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil or peat underlain by a deposit of sandy silt to sand which in turn is generally underlain by granite gneiss bedrock. At the west end of the culvert the deposit of silty sand is underlain by a deposit of silty sand and gravel which in turn is also underlain by granite gneiss bedrock.

Details of the subsurface conditions along this culvert are presented in Section 4.9 and shown on Drawing D1 and D2 in Appendix D.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 7.5 m wide closed box cast-in-place box culvert, assuming the culvert is founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying sandy silt to silt and sand at this location, is estimated to be 400 kPa and 100 kPa, respectively.

Given the absence of cohesive deposits the total settlement along the new culvert is estimated to range from about 15 mm to 35 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 20.5 m long culvert associated with the total settlements is estimated to be up to about 0.20 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.8 Highway 69 NBL – STA 14+656 (Culvert C49A – Site No. 44-618/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment at about STA 14+656 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 4.5 m high. The topography in the area is low-lying encompassing wet grassy areas, shallow open water and bedrock outcrops, confined by moderately tree covered slopes immediately to the south as well as to the north of the adjacent swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil/organic silty sand underlain by a deposit of silt and sand to sand which in turn is generally underlain by a sand and gravel deposit over granite gneiss bedrock. At one location a boulder was encountered between the silt and sand to sand deposit and the deposit of sand and gravel. At the west end of the culvert the deposit of silty sand is underlain by a deposit of cobbles which in turn is underlain by granite gneiss bedrock.

Details of the subsurface conditions along this culvert are presented in Section 4.10 and shown on Drawing D1 and D2 in Appendix D.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 7.5 m wide closed box cast-in-place box culvert, assuming culvert is founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying silt and sand to sand at this location, is estimated to be 400 kPa and 200 kPa, respectively.

Given the absence of cohesive deposits the total settlement along the new culvert is estimated to range from about 20 mm to 25 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 22.4 m long culvert associated with the total settlements is estimated to be up to about 0.15 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.9 Highway 69 SBL – STA 14+706 (Culvert C50 – Site No. 44-619/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 21 at about STA 14+706 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography is relatively flat and low low-lying encompassing a wet grassy area, shallow open water and bedrock outcrops, located within the confines of moderately tree covered valley slopes to the north and south.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat and a deposit of organic sand, underlain by interlayered deposits of silty sand and silt and sand. The non-cohesive deposits are underlain by granite gneiss bedrock. At the borehole location near the centre of the culvert, refusal/inferred bedrock was encountered immediately below ponded water which covers the entire culvert site.

Details of the subsurface conditions along this culvert are presented in Section 4.11 and shown on Drawing E1 in Appendix E.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3.0 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying silty sand and granitic gneiss bedrock at this location is estimated to be 400 kPa and 250 kPa, respectively (assuming the removal and replacement of organics and localized surficial clayey silt). It should be noted that sub-excavation of bedrock (up to about 1.0 m deep) will be required near the centre of the culvert.

Given the absence of cohesive deposits the total settlement along the new culvert is estimated to range from about less than 5 mm to 15 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 36.2 m long culvert associated with the total settlements is estimated to be up to about 0.15 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.10 Highway 69 NBL – STA 14+726 (Culvert C50 – Site No. 44-619/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment within Swamp 21 at about STA 14+726 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography is relatively flat and low-lying encompassing a wet grassy area, shallow open water and bedrock outcrops located within the confines of moderately tree covered valley slopes to the north and south.

In general, the subsurface soils along the culvert alignment consist of surficial layers of peat, organic sand and clayey silt underlain by a non-cohesive deposit comprised of various layers of silt to silty sand. The deposit of silt to silty sand contains layers/pockets of clayey silt to clay at some locations. The silt to silty sand deposit is underlain by a thin granular deposit comprised of sand and gravel prior to refusal.

Details of the subsurface conditions along this culvert are presented in Section 4.12 and shown on Drawing E1 in Appendix E.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3.0 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying silt to silty sand at this location is estimated to be 300 kPa and 60 kPa, respectively.

If the construction of the culvert is carried out concurrently with the embankment construction following the localized sub-excavation of the surficial soft clayey silt (and removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about 155 mm to 335 mm over a 10-year period following completion of construction. Given the large settlement values and the estimated differential settlement being more than a precast culvert could withstand without cracking (understood to be a maximum of 100 mm), this option is not preferred.

If the construction of the permanent culvert is carried out following the localized sub-excavation of the surficial clayey silt (and removal and replacement of organics) and a 30 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 21), the total settlement along the new permanent culvert is estimated to range from less than about 5 mm to 30 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 46.4 m long culvert associated with these total settlements is estimated to be up to about 0.10 per cent of the culvert length. As a result, culvert construction can be carried out following the localized sub-excavation of the surficial soft clayey silt (and removal and replacement of organics) and the 30 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.11 Highway 69 SBL – STA 15+710 (Culvert C55 – Site No. 44-620/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 23 at about STA 15+710 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 6.5 m high. The topography in the culvert area is relatively flat, with ground cover consisting of shrubs and wet grassy areas, and is located within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a deposit of peat (where present) underlain by a thick deposit of sand which extends to the refusal depth. Bedrock outcrops are present to the south of the culvert.

Details of the subsurface conditions along this culvert are presented in Section 4.13 and shown on Drawing F1 in Appendix F.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 4.0 m wide cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granular fill and sand at this location is estimated to be 400 kPa and 100 kPa, respectively.

If the construction of the culvert is carried out concurrently with the embankment construction (including removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about less than 5 mm to 70 mm over a 10-year period following completion of construction. Given the estimated differential settlement being more than a cast-in-place culvert could withstand without cracking (understood to be a maximum of 25 mm) this option is not preferred.

If the construction of the permanent culvert is carried out after the removal and replacement of organics and a 45 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 23), the total settlement along the new culvert is estimated to be about less than about 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 38.3 m long culvert associated with these total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, culvert construction can be carried out following the removal and replacement of organics and the 45 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.12 Highway 69 NBL – STA 15+717 (Culvert C55 – Site No. 44-620/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment within Swamp 23 at about STA 15+717 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 6.5m high. The topography in the culvert area is relatively flat, with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat (where present) underlain by a thick deposit of silty sand to sand which extends to the refusal depth. A pocket of organic sand was encountered in one borehole within the silty sand deposit below the centre of the culvert. Bedrock outcrops are present to the south of the culvert.

Details of the subsurface conditions along this culvert are presented in Section 4.14 and shown on Drawing F1 in Appendix F.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 4.0 m wide cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying granular fill and sand to silty sand at this location is estimated to be 400 kPa and 100 kPa, respectively. It should be noted that sub-excavation of a localized zone of organic sand (up to about 0.5 m deep) will be required near the east end of the culvert.

If the construction of the culvert is carried out concurrently with the embankment construction (including removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about 5 mm to 40 mm over a 10-year period following completion of construction. Given the estimated differential settlement being more than a cast-in-place culvert could withstand without cracking (understood to be a maximum of 25 mm) this option is not preferred.

If the construction of the permanent culvert is carried out after the removal and replacement of organics and a 20 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 23), the total settlement along the new culvert is estimated to be about less than about 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 29.3 m long culvert associated with these total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, culvert construction can be carried out following the removal and replacement of organics and the 20 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.13 Highway 69 SBL – STA 16+345 (Culvert C57.1 – Site No. 44-621/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment at about STA 16+345 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography in the culvert area is relatively flat with ground cover consisting of relatively densely treed areas. In general, the ground surface slopes downward relatively gently towards the north towards a low-lying swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil, underlain by a non-cohesive deposit ranging in composition from silt to sand with pockets of gravelly silty sand to sand and gravel, containing some cobbles, which is underlain by a silty sand and gravel to gravelly silt and sand deposit in places, in turn underlain by granite gneiss bedrock.

Details of the subsurface conditions along this culvert are presented in Section 4.15 and shown on Drawing G1 in Appendix G.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 7.0 m wide closed box cast-in-place box culvert, assuming the culvert is founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying sand to silt at this location, is estimated to be 400 kPa and 200 kPa, respectively.

Given the absence of cohesive deposits the total settlement along the new culvert is estimated to range from about 5 mm to 20 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 16.9 m long culvert associated with the total settlements is estimated to be up to about 0.15 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.14 Highway 69 NBL – STA 16+345 (Culvert C57.1 – Site No. 44-621/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment at about STA 16+345 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.0 m high. The topography in the culvert area is relatively flat with ground cover consisting of relatively densely treed areas. In general, the ground surface slopes downwards relatively gently towards the north where a low-lying swamp is located.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil underlain in places by a near-surface deposit of silt of high plasticity or sandy clayey silt. The topsoil and the near-surface cohesive deposit are underlain by a non-cohesive deposit ranging in composition from silt to sand inferred to contain some cobbles at the west end of the culvert, which in turn is underlain by a deposit of gravelly silt and sand to sand and gravel, underlain by granite gneiss and schist bedrock.

Details of the subsurface conditions along this culvert are presented in Section 4.16 and shown on Drawing G1 in Appendix G.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics and surficial high plasticity silt to sandy clayey silt), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 7.0 m wide closed box cast-in-place box culvert, assuming the culvert is founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying sand to silt at this location, is estimated to be 400 kPa and 300 kPa, respectively. It should be noted that sub-excavation of bedrock (up to about 2.5 m deep) will be required near the east end of the culvert.

If the construction of the permanent culvert is carried out following the required excavation to reach the design invert level (which will include removal of the surficial high plasticity silt to sandy clayey silt layers) then the total settlement along the new culvert is estimated to be about less than 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 16.9 m long culvert associated with the total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics and surficial silt to sandy clayey silt), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.15 Highway 69 SBL – STA 16+499 (Culvert C57 – Site No. 44-622/C2)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 24 at about STA 16+499 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 8.5 m high. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/peat underlain by a thick non-cohesive deposit generally grading from sandy silt to sand, underlain in places by a deposit of sand and gravel. Bedrock outcrops are present to the south of the proposed culvert alignment.

Details of the subsurface conditions along this culvert are presented in Section 4.17 and shown on Drawing H1 in Appendix H.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3.0 m wide closed box cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying silt to sand at this location is estimated to be 350 kPa and 75 kPa, respectively.

If the construction of the culvert is carried out concurrently with the embankment construction (including removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about 15 mm to 135 mm over a 10-year period following completion of construction. Given the estimated differential settlement being more than a cast-in-place culvert could withstand without cracking (understood to be a maximum of 25 mm) this option is not preferred.

If the construction of the permanent culvert is carried out after the removal and replacement of organics and a 45 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 24), the total settlement along the new culvert is estimated to be less than about 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 41.2 m long culvert associated with these total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, permanent culvert construction can be carried out following the removal and replacement of organics and the 45 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.16 Highway 69 NBL – STA 16+485 (Culvert C57 – Site No. 44-622/C1)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment within Swamp 24 at about STA 16+485 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 8.0 m high. The topography in the culvert area is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, within the confines of tree covered valley slopes at the north and south limits of the associated swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/peat underlain by a thick deposit of sandy silt to sand, which in turn is underlain by a deposit of sand and gravel. The sand and gravel deposit is underlain by a lower deposit of silt and sand that extends to the refusal depth. Resistance to dynamic cone penetration and borehole advancement was encountered at greatest depth at about STA 16+475. Bedrock outcrops are present along the southern limit of the swamp.

Details of the subsurface conditions along this culvert are presented in Section 4.17 and shown on Drawing H1 in Appendix H.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 3.0 m wide closed box cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying silt to sand at this location is estimated to be 350 kPa and 150 kPa, respectively.

If the construction of the culvert is carried out concurrently with the embankment construction (including removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about 10 mm to 250 mm over a 10-year period following completion of construction. Given the estimated differential settlement being more than a cast-in-place culvert could withstand without cracking (understood to be a maximum of 25 mm) this option is not preferred.

If the construction of the permanent culvert is carried out after the removal and replacement of organics and a 55 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 24), the total settlement along the new culvert is estimated to be about less than about 5 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 42.4 m long culvert associated with these total settlements is estimated to be less than 0.05 per cent of the culvert length. As a result, permanent culvert construction can be carried out following the removal and replacement of organics and the 55 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.17 Highway 69 SBL – STA 17+272 (Culvert C60)

The culvert crossing will extend across the proposed new Highway 69 Southbound lanes (SBL) embankment within Swamp 25 at about STA 17+272 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 9 m high. The topography in the area is relatively flat to low-lying consisting of bedrock outcrops, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat underlain by a deposit of silty sand, over a deposit of clay. The clay deposit is in turn underlain by a thick deposit of silt in places, underlain by a deposit of sand which extends to the refusal depth. Bedrock outcrops are present to the north and south of the swamp in which the culvert is located.

Details of the subsurface conditions along this culvert are presented in Section 4.19 and shown on Drawing I1 in Appendix I.

The stability analysis performed on the proposed embankment at the culvert location upon completion of full sub-excavation and replacement of the clay deposit (in accordance with the foundation mitigation recommendations for Swamp 25 contained in the Phase 2 Swamp Crossings and High Fill Areas Foundation Investigation and Design Report dated April 11, 2016), indicates that after completion of construction, the embankment will have a Factor of Safety (FoS) of greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 2.5 m wide closed box cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying rock fill, silt and sand at this location, is estimated to be 275 kPa and 150 kPa, respectively.

If full sub-excavation of the compressible foundation soils and replacement with rock fill is carried out (up to about 4.6 m below the existing ground surface), the settlement of the foundation soils at the culvert invert during construction is estimated to range from about 10 mm to 55 mm. In addition, following construction of the culvert, settlement of the below grade rock fill is estimated to be between about 40 mm and 90 mm (based on 9 m high embankment plus about 4.8 m of additional rock fill required after below grade full sub-excavation) and is expected to occur over the life of the roadway. Therefore, the total settlements at the culvert are estimated to range from about 50 mm to 135 mm. In addition, the maximum horizontal strain along the approximately 38.3 m long culvert associated with these settlements is estimated to be up to about 0.40 per cent of the culvert length. If the construction of the culvert is carried out concurrently with the embankment construction (following full sub-excavation and replacement of the existing cohesive deposit), transverse expansion joints will be required to mitigate cracking of the culvert.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.18 Highway 69 NBL – STA 17+276 (Culvert C60)

The culvert crossing will extend across the proposed new Highway 69 Northbound lanes (NBL) embankment within Swamp 25 at about STA 17+276 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 8 m high. The topography in the area is relatively flat to low-lying consisting of bedrock outcrops, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of peat underlain by a deposit of silt and sand to sand, underlain by a deposit of silty clay. The silty clay deposit is underlain by deposits of silt and/or silty sand in places, which in turn is underlain by a thick deposit of silt and sand to sand. Bedrock outcrops are present to the north and south of the swamp in which the culvert is located.

Details of the subsurface conditions along this culvert are presented in Section 4.20 and shown on Drawing I1 in Appendix I.

The stability analysis performed on the proposed embankment at the culvert location upon completion of full sub-excavation and replacement of the silty clay (in accordance with the foundation mitigation recommendations for Swamp 25 contained in the Phase 2 Swamp Crossings and High Fill Areas Foundation Investigation and Design Report dated April 11, 2016), indicates that after completion of construction, the embankment will have a Factor of Safety (FoS) of greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance at SLS for 25 mm of settlement for the proposed 2.5 m wide closed box cast-in-place box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying rock fill, silt and sand and silt to sand at this location, is estimated to be 275 kPa and 150 kPa, respectively.

If full sub-excavation of the compressible soils and replacement with rock fill is carried out (up to about 5.3 m below the existing ground surface), the settlement of the foundation soils along the culvert invert during construction is estimated to range from about 15 mm to 130 mm. In addition, following construction of the culvert, settlement of the below grade rock fill is estimated to be between about 40 mm and 90 mm (based on 9 m high embankment plus about 4.9 m of additional rock fill required after below grade full sub-excavation). Therefore, the total settlements at the culvert are estimated to range from about 105 mm to 170 mm. In addition the maximum horizontal strain along the approximately 38.6 m long culvert associated with these total settlements is estimated to be up to about 0.60 per cent of the culvert length. If the construction of the culvert is carried out concurrently with the embankment construction (following full sub-excavation and replacement of the existing cohesive deposit), transverse expansion joints will be required to mitigate cracking of the culvert.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.19 Shebeshekong Road S-E/W Ramp – STA 14+990 (Culvert C51)

The culvert crossing will extend across the proposed new Shebeshekong Road S-E/W ramp embankment within Swamp 22 at about STA 14+990 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 5.5 m high. The topography in the area is relatively flat to low-lying consisting of bedrock outcrops, grassy and heavily treed ground with areas of shallow open water.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of topsoil (where present) underlain by a thick deposit of sandy silt, to silty sand to sand which extends to the refusal depths. The sandy silt to sand deposit contains an upper interlayer of clayey silt and a lower interlayer of clay.

Details of the subsurface conditions along this culvert are presented in Section 4.21 and shown on Drawing J1 in Appendix J.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 2.4 m wide precast box culvert founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying sandy silt to sand at this location is estimated to be 200 kPa and 100 kPa, respectively.

If the construction of the culvert is carried out concurrently with the embankment construction (including removal and replacement of organics), then the total settlement along the new culvert is estimated to range from about 60 mm to 280 mm over a 10-year period following completion of construction. Given the estimated differential settlement is more than a precast culvert could withstand without cracking (understood to be a maximum of 100 mm) this option is not preferred.

If the construction of the permanent culvert is carried out after the removal and replacement of organics and a 30 day embankment preload period (which is consistent with the foundation mitigation recommendations provided for Swamp 22), the total settlement along the new culvert is estimated to range from about 20 mm to 50 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 30.5 m long culvert associated with these total settlements is estimated to be up to about 0.20 per cent of the culvert length. As a result, culvert construction can be carried out following the removal and replacement of organics and the 30 day preload period, so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.6.20 Site No. 9 Road – STA 10+235 (Culvert C53)

The culvert crossing will extend across the proposed new site No. 9 Road embankment within Swamp 26 at about STA 10+235 in the Township of Shawanaga. The proposed embankment at the culvert location is approximately 4.5 m high. The topography in the area is relatively flat, with ground cover consisting of shrubs, sparse trees and wet grassy areas, located within the confines of a relatively higher ground and densely treed area and bounded to the east by the existing Highway 69. Bedrock outcrops are present along the southern limit of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of sandy organic silt (where present) underlain by a non-cohesive deposit of silt to sand which is underlain by granite gneiss bedrock.

Details of the subsurface conditions along this culvert are presented in Section 4.22 and shown on Drawing K1 in Appendix K.

The stability analysis performed on the proposed embankment at the culvert location indicates that after completion of construction (including removal and replacement of organics), the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway.

The factored geotechnical axial resistance at ULS and geotechnical resistance for SLS for 25 mm of settlement for the proposed 0.6 m diameter precast circular pipe founded on a properly prepared subgrade/granular bedding (as discussed in Section 6.8.2) overlying sandy silt to sand is estimated to be 100 kPa and 100 kPa, respectively.

Given the absence of cohesive deposits, the total settlement along the new culvert is estimated to range from about 10 mm to 70 mm over a 10-year period following completion of construction. The maximum horizontal strain along the 38.8 m long culvert associated with the total settlements is estimated to be up to about 0.30 per cent of the culvert length. As a result, culvert construction can be carried out concurrent with embankment construction without the need for any additional special foundation mitigation measures (other than removal and replacement of organics), so long as the structural design of the culvert can accommodate the estimated settlement and horizontal strain.

Details on the requirements for excavation through the existing embankment, backfilling and bedding are provided in Section 6.8.



6.7 Lateral Earth Pressures – Culverts, Head Walls and Wing Walls

The lateral earth pressures acting on the side walls, head walls and/or wing walls of the culverts will depend on the type and method of placement of backfill materials, the nature of the soils/embankment fill behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure and the drainage conditions behind the walls.

The following recommendations are made concerning the design of the culverts and walls. It should be noted that these design recommendations and parameters assume level backfill and ground surface behind the walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope.

- Select, free draining granular fill meeting the specifications of OPSS.PROV 1010 (Aggregates) Granular 'A' or Granular 'B' Type II should be used as backfill, with a minimum thickness of 300 mm (in accordance with the minimum requirements of Ontario Provincial Standard Drawing (OPSD) 803.010), behind the culvert and walls. Placement and compaction (including lift thickness, type of equipment, target densities, etc.) should be carried out in accordance with OPSS 902 (Excavating and Backfilling – Structures).
- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the culverts and walls, in accordance with CHBDC Section 6.9.3 and Figure 6.6. Other surcharge loadings should be accounted for in the design, as required.
- For box culverts, granular fill should be placed in a zone with the width equal to at least 1.8 m behind the back of the culvert (in accordance with Figure C6.20(a) of the *Commentary* to the CHBDC). For the head/wing walls, granular fill should be placed within the wedge shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the base of the head/wing walls (in accordance with Figure C6.20(b) of the *Commentary* to the CHBDC).
- For box culverts, the pressures are based on the proposed embankment fill materials and the existing overburden soils and the following parameters (unfactored) may be used assuming the use of granular fill or rock fill:

	Granular Fill	Rock Fill
Soil unit weight:	21 kN/m ³	19 kN/m ³
Coefficients of static lateral earth pressure:		
Active, K_a	0.31	0.22
At rest, K_o	0.47	0.36

- For head/wing walls, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	Granular 'A'	Granular 'B' Type II
Soil unit weight:	22 kN/m ³	21 kN/m ³
Coefficients of static lateral earth pressure:		
Active, K_a	0.27	0.27
At rest, K_o	0.43	0.43

If the head/wing walls and culverts allow for lateral yielding, active earth pressures may be used in the geotechnical design of the structures. If the head/wing walls and culvert structures do not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design. The movement to allow active pressures to



develop within the backfill, and thereby assume a restrained structure, may be taken as per Table C6.6 of the *Commentary to the CHBDC*.

6.8 Culverts – Construction Considerations

6.8.1 Subgrade Preparation and Excavation

The four-laning of the new Highway 69 for the section between Nobel and the Shawanaga River (including the associated interchange ramps and access/service roadways) will require the construction of numerous culverts. The following sections discuss general aspects of subgrade preparation and embankment construction at the culvert locations, including: removal of surficial organic soils; and excavation and replacement of soft/loose subsoils.

All excavations must be carried out in accordance with Ontario Regulation 213 Ontario Occupational Health and Safety Act for Construction Projects (as amended by Ontario Regulation 443). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of the Highway 69 and any associated side roads or detours during excavation operations, where applicable.

Where required, temporary excavation support system should be designed and constructed in accordance with OPSS.PROV 539 (Temporary Protection Systems). Temporary excavation support systems should be designed to Performance Level 2 for any excavation adjacent to existing roadways or Performance Level 3 for excavations in other areas.

6.8.1.1 Removal of Organic Materials

Based on the information from the boreholes advanced during the field investigation, the thickness of organic deposits (i.e. peat) in the Phase 2 section of the roadway development at the culvert locations generally ranges from about 0.1 m to 0.6 m. After clearing and grubbing, and prior to the placement of any bedding material and fill for new construction, all organic soils should be stripped from the plan limits of the proposed works.

Where the culverts are located within new embankments being constructed in a swamp area away from or adjacent to existing highway embankments, embankment construction should be carried out as per OPSD 203.010 (Embankments Over Swamp - New Construction).

6.8.1.2 Excavation of Soft Soils

Excavations up to about 5.5 m below existing ground surface are anticipated at the culvert locations along the Phase 2 section of the project where full sub-excavation and replacement of soft materials is recommended as the preferred mitigation option for culvert construction (refer to Table 3). It is anticipated that conventional equipment will be suitable for the excavation of the soft subsoils in these areas.

6.8.1.3 Replacement/Backfill Below Base of Culverts

For replacement of full sub-excavated material along culvert alignments, it is assumed that rock fill will be used to backfill the excavations. Where sub-excavation of soft subsoils is being carried out as a foundation mitigation option, it will not likely be possible to place rock fill in accordance with OPSS.PROV 206 (Grading), as discussed in Section 6.4.2.3. In these instances (i.e. typically backfill below the water table), the rock fill is anticipated to be end-dumped concurrently as the excavation advances.



6.8.2 Bedding and Backfill Above Base of Culverts

6.8.2.1 Cast-in-Place Culverts

The bedding and backfill requirements for the proposed cast-in-place culverts should be in accordance with OPSS 902 (Excavating and Backfilling – Structures). The culverts should be provided with at least 300 mm of OPSS.PROV 1010 (Aggregates) Granular 'A' for bedding purposes and partial frost protection. The placement of a non-woven geotextile (OPSS 1860 Geotextiles) with a fabric opening size not greater than 212 µm between the bottom of the bedding/engineered fill and native soils/rock fill is recommended. The bedding should be placed and compacted in accordance with OPSS 902 (Excavating and Backfilling – Structures).

6.8.2.2 Precast Culverts

The bedding, levelling pad, and backfill requirements for the proposed permanent culverts should be in accordance with OPSS 422 (Precast Reinforced Concrete Box Culverts). The box culverts should be provided with at least 300 mm of OPSS.PROV 1010 (Aggregates) Granular 'A' (or Granular 'B' Type II material if in wet ground conditions) for bedding purposes and partial frost protection. The placement of a non-woven Class II geotextile (OPSS 1860 Geotextiles) with a fabric opening size not greater than 212 µm between the bottom of the bedding/engineered fill and native soils/rock fill is recommended. The bedding should be placed and compacted in accordance with OPSS 422 in lifts not exceeding 200 mm in loose thickness, and compacted to at least 98 per cent of the Standard Proctor maximum dry density of the material, as specified in accordance with OPSS.PROV 501 (Compacting). In addition, a minimum 75 mm thick uncompacted levelling pad consisting of Granular 'A' material or fine concrete aggregate meeting the grading requirements specified in OPSS.PROV 1002 (Aggregates – Concrete) should be provided as shown on OPD 803.010 (Backfill and Cover for Concrete Culverts) for culvert construction in dry conditions.

6.8.2.3 Circular Pipe

The bedding, cover material and backfill requirements for a concrete pipe culvert should be in accordance with OPD 802.031 (Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil – Earth Excavation) and culvert construction should be in accordance with OPSS.PROV 421 (Pipe Culvert Installation in Open Cut). It is important that the backfill at the haunches be well compacted. The circular culvert should be constructed on a minimum 150 mm thick layer of OPSS.PROV 1010 (Aggregates) Granular 'A' or Granular 'B' Type II material for bedding and up to 300 mm above the pipe for cover purposes. The placement of a non-woven Class II geotextile (OPSS 1860 Geotextiles) with a fabric opening size not greater than 212 µm between the bottom of the bedding/engineered fill and native soils is recommended. The bedding should be placed and compacted in accordance with OPSS 421 in lifts not exceeding 200 mm in loose thickness.

6.8.2.4 General

Backfill behind the culvert walls and any head/wing walls should consist of granular fill meeting the specifications for OPSS.PROV 1010 (Aggregates) Granular 'A' or Granular 'B' Type II. The backfill should be placed and compacted in accordance with OPSS 902 (Excavating and Backfilling – Structures) to at least 98 per cent of the Standard Proctor maximum dry density of the material. The fill should also be placed concurrently on both sides of the culvert walls, ensuring that the backfill depth on one side does not exceed the other side by more than 400 mm for a pre cast box culvert and 500 mm for an open footing culvert, in accordance with OPSS 422 (Precast Reinforced Concrete Box Culverts) and OPSS 902, respectively.

Where preloading is used to reduce post-construction settlements, and temporary culverts are incorporated into the works and are subsequently removed, the backfill above the permanent culverts should consist of



Granular 'A' or Granular 'B' Type II or rock fill with a maximum particle size less than or equal to 250 mm, to minimize differential settlements along the highway embankments in the area of the permanent culverts.

The culverts should be designed for the full overburden stress and appropriate live loads, assuming a fill unit weight of 22 kN/m³ for Granular 'A' and 21 kN/m³ for Granular 'B' Type II backfill above and surrounding the culvert.

Inspection and field density testing should be carried out by qualified geotechnical personnel during all engineered fill placement operations to ensure that appropriate materials are used, and that adequate levels of compaction have been achieved.

6.8.3 Erosion Protection

Provision should be made for scour and erosion protection (suitable non-woven geotextiles and/or rip-rap) at the culvert locations. In order to prevent surface water from flowing either beneath the culvert (potentially causing undermining and scouring) or around the culvert (creating seepage through the embankment fill, and potentially causing erosion and loss of fine soil particles), a clay seal or concrete cut-off wall should be provided at the upstream end of the culverts. If a clay seal is adopted, the clay material should meet the requirements of OPSS.PROV 1205 (Material Specification for Clay Seal), and the seal should be a minimum 1 m thick if constructed of natural clay or soil-bentonite mix and extend from a depth of 1 m below the scour level or to the bedrock surface, whichever is higher, to a minimum horizontal distance of 2 m on either side of the culvert inlet opening, and a minimum vertical height equivalent to the high water level including along the embankment slope. Alternatively, a 0.6 m thick clay blanket (if constructed of natural clay or a soil-bentonite mix) may be constructed, extending upstream three (3) times the culvert height and along the adjacent slopes to a height of two (2) times the culvert height or the high water level, whichever is greater.

The requirements for and design of erosion protection measures for the inlet and outlet of the various culverts should be assessed by the hydraulics design engineer. As a minimum, rip-rap treatment for the outlet of the culverts should be consistent with the standard presented in OPSD 810.010 (Rip-Rap Treatment for Sewer and Culvert Outlets). Erosion protection for the inlet of the culverts should generally follow the standard presented in OPSD 810.010, with the rip-rap placed up to the toe of slope level, in combination with the cut-off measures noted above. Similarly, rip-rap should be provided over the full extent of the clay blanket, including the creek side slopes and fill slope over the culverts.

6.8.4 Control of Groundwater and Surface Water

Excavation within the plan limits of the proposed culvert alignments will be required to remove organic and/or soft deposits prior to placement of backfill/embankment fill, bedding material and the actual culvert structure. As a result of the excavation, groundwater flow into the excavation can be expected to occur due to the relatively permeable subsoils and high groundwater levels observed at the culvert locations. Therefore, control of surface water and groundwater will be necessary at the culvert locations to allow for excavation and foundation construction to be carried out in dry conditions.

Depending on surface flows and groundwater levels at the time of construction, water flow could be passed through the area by means of a temporary culvert (as discussed in Section 6.9), or diverted by pumping from behind a temporary cofferdam. Surface water should be directed away from the excavations areas to prevent ponding of water.

Control of groundwater will be required at the culvert locations, as the foundation excavations are expected to extend below the groundwater level. Where the excavations will be advanced through existing fill and cohesive soils to terminate within cohesive soils at shallow depths (i.e. no excavation through water-bearing granular soils), seepage into the excavation should be adequately controlled by use of temporary cofferdams and by



pumping from properly filtered sumps. Where the excavations will be advanced through or into water-bearing non-cohesive soils, appropriate unwatering of the water-bearing granular soil deposits will be required (in addition to the use of temporary cofferdams) to maintain the water level below the founding level for the culverts during excavation and construction.

For cast-in-place culverts and for pre-cast culverts that require cast-in-place elements, unwatering is required to minimize groundwater inflow into the excavation and construction area and to ensure construction of the cast-in-place elements in dry conditions. Seepage into the excavation should be adequately controlled by a suitable pumping system and/or diversion system and/or a cut-off system such as a sheet pile cofferdam. In the case of a sheet pile cofferdam, the area for the construction of the cast-in-place elements should be fully enclosed within the temporary sheet pile cut-off wall which should be driven into a Granular 'B' Type II "blanket" a minimum of 3 m thick, extending downwards from the lowest elevation of the cast-in-place element and constructed over the entire bottom of the excavation area. The Granular 'B' Type II blanket should extend laterally for a minimum of 6 m beyond the limits of the sheet pile cofferdam below and adjacent to the pre-cast culvert end-sections. Alternatively, a minimum 0.5 m thick tremie concrete plug could be placed in the bottom of the cofferdam to facilitate dewatering of groundwater inflow into the excavation area.

Dewatering of all excavations for culvert construction should be carried out in accordance with OPSS 902 (Excavating and Backfilling – Structures) and OPSS 517 (Dewatering).

6.9 Temporary Culverts

Where permanent culverts will be constructed subsequent to a preload period to mitigate settlements, temporary culverts may be required to promote drainage through the fills during the recommended preload period. Temporary culverts may consist of pre-cast concrete culverts (box or pipe) or corrugated steel pipe (CSP) culverts. It should be noted that at some of the culvert locations the estimated settlements are expected to be relatively large (as outlined in Table 3) and as a result the temporary culverts should be sized such that they may still perform the intended function for the duration of the preload period. Bedding recommendations should be in accordance with the corresponding OPSS and/or OPSD depending on the type of the temporary culvert chosen. Assuming the temporary culvert are CSPs, construction of these culverts should be in accordance with OPSD 802.010 (Flexible Pipe Embedment and Backfill, Earth Excavation).

The location of the temporary culverts could be offset from the actual alignment of the permanent culverts, provided that surface drainage paths are adequate. The temporary culvert should also be constructed within a temporary granular core. Due to the potential size of the temporary culverts, it is recommended that these culverts be removed following the permanent culvert construction. If it is not desirable to remove the temporary culvert, consideration could be given to backfilling the temporary culvert with 'unshrinkable' fill material.

6.9.1 Granular Fill Core

Where permanent culverts will be constructed subsequent to the preload period, excavation through the new embankment roadway fill will be required to reach the permanent culvert founding level. Therefore, to provide for easier excavation operation, it may be preferable to construct a 'temporary core' at the culvert location using granular fill or Granular 'B' Type II material, as these materials may be excavated more easily than rock fill. The material comprising the temporary core should be placed in accordance with OPSS.PROV 206 (Grading).

If constructed, the granular core should encompass the entire width of the culvert and should extend upwards at a slope no steeper than 1.25H:1V from the base of the core to the crest of the embankment. However, the outer side slopes of the temporary granular fill core (i.e. embankment side slopes near/at the ends of the culvert) should be no steeper than 2H:1V. This requires that the length of the temporary culvert be greater than the length of the permanent culvert, as the temporary culvert will need to extend beyond the temporary granular side



slopes of the embankment to allow for drainage. A temporary geotextile separator should be placed between the rock fill and granular fill core to prevent mitigation of fines into the rock fill. A schematic of the temporary core construction details is presented on Figure 1.

Upon completion of the preload period and construction of the permanent culvert, the temporary core material may be reused as backfill material. However, the permanent outer side slopes of the embankment where comprised of the granular fill would need to be maintained at no steeper than 2H:1V, resulting in a longer permanent culvert. If this option is not desired, the temporary core material should be completely removed and replaced with rock fill with maximum particle size less than or equal to 250 mm to minimize differential settlement.

7.0 CLOSURE

This report was prepared by Mr. Alex Szot, EIT with technical input from Mr. Christopher Ng, P.Eng., a geotechnical engineer and Associate with Golder. The technical aspects were 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 a Principal with Golder, conducted an independent quality control review of the report.



FOUNDATION REPORT – CULVERTS – PHASE 2
HIGHWAY 69 G.W.P. 5111-07-00

Report Signature Page

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STANDARDS:

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D7012	Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature
ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil

Ministry of Transportation Ontario:

MTO Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates. September 2010.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91 Construction Projects (as amended)

Ontario Provincial Standard Drawing:

OPSD 203.010	Embankments Over Swamp – New Construction
OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil – Earth Excavation
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 810.010	Rip-Rap Treatment for Sewer and Culvert Outlets

Ontario Provincial Standard Specification:

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 421	Construction Specifications for Pipe Culvert Installation in Open Cut
OPSS 422	Construction Specification for Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut
OPSS.PROV 501	Construction Specification for Compacting
OPSS 517	Construction Specification for Dewatering of Pipeline, Utility and Associated Structure Excavation
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS 902	Construction Specification for Excavating and Backfilling – Structures
OPSS.PROV 1002	Material Specifications for Aggregates - Concrete
OPSS.PROV 1010	Material Specifications for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1205	Material Specification for Clay Seal
OPSS 1860	Material Specification for Geotextiles



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Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)



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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_{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 $= \sigma'_p / \sigma'_{vo}$

(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

Notes: 1
2

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



LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d :

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

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 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.

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

(b) Cohesive Soils Consistency

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

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test 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

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



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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



TABLES



FOUNDATION REPORT – CULVERTS – PHASE 2

HIGHWAY 69 G.W.P. 5111-07-00

TABLE 1 – SUMMARY OF CULVERT DETAILS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Invert Elevations ¹		Culvert Dimensions ¹			Head Walls and Wing Walls ¹	Boreholes / DCPTs	Reference Appendix
			East End of Culvert (m)	West End of Culvert (m)	Width (m)	Height (m)	Length (m)			
C45 (Precast Box)	Highway 69 SBL STA 13+380 (Swamp 18)	4.0 m	210.477	210.390	2.4	1.8	29.1	No	3 Boreholes (C45-S1 to C45-S3) / 6 DCPTs (C45-DC01 to C45-DC06))	A
	Highway 69 NBL STA 13+380 (Swamp 18)	5.0 m (< 0.5 m grade raise)	210.600	210.497	2.4	1.8	34.4	No	3 Boreholes (C45-N1 to C45-N3) / 2 DCPTs (C45-DC07 and C45-DC08)	
C47 (Site No. 44-616/C2 & 44-616/C1) (Precast Box)	Highway 69 SBL STA 13+778 (Swamp 19)	5.0 m	210.610	210.508	3.0	1.5	35.3	No	3 Boreholes (S19-05, C47-S1 and C47-S2) / 3 DCPTs (C47-DC01 to C47-DC03)	B
	Highway 69 NBL STA 13+791 (Swamp 19)	4.0 m	210.729	210.634	3.0	1.5	32.4	No	3 Boreholes (C47-N1 to C47-N3)	
C48.1 (Site No. 44-617/C2 & 44-617/C1) (Precast Box)	Highway 69 SBL STA 14+315 (Swamp 20)	3.0 m	213.117	213.175	3.0	1.8	19.1	Yes	3 Boreholes (S20-02, C48.1-S1 and C48.1-S2) / 3 DCPTS (C48.1-DC01 to C48.1-DC03)	C
	Highway 69 NBL STA 14+325 (Swamp 20)	3.0 m	212.971	213.024	3.0	1.8	17.7	Yes	4 Boreholes (S20-12, S20-12A, C48.1-N1 and C48.1-N2) / 3 DCPTS (C48.1-DC04 to C48.1-DC06)	



FOUNDATION REPORT – CULVERTS – PHASE 2 **HIGHWAY 69 G.W.P. 5111-07-00**

TABLE 1 – SUMMARY OF CULVERT DETAILS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Invert Elevations ¹		Culvert Dimensions ¹			Head Walls and Wing Walls ¹	Boreholes / DCPTs	Reference Appendix
			East End of Culvert (m)	West End of Culvert (m)	Width (m)	Height (m)	Length (m)			
C49A (Site No. 44-618/C2 & 44-618/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 14+649 (NA)	5.0 m	207.539	207.600	7.5	4.2	20.5	Yes	5 Boreholes (C49A-S1A, C49A-S1B, C49A-S2, C49A-S3 and H9-01) / 2 DCPTs (C49A-DC01 and C49A-DC02)	D
	Highway 69 NBL STA 14+656 (NA)	4.5 m	207.530	207.597	7.5	4.2	22.4	Yes	3 Boreholes (C49A-N1, C49A-N2 and C49A-N3) / 2 DCPTs (C49A-DC03 and C49A-DC04)	
C50 (Site No. 44-619/C2 & 44-619/C1) (Precast Box)	Highway 69 SBL STA 14+706 (NA)	5.0 m	206.534	206.641	3.0	2.4	36.2	Yes	3 Boreholes (C50-S1, S21-01 and S21-02)	E
	Highway 69 NBL STA 14+726 (NA)	5.0 m	206.353	206.480	3.0	2.4	46.4	Yes	4 Boreholes (S21-10, S21-10A, S21-11 and S21-19) / 1 DCPT (C50-DC01)	
C55 (Site No. 44-620/C2 & 44-620/C1) (Cast-in-Place)	Highway 69 SBL STA 15+710 (Swamp 23)	6.5 m	208.145	208.257	4	3	38.3	Yes	3 Boreholes (S23-03A, S23-04 and S23-06) / 1 DCPT (S23-DC02)	F
	Highway 69 NBL STA 15+717 (Swamp 23)	6.5 m	208.027	208.114	4	3	29.3	Yes	3 Boreholes (S23-08 to S23-10)	



FOUNDATION REPORT – CULVERTS – PHASE 2 **HIGHWAY 69 G.W.P. 5111-07-00**

TABLE 1 – SUMMARY OF CULVERT DETAILS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Invert Elevations ¹		Culvert Dimensions ¹			Head Walls and Wing Walls ¹	Boreholes / DCPTs	Reference Appendix
			East End of Culvert (m)	West End of Culvert (m)	Width (m)	Height (m)	Length (m)			
C57.1 (Site No. 44-621/C2 & 44-621/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+345 (N/A)	5.0 m	206.638	207.010	7	4.5	16.9	Yes	5 Boreholes (C57.1-S1 to C57.1-S5) / 3 DCPTs (C57.1-DC01 to C57.1-DC03)	G
	Highway 69 NBL STA 15+345 (N/A)	5.0 m	205.770	206.171	7	4.5	16.9	Yes	5 Boreholes (C57.1-N1 to C57.1-N5) / 4 DCPTs (C57.1-DC04 to C57.1-DC047)	
C57 (Site No. 44-622/C2 & 44-622/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+499 (Swamp 24)	8.5 m	202.693	202.817	3	2	41.2	Median Only	3 Boreholes (S24-03, S24-04 and S24-06) / 1 DCPT (S24-DC01)	H
	Highway 69 NBL STA 16+485 (Swamp 24)	8.0 m	202.453	202.579	3	2	42.4	Median Only	3 Boreholes (S24-06, S24-10 and S24-11) / 1 DCPT (S24-DC01)	
C60 (Closed Box Cast-in-Place)	Highway 69 SBL STA 17+272 (Swamp 25)	9.0 m	202.017	202.132	2.5	1.5	38.3	Median Only	3 Boreholes (C60-S1 to C60-S3)	I
	Highway 69 NBL STA 17+276 (Swamp 25)	9.0 m	201.891	202.006	2.5	1.5	38.6	Median Only	3 Boreholes (C60-N1 to C60-N3)	



FOUNDATION REPORT – CULVERTS – PHASE 2

HIGHWAY 69 G.W.P. 5111-07-00

TABLE 1 – SUMMARY OF CULVERT DETAILS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Invert Elevations ¹		Culvert Dimensions ¹			Head Walls and Wing Walls ¹	Boreholes / DCPTs	Reference Appendix
			East End of Culvert (m)	West End of Culvert (m)	Width (m)	Height (m)	Length (m)			
C51 (Precast Box)	Shebesheko ng Road S-E/W Ramp STA 14+990 (Swamp 22)	5.5 m	207.366	207.550	2.4	1.5	30.5	No	3 Boreholes (C51-R1, S22-02 and S22-03) / 1 DCPT (S22-DC03)	J
C53 (Precast – circular pipe)	Site No. 9 Road STA 10+235 (Swamp 26)	4.5 m	211.164	211.358	0.6	0.6	38.8	No	3 Boreholes (C53-01, C53-02 and S26-03)	K

Note: 1. Culvert invert elevations and dimensions provided by MRC on November 11, 2014.

Prepared By: MCK/AJS

Reviewed By: CN/JPD



TABLE 2 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Stratigraphic Unit	Top Elevation (m)	Thickness (m)	γ' (kN/m ³)	ϕ' (°)	c' (kPa)	S_u (kPa)	σ_p' (kPa)	e_o	C_c	C_r	m_v (kPa ⁻¹)	E' (MPa)	c_v (cm ² /s)
C45	Highway 69 SBL STA 13+380 (Swamp 18) Highway 69 NBL STA 14+380	Sand to Sand and Gravel Fill to Rock Fill	~ 214.8	~5.5	19 – 20	30 – 40	-	-	-	-	-	-	-	25 – 50	-
		Silty Peat to Sandy Peat	211.0 – 210.4	0.6 – 1.2	12	27	1	-	-	-	-	-	-	-	-
		Organic Silty Sand	210.9 – 210.4	0.2 – 1.5	17	26	0	-	-	-	-	-	-	-	-
		Silty Sand to Sand	209.4 – 208.0	0.6 – 1.2	18.5	26 – 27	0	-	-	-	-	-	-	5 – 10	-
		Silty Clay (Pocket)	~208.2	~0.2	18	-	-	20	75	1.5	0.7	0.07	-	-	1.5 x 10 ⁻³
C47 (Site No. 44-616/C2 & 44-616/C1)	Highway 69 SBL STA 13+778 (Swamp 19) Highway 69 NBL STA 13+791 (Swamp 19)	Silty Peat to Peat	210.7 – 210.3	0.6 – 2.1	12	27	1	-	-	-	-	-	-	-	-
		Organic Sand	~209.8	~0.6	17	26	0	-	-	-	-	-	-	-	-
		Silt and Sand to Sand	209.2 – 207.2	0.9 – 2.3	18 – 19	27 – 28	0	-	-	-	-	-	-	5 – 15	-
		Clay (Pocket)	~207.4	~0.2	18	-	-	15	-	-	-	-	3 x 10 ⁻⁴	-	7 x 10 ⁻³
C48.1 (Site No. 44-617/C2 & 44-617/C1)	Highway 69 SBL STA 14+315 (Swamp 20) Highway 69 NBL STA 14+325 (Swamp 20)	Silty Peat	213.2 – 212.4	0.2 - 0.8	12	27	1	-	-	-	-	-	-	-	-
		Silt	212.4 – 211.7	~1.2	19	27	0	-	-	-	-	-	-	3	-
		Sand and Silt to Sand	210.9 – 210.8	0.4 – 1.3	18.5	29	0	-	-	-	-	-	-	25	-
		Silty Clay	212.9 – 212.4	~0.9	18	-	-	18	80	0.92	0.2	0.02	-	-	5.7 x 10 ⁻³
		Silt to Sand Till	~211.5	~1.0	19	29	0	-	-	-	-	-	-	25	-
C49A (Site No. 44-618/C2 & 44-618/C1)	Highway 69 SBL STA 14+649 Highway 69 NBL STA 14+656	Organic Silty Sand	~ 208.3	~0.5	17	26	0	-	-	-	-	-	-	-	-
		Sandy Silt to Silty Sand	208.2 – 207.5	0.6 – 2.5	18.5	28	0	-	-	-	-	-	-	10	-
		Silty Sand and Gravel to Sand and Gravel	207.2 – 205.9	1.1 – 1.5	19	30	0	-	-	-	-	-	-	50	-
C50 (Site No. 44-619/C2 & 44-619/C1)	Highway 69 SBL STA 14+706 (Swamp 21) Highway 69 NBL STA 14+726 (Swamp 21)	Peat	207.0 – 206.7	0.3 – 0.4	12	27	1	-	-	-	-	-	-	-	-
		Organic Sand	206.6 – 206.3	0.3 – 1.0	18	27	0	-	-	-	-	-	-	-	-
		Clayey Silt (Near Surface)	~206.3	~0.8	18	-	-	18	100	1.5	0.8	0.08	-	-	5.7 x 10 ⁻³
		Silt to Sand	207.0 – 205.3	0.4 – 9.8	19	28	0	-	-	-	-	-	-	3	-
		Clay to Silty Clay (Pockets)	202.8 – 200.0	0.5 – 2.0	19	-	-	18	100	1.5	0.8	0.08	-	-	5.7 x 10 ⁻³
		Sand and Gravel	200 – 196.8	0.1 – 0.2	19	-	-	-	-	-	-	-	-	50	-
C55 (Site No. 44-620/C2 & 44-620/C1)	Highway SBL STA 15+710 (Swamp 23) Highway NBL STA 15+717 (Swamp 23)	Peat	208.1 – 208.0	0.1 – 1.8	12	27	1	-	-	-	-	-	-	-	-
		Organic Sand	~207.4	~0.7	18	27	0	-	-	-	-	-	-	-	-
		Silty Sand to Sand	208.6 – 206.2	6.0 – 10.2	19	32	0	-	-	-	-	-	-	10 – 20	-



TABLE 2 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS
HIGHWAY 69 FOUR-LANING – PHASE 2

Culvert Designation	Culvert Location (Associated Swamp)	Stratigraphic Unit	Top Elevation (m)	Thickness (m)	γ' (kN/m ³)	ϕ' (°)	c' (kPa)	S_u (kPa)	σ_p' (kPa)	e_o	C_c	C_r	m_v (kPa ⁻¹)	E' (MPa)	c_v (cm ² /s)
C57.1 (Site No. 44-621/C2 & 44-621/C1)	Highway 69 STA 16+345	Silt to Sand	208.9 – 207.6	0.6 – 3.4	18.5	28	0	-	-	-	-	-	-	7.5	-
		Gravelly Silty Sand to Sand and Gravel (Pockets)	208.2 – 207.1	~0.7	19	30	0	-	-	-	-	-	-	20	-
		Silty Sand and Gravel to Sand and Gravel	208.2 – 204.2	0.3 – 2.1	19	32	0	-	-	-	-	-	-	50	-
C57 (Site No. 44-622/C2 & 44-622/C1)	Highway 69 SBL STA 16+499 (Swamp 24)	Peat	203.1 – 201.9	0.2 – 0.7	12	27	1	-	-	-	-	-	-	-	-
		Silt to Sand	202.7 – 201.9	2.8 – 14.2	18.5	31	0	-	-	-	-	-	-	10	-
	Highway 69 NBL STA 16+485 (Swamp 24)	Sand and Gravel (Pocket)	~192.5	~1.4	19	32	0	-	-	-	-	-	-	20	-
		Sand to Sand and Gravel	196.4 – 191.6	1.6 – 5.8	19	32	0	-	-	-	-	-	-	20	-
C60	Highway 69 SBL STA 17+269 (Swamp 25)	Peat	202.3 – 200.6	0.1 – 0.6	12	27	1	-	-	-	-	-	-	-	-
		Silt and Sand to Sand	201.7 – 200.3	1.5 – 3.1	18.5	28	0	-	-	-	-	-	-	20	-
		Clay to Silty Clay	199.1 – 198.3	0.7 – 3.1	16.5	-	-	18	80	1.5	0.9	0.09	-	-	2.3 x 10 ⁻³
	Highway 69 NBL STA 17+279 (Swamp 25)	Silty Sand	~197.8	~1.4	18.5	28	0	-	-	-	-	-	-	20	-
		Silt	197.9 – 196.0	0.3 – 1.3	18	26	0	-	-	-	-	-	-	4	-
		Silt and Sand to Sand	197.1 – 195.1	0.1 – 9.3	18.5	28	0	-	-	-	-	-	-	20	-
C51	Shebeshekong Road S-E/W Ramp STA 14+990 (Swamp 22)	Sandy Silt to Sand	207.7 – 207.0	2.5 – 3.2	19	28	0	-	-	-	-	-	-	10	-
		Clayey Silt	204.5 – 204.2	1.0 – 1.2	18	-	-	35	160	1.05	0.56	0.05	-	-	1.6 x 10 ⁻²
		Silt and Sand (Upper)	203.4 – 203.1	2.8 – 3.4	19	28	0	-	-	-	-	-	-	2.5	-
		Clay	200.3 – 200.1	~1.5	16.5	-	-	35	145	1.55	0.72	0.10	-	-	3.5 x 10 ⁻³
		Silt and Sand to Sand (Lower)	198.8 – 198.6	4.0 – 4.7	19	28	0	-	-	-	-	-	-	15	-
C53	Site 9 Road STA 10+235 (Swamp 26)	Sandy Organic Silt	211.0 – 210.8	~0.3	17	27	0	-	-	-	-	-	-	-	-
		Silt to Sand	210.9 – 210.5	5.1 – 7.1	18.5	28	0	-	-	-	-	-	-	7.5	-
		Clayey Silt (Pocket)	~208.0	~0.5	16.5	-	-	40	-	-	-	-	1x10 ⁻⁴	-	-

Prepared By: MCK/AJS

Reviewed By: CN/JPD



FOUNDATION REPORT – CULVERTS – PHASE 2

HIGHWAY 69 G.W.P. 5111-07-00

TABLE 3 – SUMMARY OF ANALYSES

Culvert Designation (Culvert Type)	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Preferred Mitigation Option for Embankment Construction in Swamp	Estimated Total Settlement for Permanent Culvert (mm) ¹			Preferred Mitigation Option for Culvert Construction ²	Geotechnical Resistance	
				Culvert Construction Concurrent with Embankment Construction	Culvert Construction Following Preload Period	Culvert Construction Following Full Sub Excavation		Founding Soil ³	ULS / SLS (kPa) ⁴
C45 (Precast)	Highway 69 SBL STA 13+380 (Swamp 18)	4.0 m	Localized Sub-Excavation of Cohesive Deposit with Preloading (90 days)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} = 10 \text{ mm}$	N/A	N/A	Culvert construction concurrent with embankment construction after sub-excavation of bedrock (up to about 1 m deep at centre of culvert)	Granular Fill over Sand or Bedrock	300 / 125
	Highway 69 NBL STA 13+380 (Swamp 18)	5.0 m (< 0.5 m grade raise)	N/A	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	N/A	Culvert construction concurrent with embankment construction	Granular Fill over Sand or Bedrock	300 / 80
C47 (Site No. 44-616/C2 & 44-616/C1) (Precast)	Highway 69 SBL STA 13+778 (Swamp 19)	5.0 m	N/A	$\delta_{East} = 10 \text{ mm}$ $\delta_{Centre} = 15 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	N/A	Construction of culvert concurrent with embankment construction	Granular Fill over Sand / Bedrock	300 / 100
	Highway 69 NBL STA 13+791 (Swamp 19)	4.0 m	N/A	$\delta_{East} = 5 \text{ mm}$ $\delta_{Centre} = 10 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	N/A	N/A	Construction of culvert concurrent with embankment construction	Granular Fill over Sand and Silt / Bedrock	300 / 125



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 3 – SUMMARY OF ANALYSES

Culvert Designation (Culvert Type)	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Preferred Mitigation Option for Embankment Construction in Swamp	Estimated Total Settlement for Permanent Culvert (mm) ¹			Preferred Mitigation Option for Culvert Construction ²	Geotechnical Resistance	
				Culvert Construction Concurrent with Embankment Construction	Culvert Construction Following Preload Period	Culvert Construction Following Full Sub Excavation		Founding Soil ³	ULS / SLS (kPa) ⁴
C48.1 (Site No. 44-617/C2 & 44-617/C1) (Precast)	Highway 69 SBL STA 14+315 (Swamp 20)	3.0 m	Preloading (10 Days)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 15 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	N/A	Construction of culvert concurrent with embankment construction	Granular Fill over Sand and Silt / Bedrock	300 / 80
	Highway 69 NBL STA 14+325 (Swamp 20)	3.0 m	Preloading (10 Days)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 25 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 10 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 10 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Concurrent with embankment construction after localized sub-excavation of bedrock (up to about 0.5 m deep at west end of culvert)	Granular Fill over Sand or Bedrock	75 / 75
C49A (Site No. 44-618/C2 & 44-618/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 14+649 (NA)	5.0 m	N/A ⁵	$\delta_{East} = 35 \text{ mm}$ $\delta_{Centre} = 35 \text{ mm}$ $\delta_{West} = 20 \text{ mm}$	N/A	N/A	Construction of culvert concurrent with embankment construction	Granular Fill over Sandy Silt to Sand	400 / 100
	Highway 69 NBL STA 14+656 (NA)	4.5 m	N/A ⁵	$\delta_{East} = 25 \text{ mm}$ $\delta_{Centre} = 25 \text{ mm}$ $\delta_{West} = 20 \text{ mm}$	N/A	N/A	Construction of culvert concurrent with embankment construction	Granular Fill over Sandy Silt to Sand	400 / 200



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 3 – SUMMARY OF ANALYSES

Culvert Designation (Culvert Type)	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Preferred Mitigation Option for Embankment Construction in Swamp	Estimated Total Settlement for Permanent Culvert (mm) ¹			Preferred Mitigation Option for Culvert Construction ²	Geotechnical Resistance	
				Culvert Construction Concurrent with Embankment Construction	Culvert Construction Following Preload Period	Culvert Construction Following Full Sub Excavation		Founding Soil ³	ULS / SLS (kPa) ⁴
C50 (Site No. 44-619/C2 & 44-619/C1) (Precast)	Highway 69 SBL STA 14+706 (Swamp 21)	5.0 m	No Foundation Mitigation Required	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} = 15 \text{ mm}$	N/A	N/A	Concurrent construction concurrent with embankment construction following sub-excavation of bedrock (up to about 1.0 m deep at the center of the culvert)	Granular Fill over Silt to Silty Sand or Bedrock	400 / 250
	Highway 69 NBL STA 14+726 (Swamp 21)	5.0 m	Localized Sub-Excavation of Cohesive Deposit with Preloading (30 days)	$\delta_{East} = 240 \text{ mm}$ $\delta_{Centre} = 335 \text{ mm}$ $\delta_{West} = 155 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 30 \text{ mm}$ $\delta_{West} = 30 \text{ mm}$	N/A	Culvert construction following localized sub-excavation of soft clayey silt (up to 0.8 m at east end of culvert) and embankment preload period (30 days)	Granular Fill over Silt to Silty Sand	300 / 60
C55 (Site No. 44-620/C2 & 44-620/C1) (Cast-in-Place)	Highway 69 SBL STA 15+710 (Swamp 23)	6.5 m	Preloading of Rock Fill Embankment (45 days)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 70 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	Culvert construction following preload period	Granular / Rock Fill over Sand	400 / 100
	Highway 69 NBL STA 15+717 (Swamp 23)	6.5 m	Preloading of Rock Fill Embankment (20 days)	$\delta_{East} = 10 \text{ mm}$ $\delta_{Centre} = 40 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	Culvert construction following sub-excavation of pocket of organic sand (up to about 0.7 m deep) and preload period	Granular Fill over Sand	400 / 100



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 3 – SUMMARY OF ANALYSES

Culvert Designation (Culvert Type)	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Preferred Mitigation Option for Embankment Construction in Swamp	Estimated Total Settlement for Permanent Culvert (mm) ¹			Preferred Mitigation Option for Culvert Construction ²	Geotechnical Resistance	
				Culvert Construction Concurrent with Embankment Construction	Culvert Construction Following Preload Period	Culvert Construction Following Full Sub Excavation		Founding Soil ³	ULS / SLS (kPa) ⁴
C57.1 (Site No. 44-621/C2 & 44-621/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+345 (NA)	5.0 m	N/A ⁵	$\delta_{East} = 5 \text{ mm}$ $\delta_{Centre} = 20 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	N/A	N/A	Culvert construction concurrent with embankment construction	Granular Fill over Sand to Silt	400 / 200
	Highway 69 NBL STA 16+345 (NA)	5.0 m	N/A ⁵	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	N/A	Culvert construction concurrent with embankment construction after sub-excavation of bedrock (up to about 2.5 m deep at east end of culvert)	Granular Fill over Sand to Silt or Bedrock	400 / 300
C57 (Site No. 44-622/C2 & 44-622/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+499 (Swamp 24)	8.5 m	Preloading of Rock Fill Embankment (45 days)	$\delta_{East} = 75 \text{ mm}$ $\delta_{Centre} = 135 \text{ mm}$ $\delta_{West} = 15 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	Culvert construction following preload period	Granular Fill over Silt to Sand	350 / 75
	Highway 69 NBL STA 16+485 (Swamp 24)	8.0 m	Preloading of Rock Fill Embankment (55 days)	$\delta_{East} = 10 \text{ mm}$ $\delta_{Centre} = 250 \text{ mm}$ $\delta_{West} = 75 \text{ mm}$	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	N/A	Culvert construction following preload period	Granular Fill over Silt to Sand	350 / 150



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 3 – SUMMARY OF ANALYSES

Culvert Designation (Culvert Type)	Culvert Location (Associated Swamp)	Approximate Proposed Embankment Height (m)	Preferred Mitigation Option for Embankment Construction in Swamp	Estimated Total Settlement for Permanent Culvert (mm) ¹			Preferred Mitigation Option for Culvert Construction ²	Geotechnical Resistance	
				Culvert Construction Concurrent with Embankment Construction	Culvert Construction Following Preload Period	Culvert Construction Following Full Sub Excavation		Founding Soil ³	ULS / SLS (kPa) ⁴
C60 (Closed Box Cast-in-Place)	Highway 69 SBL STA 17+272 (Swamp 25)	8.5 m	Full Sub Excavation of Clay Deposit with Preloading of Rock Fill (120 days)	N/A	N/A	$\delta_{East} = 135 \text{ mm}$ $\delta_{Centre} = 110 \text{ mm}$ $\delta_{West} = 50 \text{ mm}$	Concurrent with embankment construction after sub-excavation (up to 4.6 m deep at culvert)	Rock Fill over Silt to Sand	275 / 150
	Highway 69 NBL STA 17+276 (Swamp 25)	8.0 m	Full Sub Excavation with Preloading of Rock Fill (145 days)	N/A	N/A	$\delta_{East} = 105 \text{ mm}$ $\delta_{Centre} = 170 \text{ mm}$ $\delta_{West} = 135 \text{ mm}$	Concurrent with embankment construction after sub-excavation (up to 5.3 m deep at culvert)	Rock Fill over Silt to Sand	275 / 150
C51 (Precast Box)	Shebeshekong Road S-E/W Ramp STA 14+990 (Swamp 22)	5.5 m	Preloading of Rock Fill Embankment (30 days)	$\delta_{East} = 60 \text{ mm}$ $\delta_{Centre} = 280 \text{ mm}$ $\delta_{West} = 90 \text{ mm}$	$\delta_{East} = 20 \text{ mm}$ $\delta_{Centre} = 50 \text{ mm}$ $\delta_{West} = 50 \text{ mm}$	N/A	Culvert construction following preload period	Granular Fill over Silt to Sand / Clayey Silt to Clay	200 / 100
C53 (Precast)	Site No. 9 Road STA 10+235 (Swamp 26)	4.5 m	No Foundation Mitigation Required	$\delta_{East} = 15 \text{ mm}$ $\delta_{Centre} = 70 \text{ mm}$ $\delta_{West} = 10 \text{ mm}$	N/A	N/A	Culvert construction concurrent with embankment construction	Granular Fill over Sandy Silt to Sand	100 / 100

- Notes:
- 1) Total settlement refers to the sum of immediate, primary and secondary/creep of the soils/rock fill below the base of the permanent culvert over a 10 year period following completion of construction.
 - 2) All peat/organic deposits to be removed prior to culvert construction.
 - 3) Bedding for the culverts should be at least 300 mm thick and consist of Granular 'A' material, plus 75 mm levelling course (uncompacted Granular 'A').
 - 4) Geotechnical resistance values at SLS are for 25 mm of settlement.
 - 5) Culvert is not associated with a swamp crossing.

Prepared By: AJS/MCK

Reviewed By: CN/JPD



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C45 (Precast)	Highway 69 SBL STA 13+380 Swamp 18 (4.0 m)	Culvert construction concurrent with embankment construction after sub-excavation of bedrock (up to about 1 m deep at centre of culvert)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} = 10 \text{ mm}$	Granular Fill over Sand or Bedrock	300 / 125	< 0.05	0.10	< 0.05	29.1	< 5
	Highway 69 NBL STA 13+380 Swamp 18 (5.0 m) (< 0.5 m grade raise)	Culvert construction concurrent with embankment construction	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Sand or Bedrock	300 / 80	< 0.05	0.18	< 0.05	34.4	< 5
C47 (Site No. 44-616/C2 & 44-616/C1) (Precast)	Highway 69 SBL STA 13+778 Swamp 19 (5.0 m)	Construction of culvert concurrent with embankment construction	$\delta_{East} = 10 \text{ mm}$ $\delta_{Centre} = 15 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Sand / Bedrock	300 / 100	0.6	0.25	0.15	35.3	55
	Highway 69 NBL STA 13+791 Swamp 19 (4.0 m)	Construction of culvert concurrent with embankment construction	$\delta_{East} = 5 \text{ mm}$ $\delta_{Centre} = 10 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	Granular Fill over Sand and Silt / Bedrock	300 / 125	0.4	0.15	0.05	32.4	15



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C48.1 (Site No. 44-617/C2 & 44-617/C1) (Precast)	Highway 69 SBL STA 14+315 Swamp 20 (3.0 m)	Construction of culvert concurrent with embankment construction	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 15 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Sand and Silt / Bedrock	300 / 80	0.45	0.20	0.10	19.1	20
	Highway 69 NBL STA 14+325 Swamp 20 (3.0 m)	Concurrent with embankment construction after localized sub-excavation of bedrock (up to about 0.5 m deep at west end of culvert)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} = 25 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Sand or Bedrock	75 / 75	1.15	0.18	0.20	17.7	40
C49A (Site No. 44-618/C2 & 44-618/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 14+649 (5.0 m)	Construction of culvert concurrent with embankment construction	$\delta_{East} = 35 \text{ mm}$ $\delta_{Centre} = 35 \text{ mm}$ $\delta_{West} = 20 \text{ mm}$	Granular Fill over Sandy Silt to Sand	400 / 100	0.9	0.19	0.20	20.5	40
	Highway 69 NBL STA 14+656 (4.5 m)	Construction of culvert concurrent with embankment construction	$\delta_{East} = 25 \text{ mm}$ $\delta_{Centre} = 25 \text{ mm}$ $\delta_{West} = 20 \text{ mm}$	Granular Fill over Sandy Silt to Sand	400 / 200	0.7	0.19	0.15	22.4	35



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C50 (Site No. 44-619/C2 & 44-619/C1) (Precast)	Highway 69 SBL STA 14+706 (5.0 m)	Concurrent with embankment construction after localized sub-excavation of bedrock (up to about 1.0 m deep at the center of the culvert) along culvert alignment	$\delta_{\text{East}} = < 5 \text{ mm}$ $\delta_{\text{Centre}} = < 5 \text{ mm}$ $\delta_{\text{West}} = 15 \text{ mm}$	Granular Fill over Silt to Silty Sand or Bedrock	400 / 250	1.35	0.1	0.15	36.2	55
	Highway 69 NBL STA 14+726 (5.0 m)	Culvert construction following localized sub-excavation of soft clayey silt (up to 0.8 m at east end of culvert) and embankment preload period (30 days)	$\delta_{\text{East}} < 5 \text{ mm}$ $\delta_{\text{Centre}} = 30 \text{ mm}$ $\delta_{\text{West}} = 30 \text{ mm}$	Granular Fill over Silt to Silty Sand	300 / 60	0.35	0.27	0.10	46.4	45
C55 (Site No. 44-620/C2 & 44-620/C1) (Cast-in-Place)	Highway 69 SBL STA 15+710 Swamp 23 (6.5 m)	Culvert construction following preload period	$\delta_{\text{East}} < 5 \text{ mm}$ $\delta_{\text{Centre}} < 5 \text{ mm}$ $\delta_{\text{West}} < 5 \text{ mm}$	Granular Fill over Sand	400 / 100	< 0.05	0.27	< 0.05	38.3	< 5
	Highway 69 NBL STA 15+717 Swamp 23 (6.5 m)	Culvert construction following sub-excavation of pocket of organic sand (up to 0.5 m deep) and preload period	$\delta_{\text{East}} < 5 \text{ mm}$ $\delta_{\text{Centre}} < 5 \text{ mm}$ $\delta_{\text{West}} < 5 \text{ mm}$	Granular Fill over Sand	400 / 100	< 0.05	0.45	< 0.05	29.3	< 5



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C57.1 (Site No. 44-621/C2 & 44-621/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+345 (5.0 m)	Culvert construction concurrent with embankment construction	$\delta_{East} = 5 \text{ mm}$ $\delta_{Centre} = 20 \text{ mm}$ $\delta_{West} = 5 \text{ mm}$	Granular Fill over Sand to Silt	400 / 200	0.70	0.21	0.15	16.9	25
	Highway 69 NBL STA 16+345 (5.0 m)	Culvert construction concurrent with embankment construction after sub-excavation of bedrock (up to about 2.5 m deep at east end of culvert) and clayey silt to sandy clayey silt (up to about 0.7 m deep at center of culvert)	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Sand to Silt or Bedrock	400 / 300	< 0.05	0.15	< 0.05	16.9	< 5
C57 (Site No. 44-622/C2 & 44-622/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+499 Swamp 24 (8.5 m)	Culvert construction following preload period	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Silt to Sand	350 / 75	< 0.05	0.46	< 0.05	41.2	< 5
	Highway 69 NBL STA 16+485 Swamp 24 (8.0 m)	Culvert construction following preload period	$\delta_{East} < 5 \text{ mm}$ $\delta_{Centre} < 5 \text{ mm}$ $\delta_{West} < 5 \text{ mm}$	Granular Fill over Silt to Sand	350 / 150	< 0.05	0.50	< 0.05	20.6	< 5



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C60 (Closed Box Cast-in-Place)	Highway 69 SBL STA 17+272 Swamp 25 (8.5 m)	Concurrent with embankment construction after sub-excavation (up to 4.6 m deep at culvert) along culvert alignment	$\delta_{East} = 135 \text{ mm}$ $\delta_{Centre} = 110 \text{ mm}$ $\delta_{West} = 50 \text{ mm}$	Rock Fill over Silt to Sand	275 / 150	0.90	0.45	0.40	38.3	155
	Highway 69 NBL STA 17+276 Swamp 25 (8.0 m)	Concurrent with embankment construction after sub-excavation (up to 5.3 m deep at culvert) along culvert alignment	$\delta_{East} = 135 \text{ mm}$ $\delta_{Centre} = 170 \text{ mm}$ $\delta_{West} = 105 \text{ mm}$	Rock Fill over Silt to Sand	275 / 150	1.35	0.47	0.60	38.6	230
C51 (Precast)	Shebeshekong Road S-E/W Ramp STA 14+990 Swamp 22 (5.5 m)	Culvert construction following preload period	$\delta_{East} = 20 \text{ mm}$ $\delta_{Centre} = 50 \text{ mm}$ $\delta_{West} = 50 \text{ mm}$	Granular Fill over Silt to Sand / Clayey Silt to Clay	200 / 100	0.40	0.50	0.20	30.5	60



FOUNDATION REPORT – CULVERTS – PHASE 2 HIGHWAY 69 G.W.P. 5111-07-00

TABLE 4 – SUMMARY OF PREFERRED MITIGATION OPTIONS FOR CULVERT CONSTRUCTION

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction ¹	Total Settlement for Permanent Culvert ²	Factored Geotechnical Resistance		Permanent Culvert Strain				
				Founding Soil ³	ULS / SLS (kPa) ⁴	Estimated Vertical Strain (%)	Estimated Ratio of Horizontal Strain to Vertical Strain	Estimated Horizontal Strain (%)	Culvert Length (m)	Estimated Maximum Joint Opening (mm)
C53 (Precast)	Site No. 9 Road STA 10+235 Swamp 22 (4.5 m)	Culvert construction concurrent with embankment construction	$\delta_{\text{East}} = 10 \text{ mm}$ $\delta_{\text{Centre}} = 70 \text{ mm}$ $\delta_{\text{West}} = 15 \text{ mm}$	Granular Fill over Sandy Silt to Sand	100 / 100	1.10	0.25	0.30	38.8	115

- Notes:
- 1) All peat/organic deposits to be removed prior to culvert construction.
 - 2) Total settlement refers to the sum of immediate, primary and secondary/creep of the soils/rock fill below the base of the permanent culvert over a 10 year period following completion of construction.
 - 3) Bedding for the culverts should be at least 300 mm thick and consist of Granular 'A' material, plus 75 mm levelling course (uncompacted Granular 'A').
 - 4) Geotechnical resistance values at SLS are for 25 mm of settlement.

Prepared By: AJS / MCK

Reviewed By: CN / JPD



FOUNDATION REPORT – CULVERTS – PHASE 2

HIGHWAY 69 G.W.P. 5111-07-00

TABLE 5 – SUMMARY OF MODULUS OF VERTICAL SUBGRADE REACTION FOR CAST-IN-PLACE CULVERTS

Culvert Designation (Culvert Type)	Culvert Location (Embankment Height)	Preferred Mitigation Option for Culvert Construction	Modulus of Vertical Subgrade Reaction, K_v (kPa/mm)¹
C49A (Site No. 44-618/C2 & 44-618/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 14+649 (5.0 m)	Construction of culvert concurrent with embankment construction	4
	Highway 69 NBL STA 14+656 (4.5 m)	Construction of culvert concurrent with embankment construction	8
C55 (Site No. 44-620/C2 & 44-620/C1) (Cast-in-Place)	Highway 69 SBL STA 15+710 Swamp 23 (6.5 m)	Culvert construction following preload period	4
	Highway 69 NBL STA 15+717 Swamp 23 (6.5 m)	Culvert construction following sub-excavation of pocket of organic sand (up to 0.5 m deep) and preload period	4
C57.1 (Site No. 44-621/C2 & 44-621/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+345 (5.0 m)	Culvert construction concurrent with embankment construction	8
	Highway 69 NBL STA 16+345 (5.0 m)	Culvert construction concurrent with embankment construction after sub-excavation of bedrock (up to about 2.5 m deep at east end of culvert) and clayey silt to sandy clayey silt (up to about 0.7 m deep at center of culvert)	12
C57 (Site No. 44-622/C2 & 44-622/C1) (Closed Box Cast-in-Place)	Highway 69 SBL STA 16+499 Swamp 24 (8.5 m)	Culvert construction following preload period	3
	Highway 69 NBL STA 16+485 Swamp 24 (8.0 m)	Culvert construction following preload period	6

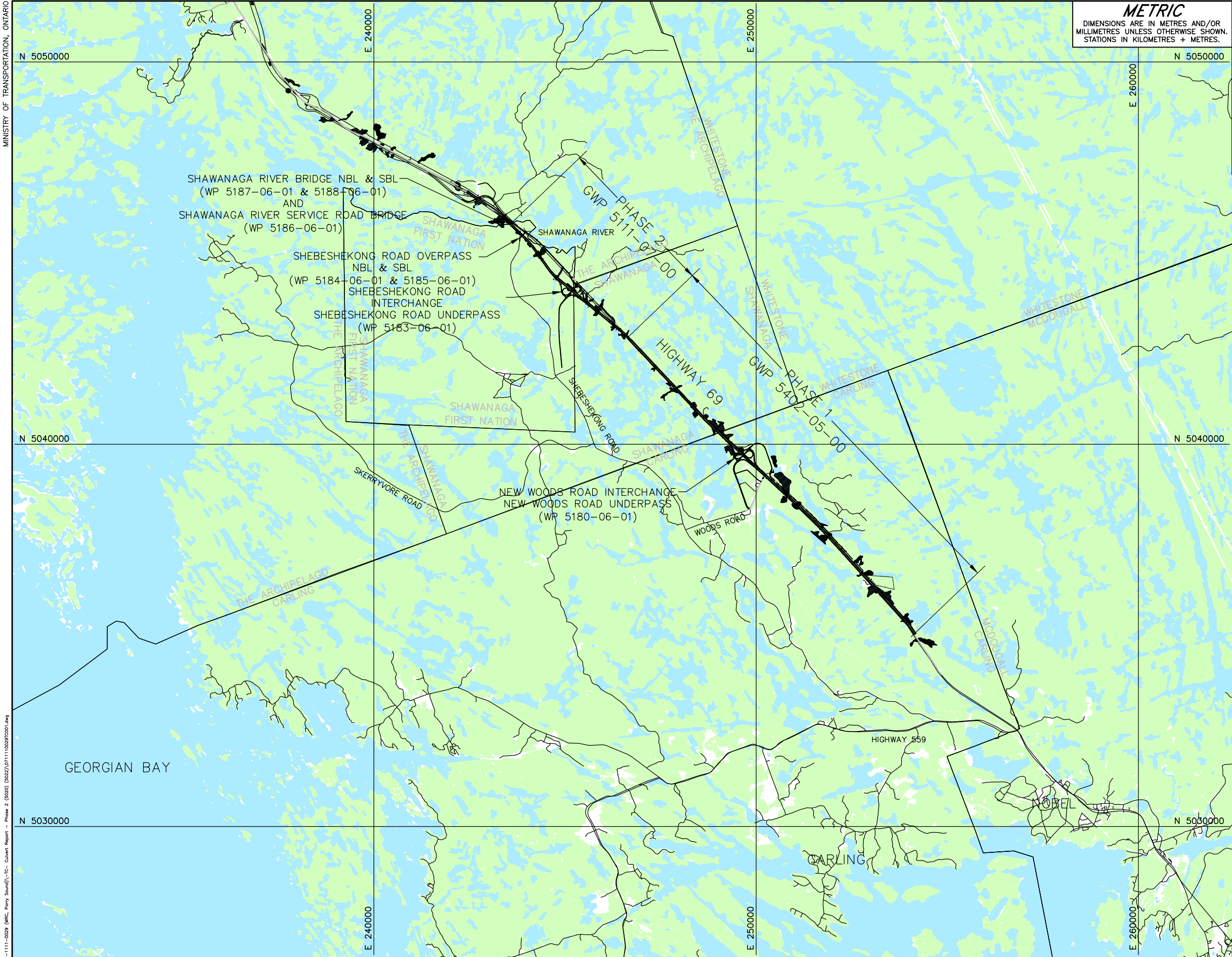
Note: 1) The modulus of vertical subgrade reaction (K_v) has been estimated at the point along the culvert anticipated to experience the largest settlement. The value of K_v may not be constant along the entire culvert alignment.

Prepared By: AJS

Reviewed By: CN



DRAWINGS



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

CONT No.
GWP No. 5111-07-00

HIGHWAY 69
SITE LOCATION PLAN

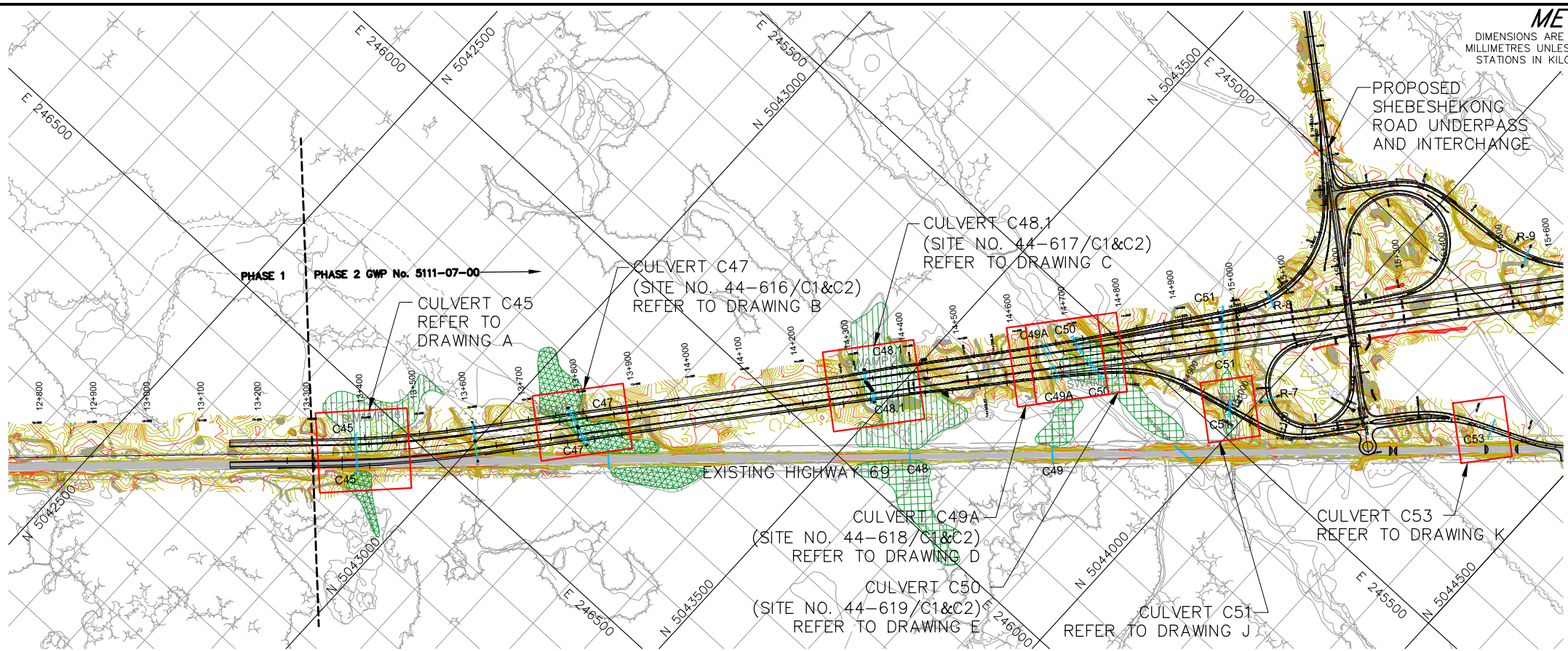
SHEET



KEY PLAN
NOT TO SCALE

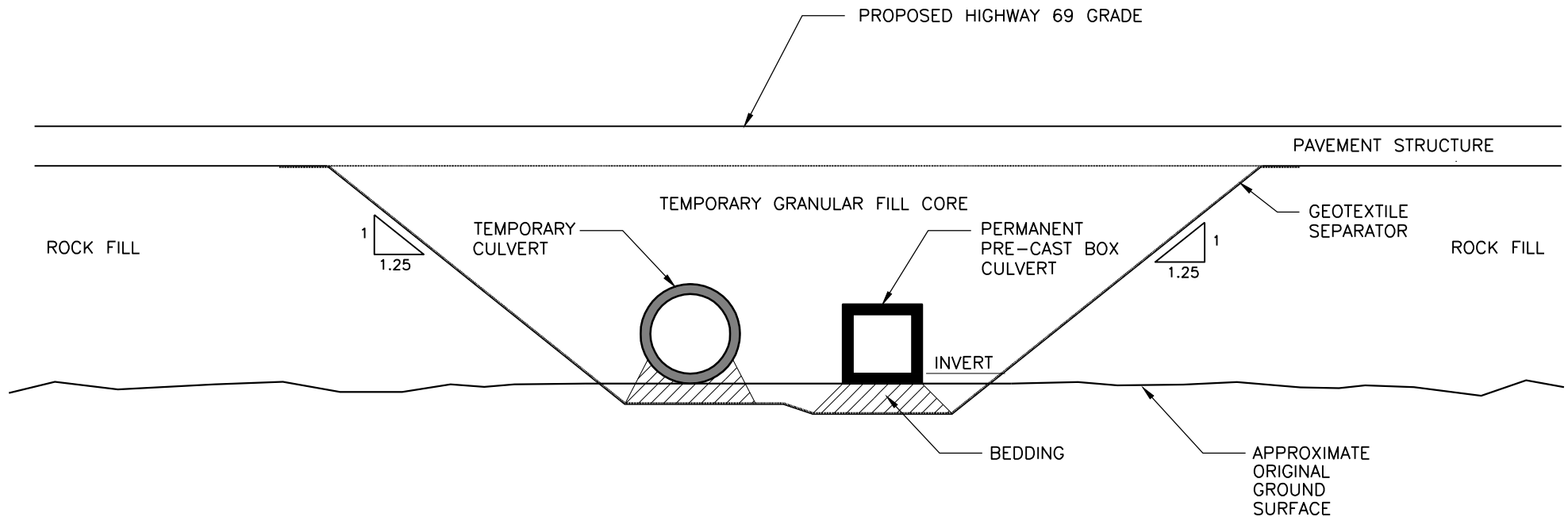
REFERENCE
Base Data — MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, ©Queens Printer 2008
Datum : NAD 83 Projection : MTM Zone 10

NO.	DATE	BY	REVISION
Geocres No. 41H-160			
HWY. 69		PROJECT NO. 07-1111-0029	DIST. .
SUBM'D. TVA		CHKD. TVA/MCK	DATE: Mar. 2016 SITE: .
DRAWN: JFC/MR		CHKD. CN	APPD. JPD/JMAC DWG. 1





FIGURES



NOTE(S)

1. SIDE SLOPES OF TEMPORARY GRANULAR FILL CORE AT ENDS OF CULVERT SHOULD BE NO STEEPER THAN 2H:1V.



SCALE	N.T.S.
DATE	September 2015
DESIGN	
CAD	DD/RJ
CHECK	TZ/VA
REVIEW	JPD/JMAC

HIGHWAY 69 FOUR - LANING - PHASE 2
FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559 INTERCHANGE
TO 1.5 KM NORTH OF HIGHWAY 7182 (SHEBESHEKONG ROAD)

FILE No. 0711110029-AGA-BG-0013.dwg

PROJECT No. 07-1111-0029-8 REV.

TEMPORARY GRANULAR FILL CORE

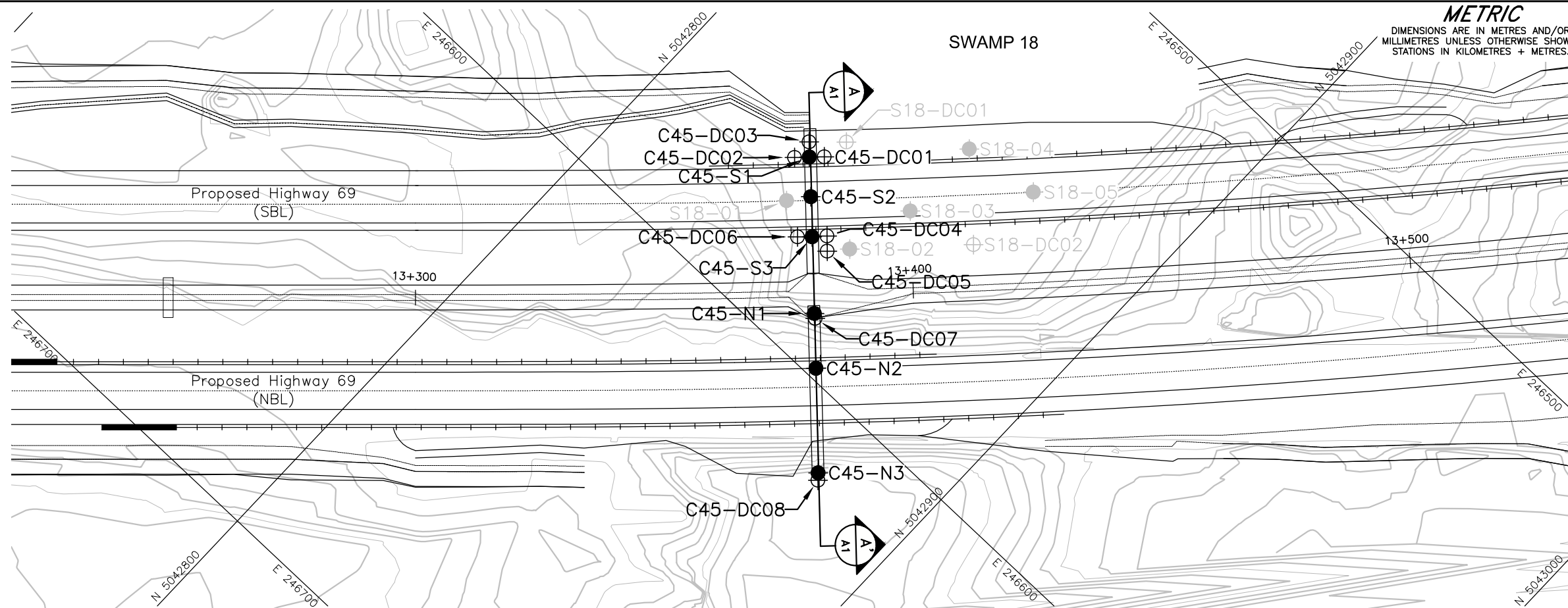
FIGURE

1

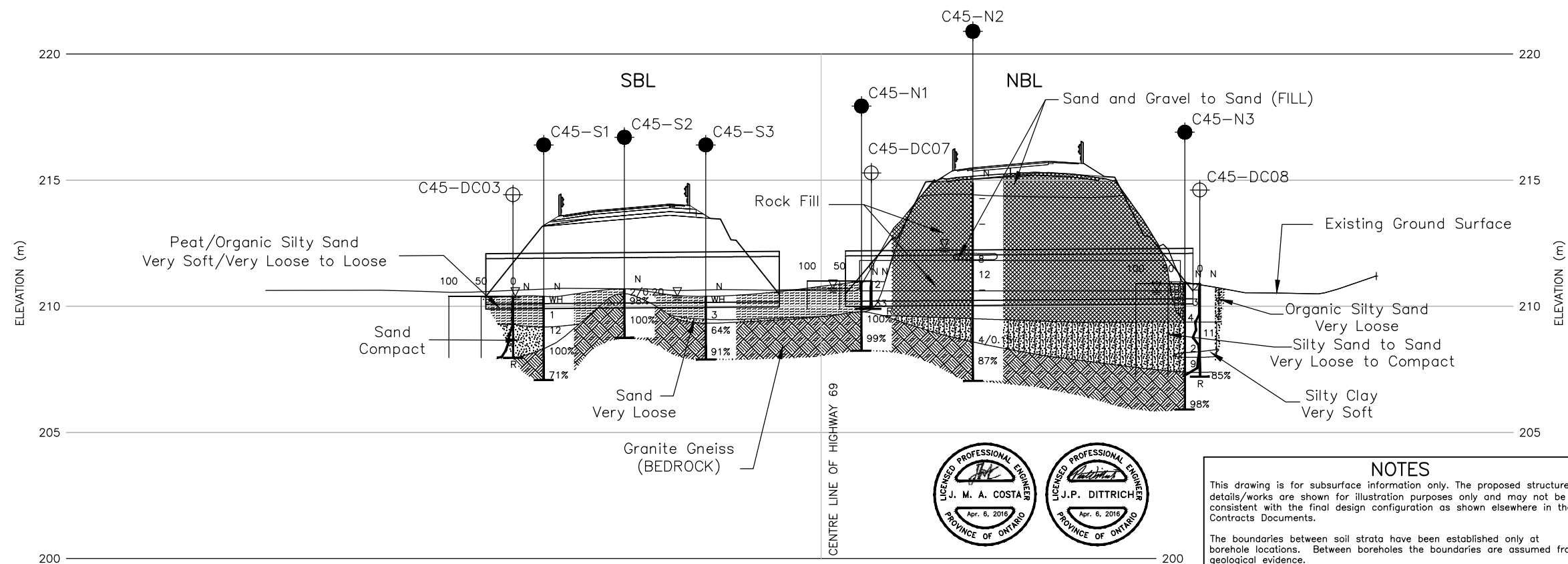


APPENDIX A

Highway 69 SBL and NBL – STA 13+380 (Culvert C45)



PLAN

SCALE
10 0 10 20 mA-A
A1

CULVERT C49A PROFILE STA 14+649 AND STA 14+656

HORIZONTAL SCALE
5 0 5 10 m
VERTICAL SCALE
2 0 2 4 m

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.

METRIC

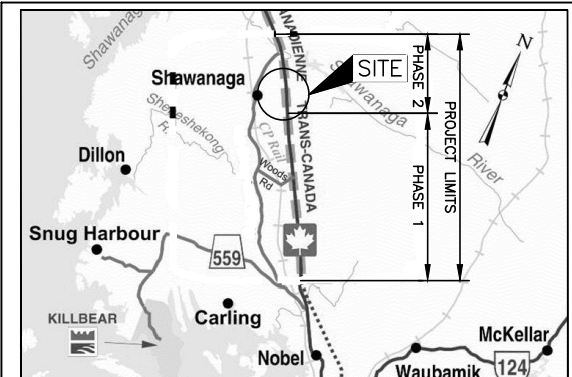
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. .
GWP No. 5117-07-00



HIGHWAY 69 (SBL AND NBL)
CULVERT C45 STA 13+380
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEY PLAN

SCALE
3.7 0 3.7 km

LEGEND

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




BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C45-DC01	210.4	5042835.7	246565.9
C45-DC02	210.4	5042831.4	246570.1
C45-DC03	210.4	5042831.4	246565.8
C45-DC04	210.4	5042847.0	246577.1
C45-DC05	210.4	5042849.1	246579.3
C45-DC06	210.4	5042842.8	246581.3
C45-DC07	211.0	5042856.6	246590.8
C45-DC08	210.9	5042879.3	246614.1
C45-N1	211.0	5042855.8	246590.2
C45-N2	214.9	5042863.6	246598.0
C45-N3	210.9	5042878.3	246613.0
C45-S1	210.4	5042833.5	246568.0
C45-S2	210.7	5042839.2	246573.6
C45-S3	210.4	5042844.9	246579.3

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1.grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.

NO.	DATE	BY	REVISION
Geocres No. 41H-160			
HWY. 69		PROJECT NO. 07-1111-0029	DIST. .
SUBM'D. TVA	CHKD. CN	DATE: 3/17/2016	SITE: .
DRAWN: JFC/MR	CHKD. JMAC	APPD. JPD/JMAC	DWG. A1

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C45-S1				SHEET 1 OF 1		METRIC									
G.W.P. 5402-05-00		LOCATION N 5042833.5 ; E 246568.0				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY AT											
DATUM Geodetic		DATE May 7, 2009				CHECKED BY TZ											
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									
210.4	GROUND SURFACE							20	40	60	80	100					
0.0	Silty PEAT Very soft Dark brown Wet		1	SS	WH		210										
209.2			2	SS	1												
1.2	SAND, trace to some silt, trace clay Compact Grey Wet		3	SS	12		209										
208.5																	
1.9	Granite Gneiss (BEDROCK)		1	RC	REC 100%		208										
	Bedrock cored from depths of 1.9 m to 3.3 m																
	For bedrock coring details, refer to Record of Drillhole C45-S1		2	RC	REC 100%												
207.1																	
3.3	END OF BOREHOLE																
NOTES: 1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at ground surface (Elev. 210.4 m) upon completion of drilling. 3. Three Dynamic Cone Penetration Tests were advanced adjacent to Borehole C45-S1 to confirm depth to bedrock; see Record of DCPT No. C45-DC01 to C45-DC03 for details.																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C45-S1

SHEET 1 OF 1

LOCATION: N 5042833.5 ;E 246568.0

DRILLING DATE: May 7, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: Landcore

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
2	NQ RC May 7, 2009	Continued from Record of Borehole C45-S1 GRANITE GNEISS Fresh, fine to coarse grained, weakly to moderately foliated, moderately porous, very strong, black, pink, green and grey		208.51 1.89	1								8.2 MPa 8.6 MPa
3					2								
		END OF DRILLHOLE		207.08 3.32									
4													
5													
6													
7													
8													
9													
10													
11													

DEPTH SCALE


1 : 50



LOGGED: ID

CHECKED: TZ

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE I-GPJ GAL-MISS.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No C45-S2		SHEET 1 OF 1		METRIC									
G.W.P. 5402-05-00		LOCATION		N 5042839.2 ; E 246573.6		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY									
DATUM		Geodetic		DATE		May 7, 2009		CHECKED BY									
								TZ									
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									
210.7	GROUND SURFACE							20	40	60	80	100					
0.0	Organic Silty SAND, containing rootlets		1	SS	2/0.20												
0.2	Very loose Dark brown Moist		1	RC	REC 100%												
	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 0.2 m to 2.0 m		2	RC	REC 100%												
208.8	For bedrock coring details, refer to Record of Drillhole C45-S2																
2.0	END OF BOREHOLE																
NOTES: 1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Open borehole dry upon completion of drilling. 3. Two Dynamic Cone Penetration Tests were drilled 3.0 m south and 3.0 m north of Borehole C45-S2 to confirm depth to bedrock; refusal encountered at depths of 0.2 m and 0.4 m below ground surface (Elev. 210.5 m and 210.3 m).																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No C45-S3		SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION		N 5042844.9 ; E 246579.3		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY									
DATUM		Geodetic		DATE		May 7, 2009		CHECKED BY									
								TZ									
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 (%)
210.4	GROUND SURFACE							20	40	60	80	100					
0.0	Silty PEAT Very soft Dark brown Wet		1	SS	WH												
209.8																	
209.5	Organic Silty SAND, trace to some clay, trace gravel, containing oxidation zones Very loose Brown Wet		2	SS	3												
1.1																	
	SAND, some silt, trace gravel Very loose Brown Wet		1	RC	REC 100%												RQD = 64%
207.9			2	RC	REC 100%												RQD = 91%
2.5	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 1.1 m to 2.5 m																
	For bedrock coring details, refer to Record of Drillhole C45-S3																
	END OF BOREHOLE																
	NOTES:																
	1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer.																
	2. Water level in open borehole at ground surface (Elev. 210.4 m) upon completion of drilling.																
	3. Three Dynamic Cone Penetration Tests were advanced adjacent to Borehole C45-S3 to confirm depth to bedrock; see Record of DCPT No. C45-DC04 to C45-DC06 for details.																

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[illegible]

PROJECT		RECORD OF BOREHOLE				No C45-N1		SHEET 1 OF 1		METRIC									
G.W.P. 5402-05-00		LOCATION				N 5042855.8 ;E 246590.2		ORIGINATED BY ID											
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY AT											
DATUM Geodetic		DATE		May 7, 2009		CHECKED BY		TZ											
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 (%)	
211.0	GROUND SURFACE							20	40	60	80	100							
0.0	Sandy PEAT, trace gravel, trace silt		1	SS	2		210												
210.4	Very soft																		
0.6	Brown		2	SS	33														
209.8	Wet																		
1.2	Organic Silty SAND, trace gravel						209												
	Loose	1	RC	REC 100%															
	Brown and grey																		
	Wet																		
	Granite Gneiss (BEDROCK)																		
	Bedrock cored from depths of 1.2 m to 2.8 m																		
208.2	For bedrock coring details, refer to Record of Drillhole C45-N1																		
2.8	END OF BOREHOLE																		
NOTES: 1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 210.7 m) upon completion of drilling. 3. A Dynamic Cone Penetration Test was advanced adjacent to Borehole C45-N1 to confirm depth to bedrock; see Record of DCPT No. C45-DC07 for details.																			

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PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C45-N1

SHEET 1 OF 1

LOCATION: N 5042855.8 ;E 246590.2

DRILLING DATE: May 7, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: Landcore

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
2	NO RC May 26, 2009	Continued from Record of Borehole C45-N1 GRANITE GNEISS Fresh, medium to coarse grained, moderately to strongly foliated, thinly to moderately porous, strong to very strong, black, pink, green and grey		209.78 1.22	1								
3		END OF DRILLHOLE		208.24 2.76	2								
4													
5													
6													
7													
8													
9													
10													
11													

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: TZ

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-L-GPJ GAL-MISS.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No C45-N2		SHEET 1 OF 1		METRIC									
G.W.P. 5402-05-00		LOCATION		N 5042863.6 ; E 246598.0		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY									
DATUM Geodetic		DATE		May 21, 2009		CHECKED BY		TZ									
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									
214.9	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT																
214.4	Sand and gravel, trace silt (FILL)																
0.5	Brown Moist ROCK FILL		1	RC	-												
			2	RC	-												
212.1																	
	Sand, trace gravel, trace silt (FILL)		3	SS	8												
3.1	Loose Grey Wet ROCK FILL		4	SS	12												
			5	RC	-												
209.3																	
5.6	SAND, trace to some gravel, trace to some silt, trace clay, slightly organic		6	SS	4/0.15												
208.6	Loose Dark brown Wet																
6.3	Granite Gneiss (BEDROCK)		1	RC	REC 100%												
	Bedrock cored from depths of 6.3 m to 7.9 m																
207.0	For bedrock coring details, refer to Record of Drillhole C45-N2																
7.9	END OF BOREHOLE																
NOTE: 1. Water level in open borehole at a depth of 2.6 m below ground surface (Elev. 212.3 m) upon completion of drilling.																	

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C45-N2

SHEET 1 OF 1

LOCATION: N 5042863.6 ;E 246598.0

DRILLING DATE: May 21, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME55

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	LEGEND													NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
								JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate			BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage			PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular			PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough			MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	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 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³		10 ⁻²	10 ⁻¹																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
7	NO RC May 21, 2009	Continued from Record of Borehole C45-N2		208.59 6.31	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

DEPTH SCALE

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PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No C45-N3		SHEET 1 OF 1		METRIC	
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042878.3 ; E 246613.0</u>		ORIGINATED BY <u>ID</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, BW Casing, Wash Boring</u>		COMPILED BY <u>AT</u>			
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>		CHECKED BY <u>TZ</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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L			WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED							
210.9	GROUND SURFACE							20 40 60 80 100						GR SA SI CL	
0.0	Organic Silty SAND, containing wood fragments Very loose Brown and grey Wet		1	SS	2		210						174.5		
			2	SS	3										
209.4			3	SS	4		209								
1.5	Silty SAND, trace gravel, slightly organic to a depth of 1.8 m Very loose to compact Grey Wet		4	SS	11										
208.2			5	SS	2		208						66.5		
2.9	SILTY CLAY, trace sand Very soft Brown Wet		6	SS	9										
207.4							207						0 80 18 2		
3.5	SAND, some silt, trace clay Very loose to loose Grey Wet		1	RC	REC 100%								RQD = 85%		
	Granite Gneiss (BEDROCK)														
205.9	Bedrock cored from depths of 3.5 m to 5.0 m		2	RC	REC 98%		206						RQD = 98%		
5.0	For bedrock coring details, refer to Record of Drillhole C45-N3 END OF BOREHOLE														
NOTES: 1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 206.9 m) upon completion of drilling. 3. A Dynamic Cone Penetration Test was advanced 1.5 m east of Borehole C45-N3 to confirm depth to bedrock; see Record of DCPT No. C45-DC08 for details.															

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C45-N3

SHEET 1 OF 1

LOCATION: N 5042878.3 ;E 246613.0

DRILLING DATE: May 7, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: Landcore

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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
								RECOVERY			R.Q.D. %			FRACT. INDEX PER 0.25 m			DISCONTINUITY DATA			HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load (MPa)			RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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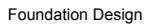
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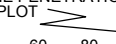
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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C45-DC02				SHEET 1 OF 1		METRIC									
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042831.4 ;E 246570.1</u>				ORIGINATED BY <u>ID</u>											
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>											
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>				CHECKED BY <u>VA</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 (%)
210.4	GROUND SURFACE						20	40	60	80	100						
0.0	Dynamic Cone Penetration Test (DCPT)						20	40	60	80	100						
208.8							20	40	60	80	100						
1.6	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)						20	40	60	80	100						
	NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.						20	40	60	80	100						

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PROJECT 07-1111-0029		RECORD OF DCPT No C45-DC03		SHEET 1 OF 1		METRIC				
G.W.P. 5402-05-00		LOCATION N 5042831.4 ;E 246565.8		ORIGINATED BY ID						
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test		COMPILED BY VA						
DATUM Geodetic		DATE May 7, 2009		CHECKED BY VA						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
210.4	GROUND SURFACE									
0.0	Dynamic Cone Penetration Test (DCPT)									
208.0										
2.4	END OF DCPT Refusal to Further Penetration (Hammer Bouncing) NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.									

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C45-DC04		SHEET 1 OF 1		METRIC										
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042847.0 ; E 246577.1</u>		ORIGINATED BY <u>ID</u>												
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>VA</u>												
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>		CHECKED BY <u>VA</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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
210.4	GROUND SURFACE						20	40	60	80	100					
0.0	Dynamic Cone Penetration Test (DCPT)						20	40	60	80	100					
208.9							20	40	60	80	100					
1.6	END OF DCPT Refusal to Further Penetration (Hammer Bouncing) NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.															

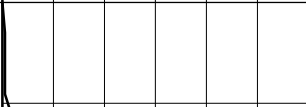
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PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C45-DC05		SHEET 1 OF 1		METRIC																
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042849.1 ;E 246579.3</u>		ORIGINATED BY <u>ID</u>																		
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>VA</u>																		
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>		CHECKED BY <u>VA</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 (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa														
210.4	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>															
0.0	Dynamic Cone Penetration Test (DCPT)						210															
208.8							209															
1.7	END OF DCPT Refusal to Further Penetration (Hammer Bouncing) NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.																					

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C45-DC06				SHEET 1 OF 1		METRIC								
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042842.8 ;E 246581.3</u>				ORIGINATED BY <u>ID</u>										
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>										
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>				CHECKED BY <u>VA</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
210.4	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>									
0.0	Dynamic Cone Penetration Test (DCPT)					210	<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>									
209.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)															
1.1	NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.															

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PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C45-DC07				SHEET 1 OF 1		METRIC											
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5042856.6 ;E 246590.8</u>				ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>													
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>				CHECKED BY <u>VA</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa											
211.0	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>												
0.0	Dynamic Cone Penetration Test (DCPT)																		
209.9	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																		
1.1	NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.																		

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC



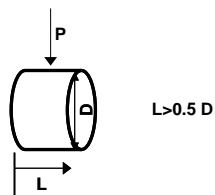
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

TABLE A1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

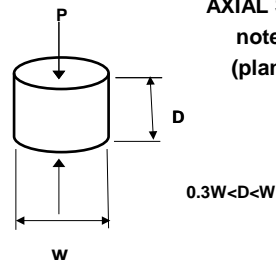
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C45-S1	1	2.0	208.4	Granite Gneiss	Diametral	6.807
C45-S1	1	2.1	208.3	Granite Gneiss	Diametral	8.168
C45-S1	1	2.2	208.2	Granite Gneiss	Diametral	8.606
C45-S2	1	0.3	210.4	Granite Gneiss	Diametral	6.777
C45-S2	1	0.4	210.3	Granite Gneiss	Diametral	6.618
C45-S2	1	0.7	210.0	Granite Gneiss	Diametral	13.823
C45-S2	1	0.8	209.9	Granite Gneiss	Diametral	12.759
C45-S2	1	0.9	209.8	Granite Gneiss	Diametral	12.590
C45-S3	2	1.5	208.9	Granite Gneiss	Diametral	11.974
C45-S3	2	1.5	208.9	Granite Gneiss	Diametral	11.567
C45-S3	2	1.6	208.8	Granite Gneiss	Diametral	7.711
C45-N1	1	1.3	209.7	Granite Gneiss	Diametral	2.544
C45-N1	1	1.4	209.6	Granite Gneiss	Diametral	4.194
C45-N1	1	1.5	209.5	Granite Gneiss	Diametral	7.681
C45-N1	1	1.6	209.4	Granite Gneiss	Diametral	3.200
C45-N2	1	6.8	208.1	Granite Gneiss	Diametral	7.404
C45-N2	1	6.9	208.0	Granite Gneiss	Diametral	8.189
C45-N2	1	7.1	207.8	Granite Gneiss	Diametral	5.234
C45-N3	1	3.6	207.3	Granite Gneiss	Diametral	4.780
C45-N3	1	3.8	207.1	Granite Gneiss	Diametral	9.103
C45-N3	1	4.1	206.8	Granite Gneiss	Diametral	8.546

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)

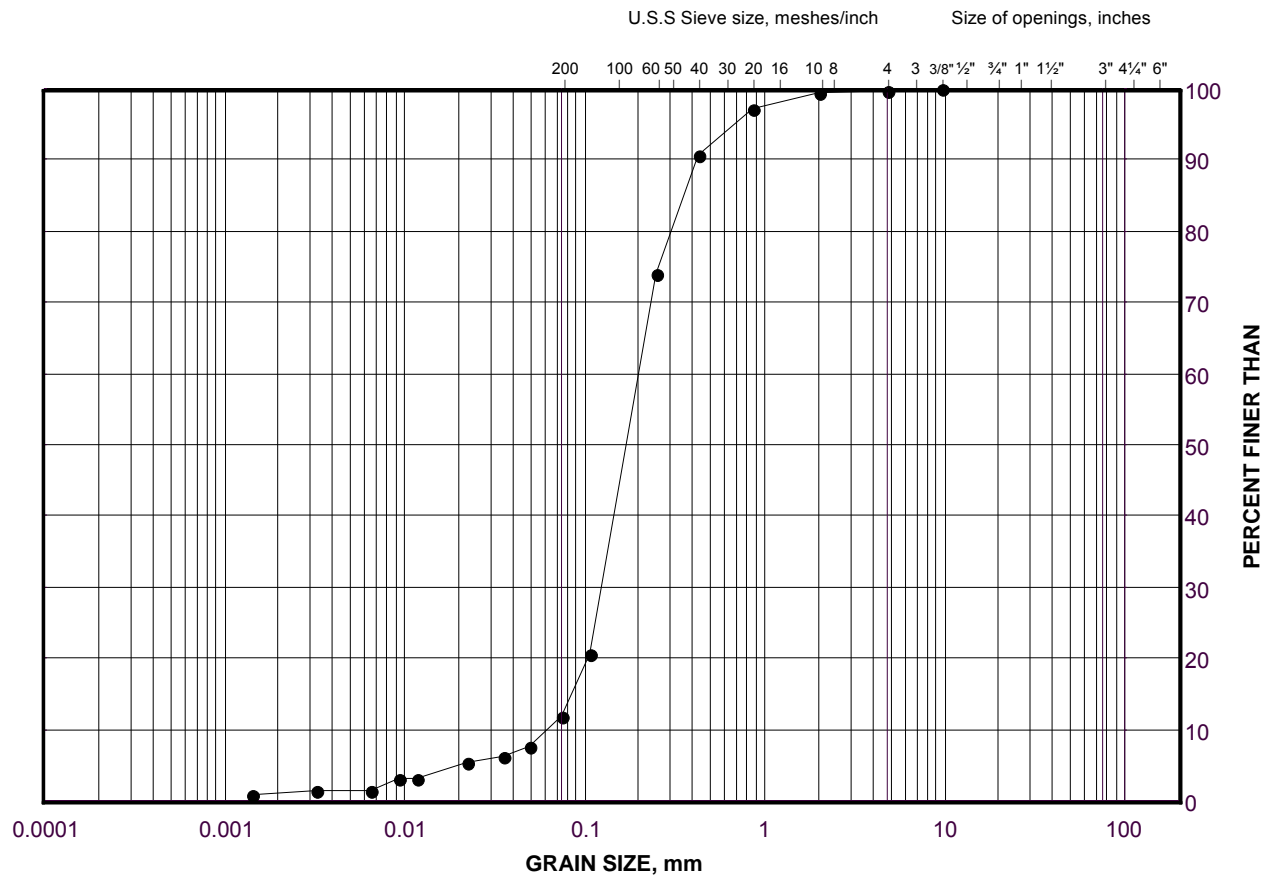


Compiled By: MCK
Checked By: CN
Reviewed By: JMAC

GRAIN SIZE DISTRIBUTION

Sand
Highway 69 (SBL) STA 13+380

FIGURE A.C45-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C45-S1	3	208.9

Project Number: 07-1111-0029

Checked By: TVA

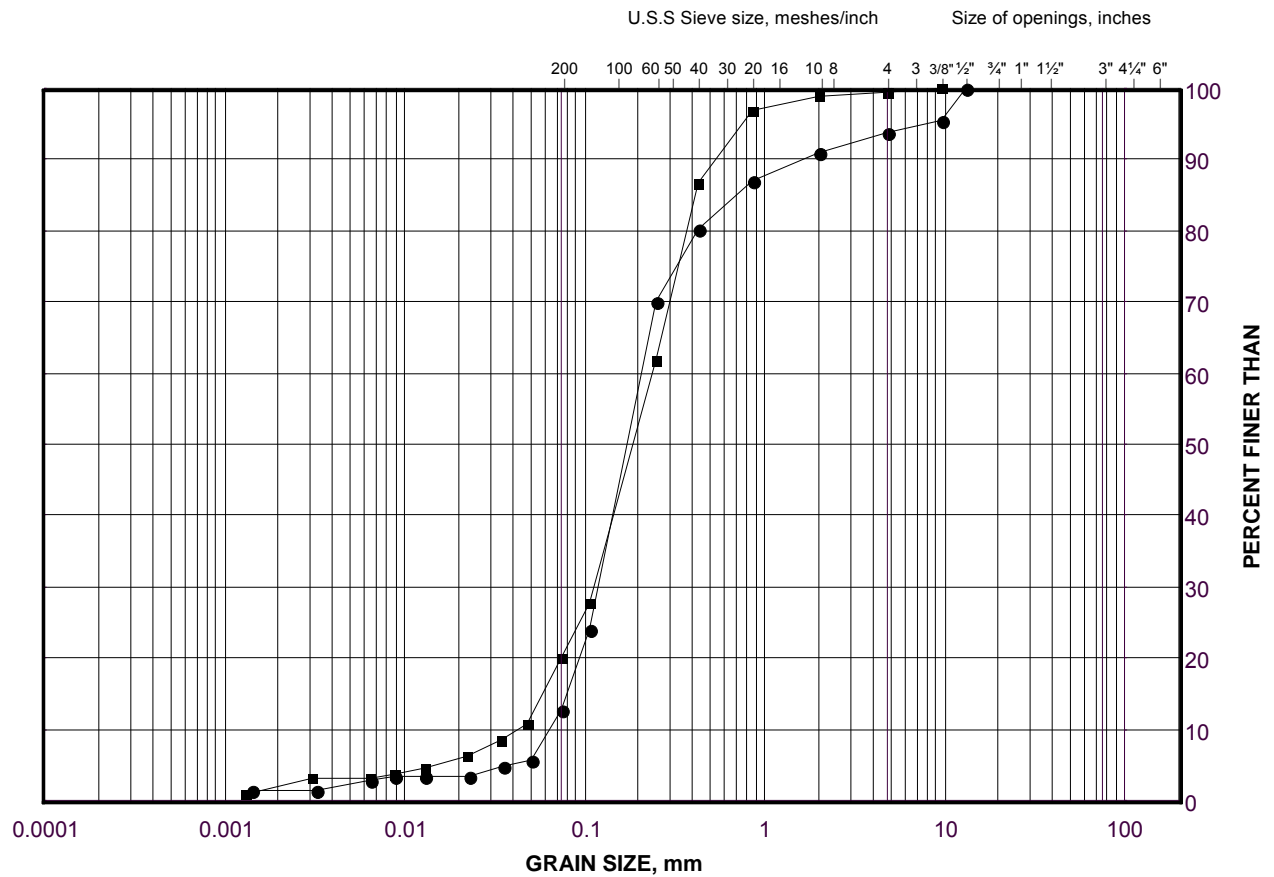
Golder Associates

Date: 19-Aug-14

GRAIN SIZE DISTRIBUTION

Sand
Highway 69 (NBL) STA 13+380

FIGURE A.C45-2



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

LEGEND

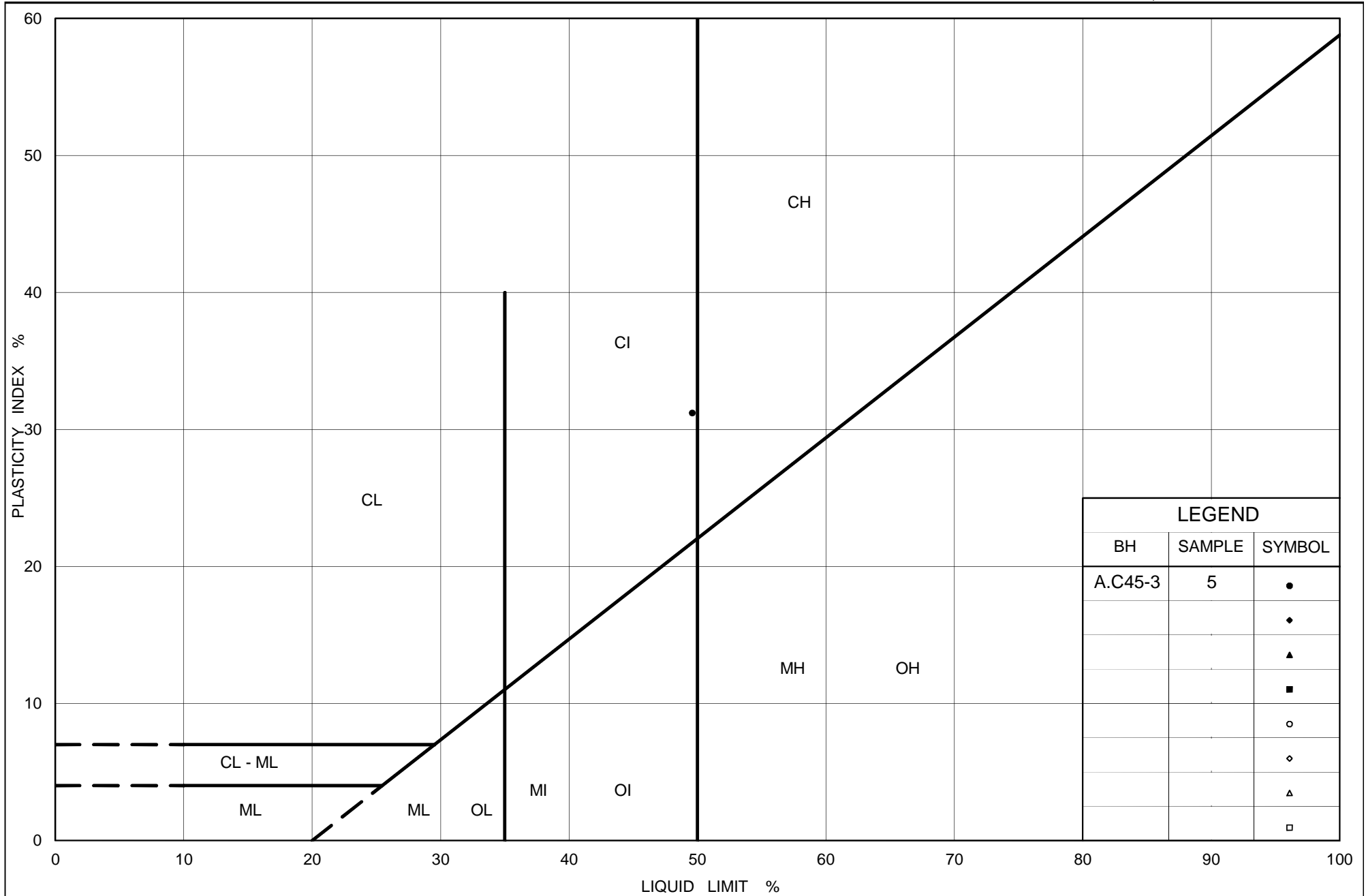
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C45-N2	6	208.8
■	C45-N3	6	207.7

Project Number: 07-1111-0029

Checked By: TVA

Golder Associates

Date: 25-Aug-09



Ministry of Transportation

Ontario

PLASTICITY CHART
Silty Clay
Highway 69 (NBL) STA 13+380

Figure No. A.C45-3

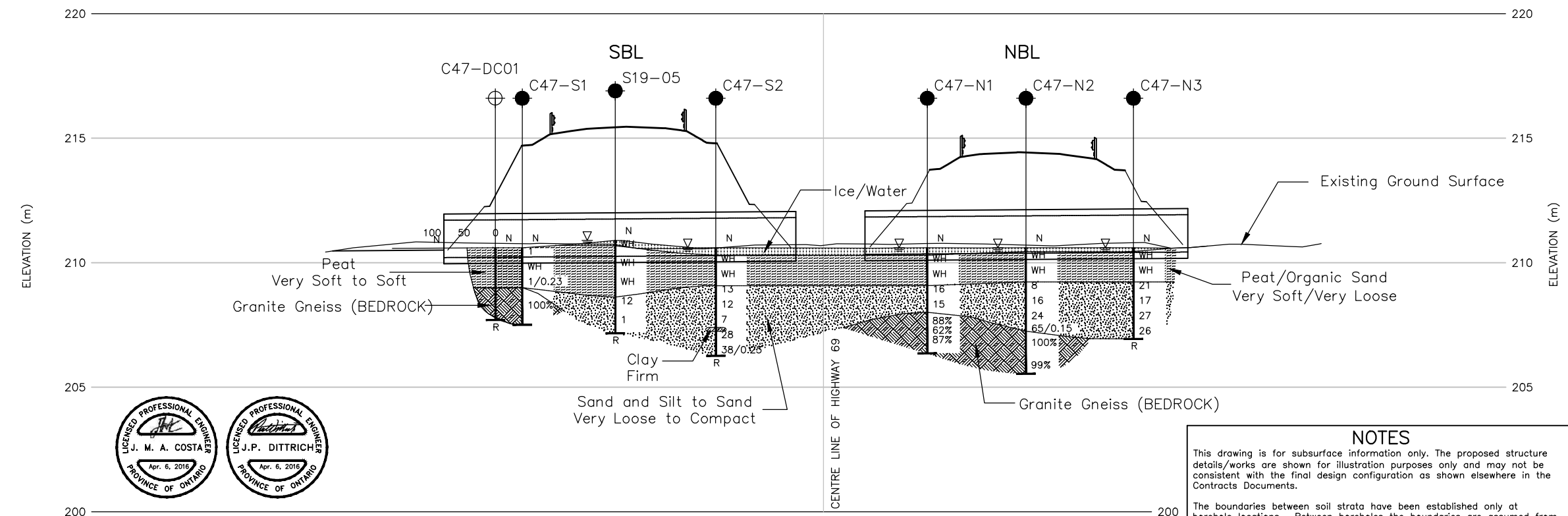
Project No. 07-1111-0029

Checked By: TVA




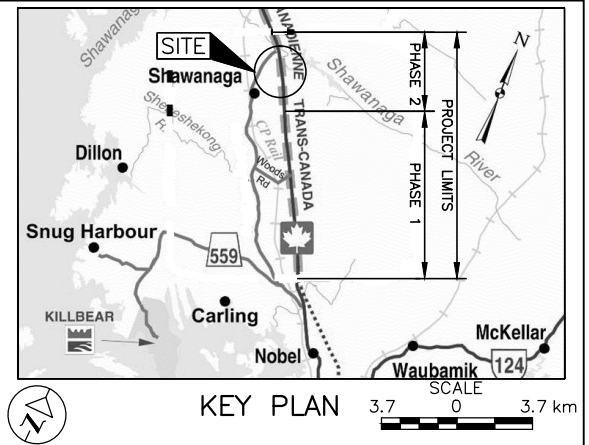
APPENDIX B






**Highway 69 SBL and NBL – STA 13+778 and STA 13+791
(Culvert C47 – Site No. 44-616/C2 and 44-616/C1)**



The diagram shows two scales. The top scale is labeled 'HORIZONTAL SCALE' and has markings at 5, 0, 5, and 10 m. The bottom scale is labeled 'VERTICAL SCALE' and has markings at 2, 0, 2, and 4 m.

<p>CONT No.</p> <p>WP No. 5077-13-01 (NBL) and 5077-13-02 (SBL)</p>	
<p>HIGHWAY 69 (SBL AND NBL) CULVERT C47 STA 13+778 AND STA 13+791</p> <p>BOREHOLE LOCATIONS AND SOIL STRATA</p>	<p>SHEET</p> <p>S28</p>





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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C47-DC01	210.6	5043087.7	246269.4
C47-DC02	210.7	5043088.1	246273.6
C47-DC03	210.6	5043091.9	246269.0
C47-N1	210.6	5043127.9	246285.7
C47-N2	210.6	5043137.1	246289.4
C47-N3	210.6	5043147.4	246292.7
C47-S1	210.6	5043089.9	246271.2
C47-S2	210.6	5043108.0	246278.3
S19-05	210.9	5043097.5	246277.5

REFERENCE

Base plans provided in digital format by MMM, drawing file nos.
 S6878-330-001.dwg, dated November 2014, and h6878_PHASE2_XD1
 grading.dwg received November 10, 2014, and h6878_PHASE2_XD1.dwg
 received May 15, 2015.
 Contours provided in digital format by MRC, drawing file no. h6878xb07
 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
 Cross-section provided in digital format, drawing file no. 6878-Ph
 2_Hwy 82 - Gilbert XS-May 2.dwg, received May 15, 2015.

[illegible]

PROJECT		RECORD OF BOREHOLE				No C47-S1		SHEET 1 OF 1		METRIC							
G.W.P. 07-1111-0029		LOCATION				N 5043089.9 ; E 246271.2				ORIGINATED BY MJR							
DIST		HWY 69		BOREHOLE TYPE				Portable Equipment, BW Casing, Wash Boring				COMPILED BY AT					
DATUM Geodetic		DATE		May 7, 2009				CHECKED BY TZ									
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									
210.6 0.0	GROUND SURFACE PEAT, trace sand, trace silt (Fibrous) Very soft Dark brown Wet		1	SS	1		210									1257.4	
			2	SS	WH												
209.0 1.6	Granite Gneiss (BEDROCK) Bedrock cored from depths of 1.6 m to 3.1 m For bedrock coring details, refer to Record of Drillhole C47-S1		3	SS	1/0.23												
207.5 3.1	END OF BOREHOLE NOTES: 1. Borehole advanced using portable drilling equipment with a one-third weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at ground surface (Elev. 210.6 m) upon completion of drilling. 3. Three Dynamic Cone Penetration Tests were advanced adjacent to Borehole C47-S1 to confirm depth to bedrock; see Record of DCPT No. C47-DC01 to C47-DC03 for details.																

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PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C47-S1

SHEET 1 OF 1

LOCATION: N 5043089.9 ;E 246271.2

DRILLING DATE: May 7, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	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 m	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
									TOTAL CORE %	SOLID CORE %	B Angle			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10	10	10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

DEPTH SCALE

1 : 50



LOGGED: MJR


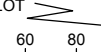

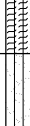

CHECKED: TZ

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-MISS.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No C47-S2		SHEET 1 OF 1		METRIC						
G.W.P. 5402-05-00		LOCATION		N 5043108.0 ; E 246278.3		ORIGINATED BY		MJR						
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		May 8, 2009		CHECKED BY						
								VA						
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						
210.6	WATER SURFACE													
0.0	Water													
210.3														
0.3	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WH								1694.4	
			2	SS	WH									
209.1														
1.5	SAND and SILT, trace clay Loose to compact Grey Wet		3	SS	13									
			4	SS	12									
			5A	SS	7									
207.4			5B	SS									75.5	
3.4	CLAY, some silt, trace sand Firm Grey Wet		6	SS	28									
			7	SS	38/0.23									
206.3	SAND and SILT, trace gravel Compact Grey Wet													
4.3	END OF BOREHOLE SPOON AND CASING REFUSAL													

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No C47-N1		SHEET 1 OF 1		METRIC	
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043127.9 ; E 246285.7</u>		ORIGINATED BY <u>MJR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, BW Casing, Wash Boring</u>		COMPILED BY <u>AT</u>			
DATUM <u>Geodetic</u>		DATE <u>May 9, 2009</u>		CHECKED BY <u>TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L			WATER CONTENT (%)							
								20 40 60 80 100														
210.6	WATER SURFACE												GR SA SI CL									
0.0	Water																					
210.3	Silty PEAT Very soft Dark brown Wet		1	SS	WH			210							OC=55.7%							
0.3			2	SS	WH																534.5	
209.1	SAND and SILT, trace clay Compact Grey Wet		3	SS	16			209							0 49 49 2							
1.5			4	SS	15																	
208.0	Granite Gneiss (BEDROCK) Bedrock cored from depths of 2.6 m to 4.3 m For bedrock coring details, refer to Record of Drillhole C47-N1		1	RC	REC 100%			208							RQD = 88%							
2.6			2	RC	REC 100%																	RQD = 62%
206.4			3	RC	REC 100%											207						
4.3	END OF BOREHOLE																					

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS

[illegible]

CHECKED: TZ

PROJECT		RECORD OF BOREHOLE		No C47-N2		SHEET 1 OF 1		METRIC								
G.W.P. 07-1111-0029		LOCATION		N 5043137.1 ; E 246289.4		ORIGINATED BY		MJR								
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY								
DATUM		Geodetic		DATE		May 10, 2009		CHECKED BY								
								TZ								
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								
210.6	WATER SURFACE															
0.0	Water															
0.2	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WH											
209.8																
0.8	Organic SAND, containing rootlets Very loose Dark brown Wet		2	SS	WH										45.8	
209.2																
1.4	SAND and SILT, trace gravel, trace clay Loose to compact Grey Wet		3	SS	8											
			4	SS	16											
			5	SS	24											
207.3			6	SS	15/0.15											0 43 55 2
3.4	Granite Gneiss (BEDROCK)															
	Bedrock cored from depths of 3.4 m to 5.1 m		1	RC	REC 100%											RQD = 100%
	For bedrock coring details, refer to Record of Drillhole C47-N2															
			2	RC	REC 99%											RQD = 99%
205.5																
5.1	END OF BOREHOLE															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C47-N2

SHEET 1 OF 1

LOCATION: N 5043137.1 ;E 246289.4

DRILLING DATE: May 10, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	B Angle	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
								TOTAL CORE %	SOLID CORE %												
								888888	888888												
								888888	888888												
4	BQ RC May 10, 2009	Continued from Record of Borehole C47-N2		207.25	1																
		3.35																			
5		GRANITE GNEISS Fresh, medium to coarse grained, moderately porous, strong to very strong, strongly foliated, black, green and white											JN/FO,UN,RO								
5		END OF DRILLHOLE		205.54	2								JN/FO,CU,RO								
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					

DEPTH SCALE

1 : 50



LOGGED: MJR

CHECKED: TZ

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-MISS.GDT 03/25/16 DD/SAC

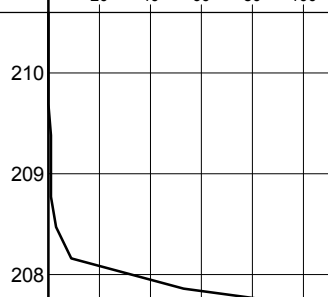
PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No C47-N3		SHEET 1 OF 1		METRIC	
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043147.4 ;E 246292.7</u>		ORIGINATED BY <u>MJR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, BW Casing, Wash Boring</u>		COMPILED BY <u>AT</u>			
DATUM <u>Geodetic</u>		DATE <u>May 10, 2009</u>		CHECKED BY <u>TZ</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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%)					
210.6	WATER SURFACE					▽		20 40 60 80 100						GR SA SI CL
0.0	Water													
0.2	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WH		210							
			2	SS	WH								628 ○	
209.2							209							
1.4	SAND and SILT, trace gravel, trace clay Compact Grey Wet Containing about 50 mm thick silty clay layer at a depth of 2.1 m		3	SS	21									
			4	SS	17	208				○				
			5	SS	27					○			3 47 49 1	
			6	SS	26									
206.9	END OF BOREHOLE SPOON AND CASING REFUSAL						207							
3.7														

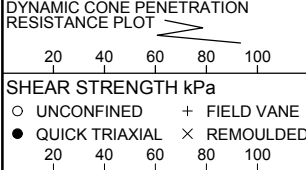
GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No S19-05		SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION		N 5043097.5 ; E 246277.5		ORIGINATED BY		DM									
DIST		HWY 69		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
DATUM Geodetic		DATE		February 29, 2008		CHECKED BY		VA									
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									
210.9	ICE SURFACE							20	40	60	80	100					
0.0	Ice																
0.2	PEAT (Amorphous) Very soft Black Wet		1	SS	WH												
			2	SS	WH												
			3	SS	WH												
208.6																	
2.3	SAND, some silt, trace clay, containing silt layers and wood fragments to a depth of 3.0 m Very loose to compact Brown to grey Wet		4	SS	12												
			5	SS	1												
207.2																	
3.7	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Water level in open borehole at ice surface (Elev. 210.9 m) upon completion of drilling.																













GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C47-DC01		SHEET 1 OF 1		METRIC														
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043087.7 ;E 246269.4</u>		ORIGINATED BY <u>ID</u>																
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>VA</u>																
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>		CHECKED BY <u>VA</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa												
210.6	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>													
0.0	Dynamic Cone Penetration Test (DCPT)																			
207.7	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																			
2.9	NOTE: 1. DCPT advanced using portable drilling equipment with a one-third weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.																			

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C47-DC02		SHEET 1 OF 1		METRIC				
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043088.1 ;E 246273.6</u>		ORIGINATED BY <u>ID</u>						
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>VA</u>						
DATUM <u>Geodetic</u>		DATE <u>May 7, 2009</u>		CHECKED BY <u>VA</u>						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
210.7	GROUND SURFACE									
0.0	Dynamic Cone Penetration Test (DCPT)									
209.6										
1.1	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)									
	NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.									

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>				RECORD OF DCPT No C47-DC03				SHEET 1 OF 1				METRIC						
G.W.P. <u>5402-05-00</u>				LOCATION <u>N 5043091.9 ; E 246269.0</u>				ORIGINATED BY <u>ID</u>										
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>										
DATUM <u>Geodetic</u>				DATE <u>May 7, 2009</u>				CHECKED BY <u>VA</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
210.6	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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;"> W_p W W_L </div>						
0.0	Dynamic Cone Penetration Test (DCPT)						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>					<div style="display: flex; justify-content: space-between;"> 10 20 30 </div>						
210																		
209																		
208																		
207																		
206																		
205.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																	
5.3	NOTE: 1. DCPT advanced using portable drilling equipment with a one-third weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.																	

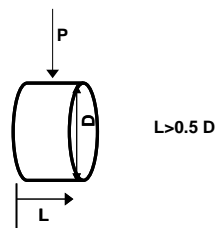
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TABLE B1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

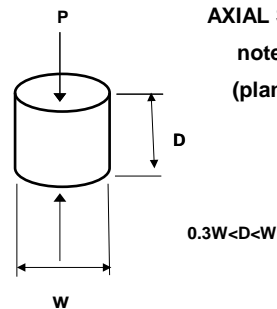
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C47-S1	1	45.0	165.6	Granite Gneiss	Diametral	3.549
C47-S1	1	1.8	208.8	Granite Gneiss	Diametral	5.225
C47-S1	1	2.1	208.5	Granite Gneiss	Diametral	5.673
C47-N1	3	3.6	207.0	Granite Gneiss	Diametral	5.165
C47-N1	3	3.7	206.9	Granite Gneiss	Diametral	6.773
C47-N1	3	3.8	206.8	Granite Gneiss	Diametral	5.430
C47-N2	1	3.6	207.0	Granite Gneiss	Diametral	5.286
C47-N2	1	3.7	206.9	Granite Gneiss	Diametral	4.285
C47-N2	1	3.8	206.8	Granite Gneiss	Diametral	2.313

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)

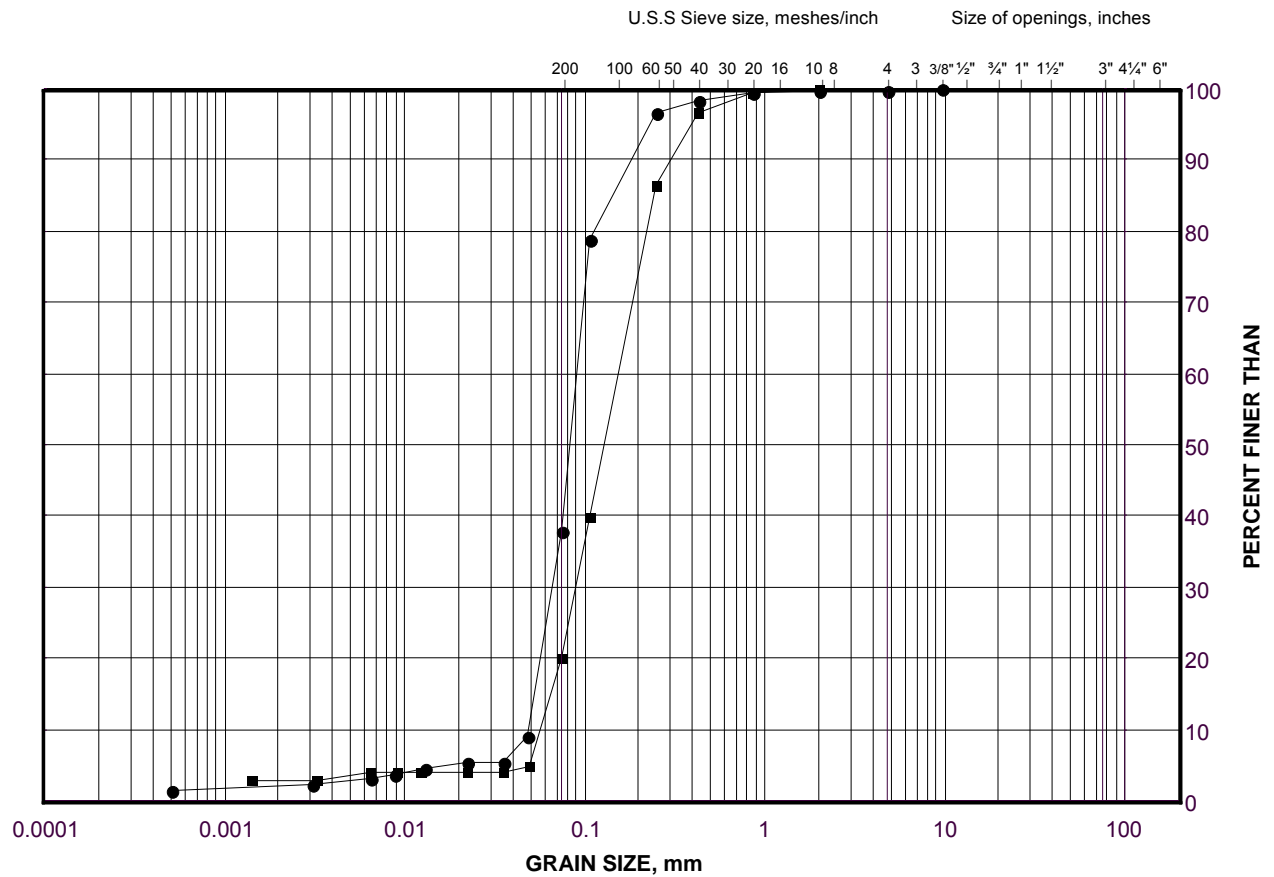


Compiled By: MCK
Checked By: CN
Reviewed By: JMAC

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand
Highway 69 (SBL) STA 13+778

FIGURE B.C47-1



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

LEGEND

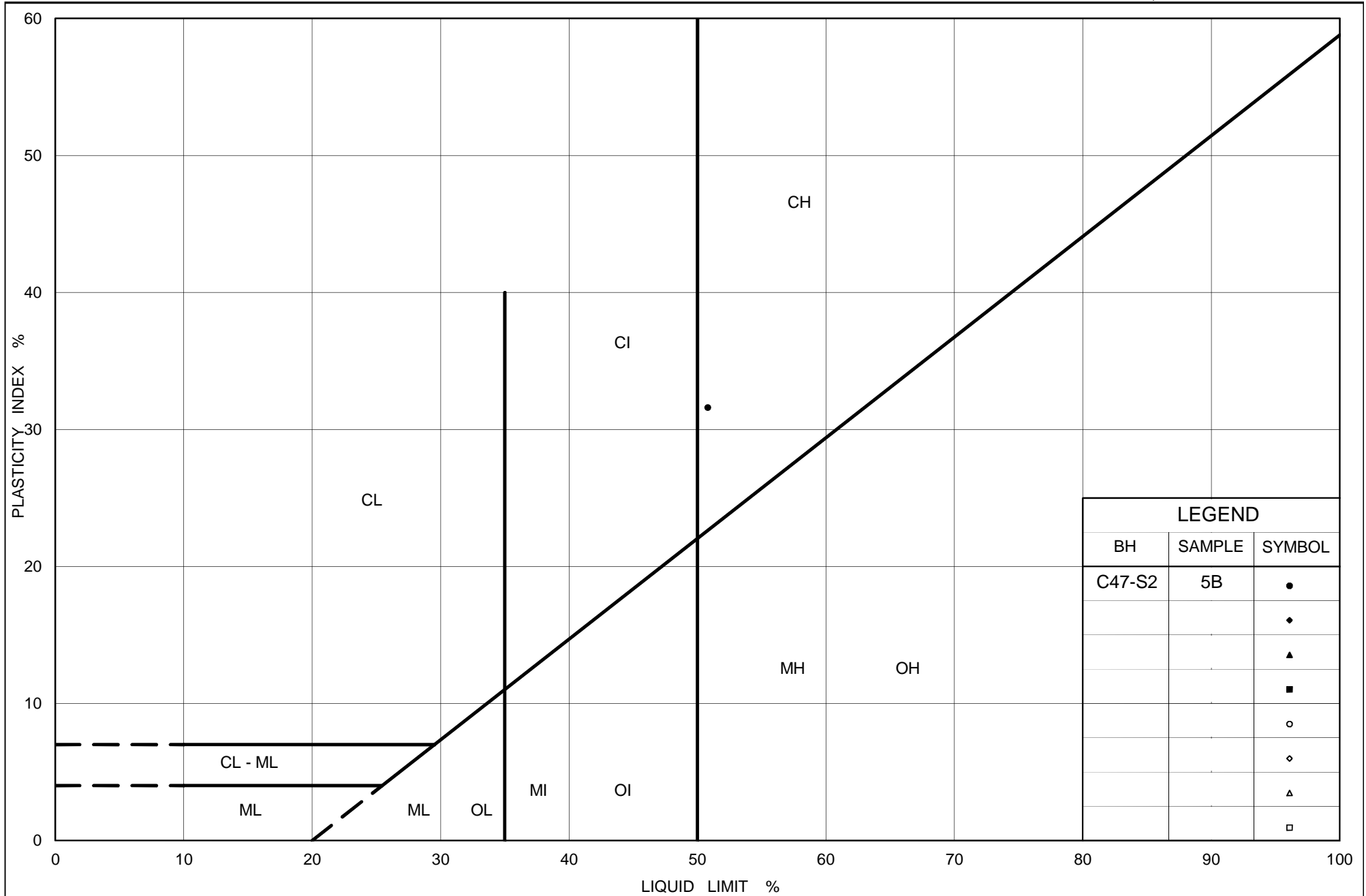
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C47-S2	4	208.2
■	S19-05	4	208.3

Project Number: 07-1111-0029

Checked By: TVA

Golder Associates

Date: 19-Aug-14



Ministry of Transportation

Ontario

PLASTICITY CHART
Clay
Highway 69 (SBL) STA 13+778

Figure No. B.C47-2

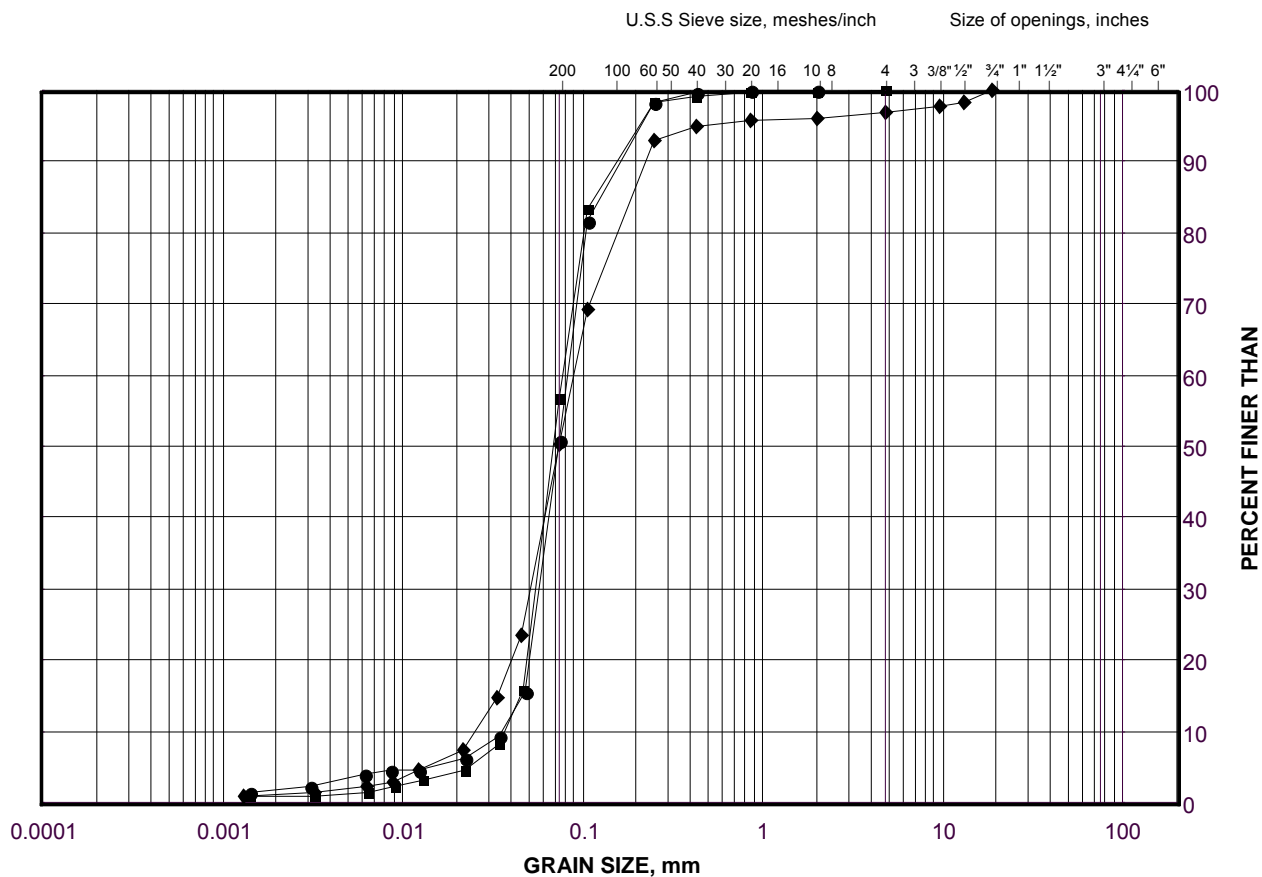
Project No. 07-1111-0029

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt and Sand
Highway 69 (NBL) STA 13+791

FIGURE B.C47-3



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

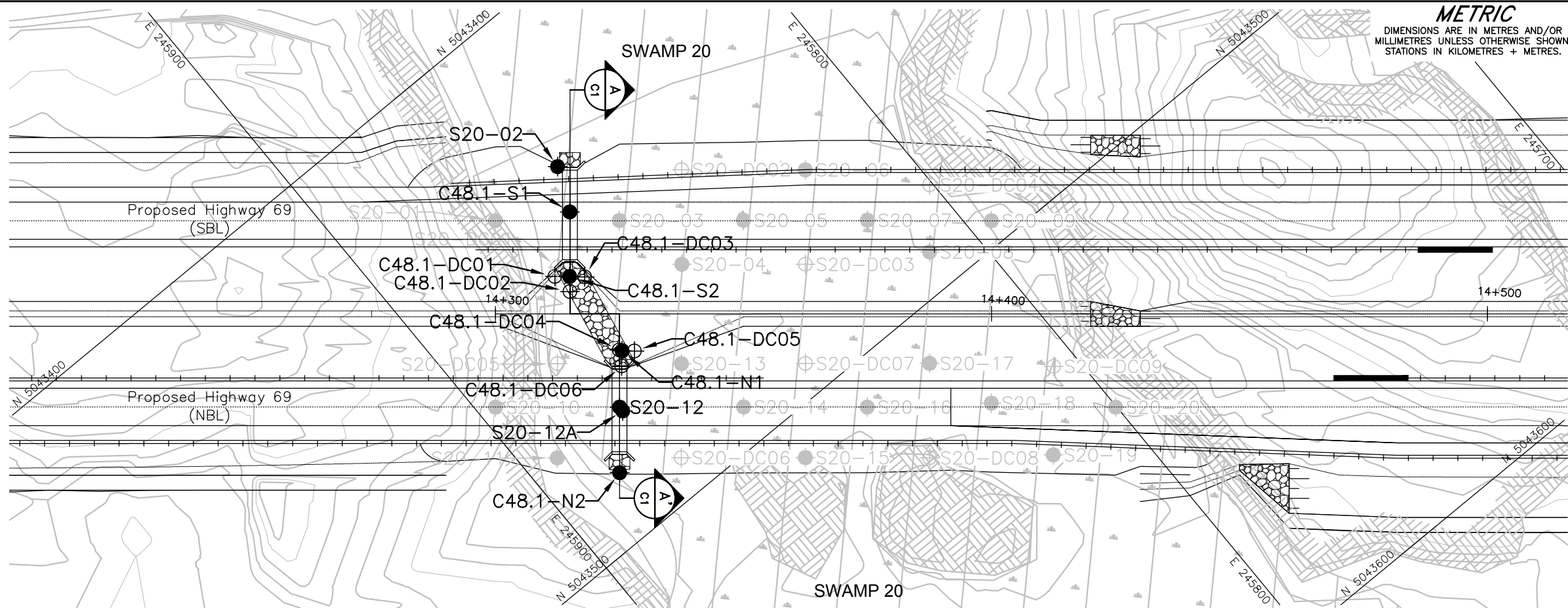
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C47-N1	4	208.2
■	C47-N2	5	207.8
◆	C47-N3	5	207.8



APPENDIX C

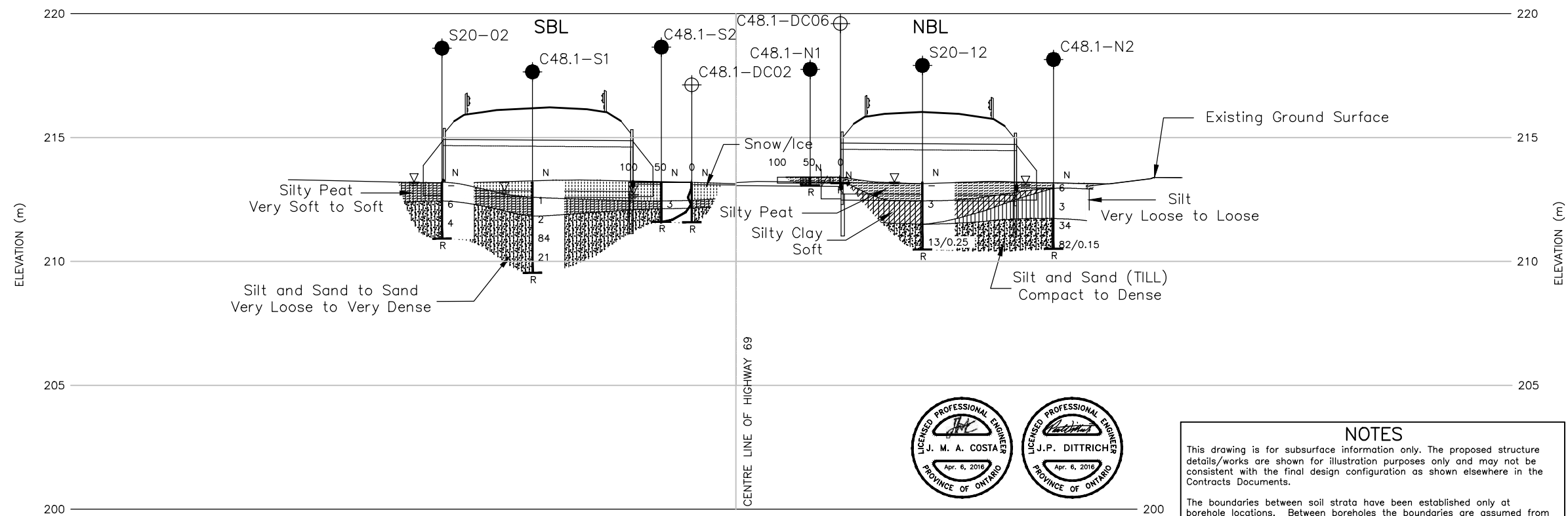
**Highway 69 SBL and NBL – STA 14+315 and STA 14+325
(Culvert C48.1 – Site No. 44-617/C2 and 44-617/C1)**



PLAN

SCALE

10 0 10 20 m

A-A
C1

CULVERT C48.1 PROFILE STA 14+315 AND STA 14+325

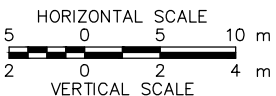


NOTES

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.

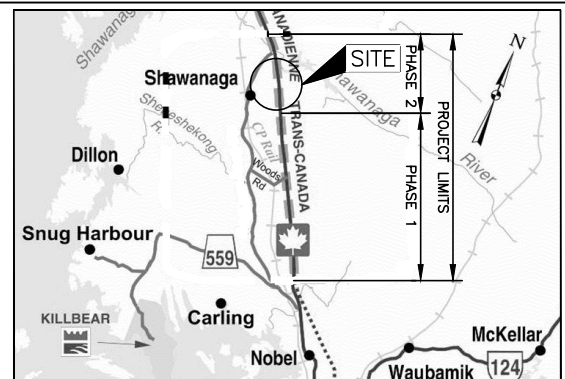


CONT No.

WP No. 5077-13-03 (NBL) and
5077-13-04 (SBL)HIGHWAY 69 (SBL AND NBL)
CULVERT C48.1 STA 14+315 AND STA 14+325
BOREHOLE LOCATIONS AND SOIL
STRATA

SHEET

S29



KEY PLAN

SCALE
3.7 0 3.7 km

LEGEND

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

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C48.1-DC01	213.2	5043448.1	245870.6
C48.1-DC02	213.2	5043452.4	245870.2
C48.1-DC03	213.2	5043452.0	245866.0
C48.1-DC04	213.1	5043467.8	245870.0
C48.1-DC05	213.1	5043469.9	245867.8
C48.1-DC06	213.4	5043470.6	245871.7
C48.1-N1	213.4	5043468.3	245869.7
C48.1-N2	213.1	5043486.9	245885.7
C48.1-S1	213.2	5043440.0	245860.0
C48.1-S2	213.2	5043450.0	245868.3
S20-02	213.2	5043431.4	245856.1
S20-12	213.2	5043476.7	245877.3
S20-12A	213.2	5043477.7	245877.3

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.

NO.	DATE	BY	REVISION
Geocres No. 41H-160			
HWY. 69			PROJECT NO. 07-1111-0029 DIST.
SUBM'D. TVA	CHKD. CN	DATE: 3/17/2016	SITE: 44-617/C1&C2
DRAWN: JFC/MR	CHKD. JMAC	APPD.	DWG. C1



PROJECT		RECORD OF BOREHOLE No C48.1-S1				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5043440.0 ; E 245860.0				ORIGINATED BY EC											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring				COMPILED BY VA/TZ											
DATUM Geodetic		DATE March 16, 2009				CHECKED BY VA											
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									
213.2	SNOW SURFACE							20	40	60	80	100					
0.0	Snow/Ice						213										
212.6							212										
0.6	Silty PEAT Very soft Black Wet		1	SS	1												
211.8							211										
1.4	SAND and SILT, trace clay Very loose to very dense Grey Wet		2	SS	2												
210.8			3A														
2.4	SAND, trace to some silt, trace gravel Compact to very dense Grey Wet		3B	SS	84												
210							210										
4																	
209.5			4	SS	21												
3.7	END OF BOREHOLE CASING REFUSAL																
NOTE: 1. Water level in open borehole at a depth of 0.4 m below snow surface (Elev. 212.8 m) upon completion of drilling.																	

PROJECT		RECORD OF BOREHOLE				No C48.1-S2		SHEET 1 OF 1		METRIC							
G.W.P. 5402-05-00		LOCATION				N 5043450.0 ; E 245868.3		ORIGINATED BY EC									
DIST _____ HWY 69		BOREHOLE TYPE				Portable Equipment, BW Casing, Wash Boring		COMPILED BY VA/TZ									
DATUM Geodetic		DATE				March 9, 2009		CHECKED BY VA									
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									
213.2 0.0	SNOW SURFACE Snow/Ice							20	40	60	80	100					
212.4																	
212.1 1.1	Silty PEAT Soft Black Wet		1A	SS	3												
211.6 1.6	SAND and SILT, trace clay, containing rootlets Very loose Grey Wet END OF BOREHOLE CASING REFUSAL NOTES: 1. Water level in open borehole at a depth of 0.5 m below snow surface (Elev 212.7 m) upon completion of drilling. 2. Three Dynamic Cone Penetration Tests were advanced adjacent to Borehole C48.1-S2 to confirm depth to refusal; see Record of DCPT No. C48.1-DC01 to C48.1-DC03 for details.		1B														

PROJECT		RECORD OF BOREHOLE No C48.1-N1				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5043468.3 ; E 245869.7				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY VA											
DATUM Geodetic		DATE July 14, 2009				CHECKED BY VA											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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 (%)				
213.4	GROUND SURFACE						20	40	60	80	100						
0.0	Silty PEAT		1	SS	1/0.15												
213.1	Very soft																
0.3	Brown																
	Wet																
	END OF BOREHOLE SPOON REFUSAL																
	NOTES:																
	1. Borehole advanced using portable drilling equipment with a half weight hammer. SPT "N" values shown have been adjusted to infer values that would be obtained using a standard weight hammer.																
	2. Water level in open borehole at ground surface (Elev. 213.4 m) upon completion of drilling.																
	3. Three Dynamic Cone Penetration Tests were advanced adjacent to Borehole C48.1-N1 to confirm depth to bedrock; see Record of DCPT No. C48.1-DC04 to C48.1-DC06 for details.																

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PROJECT		RECORD OF BOREHOLE				No C48.1-N2		SHEET 1 OF 1		METRIC							
G.W.P. 5402-05-00		LOCATION				N 5043486.9 ; E 245885.7				ORIGINATED BY MJR							
DIST _____ HWY 69		BOREHOLE TYPE				Portable Equipment, BW Casing, Wash Boring				COMPILED BY VA/TZ							
DATUM Geodetic		DATE				March 18, 2009				CHECKED BY VA							
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									
213.1	GROUND SURFACE																
0.0	Silty PEAT																
0.2	Dark brown Wet		1	SS	6												
	SILT, trace to some clay, trace to some sand, containing rootlets Very loose to loose		2	SS	3												
211.7	Grey Wet																
1.4	SAND and SILT, some clay, trace gravel (TILL) Dense		3	SS	34												
	Brown and grey Wet																
210.5			4	SS	82/0.15												
2.6	END OF BOREHOLE SPOON AND CASING REFUSAL																
NOTES: 1. Water level in open borehole at ground surface (Elev 213.1 m) upon completion of drilling. 2. Borehole caved to a depth of 1.6 m below ground surface (Elev. 211.5 m) upon removal of casing.																	

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S20-02		SHEET 1 OF 1		METRIC																
G.W.P. 5402-05-00		LOCATION N 5043431.4 ;E 245856.1		ORIGINATED BY DM																		
DIST _____ HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY VO																		
DATUM Geodetic		DATE February 26, 2008		CHECKED BY VA																		
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ			GR SA SI CL			
213.2 0.0	GROUND SURFACE Silty PEAT, containing rootlets Black Wet		1	AS	-		213															
212.4 0.8	SAND and SILT, trace to some clay, slightly organic to a depth of 1.4 m Loose Dark brown to grey Wet		2	SS	6		212															
210.9 2.3	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Water level in open borehole at ground surface (Elev. 213.2 m) upon completion of drilling.		3	SS	4		211															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No S20-12		SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION		N 5043476.7 ; E 245877.3		ORIGINATED BY		DM									
DIST		HWY 69		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
DATUM		Geodetic		DATE		February 26, 2008		CHECKED BY									
								VA									
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									
213.2	GROUND SURFACE							20	40	60	80	100					
0.0	Silty PEAT, containing rootlets Black Wet		1	AS	-		213										
212.4	SILTY CLAY, trace sand Soft Brown Wet		2	SS	3		212										
211.5	SAND and SILT, trace gravel, trace clay, containing sandy silt seams (TILL) Compact Grey Wet						211										
210.5			3	SS	13/0.25												
2.7	END OF BOREHOLE SPOON AND AUGER REFUSAL																
NOTES: 1. Water level in open borehole at ground surface (Elev. 213.2 m) upon completion of drilling. 2. An additional borehole was drilled 1.0 m north of Borehole S20-12 to obtain Shelby tube sample; see Record of Borehole No. S20-12A for details.																	

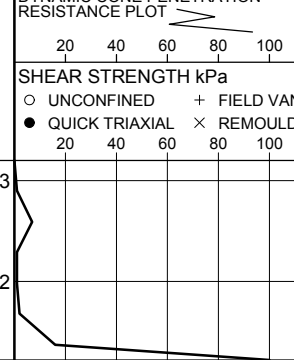
PROJECT		RECORD OF BOREHOLE		No S20-12A		SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION		N 5043477.7 ; E 245877.3		ORIGINATED BY		DM									
DIST		HWY 69		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
VO		DATE		February 26, 2008		CHECKED BY		CN									
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 (%)				
213.2	GROUND SURFACE						20	40	60	80	100						
0.0	See Record of Borehole S20-12 for subsurface conditions within these elevations.					213											
212.4	SILTY CLAY																
0.8	Brown to reddish brown																
211.8	Wet		1	TO	PM	212											
1.4	END OF BOREHOLE																

<div style="display: flex; justify-content: space-between;"> PROJECT <u>07-1111-0029</u> RECORD OF DCPT No C48.1-DC01 SHEET 1 OF 1 METRIC </div>																
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043448.1 ; E 245870.6</u>		ORIGINATED BY <u>EC</u>												
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>										
DATUM <u>Geodetic</u>		DATE <u>March 16, 2009</u>				CHECKED BY <u>VA</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
213.2	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div>									
0.0	Dynamic Cone Penetration Test (DCPT)					213	<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div>									
211.7	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)					212	<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 </div>									
1.5																

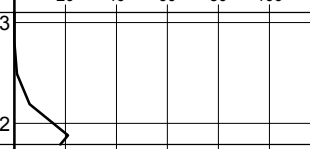
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PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C48.1-DC02 SHEET 1 OF 1										METRIC			
G.W.P. <u>5402-05-00</u>					LOCATION <u>N 5043452.4 ;E 245870.2</u>					ORIGINATED BY <u>EC</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>					COMPILED BY <u>VA</u>													
DATUM <u>Geodetic</u>					DATE <u>March 16, 2009</u>					CHECKED BY <u>VA</u>													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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					W _p W W _L						WATER CONTENT (%)				
213.2	GROUND SURFACE						213																
0.0	Dynamic Cone Penetration Test (DCPT)						212																
211.6	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						
1.6																							

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>				RECORD OF DCPT No C48.1-DC03				SHEET 1 OF 1				METRIC				
G.W.P. <u>5402-05-00</u>				LOCATION <u>N 5043452.0 ; E 245866.0</u>				ORIGINATED BY <u>EC</u>								
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>								
DATUM <u>Geodetic</u>				DATE <u>March 16, 2009</u>				CHECKED BY <u>VA</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 W _L			
213.2	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> 10 20 30 </div>				
0.0	Dynamic Cone Penetration Test (DCPT)					213										
211.2	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)					212										
2.0																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>				RECORD OF DCPT No C48.1-DC04				SHEET 1 OF 1				METRIC						
G.W.P. <u>5402-05-00</u>				LOCATION <u>N 5043467.8 ; E 245870.0</u>				ORIGINATED BY <u>MJR</u>										
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>										
DATUM <u>Geodetic</u>				DATE <u>March 17, 2009</u>				CHECKED BY <u>VA</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
213.1	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>						
0.0	Dynamic Cone Penetration Test (DCPT)					213												
211.8					212													
1.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C48.1-DC05 SHEET 1 OF 1										METRIC			
G.W.P. <u>5402-05-00</u>					LOCATION <u>N 5043469.9 ; E 245867.8</u>					ORIGINATED BY <u>MJR</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>					COMPILED BY <u>VA</u>													
DATUM <u>Geodetic</u>					DATE <u>March 17, 2009</u>					CHECKED BY <u>VA</u>													
SOIL PROFILE					SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20	40	60			80	100	W _p	W	W _L								
213.1	GROUND SURFACE																						
0.0	Dynamic Cone Penetration Test (DCPT)																						
211.9																							
1.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

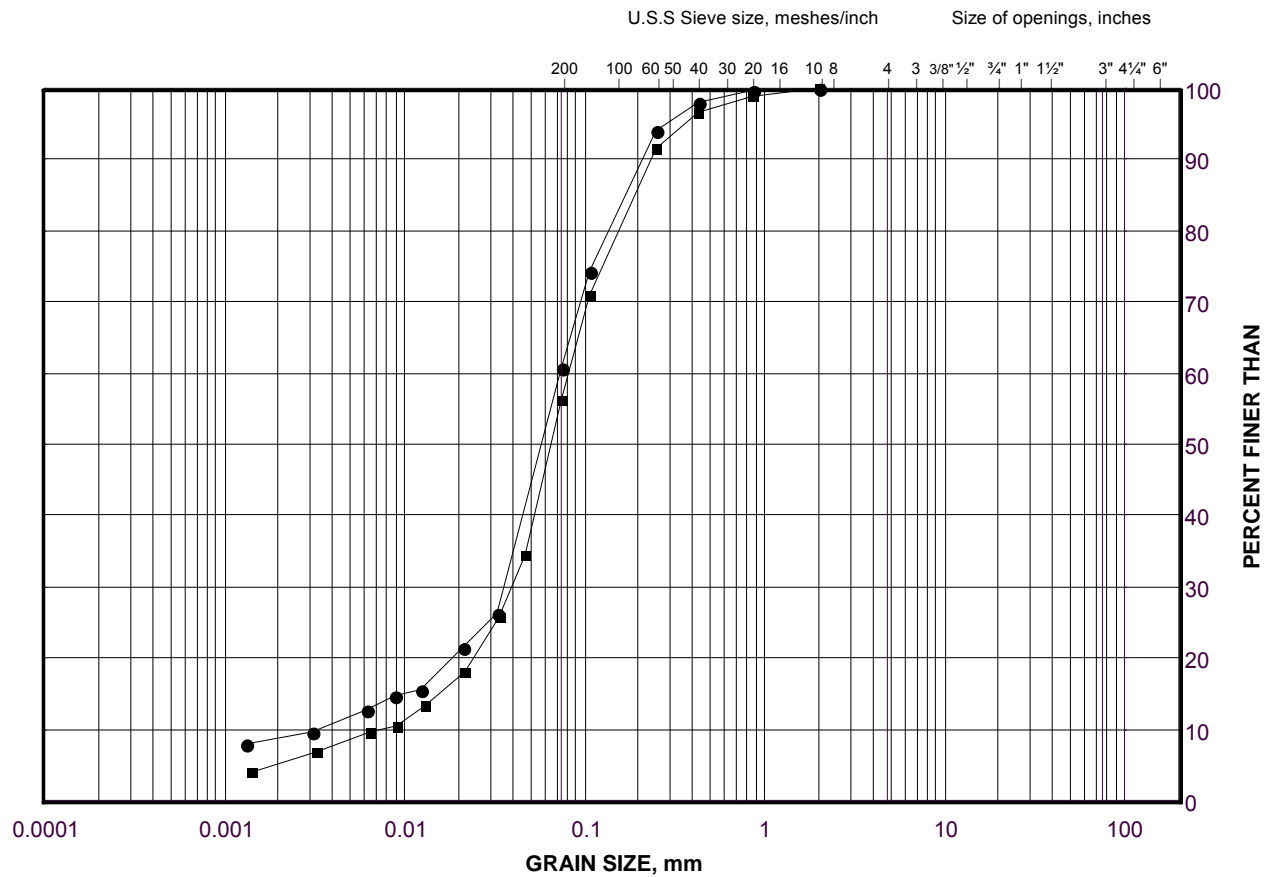
PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C48.1-DC06				SHEET 1 OF 1		METRIC								
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043470.6 ; E 245871.7</u>				ORIGINATED BY <u>MJR</u>										
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>VA</u>										
DATUM <u>Geodetic</u>		DATE <u>March 17, 2009</u>				CHECKED BY <u>VA</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
213.4	GROUND SURFACE						20	40	60	80	100					
0.0	Dynamic Cone Penetration Test (DCPT)															
0.2	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)															
	NOTE: 1. DCPT advanced using portable drilling equipment with a half weight hammer. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE I-GPJ GAL-GTA.GDT 03/25/16 DD/SAC

GRAIN SIZE DISTRIBUTION

Silt and Sand
Highway 69 (SBL) STA 14+315

FIGURE C.C48.1-1



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

LEGEND

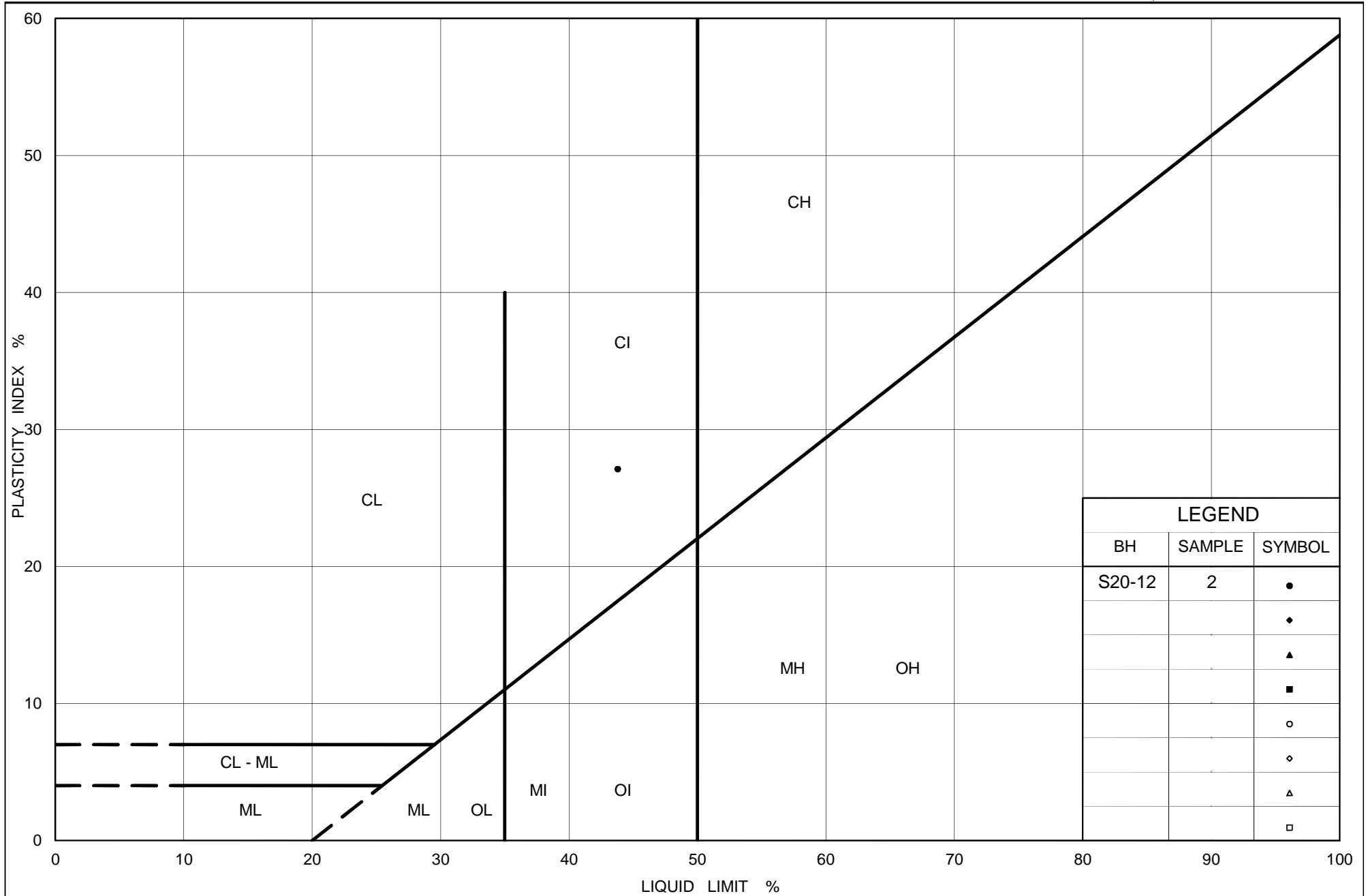
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S20-02	3	211.4
■	C48.1-S1	3A	210.9

Project Number: 07-1111-0029

Checked By: TVA

Golder Associates

1Date: 25-Aug-09



Ministry of Transportation

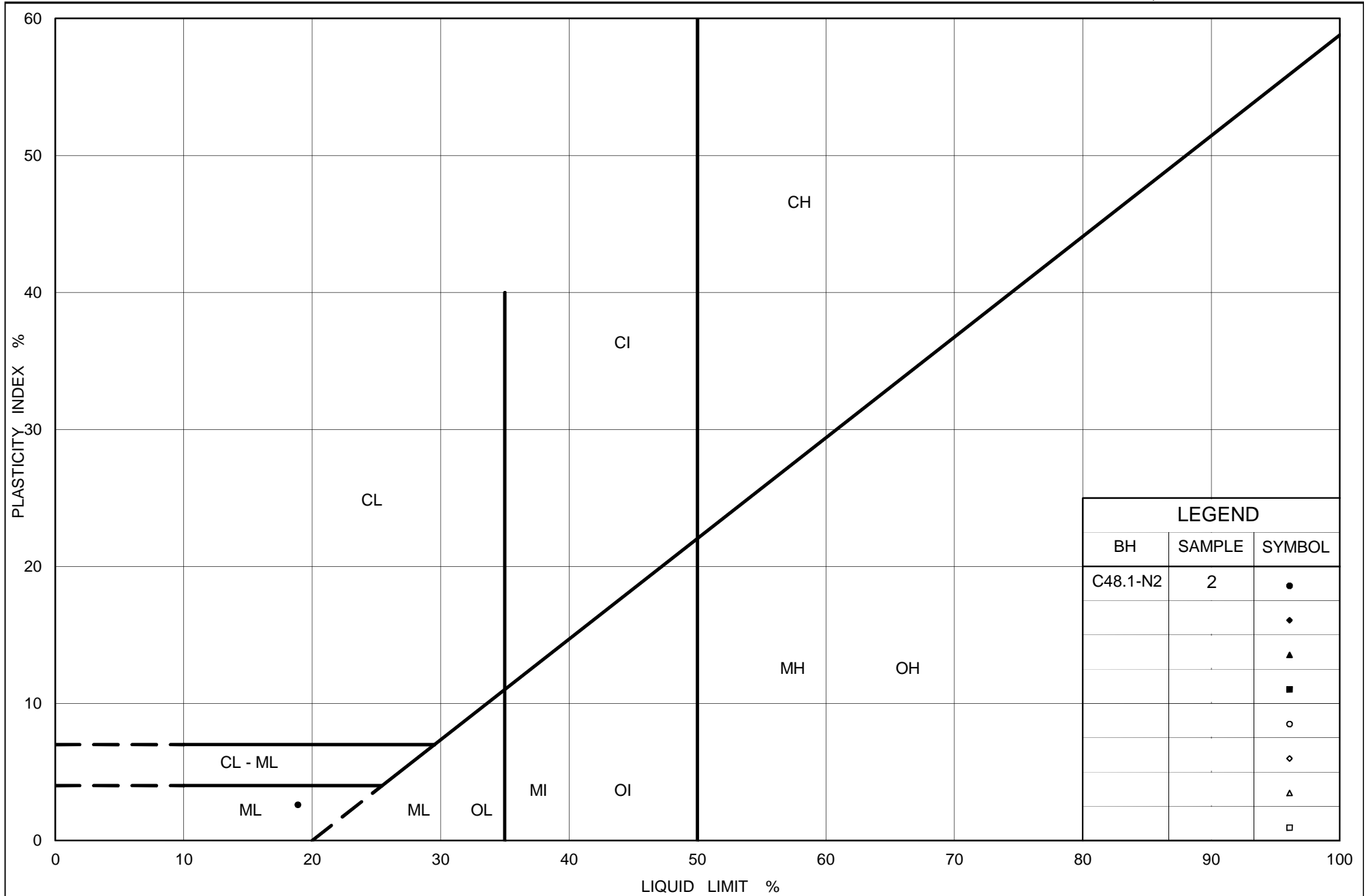
PLASTICITY CHART
Silty Clay
Highway 69 (NBL) STA 14+325

Ontario

Figure No. C.C48.1-2

Project No. 07-1111-0029

Checked By: TVA



Ministry of Transportation

Ontario

PLASTICITY CHART
 Silt
 Highway 69 (NBL) STA 14+325

Figure No. C.C48.1-3

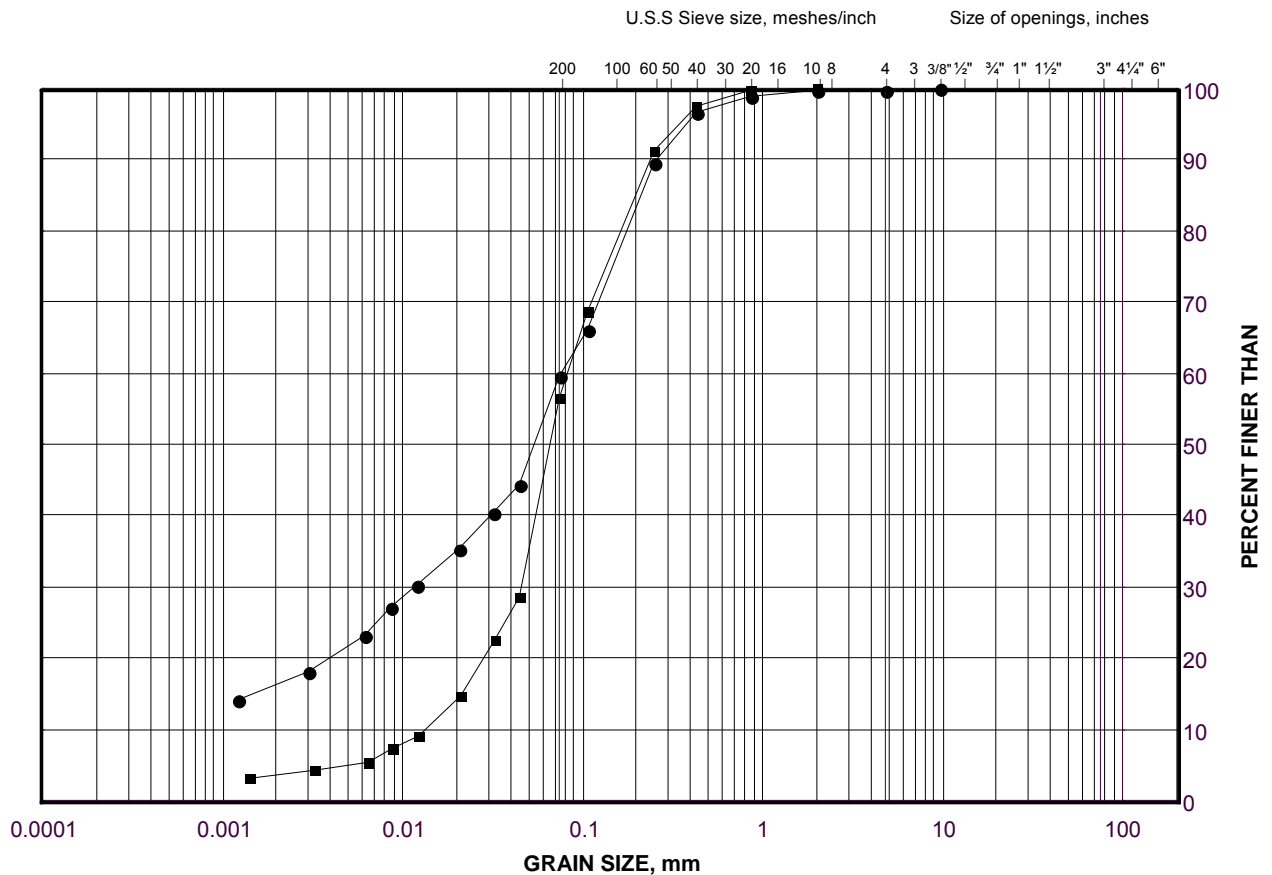
Project No. 07-1111-0029

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt and Sand Till
Highway 69 (NBL) STA 14+325

FIGURE C.C48.1-4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C48.1-N2	3	211.3
■	S20-12	3	210.7

Project Number: 07-1111-0029

Checked By: TVA

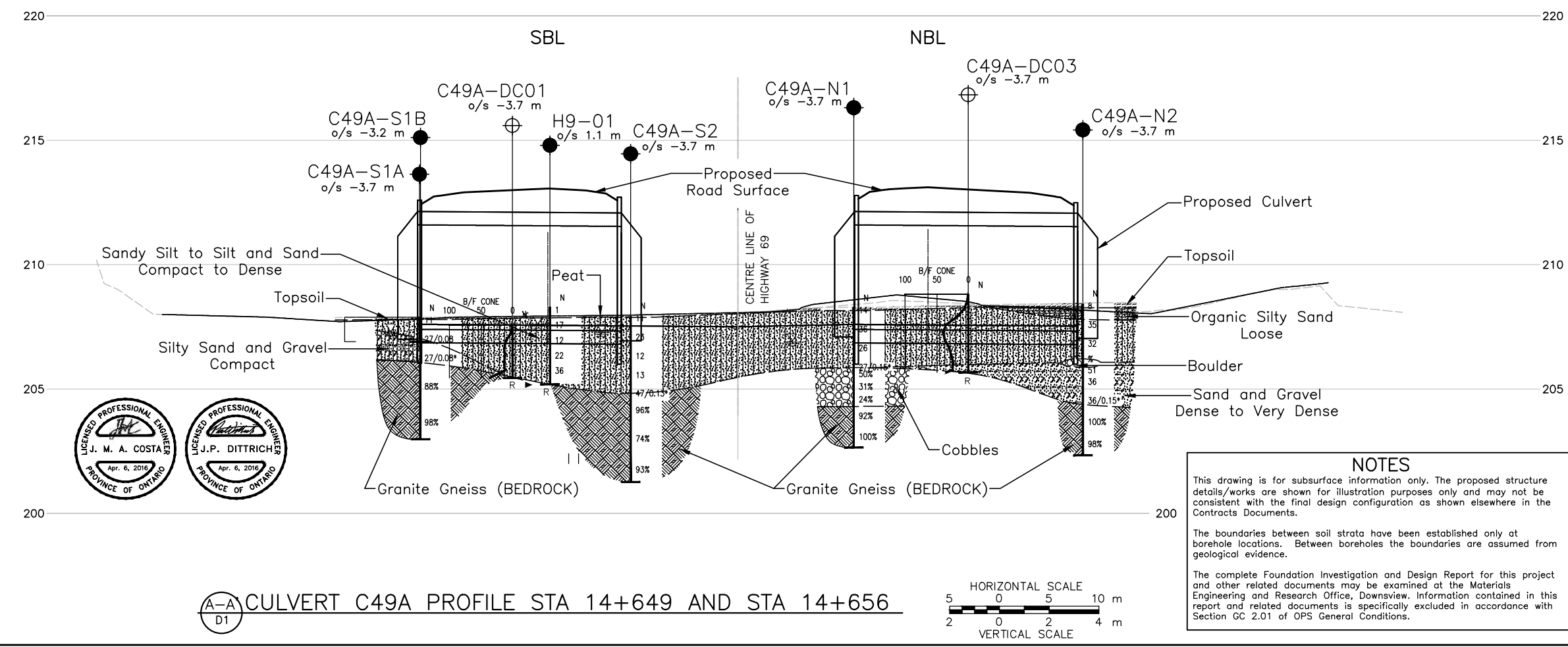
Golder Associates


Date: 27-Aug-09

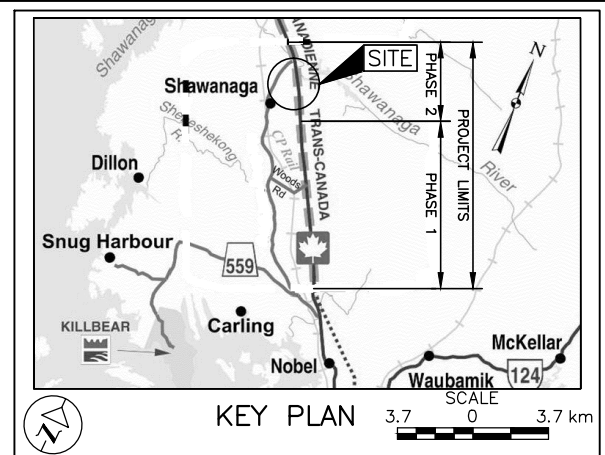







APPENDIX D

**Highway 69 SBL and NBL – STA 14+649 and STA 14+656
(Culvert 49A – Site No. 44-618/C2 and 44-618/C1)**



<p>CONT No.</p> <p>WP No. 5077-13-05 (NBL) and 5077-13-06 (SBL)</p>	
<p>HIGHWAY 69 (SBL AND NBL) CULVERT C49A STA 14+649 AND STA 14+656</p> <p>BOREHOLE LOCATIONS AND SOIL STRATA</p>	<p>SHEET</p> <p>S2</p>



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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C49A-DC01	207.6	5043649.1	245605.2
C49A-DC02	207.8	5043663.7	245604.2
C49A-DC03	208.8	5043689.3	245627.2
C49A-DC04	207.5	5043703.3	245626.4
C49A-N1	208.3	5043679.2	245621.6
C49A-N2	208.5	5043699.3	245632.7
C49A-N3	208.3	5043683.1	245615.4
C49A-S1A	207.9	5043640.9	245600.7
C49A-S1B	207.9	5043641.2	245600.3
C49A-S2	208.0	5043659.5	245610.9
C49A-S3	207.7	5043644.9	245594.3
H9-01	208.3	5043654.7	245602.8

REFERENCE

Base plans provided in digital format by MMM, drawing file nos.
 S6878-330-001504.dwg, dated November 2013, and h6878_PHA5E2_XD1
 grading.dwg received November 10, 2014, and h6878_PHA5E2_XN1.dwg
 received May 15, 2015.

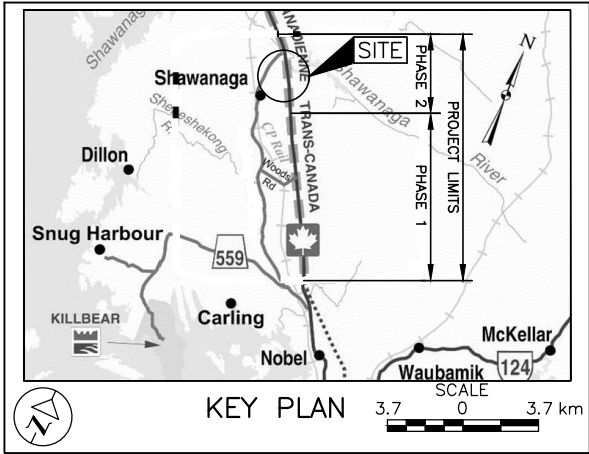
Contours provided in digital format by MRC, drawing file no. h6878xb07
 Phase-2 contours 1m intervals.dwg, received October 31, 2014.

Cross-section provided in digital format by MMM, drawing file no. 6878 jh
 Revised_C49A & C50-Nov 4, 2015.dwg, received November 30, 2015.

-	-	-		
NO.	DATE	BY	REVISION	
Geocres No. 41H-160				
Hwy. 69	PROJECT NO. 07-1111-0029			DIST. .
SUBM'D. AJS	CHKD. CN	DATE: 12/9/2015		SITE: 44-618/C1&C2
DRAWN: MR	CHKD. JMAC	APPD. JPD/JMAC		DWG. D1

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

CONT No.		
WP No.		5077-13-05 (NBL) and 5077-13-06 (SBL)
HIGHWAY 69 (SBL AND NBL) CULVERT C49A STA 14+649 AND STA 14+656		SHEET S3
SOIL STRATA		



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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C49A-DC02	207.8	5043663.7	245604.2
C49A-DC04	207.5	5043703.3	245626.4
C49A-N3	208.3	5043683.0	245615.4
C49A-S3	207.7	5043644.9	245594.3

NOTES

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

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

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

REFERENCE

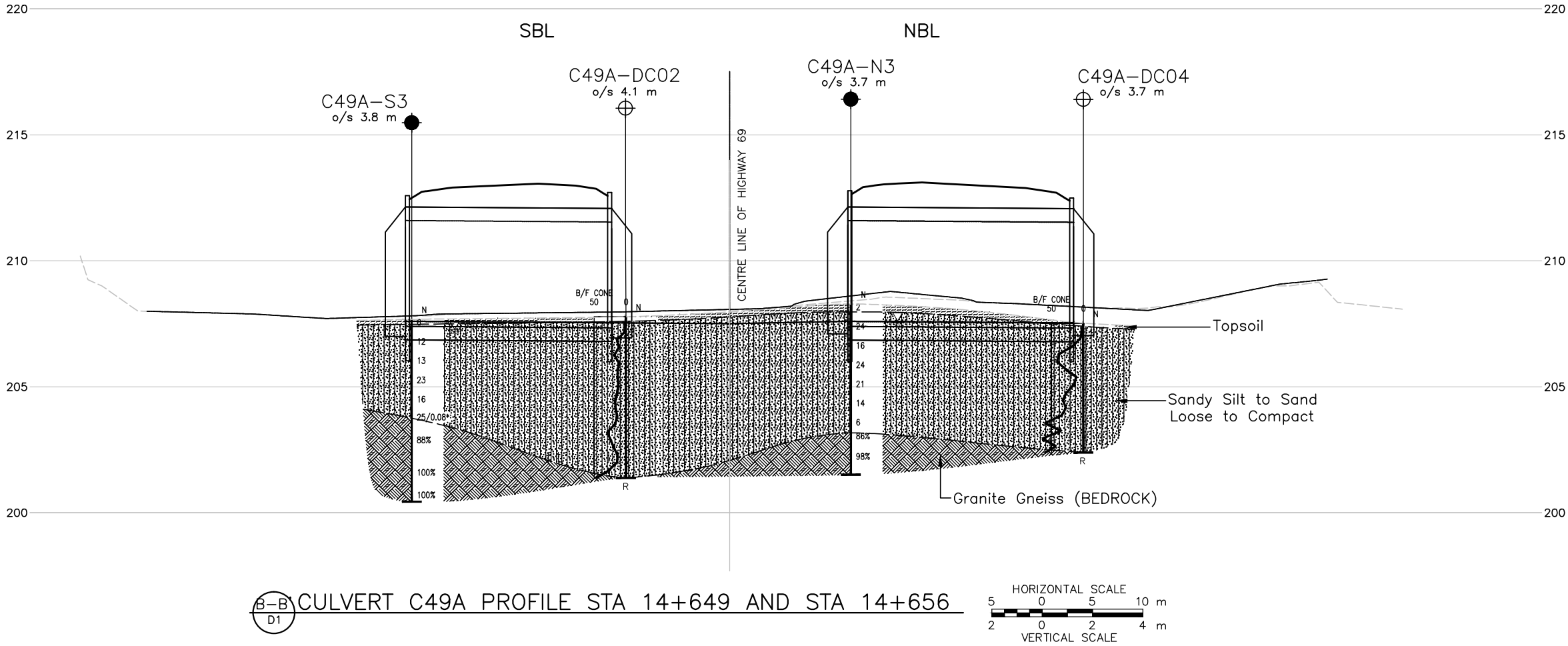
Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.

Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.

Cross-section provided in digital format by MMM, drawing file no. 6878 jh Revised C49A & C50-Nov 4, 2015.dwg, received November 30, 2015.




NO.	DATE	BY	REVISION
Geocres No. 41H-160			
HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. AJS	CHKD. CN	DATE: 3/17/2016	SITE: 44-618/C1&C2
DRAWN: MR	CHKD. JMAC	APPD. JPD/JMAC	DWG. D2



B-B CULVERT C49A PROFILE STA 14+649 AND STA 14+656

PROJECT 07-1111-0029				RECORD OF BOREHOLE No C49A-S1A SHEET 1 OF 1				METRIC									
G.W.P. 5111-07-00				LOCATION N 5043640.9 ; E 245600.7				ORIGINATED BY ID									
DIST _____ HWY 69				BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR									
DATUM Geodetic				DATE June 3, 2015				CHECKED BY MCK									
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
207.9	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	11												
207.2	Silty SAND, trace organics Compact Brown Moist		1B														
206.9	Silty SAND and GRAVEL, trace clay Brown Moist to wet		2	SS	27/0.08												
1.0	END OF BOREHOLE SPOON REFUSAL																
NOTE: 1. Water level in open borehole not recorded.																	

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C49A-S1B				SHEET 1 OF 1		METRIC								
G.W.P. 5111-07-00		LOCATION N 5043641.2 ; E 245600.3				ORIGINATED BY ID										
DIST HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR										
DATUM Geodetic		DATE June 3, 2015				CHECKED BY MCK										
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								
207.9 0.0	GROUND SURFACE No sample taken. Refer to Record of Borehole C49A-S1A.															
206.4																
206.1 1.8	Silty SAND and GRAVEL, trace clay Brown Moist to wet Granite Gneiss (BEDROCK) Bedrock cored from depths of 1.8 m to 4.9 m. For bedrock coring details refer to Record of Drillhole C49A-S1B.		1	SS	20/0.15											
			1	RC	REC 97%											RQD = 88%
			2	RC	REC 100%											RQD = 98%
203.0 4.9	END OF BOREHOLE NOTE: 1. Water level measured in open borehole at a depth of 0.6 m below ground surface (Elev. 207.3 m) upon completion of drilling. * Split-spoon bouncing															

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C49A-S1B

SHEET 1 OF 1

LOCATION: N 5043641.2 ;E 245600.3

DRILLING DATE: June 3, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling 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 m	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	DIP W/L CORE AXIS	B Angle	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	Diameter Point Load Index (MPa)	RMC -Q' AVG.	
Continued from Record of Borehole C49A-S1													
2	1.80												
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GFPJ GAL-MISS.GDT 03/25/16 DV

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C49A-S2				SHEET 1 OF 1		METRIC										
G.W.P. 5111-07-00		LOCATION N 5043659.5 ; E 245610.9				ORIGINATED BY ID												
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR												
DATUM Geodetic		DATE June 5, 2015				CHECKED BY MCK												
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 (%)
208.0	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL		1A	SS	11	▽												
0.1	SAND, some silt, trace organics		1B															
207.3	Compact Light brown																	
0.7	Moist Sandy SILT		2	SS	23													
	Compact Grey to light brown																	
	Moist to wet		3	SS	12													
			4	SS	13													
204.8	Granite Gneiss (BEDROCK)		5	SS	47/0.13													
3.2	Bedrock cored from depths of 3.2 m to 6.7 m.		1	RC	REC 100%												RQD = 96%	
	For bedrock coring details refer to Record of Drillhole C49A-S2.		2	RC	REC 100%												RQD = 74%	
			3	RC	REC 100%												RQD = 93%	
201.6	END OF BOREHOLE																	
6.4	NOTE: 1. Water level measured in open borehole at a depth of 0.7 m below ground surface (Elev. 207.3 m) upon completion of drilling. * Split-spoon bouncing																	

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C49A-S2

SHEET 1 OF 1

LOCATION: N 5043659.5 ; E 245610.9

DRILLING DATE: June 5, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling Inc.

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 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
								TOTAL CORE %	SOLID CORE %									10 ⁻⁶	10 ⁻⁵	10 ⁻⁴																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
		Continued from Record of Borehole C49A-S2		204.80																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			</

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II.GPJ GAL-MISS.GDT 03/25/16 DV

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C49A-S3				SHEET 1 OF 1		METRIC									
G.W.P. 5111-07-00		LOCATION N 5043644.9 ; E 245594.3				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR											
DATUM Geodetic		DATE June 4, 2015				CHECKED BY MCK											
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									
207.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	6												
0.2	Sandy SILT Loose to compact Light brown to grey Moist to wet		1B	SS													
			2	SS	12												
			3	SS	13												
			4	SS	23												
			5	SS	16												
203.8	Granite Gneiss (BEDROCK)		6	SS	25/0.08												
3.9	Bedrock cored from depths of 3.9 m to 7.2 m. For bedrock coring details refer to Record of Drillhole C49A-S3.		1	RC	REC 96%												RQD = 88%
			2	RC	REC 100%												RQD = 100%
			3	RC	REC 100%												RQD = 100%
200.5	END OF BOREHOLE																
7.2	NOTE: 1. Water level measured in open borehole at a depth of 0.4 m below ground surface (Elev. 207.3 m) upon completion of drilling. * Split-spoon bouncing																

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C49A-S3

SHEET 1 OF 1

LOCATION: N 5043644.9 ;E 245594.3

DRILLING DATE: June 4, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling Inc.

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 m	B Angle °	DIP w.r.t. CORE AXIS °	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY K, cm/sec										Diametral Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																													
								TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°			10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°		10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GPJ GAL-MISS.GDT 03/25/16 DV

PROJECT		RECORD OF BOREHOLE No C49A-N1				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5043679.2 ; E 245621.6				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR											
DATUM Geodetic		DATE June 8 and 9, 2015				CHECKED BY MCK											
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									
208.3	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	14		208										
0.1	Silty SAND, trace organics Compact Light brown Moist		1B														
			2	SS	36												
			3	SS	26		207										
			4	SS	27/0.15		206										
205.9	COBBLES		1	RC	REC 50%												
2.4			2	RC	REC 31%		205										
			3	RC	REC 24%												
204.3	Granite Gneiss (BEDROCK)		4	RC	REC 92%		204										
4.0	Bedrock cored from depths of 4.0 m to 5.7 m. For bedrock coring details refer to Record of Drillhole C49A-N1.		5	RC	REC 100%		203										
202.7	END OF BOREHOLE																
5.6	NOTE: 1. Water level measured in open borehole at a depth of 1.4 m below ground surface (Elev. 206.9 m) upon completion of drilling. * Split-spoon bouncing																

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C49A-N1

SHEET 1 OF 1

LOCATION: N 5043679.2 ;E 245621.6

DRILLING DATE: June 8 and 9, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling Inc.

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 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q- AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GFPJ GAL-MISS.GDT 03/25/16 DV

PROJECT		RECORD OF BOREHOLE No C49A-N2				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5043699.3 ; E 245632.7				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR											
DATUM Geodetic		DATE June 11, 2015				CHECKED BY MCK											
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									
208.5	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	8		208										OC = 7.2%
0.2	Organic Silty SAND		1B	SS													
207.8	Loose Red to dark brown Moist																
0.7	SILT and SAND Compact Brown Moist		2	SS	35		207										0 37 63 0
			3	SS	32												
206.2	BOULDER						206										
205.9																	
2.6	SAND and GRAVEL, trace to some silt to silty Dense to very dense Brown Wet		4	SS	51												
			5	SS	36		205										39 53 7 1
			6	SS	36/0.15												
204.2	Cobbles encountered at a depth of 4.1 m (Elev. 204.4 m)						204										
4.3	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 4.3 m to 6.1 m.		1	RC	REC 100%												RQD = 100%
	For bedrock coring details refer to Record of Drillhole C49A-N2.																
			2	RC	REC 98%		203										RQD = 98%
202.4	END OF BOREHOLE																
6.1	NOTE: 1. Water level measured in open borehole at a depth of 1.5 m below ground surface (Elev. 207.0 m) upon completion of drilling. * Split-spoon bouncing																

PROJECT		07-1111-0029		RECORD OF BOREHOLE No C49A-N3		SHEET 1 OF 1		METRIC								
G.W.P.		5111-07-00		LOCATION		N 5043683.1 ; E 245615.4		ORIGINATED BY ID								
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY ZR/MR								
DATUM		Geodetic		DATE		June 8, 2015		CHECKED BY MCK								
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								
208.3	GROUND SURFACE															
0.0	TOPSOIL		1A	SS	2											
0.3	Silty SAND, trace organics Very loose to compact Light brown Moist		1B													
			2	SS	24											
206.8																
1.5	SILT and SAND, trace clay Compact Reddish brown to grey Wet		3	SS	16											0 31 66 3
			4	SS	24											
			5	SS	21											0 42 56 2
			6	SS	14											
203.8																
4.5	SAND, some silt, trace gravel Loose Grey Wet		7	SS	6											
203.2																
5.1	Granite Gneiss (BEDROCK)		1	RC	REC 86%											RQD = 86%
	Bedrock cored from depths of 5.1 m to 6.8 m.															
	For bedrock coring details refer to Record of Drillhole C49A-N3.		2	RC	REC 98%											RQD = 98%
201.5																
6.8	END OF BOREHOLE															
	NOTE: 1. Water level measured in open borehole at a depth of 0.7 m below ground surface (Elev. 207.6 m) upon completion of drilling.															

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C49A-N3

SHEET 1 OF 1

LOCATION: N 5043683.1 ;E 245615.4

DRILLING DATE: June 8, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling 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 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec												Diametral Point Load Index (MPa)	RMC -Q' AVG.						
									TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja	Jn	10	10	10	10													
									80	80	80	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Continued from Record of Borehole C49-N3		203.17																																
	NQRC June 8, 2015	Fresh, foliated, grey, medium grained, very strong GRANITE GNEISS		5.11	1																															
6						2																														

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

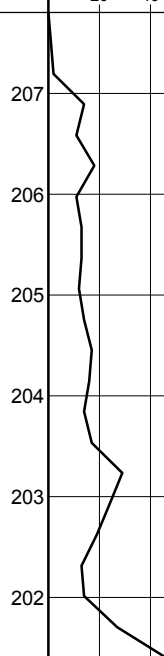
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+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

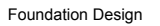
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PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C49A-DC01 SHEET 1 OF 1										METRIC			
G.W.P. <u>5111-07-00</u>					LOCATION <u>N 5043649.1 ; E 245605.2</u>					ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>					COMPILED BY <u>ZR/MR</u>													
DATUM <u>Geodetic</u>					DATE <u>June 4, 2015</u>					CHECKED BY <u>AJS</u>													
SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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					W _p	W	W _L										
207.6	GROUND SURFACE																						
0.0	Dynamic Cone Penetration Test (DCPT)																						
207																							
206																							
205.5																							
2.1	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C49A-DC02				SHEET 1 OF 1		METRIC												
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5043663.7 ; E 245604.2</u>				ORIGINATED BY <u>ID</u>														
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>ZR/MR</u>														
DATUM <u>Geodetic</u>		DATE <u>June 3, 2015</u>				CHECKED BY <u>AJS</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 (%)			
207.8	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>													
0.0	Dynamic Cone Penetration Test (DCPT)																			
201.4	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																			
6.4																				

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV



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

<div style="display: flex; justify-content: space-between;"> PROJECT <u>07-1111-0029</u> RECORD OF DCPT No C49A-DC04 SHEET 1 OF 1 METRIC </div>													
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5043703.3 ; E 245626.4</u>		ORIGINATED BY <u>ID</u>									
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>ZR/MR</u>							
DATUM <u>Geodetic</u>		DATE <u>June 10, 2015</u>				CHECKED BY <u>AJS</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
207.5 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>						
207													
206													
205													
204													
203													
202.4 5.1	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)												

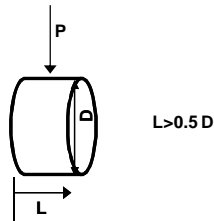
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TABLE D1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

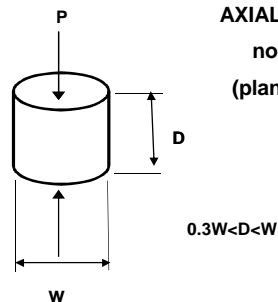
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C49A-S1B	2	3.3	204.6	Granite Gneiss	Diametral	9.18
C49A-S1B	2	3.6	204.3	Granite Gneiss	Axial	4.95
C49A-S1B	2	4.1	203.8	Granite Gneiss	Diametral	5.21
C49A-S1B	2	4.3	203.7	Granite Gneiss	Axial	1.56
C49A-S2	1	3.9	204.1	Granite Gneiss	Axial	5.56
C49A-S2	2	4.7	203.3	Granite Gneiss	Axial	6.06
C49A-S2	3	6.0	202.0	Granite Gneiss	Diametral	4.85
C49A-S3	1	4.2	203.5	Granite Gneiss	Diametral	5.64
C49A-S3	1	4.2	203.5	Granite Gneiss	Axial	8.01
C49A-S3	2	5.9	201.8	Granite Gneiss	Diametral	3.77
C49A-S3	2	5.9	201.8	Granite Gneiss	Axial	8.54
C49A-N1	5	5.2	203.1	Granite Gneiss	Diametral	8.12
C49A-N1	5	5.2	203.1	Granite Gneiss	Axial	6.73
C49A-N2	1	5.1	203.4	Granite Gneiss	Diametral	5.22
C49A-N2	1	5.2	203.3	Granite Gneiss	Axial	5.44
C49A-N3	2	5.6	202.7	Granite Gneiss	Diametral	5.26
C49A-N3	2	5.6	202.7	Granite Gneiss	Axial	4.08

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: MCK
 Checked By: CN
 Reviewed By: JMAC

Table D2

UNCONFINED COMPRESSION TEST (UC)
ASTM D7012

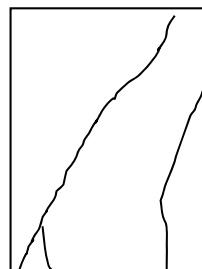
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	C49A-S1B	SAMPLE DEPTH, m	1.82

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

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	9.55	WATER CONTENT, (specimen) %	0.09
SAMPLE DIAMETER, cm	4.26	UNIT WEIGHT, kN/m ³	25.84
SAMPLE AREA, cm ²	14.25	DRY UNIT WT., kN/m ³	25.81
SAMPLE VOLUME, cm ³	136.15	SPECIFIC GRAVITY	-
WET WEIGHT, g	358.84	VOID RATIO	-
DRY WEIGHT, g	358.52		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	84.3

REMARKS:

DATE:

2015-06-25

Checked By: MCK

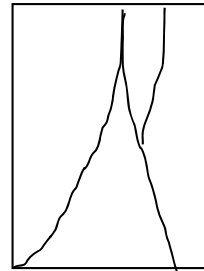
Golder Associates

Table D3**UNCONFINED COMPRESSION TEST (UC)****ASTM D7012**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	C49A-N2	SAMPLE DEPTH, m	5.25

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

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	9.34	WATER CONTENT, (specimen) %	0.39
SAMPLE DIAMETER, cm	4.27	UNIT WEIGHT, kN/m ³	26.00
SAMPLE AREA, cm ²	14.29	DRY UNIT WT., kN/m ³	25.90
SAMPLE VOLUME, cm ³	133.49	SPECIFIC GRAVITY	-
WET WEIGHT, g	354.06	VOID RATIO	-
DRY WEIGHT, g	352.68		

VISUAL INSPECTION**FAILURE SKETCH**

TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	48.3

REMARKS:

DATE:

2015-06-25

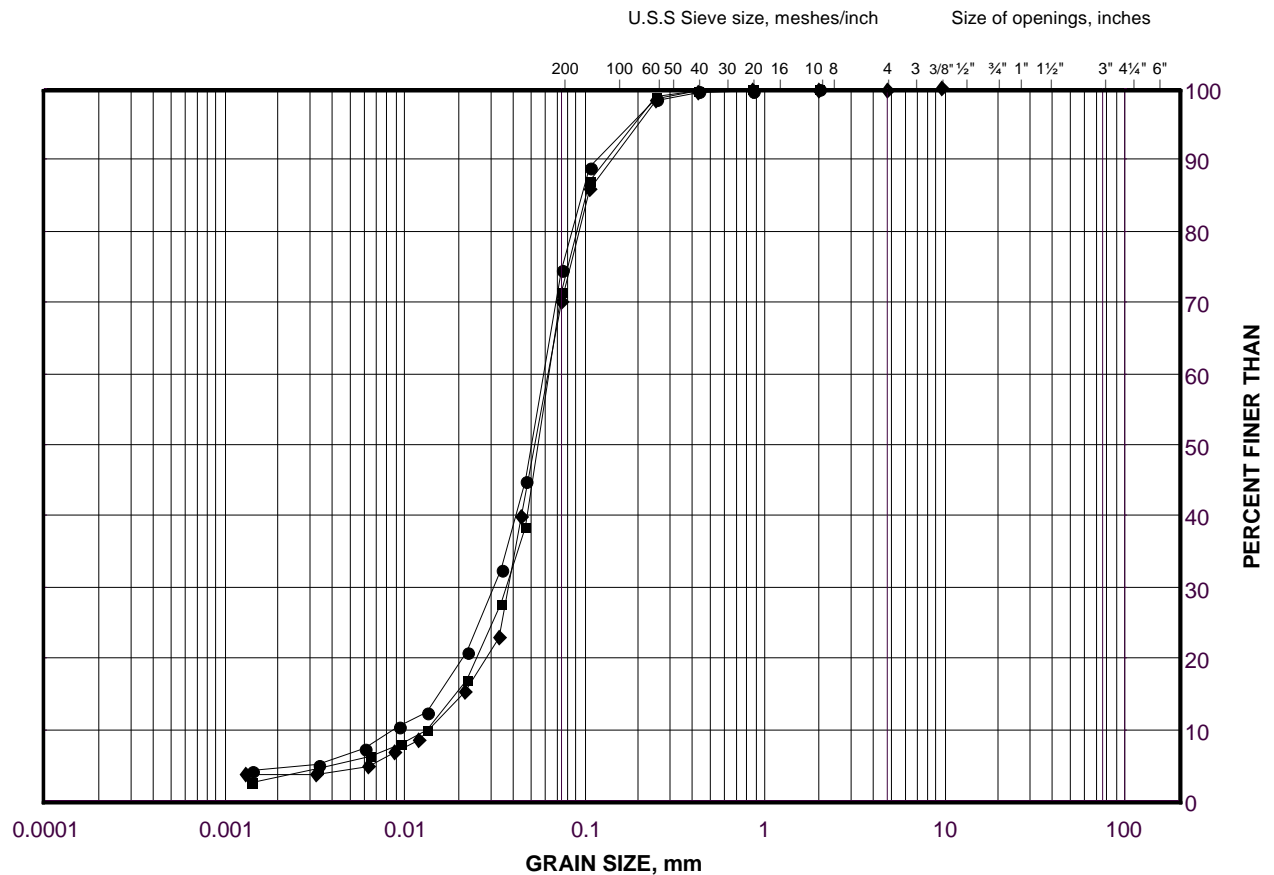
Checked By: MCK

Golder Associates

GRAIN SIZE DISTRIBUTION

Sandy Silt
Highway 69 (SBL) STA 14+649

FIGURE D.C49A-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C49A-S3	2	206.7
■	C49A-S2	3	206.2
◆	H9-01	5	205.6

Project Number: 07-1111-0029

Checked By: AJS

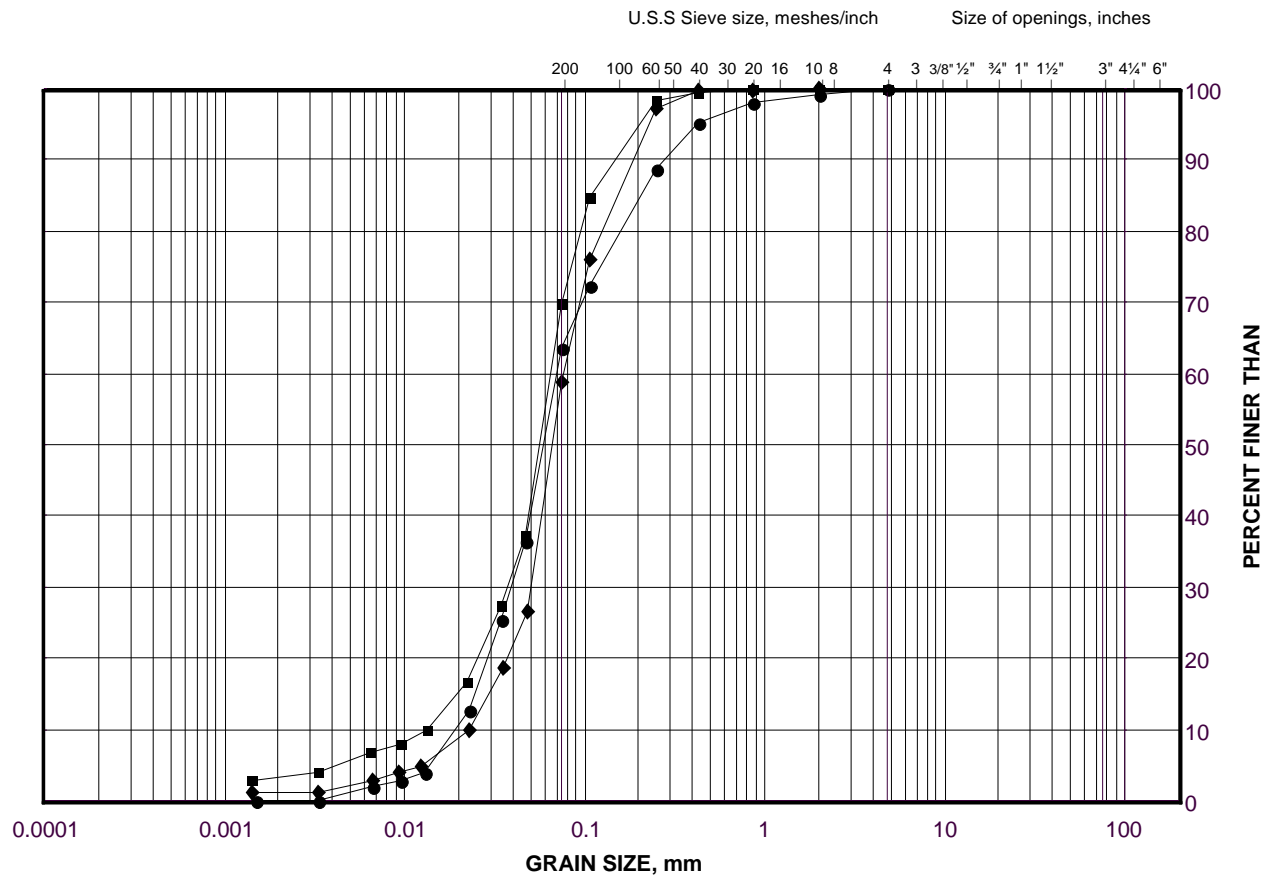
Golder Associates

Date: 30-Jul-15

GRAIN SIZE DISTRIBUTION

Silt and Sand
Highway 69 (NBL) STA 14+656

FIGURE D.C49A-2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C49A-N2	3	206.7
■	C49A-N3	3	206.5
◆	C49A-N3	5	205.0

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

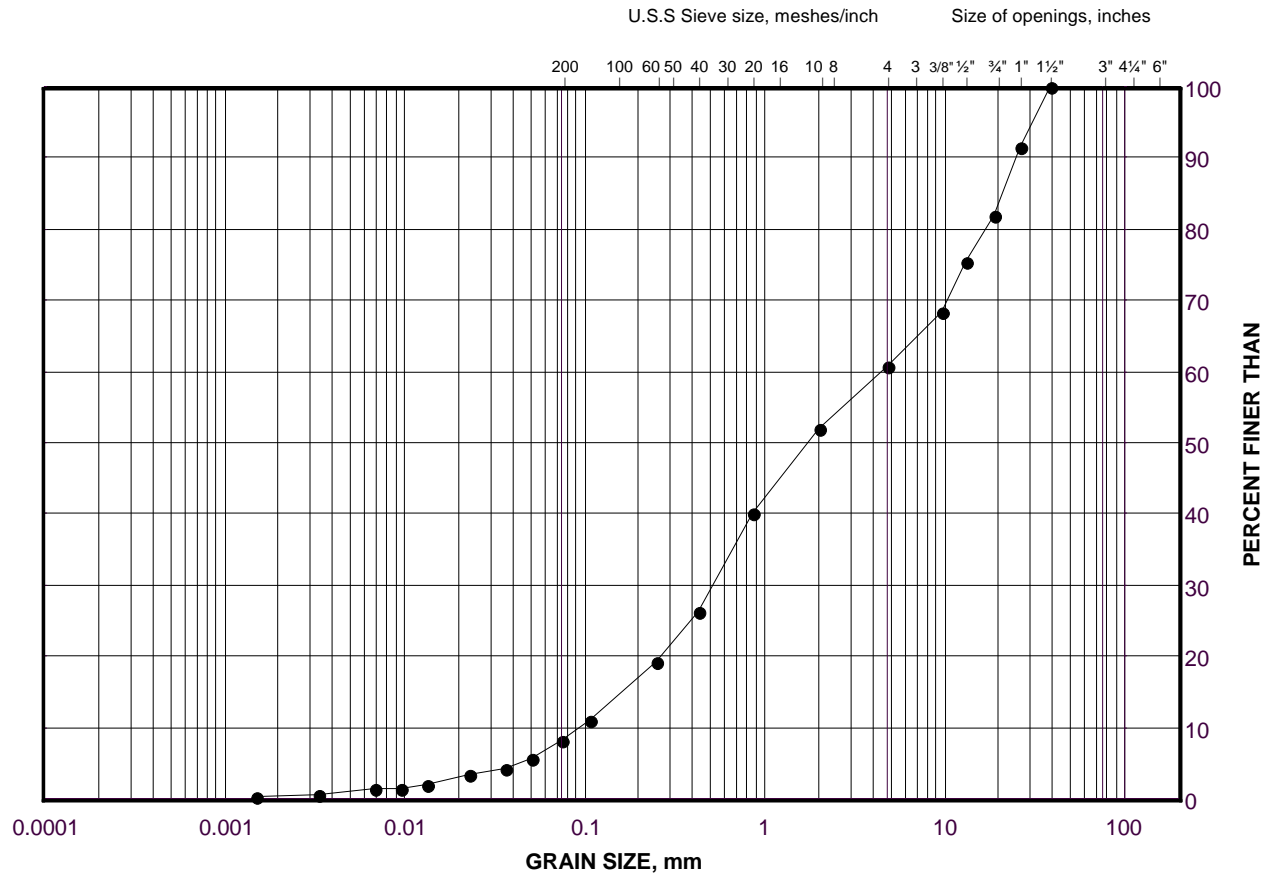
Date: 16-Aug-15

GRAIN SIZE DISTRIBUTION

Sand and Gravel

Highway 69 (NBL) STA 14+656

FIGURE D.C49A-3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C49A-N2	5	205.2

Project Number: 07-1111-0029

Checked By: AJS

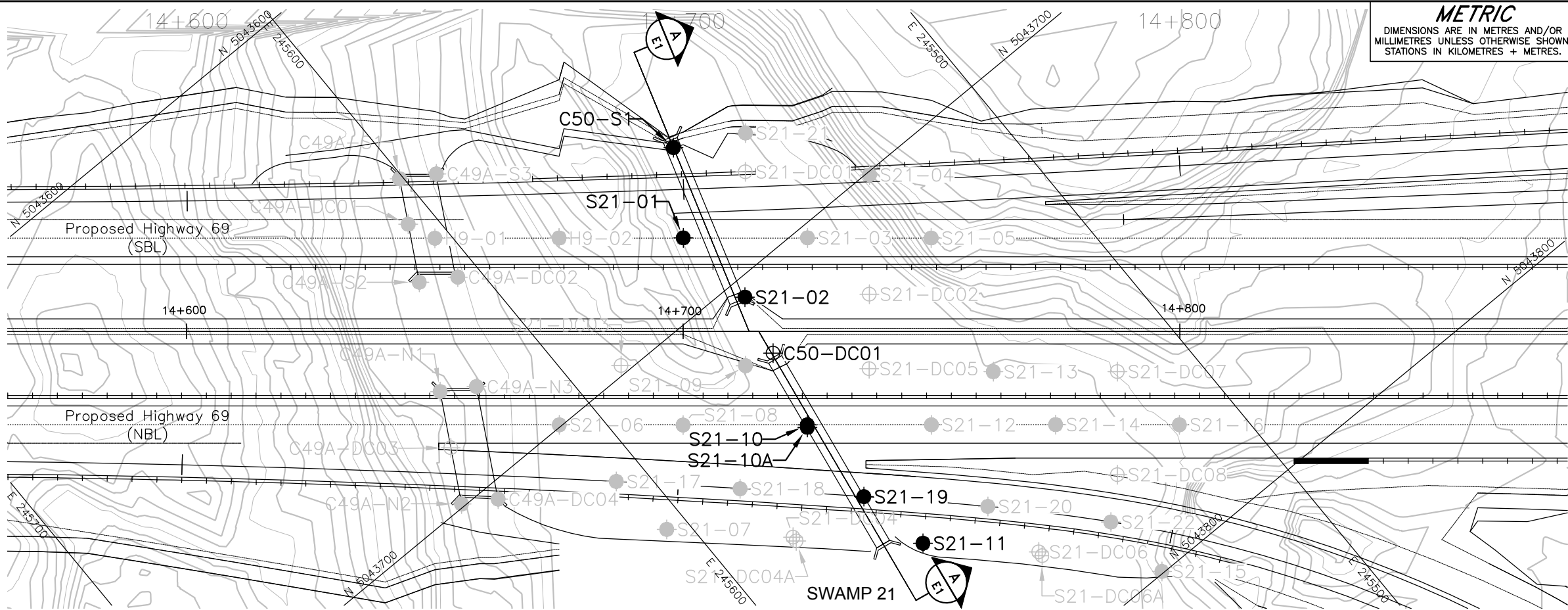
Golder Associates

Date: 17-Aug-15



APPENDIX E

Highway 69 SBL and NBL – STA 14+706 and STA 14+726
(Culvert C50 – Site No. 44-619/C2 and 44-619/C1)

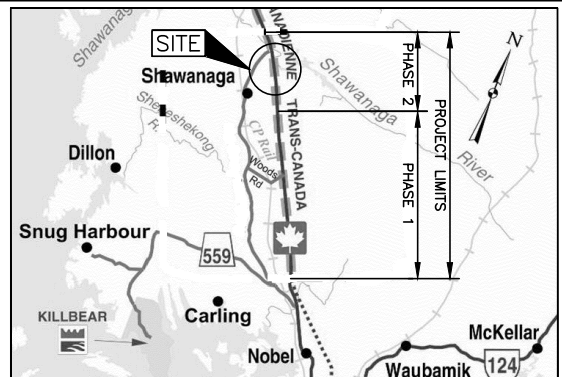


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. _____
WP No. 5077-13-07 (NBL) and
5077-13-08 (SBL)
HIGHWAY 69 (SBL AND NBL)
CULVERT C50 STA 14+706 AND STA 14+726
BOREHOLE LOCATIONS AND SOIL
STRATA



SHEET
S33



KEY PLAN SCALE 0 3.7 km

LEGEND

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

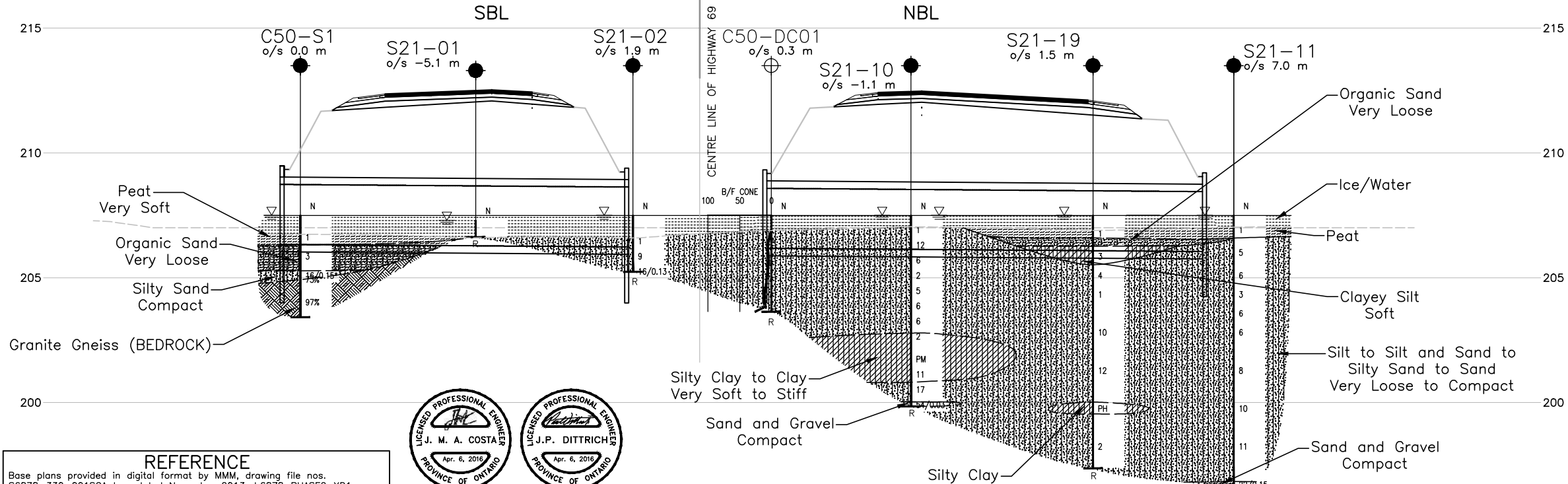
BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C50-DC01	207.5	5043715.9	245565.0
C50-S1	207.5	5043671.2	245554.2
S21-01	207.3	5043686.5	245564.2
S21-02	207.5	5043703.6	245562.2
S21-10	207.5	5043731.4	245568.9
S21-11	207.5	5043764.6	245566.1
S21-19	207.5	5043749.8	245569.3

NOTES

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

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

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

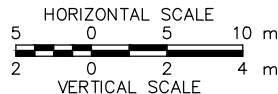


REFERENCE

Base plans provided in digital format by MMM, drawing file no. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878 jh Revised C49A & C50-Nov 4, 2015.dwg, received November 30, 2015.



CULVERT C50 PROFILE STA 14+706 AND 14+726



NO.	DATE	BY	REVISION
1	12/9/2015	JMAC	ISSUED FOR CONSTRUCTION
2	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS
3	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS
4	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS
5	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS
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99	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS
100	12/9/2015	JMAC	REVISED TO REFLECT COMMENTS

PROJECT		RECORD OF BOREHOLE		No C50-S1		SHEET 1 OF 1		METRIC					
G.W.P. 5111-07-00		LOCATION		N 5043671.2 ; E 245554.2		ORIGINATED BY		ID					
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment		COMPILED BY					
DATUM		Geodetic		DATE		June 2, 2015		CHECKED BY					
								MCK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
207.5	GROUND SURFACE												
0.0	WATER												
206.7													
0.8	PEAT (Fibrous)		1A	SS	1								
206.3	Very soft												
1.2	Dark brown		1B										
	Wet												
	Organic SAND, some silt												
	Very loose		2	SS	3								
	Dark brown												
	Wet												
205.3													
	Silty SAND												
	Compact		3	SS	16/0.15								
	Light grey												
	Wet												
204.9													
2.6	Granite Gneiss (BEDROCK)		1	RC	REC 97%								
	Bedrock cored from depths of 2.6 m to 4.1 m.												
			2	RC	REC 97%								
203.4													
4.1	For bedrock coring details refer to Record of Drillhole C50-S1.												
	END OF BOREHOLE												
	NOTE:												
	* Split-spoon bouncing												

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C50-S1

SHEET 1 OF 1

LOCATION: N 5043671.2 ;E 245554.2

DRILLING DATE: June 2, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling 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			
							TOTAL CORE %	SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn							Hydraulic Conductivity K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		Continued from Record of Borehole C50-S1		204.91																					
3	NQRC NW Casing June 2, 2015	Slightly weathered to fresh, foliated, green-grey-pink, medium grained, medium strong GRANITE GNEISS		2.59	1																				
4				203.44	2														(Axial) UC = 45.7 MPa						
		END OF DRILLHOLE		4.06																					
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GFPJ GAL-MISS GDT 03/25/16 DV

PROJECT		RECORD OF BOREHOLE No S21-01				SHEET 1 OF 1		METRIC								
G.W.P. 07-1111-0029		LOCATION N 5043686.5 ; E 245564.2				ORIGINATED BY TDM										
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY VO										
DATUM Geodetic		DATE March 10, 2008				CHECKED BY CN										
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								
207.3	ICE SURFACE						20	40	60	80	100					
0.0	Ice						20	40	60	80	100					
206.8	Water															
0.7	END OF BOREHOLE CASING REFUSAL															
NOTE: 1. Water level in open borehole at ice surface (Elev. 207.3 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE\GPJ GAL-GTA.GDT 03/25/16 DD/SAC


PROJECT 07-1111-0029		RECORD OF BOREHOLE No S21-02		SHEET 1 OF 1		METRIC														
G.W.P. 5402-05-00		LOCATION N 5043703.6 ; E 245562.2		ORIGINATED BY TDM																
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY VO																
DATUM Geodetic		DATE March 10, 2008		CHECKED BY CN																
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ	GR	SA	SI	CL
207.5	ICE SURFACE							20	40	60	80	100								
0.0	Ice						207													
0.2	Water																			
206.6																				
0.9	Silty SAND, trace gravel, trace organics, silt seams and rootlets Very loose to loose Dark brown Wet		1	SS	1		206													
205.7			2A	SS	9															
1.8	SILT and SAND, trace to some clay		2B																	
205.2	Loose Grey Wet Some gravel below a depth of 2.1 m		3	SS	16/0.13															
2.3	END OF BOREHOLE SPOON REFUSAL																			
NOTES: 1. Borehole advanced using portable drilling equipment with half weight hammer. SPT N values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at ice surface (Elev. 207.5 m) upon completion of drilling.																				

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S21-10		SHEET 1 OF 1		METRIC																				
G.W.P. 5402-05-00		LOCATION N 5043731.4 ;E 245568.9		ORIGINATED BY TDM																						
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY VO																						
DATUM Geodetic		DATE March 11, 2008		CHECKED BY CN																						
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ			GR	SA	SI	CL				
207.5 0.0	ICE SURFACE Ice																									
207.0 0.5	Silty SAND, trace to some clay, trace organics, rootlets to a depth of 1.6 m Very loose to compact Dark brown and black Wet		1	SS	1		207									149.7										
			2	SS	12		206																			
			3	SS	6		205																			
			4	SS	2		204																			
204.6 2.9	SILT and SAND, trace to some clay Loose Grey Wet		5	SS	5		203									53										
			6	SS	6		202																			
	Some gravel below a depth of 4.1 m		7	SS	6		201									44										
202.8 4.7	CLAY, trace silt Very soft Light brown and grey Wet		8	SS	2		200									56.2										
			9	TO	PM																					
201.2 6.3	SILTY CLAY, some sand Stiff Grey Wet		10A	SS	11																					
200.8 6.7	SILT and SAND, trace clay, containing silt seams Compact Grey Wet		10B	SS	17																					
200.0 7.7	SAND and GRAVEL, some silt Compact Grey Wet END OF BOREHOLE SPOON REFUSAL NOTES: 1. Borehole advanced using portable drilling equipment with half weight hammer. SPT N values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at ice surface (Elev. 207.5 m) upon completion of drilling. 3. An additional borehole was drilled 0.5 m north of Borehole S21-10 to carry out in situ vane testing and to obtain split spoon samples; see Record of Borehole No. S21-10A for details.		11	SS	54/0.03																					

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S21-10A				SHEET 1 OF 1		METRIC									
G.W.P. 5402-05-00		LOCATION N 5043731.8 ; E 245569.2				ORIGINATED BY TDM											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY VO											
DATUM Geodetic		DATE March 17, 2008				CHECKED BY CN											
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 (%)
207.5 0.0	ICE SURFACE																
207.0 0.5	GROUND SURFACE See Record of Borehole S21-10 for subsurface conditions within these elevations.					207											
						206											
						205											
						204											
202.8 4.7	CLAY, trace silt Soft Brown Wet					203											
202.3 5.2	SAND and SILT, trace clay, containing clay and silt seams Loose to compact Grey Wet		1	SS	11	202											0 48 49 3 Non-Plastic
			2	SS	6												0 45 51 4
						201											
200.1 7.4	END OF BOREHOLE SPOON REFUSAL		3	SS	6												
	NOTES: 1. Borehole advanced using portable drilling equipment with half weight hammer. SPT N values shown have been adjusted to infer values that would be obtained using a standard weight hammer. 2. Water level in open borehole at ice surface (Elev. 207.5 m) upon completion of drilling.																

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S21-11		SHEET 1 OF 1		METRIC												
G.W.P. 5402-05-00		LOCATION N 5043764.6 ; E 245566.1		ORIGINATED BY ID														
DIST HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY VO														
DATUM Geodetic		DATE March 19, 2008		CHECKED BY CN														
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 (%)					
207.5	ICE SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 10 20 30			GR SA SI CL		
0.0	Ice																	
207.0	PEAT (Amorphous)						207											
0.5	Very soft		1	SS	1													
206.6	Dark brown																	
0.9	Wet																	
	Silty SAND, trace organics, rootlets to a depth of 1.4 m		2	SS	5		206											
	Loose																	
205.4	Grey and brown																	
2.1	Wet																	
	Sandy SILT, trace clay		3	SS	6		205											
	Very loose to loose																	
	Grey		4	SS	3		204									0 29 (71)		
	Wet																	
			5	SS	6		203											
			6	SS	6		202											
201.9	SILT and SAND, trace clay																	
5.6	Loose to compact		7	SS	8		201											
	Grey																	
	Wet																	
			8	SS	10		200											
							199											
198.4	SILT, some sand, trace to some clay		9A	SS	11		198									0 15 79 6		
9.4	Compact		9B															
	Brown and grey																	
	Wet																	
	SILT and SAND, trace clay																	
	Compact																	
196.8	Grey		10	SS	22/0.15		197											
	Wet																	
10.8	SAND and GRAVEL, trace silt																	
	Compact																	
	Grey to brown																	
	Wet																	
	END OF BOREHOLE																	
	SPOON REFUSAL																	
	NOTES:																	
	1. Borehole caved to a depth of 5.7 m below ice surface (Elev. 201.8 m) upon removal of casing.																	
	2. Water level in open borehole at ice surface (Elev. 207.5 m) upon completion of drilling.																	

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S21-19		SHEET 1 OF 1		METRIC												
G.W.P. 5402-05-00		LOCATION N 5043749.8 ; E 245569.3		ORIGINATED BY ID														
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY VO														
DATUM Geodetic		DATE March 18, 2008		CHECKED BY CN														
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 (%)					
207.5	ICE SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 10 20 30			GR SA SI CL		
0.0	Ice																	
207.0	Water						207											
206.6	PEAT (Amorphous)		1	SS	1													
206.3	Organic SAND																	
1.2	Very loose Dark brown Wet						206											
205.5	CLAYEY SILT		2	SS	3								H ○					
2.0	Soft Grey Wet																	
	SILT, trace clay seams		3	SS	4		205											
	Very loose Grey Wet																	
			4	SS	1		204						H ○					
203.2	SAND and SILT, trace clay																	
4.3	Compact Grey Moist		5	SS	10		203											
							202											
			6	SS	12		201						○					
200.0	SILTY CLAY																	
7.5	Light brown Wet		7A	TO	PH		200						50 52.4					
199.6	SILT, some sand, trace to some clay		7B										○			0 13 76 11		
8.0	Very loose Grey Wet						199											
			8	SS	2		198						○					
197.4	END OF BOREHOLE CASING REFUSAL																	
10.1	NOTES:																	
	1. Borehole caved to a depth of 6.3 m below ice surface (Elev. 201.2 m) upon removal of casing.																	
	2. Water level in open borehole at ice surface (Elev. 207.5 m) upon completion of drilling.																	

PROJECT <u>07-1111-0029</u>				RECORD OF DCPT No C50-DC01				SHEET 1 OF 1				METRIC						
G.W.P. <u>5111-07-00</u>				LOCATION <u>N 5043715.9 ; E 245565.0</u>				ORIGINATED BY <u>ID</u>										
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>				COMPILED BY <u>ZR/MR</u>										
DATUM <u>Geodetic</u>				DATE <u>June 2, 2015</u>				CHECKED BY <u>AJS</u>										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
207.5 0.0	WATER SURFACE WATER							20	40	60	80	100						
206.9 0.6	Dynamic Cone Penetration Test (DCPT)						207											
							206											
							205											
							204											
203.6 3.9	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																	

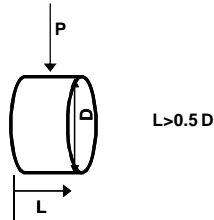
GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

TABLE E1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

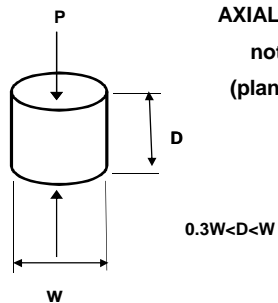
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C50-S1	1	2.9	204.6	Granite Gneiss	Diametral	5.06
C50-S1	2	3.7	203.9	Granite Gneiss	Axial	4.83

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: MCK
 Checked By: CN
 Reviewed By: JMAC

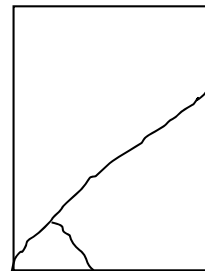
Table E2

UNCONFINED COMPRESSION TEST (UC)
ASTM D7012

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	C50-S1	SAMPLE DEPTH, m	3.92

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.25

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	9.56	WATER CONTENT, (specimen) %	0.10
SAMPLE DIAMETER, cm	4.24	UNIT WEIGHT, kN/m ³	26.38
SAMPLE AREA, cm ²	14.11	DRY UNIT WT., kN/m ³	26.36
SAMPLE VOLUME, cm ³	134.89	SPECIFIC GRAVITY	-
WET WEIGHT, g	363.05	VOID RATIO	-
DRY WEIGHT, g	362.69		

VISUAL INSPECTION**FAILURE SKETCH**

TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	45.7

REMARKS:

DATE:

2015-06-25

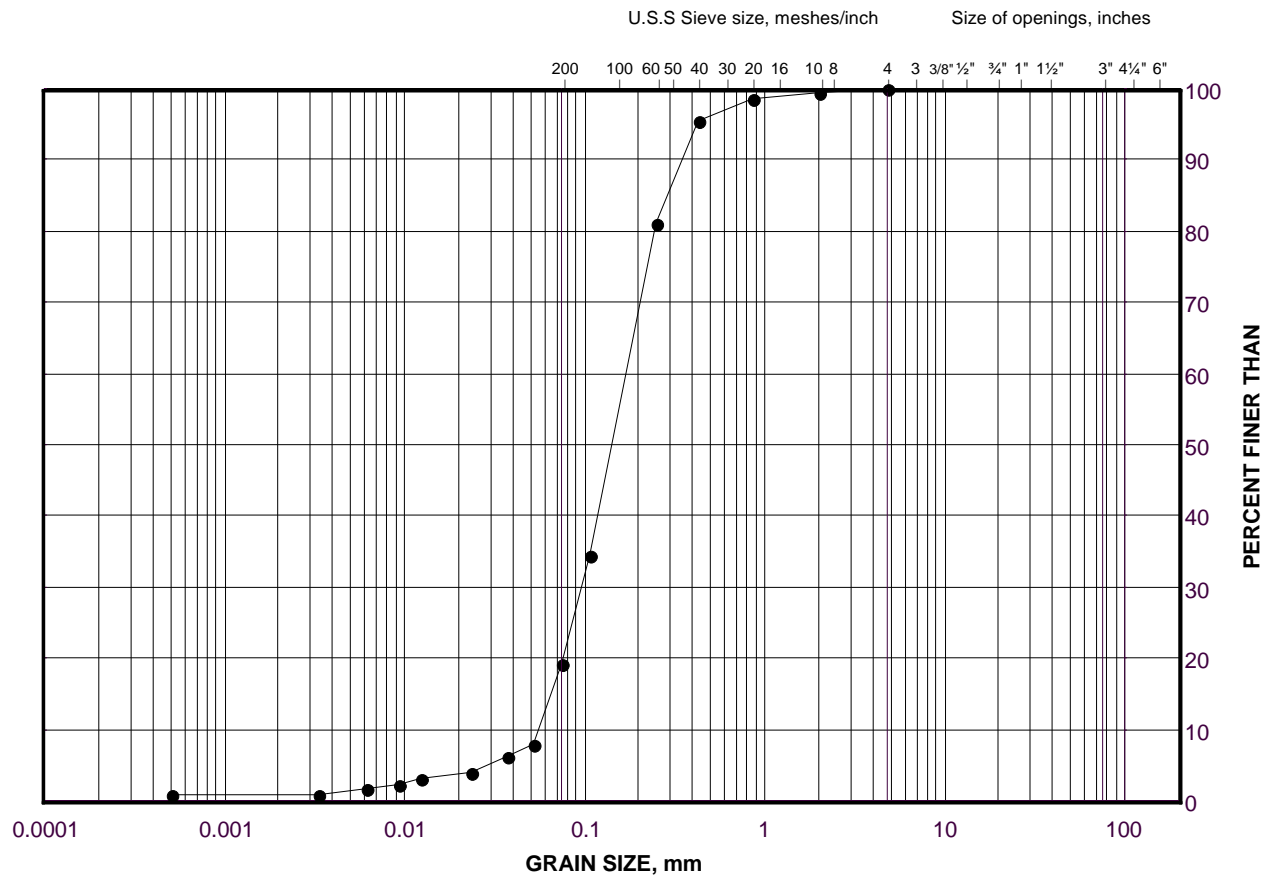
Checked By: MCK

Golder Associates

GRAIN SIZE DISTRIBUTION

Organic Sand
Highway 69 (SBL) STA 14+706

FIGURE E.C50-1



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

LEGEND

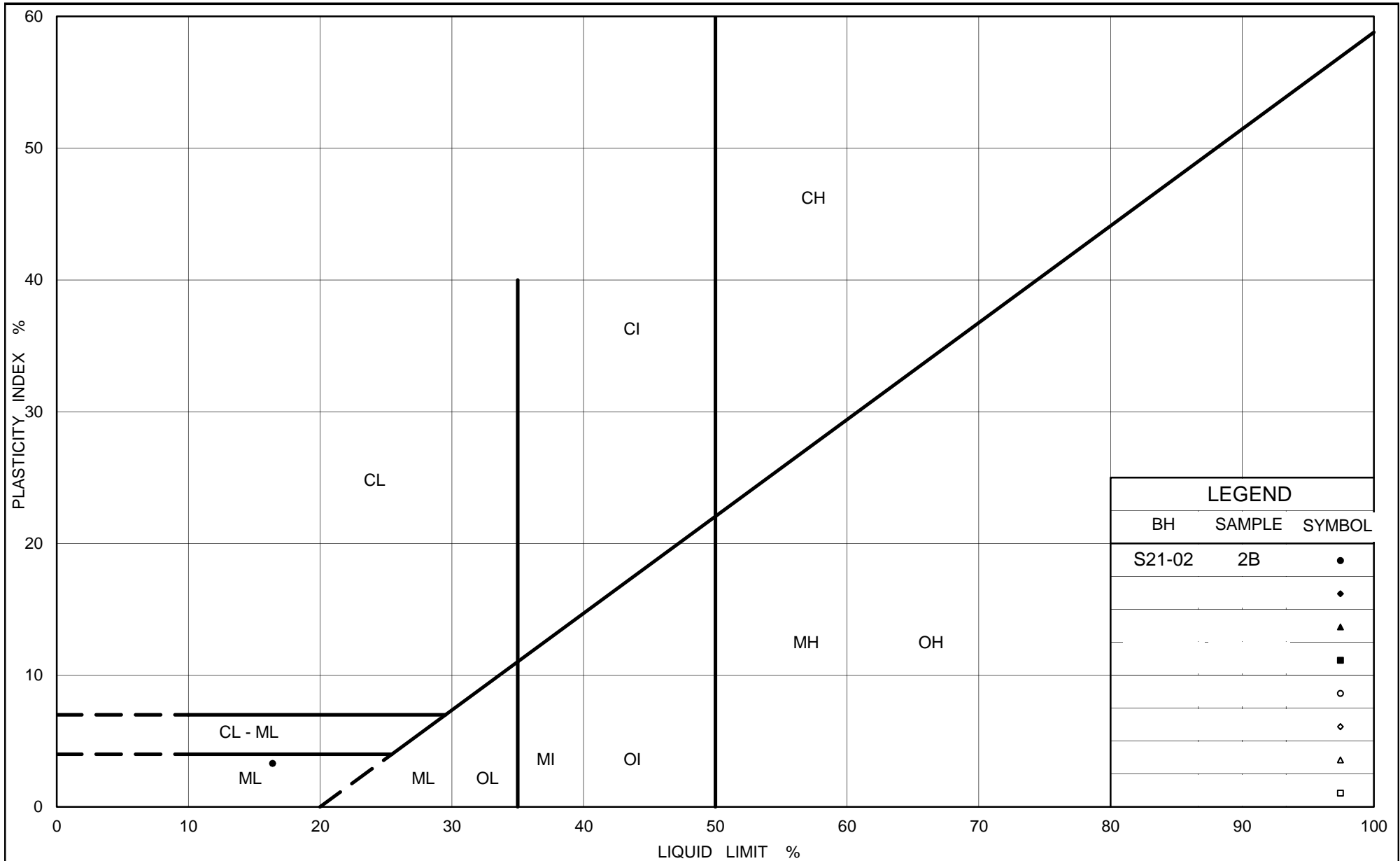
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C50-S1	2	205.7

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 16-Aug-15



Ministry of Transportation

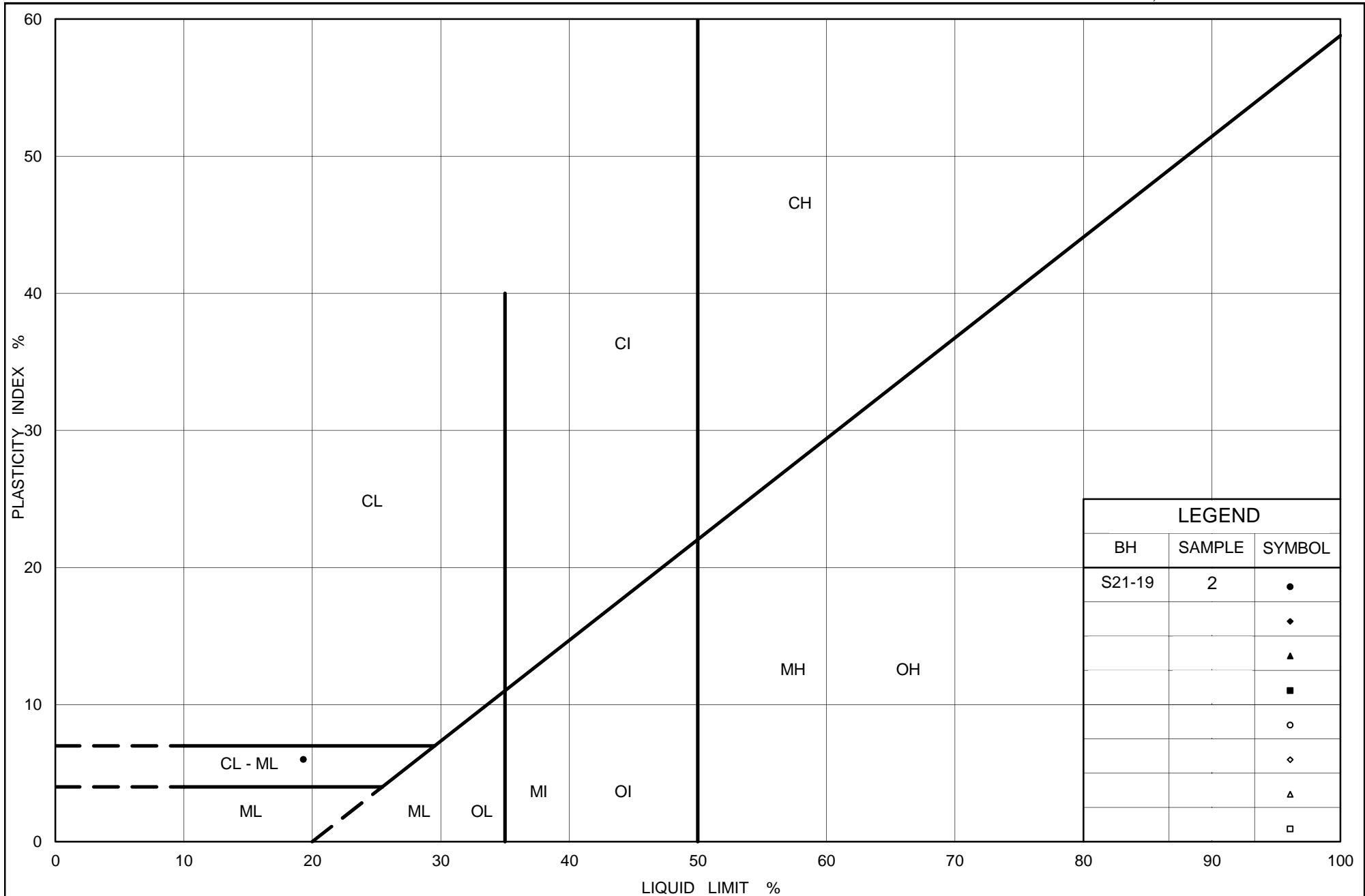
Ontario

PLASTICITY CHART
 Silt and Sand
 Highway 69 (SBL) STA 14+706

Figure No. E.C50-2

Project No. 07-1111-0029

Checked By: AJS



Ministry of Transportation

Ontario

PLASTICITY CHART
 Clayey Silt
 Highway 69 (NBL) STA 14+726

Figure No. E.C50-3

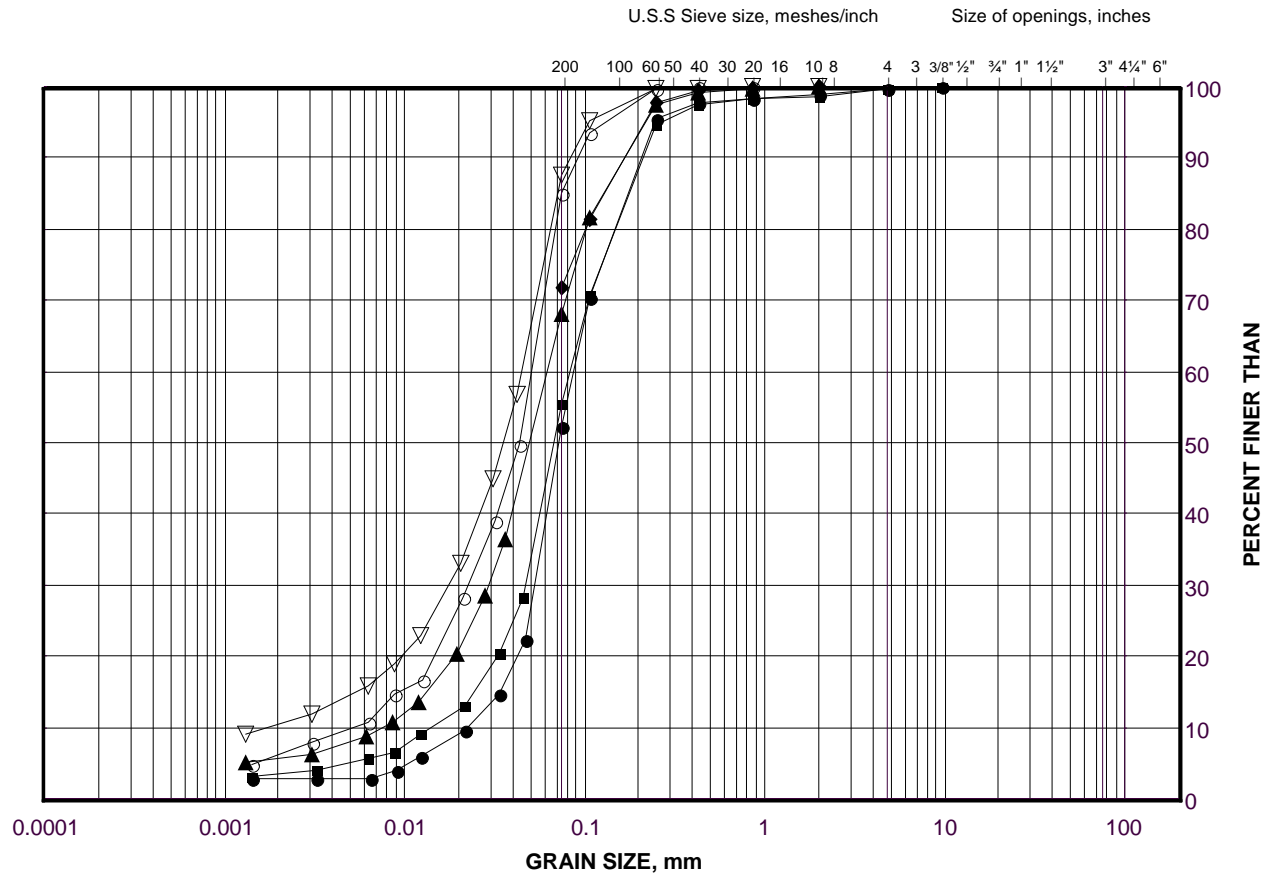
Project No. 07-1111-0029

Checked By: MCK

GRAIN SIZE DISTRIBUTION

Silt to Silt and Sand
Highway 69 (NBL) STA 14+726

FIGURE E.C50-4



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

LEGEND

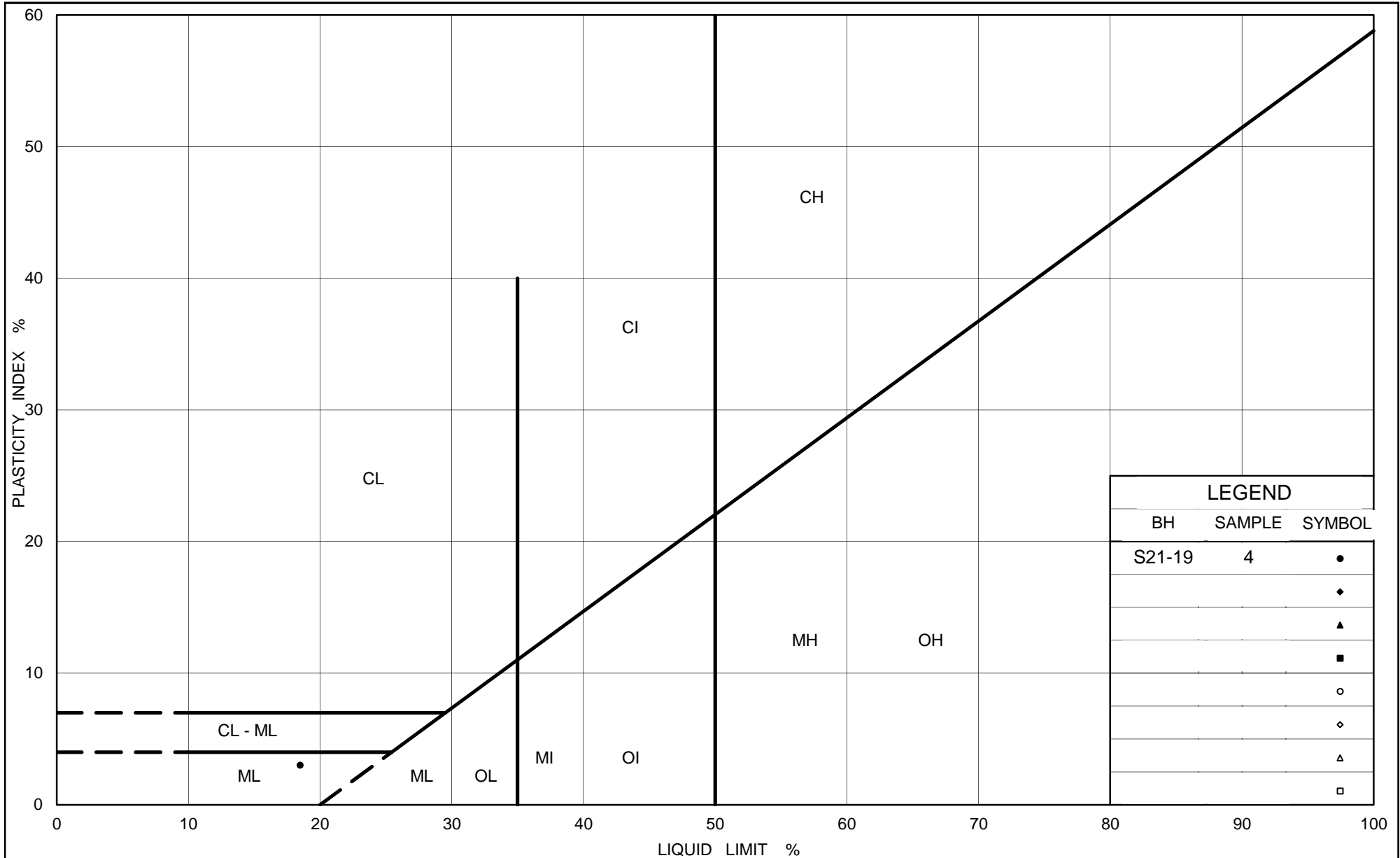
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S21-10A	1	201.7
■	S21-10A	2	201.4
◆	S21-11	4	204.1
▲	S21-10	5	204.3
▽	S21-19	7B	199.4
○	S21-11	9A	198.4

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 06-Jan-16



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt
Highway 69 (NBL) STA 14+726

Figure No. E.C50-5

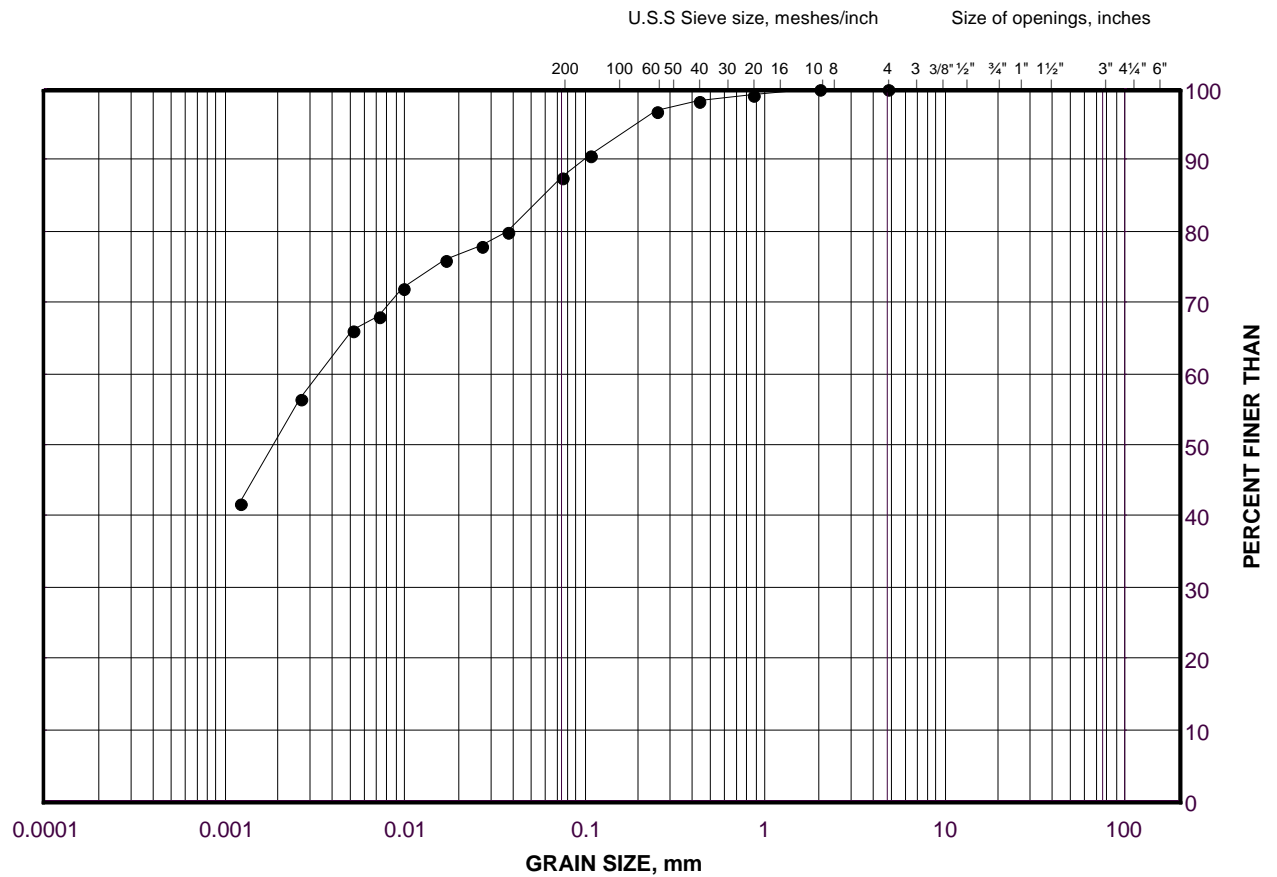
Project No. 07-1111-0029

Checked By: MCK

GRAIN SIZE DISTRIBUTION

Silty Clay (Pocket)
Highway 69 (NBL) STA 14+726

FIGURE E.C50-6



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

LEGEND

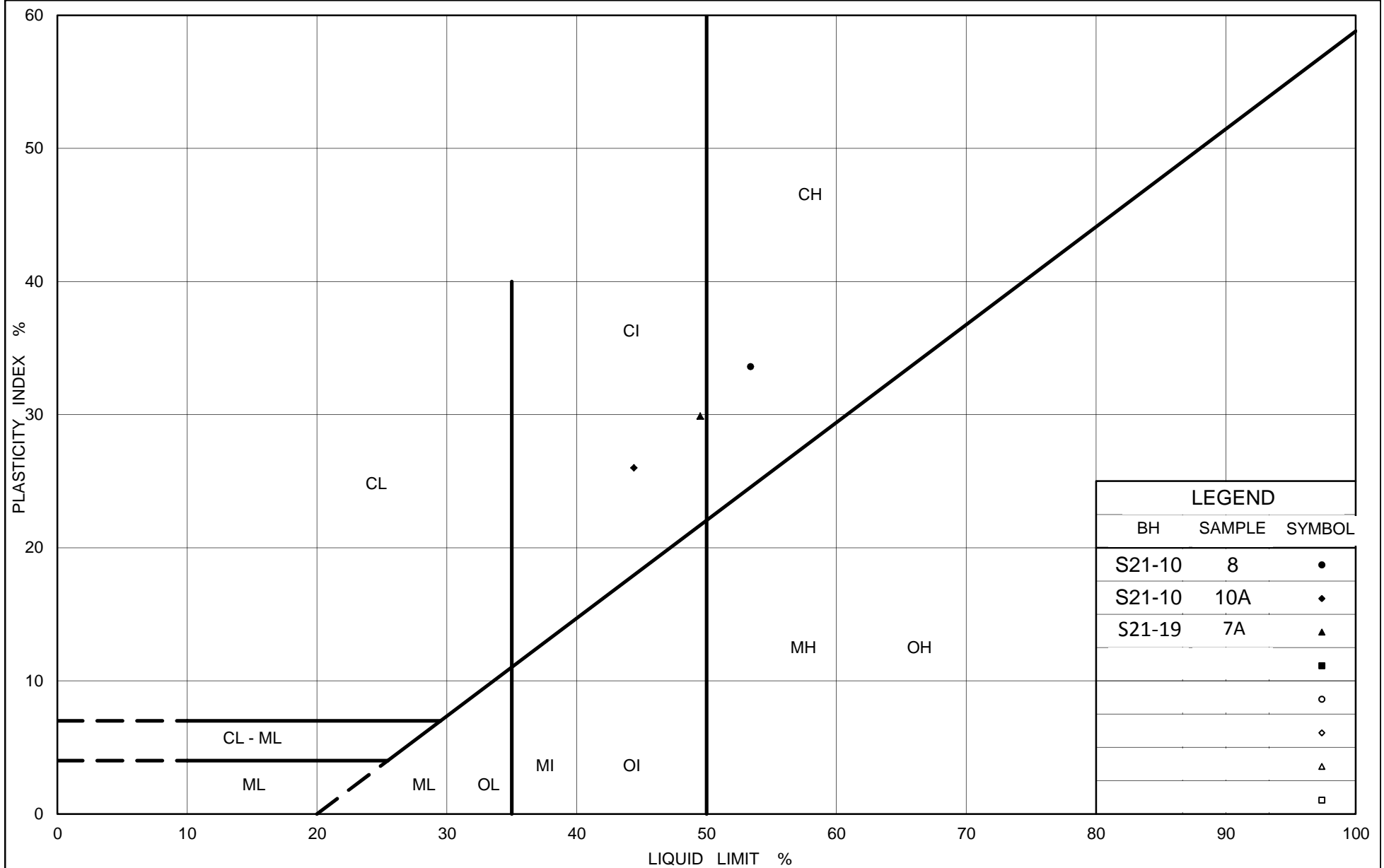
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	S21-10	10A	201.1

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 16-Aug-15



Ministry of Transportation

Ontario

PLASTICITY CHART
 Silty Clay to Clay (Pockets)
 Highway 69 (NBL) STA 14+726

Figure No. E.C50-7

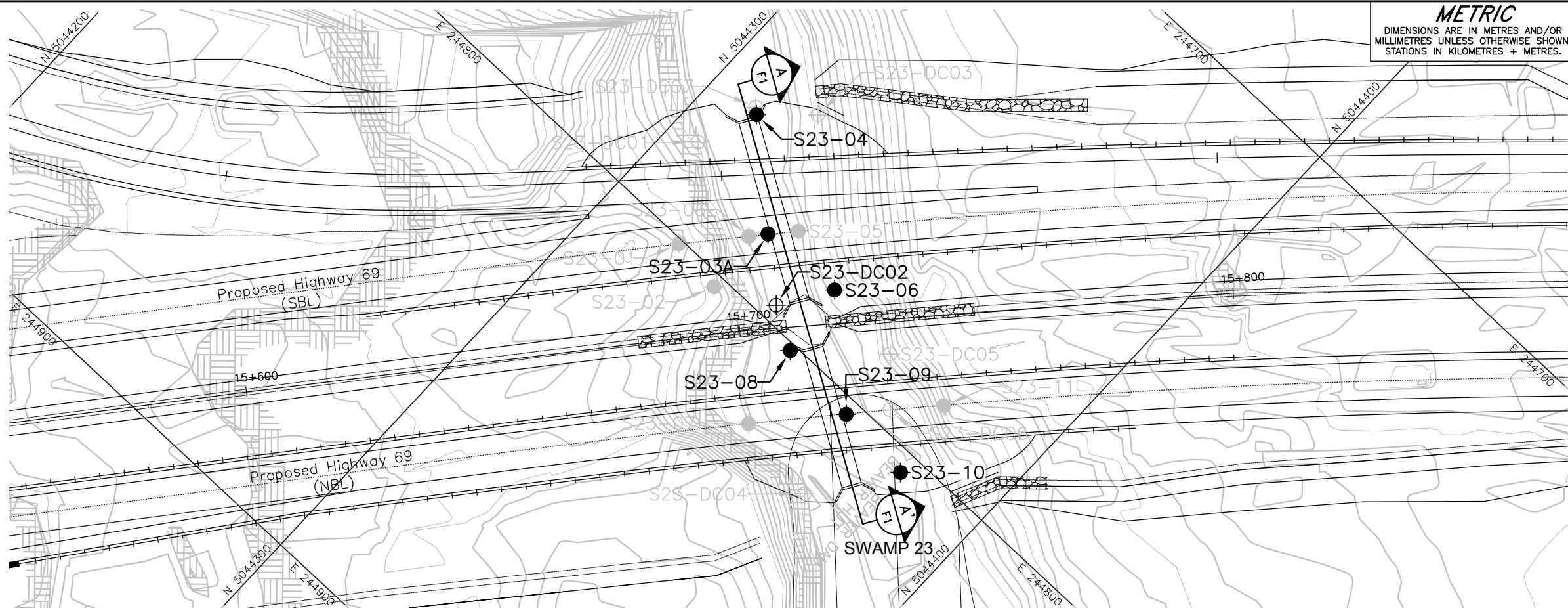
Project No. 07-1111-0029

Checked By: MCK



APPENDIX F

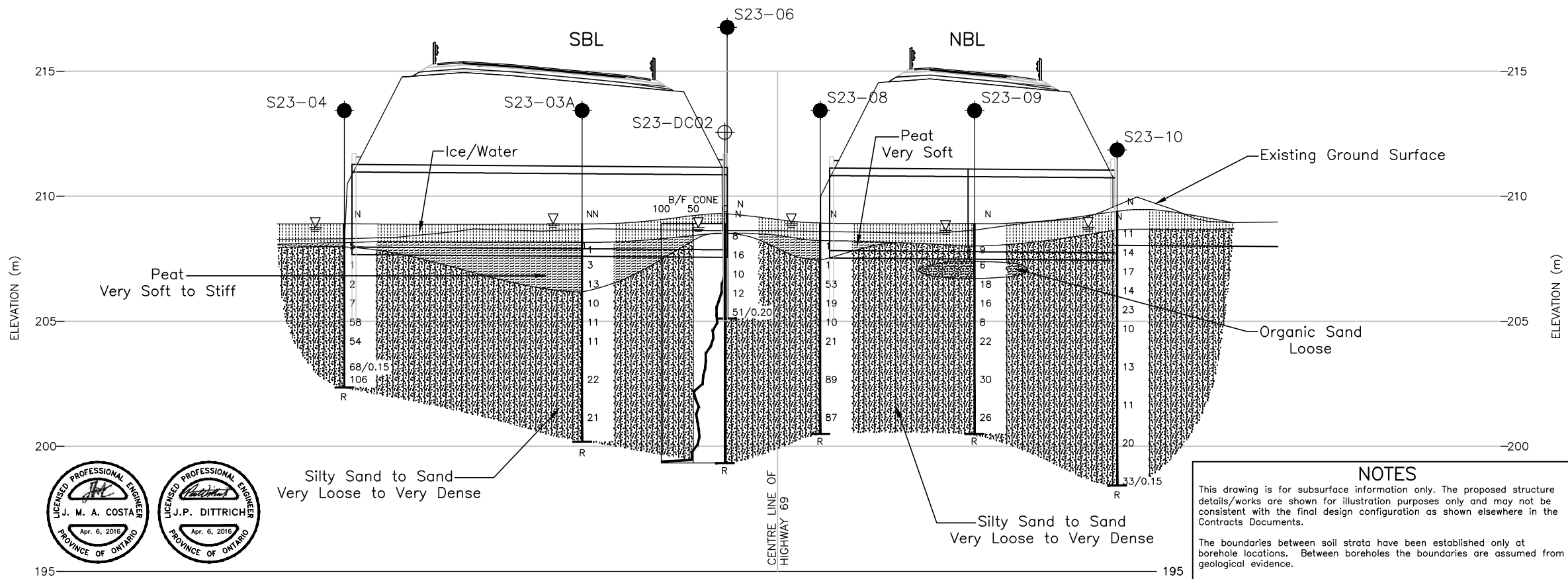
**Highway 69 SBL and NBL – STA 15+710 and STA 15+717
(Culvert C55 – Site No. 44-620/C2 and 44-620/C1)**



PLAN

SCALE

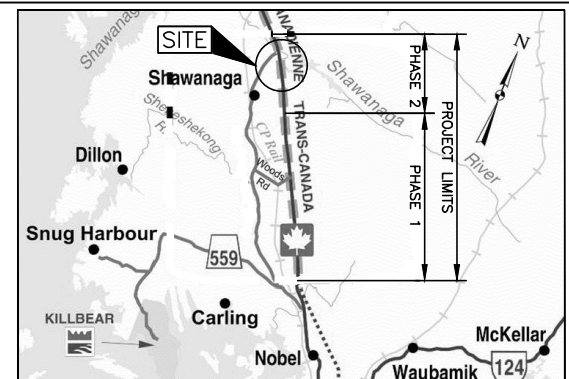
10 0 10 20 m

A-A
F1

CULVERT C55 PROFILE STA 15+710 AND STA 15+717

HORIZONTAL SCALE
5 0 5 10 m
2 0 2 4 m
VERTICAL SCALE**METRIC**DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.

WP No. 5077-13-09 (NBL) and
5077-13-10 (SBL)HIGHWAY 69 (SBL AND NBL)
CULVERT C55 STA 15+710 AND STA 15+717
BOREHOLE LOCATIONS AND SOIL
STRATASHEET
S8

KEY PLAN

SCALE
3.7 0 3.7 km

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation
- ⊕ Dynamic Cone Penetration Test
- ⊕ Dynamic Cone Penetration Test - Previous Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- ≡ WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
S23-03A	0.0	5044329.2	244787.2
S23-04	0.0	5044311.1	244771.2
S23-06	0.0	5044346.7	244786.3
S23-08	0.0	5044348.5	244801.3
S23-09	0.0	5044365.5	244803.0
S23-10	0.0	5044381.5	244804.1
S23-DC02	0.0	5044340.2	244796.6

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.

NOTES

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

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



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

NO.	DATE	BY	REVISION
Geocres No. 41H-160			
HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. TVA/AJS	CHKD. TVA/AJS	DATE: 3/18/2016	SITE: 44-620/C1&C2
DRAWN: JFC/MR	CHKD. TVA/JMAC	APPD. JPD/JMAC	DWG. F1



PROJECT		RECORD OF BOREHOLE				No S23-03A		SHEET 1 OF 1		METRIC							
G.W.P. 5111-07-00		LOCATION				N 5044329.2 ; E 244787.2				ORIGINATED BY ID							
DIST		HWY 69		BOREHOLE TYPE				Portable Equipment, BW Casing, Wash Boring				COMPILED BY PKS					
DATUM Geodetic		DATE		February 18, 2009				CHECKED BY VA/OK									
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									
208.9	ICE SURFACE																
0.0	Ice																
208.5																	
0.4	Water																
208.0																	
0.9	PEAT, trace roots and wood fragments (Amorphous) Very soft to stiff Dark brown Wet		1	SS	1												OC=55.5%
			2	SS	3												
206.2			3	SS	13												
2.7	SAND, trace to some silt, trace to some gravel Compact Brown Wet																
			4	SS	10												7 85 7 1
			5	SS	11												
			6	SS	11												
			7	SS	22												17 76 7 0
			8	SS	21												
200.2																	
8.7	END OF BOREHOLE CASING AND SPOON REFUSAL (HAMMER BOUNCING)																
NOTES: 1. Water level in open borehole at ice surface (Elev. 208.9 m) upon completion of drilling 2. Borehole caved to a depth of 3.1 m below ice surface (Elev. 205.8 m) upon removal of casing.																	

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S23-04		SHEET 1 OF 1		METRIC													
G.W.P. 5111-07-00		LOCATION N 5044311.1 ; E 244771.2		ORIGINATED BY ID															
DIST HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY PKS															
DATUM Geodetic		DATE February 17 and 18, 2009		CHECKED BY VA/OK															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)						
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L	γ	GR	SA	SI	CL	
208.9	ICE SURFACE																		
0.0	Ice																		
208.4																			
208.1	Water																		
0.9	PEAT, trace roots and wood fragments (Amorphous) Dark brown Wet		1A	SS	5		208							357.3					OC = 2.2%
	SAND, trace to some silt, trace clay, trace organics Very loose to loose Brown Wet		1B																OC = 3.8%
			2	SS	1		207												
			3	SS	2		206												0 89 10 1
			4	SS	7														
205.2							205												
3.7	SAND, some gravel, trace to some silt, trace clay Very dense Brown to grey Wet		5	SS	58														
			6	SS	54		204												
			7	SS	68/0.15		203												15 76 8 1
	Grey below a depth of 6.1 m		8	SS	106														
202.4																			
6.6	END OF BOREHOLE SPOON AND CASING REFUSAL																		
NOTES: 1. Borehole advanced using portable drilling equipment with half-weight hammer to a depth of 5.9 . SPT 'N' values shown have been adjusted to reflect values that would be obtained using a standard weight hammer. 2. Water level in open borehole at a depth of 0.2 m below ice surface (Elev. 208.7 m) upon completion of drilling.																			

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S23-06				SHEET 1 OF 1		METRIC									
G.W.P. 5111-07-00		LOCATION N 5044346.7 ; E 244786.3				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring				COMPILED BY PKS											
DATUM Geodetic		DATE February 19, 2009				CHECKED BY VA/OK											
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									
209.3 0.0	ICE SURFACE Ice						209									1 89 9 1	
208.5 0.8	SAND, trace to some silt, trace gravel, trace clay, trace organics to a depth of 1.5 m, clay seams between depths of 1.5 m and 2.3 m Loose to compact Brown Wet		1	SS	8		208										
			2	SS	16												
			3	SS	10		207										
			4	SS	12		206										
			5	SS	51/0.20												
205.1 4.2	END OF BOREHOLE SPOON AND CASING REFUSAL NOTES: 1. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 208.7 m) upon completion of drilling. 2. Borehole caved to a depth of 1.6 m below snow surface (Elev. 207.7 m) upon removal of casing.																

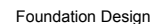
PROJECT 07-1111-0029		RECORD OF BOREHOLE No S23-08		SHEET 1 OF 1		METRIC													
G.W.P. 5111-07-00		LOCATION N 5044348.5 ; E 244801.3		ORIGINATED BY MJR															
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY VA															
DATUM Geodetic		DATE February 17, 2009		CHECKED BY VA/OK															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)						
208.9	ICE SURFACE							20 40 60 80 100						W _p	W	W _L			
0.0	Ice							20 40 60 80 100											
208.6	Water																		
208.2	PEAT, trace wood fragments (Fibrous) Very soft Brown Wet		1	SS	1		208												
0.7																			
207.5	SAND, trace gravel, trace silt Very loose to very dense Grey Wet		2	SS	1		207												
1.5																			
			3	SS	53		206												
			4	SS	19		205												
			5	SS	10		204												
			6	SS	21		203												
			7	SS	89		202												
			8	SS	87		201												
200.5	END OF BOREHOLE CASING REFUSAL																		
8.4	NOTES: 1. Water level in open borehole at ice surface (Elev. 208.9 m) upon completion of drilling. 2. Borehole caved to a depth of 1.5 m below ice surface (Elev. 207.4 m) upon removal of casing.																		

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S23-09		SHEET 1 OF 1		METRIC																		
G.W.P. 5111-07-00		LOCATION N 5044365.5 ; E 244803.0		ORIGINATED BY MJR																				
DIST HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY VA																				
DATUM Geodetic		DATE February 19, 2009		CHECKED BY VA/OK																				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																			
208.9	ICE SURFACE																							
0.0	Ice																							
208.3																								
208.0	Water																							
0.9	SAND, trace gravel, trace silt, trace organics		1	SS	9																			
207.4	Loose Brown and grey Wet		2	SS	6																			
1.5	Organic SAND, trace to some silt, trace clay																							
206.7	Loose Dark brown/grey Wet		3	SS	18																			
2.2	SAND, trace to some silt, trace gravel, trace clay		4	SS	16																			
	Loose to compact Brown Wet		5	SS	8																			
			6	SS	22																			
			7	SS	30																			
			8	SS	26																			
200.5	END OF BOREHOLE CASING REFUSAL																							
8.4	NOTES: 1. Water level in open borehole at a depth of 0.3 m below ice surface (Elev. 208.6 m) upon completion of drilling. 2. Borehole caved to a depth of 1.4 m below ice surface (Elev. 207.5 m) upon removal of casing.																							

PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No S23-10		SHEET 1 OF 1		METRIC	
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5044381.5 ; E 244804.1</u>		ORIGINATED BY <u>ID</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, BW Casing, Wash Boring</u>		COMPILED BY <u>PKS</u>			
DATUM <u>Geodetic</u>		DATE <u>February 19 and 20, 2009</u>		CHECKED BY <u>VA/OK</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			WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED							
209.4	ICE SURFACE																	
0.0	Ice																	
208.6																		
0.8	SAND, trace silt, trace organics Compact Brown Wet		1	SS	11													
207.9																		
1.5	Silty SAND, trace gravel, containing clay seams Compact Brown Wet		2	SS	14													
			3	SS	17													
			4	SS	14													
			5	SS	23													
			6	SS	10													
			7	SS	13													
			8	SS	11													
			9	SS	20													
199.2																		
10.2	SAND, some gravel, trace silt Dense Brown Wet		10	SS	33/0.15													
198.4																		
11.0	END OF BOREHOLE SPOON AND CASING REFUSAL NOTES: 1. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 208.8 m) upon completion of drilling. 2. Borehole caved to a depth of 2.1 m below ice surface (Elev. 207.3 m) upon removal of casing.																	

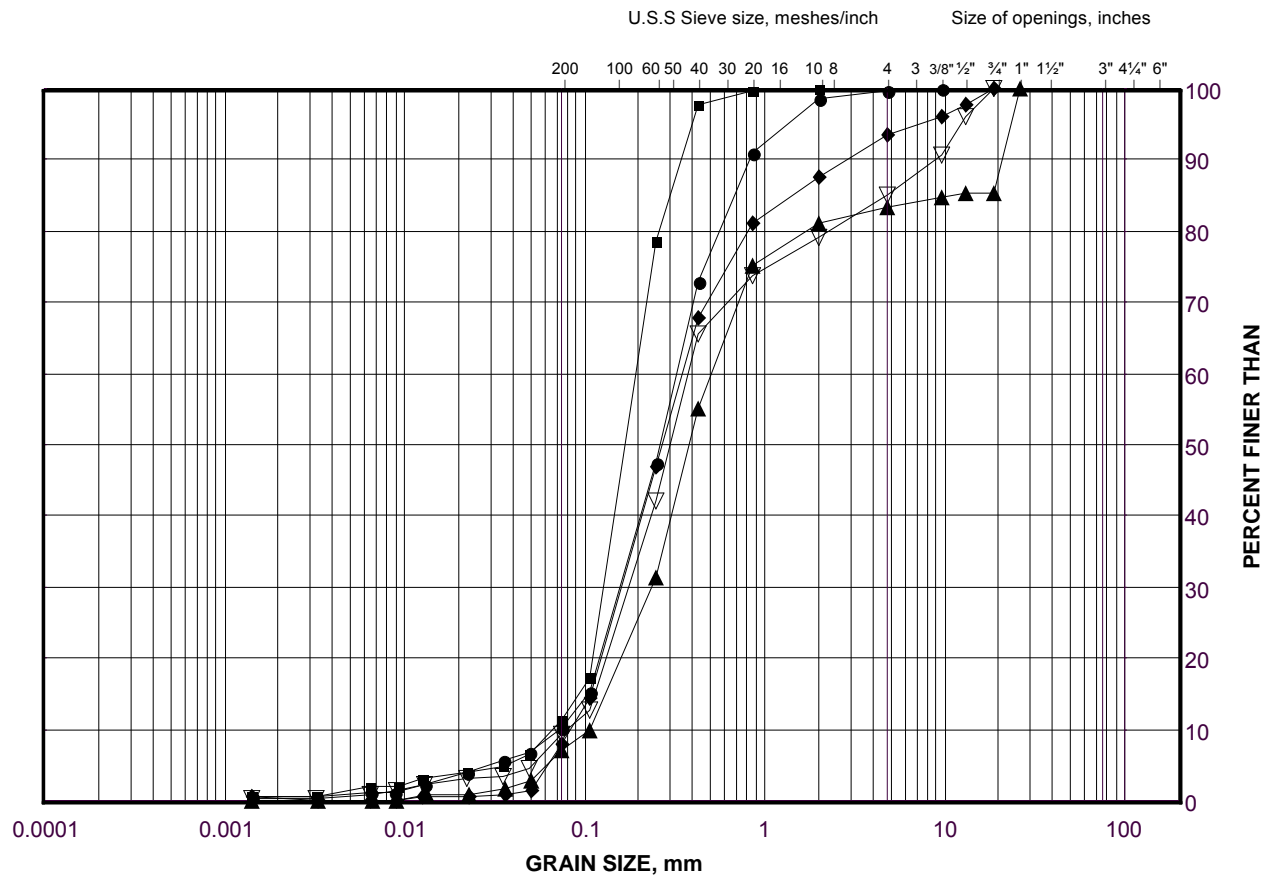


+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Sand
Highway 69 (SBL) STA 15+710

FIGURE F.C55-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S23-06	2	207.5
■	S23-04	3	206.3
◆	S23-03A	4	205.6
▲	S23-03A	7	202.5
▽	S23-04	7	203.1

Project Number: 07-1111-0029

Checked By: TVA

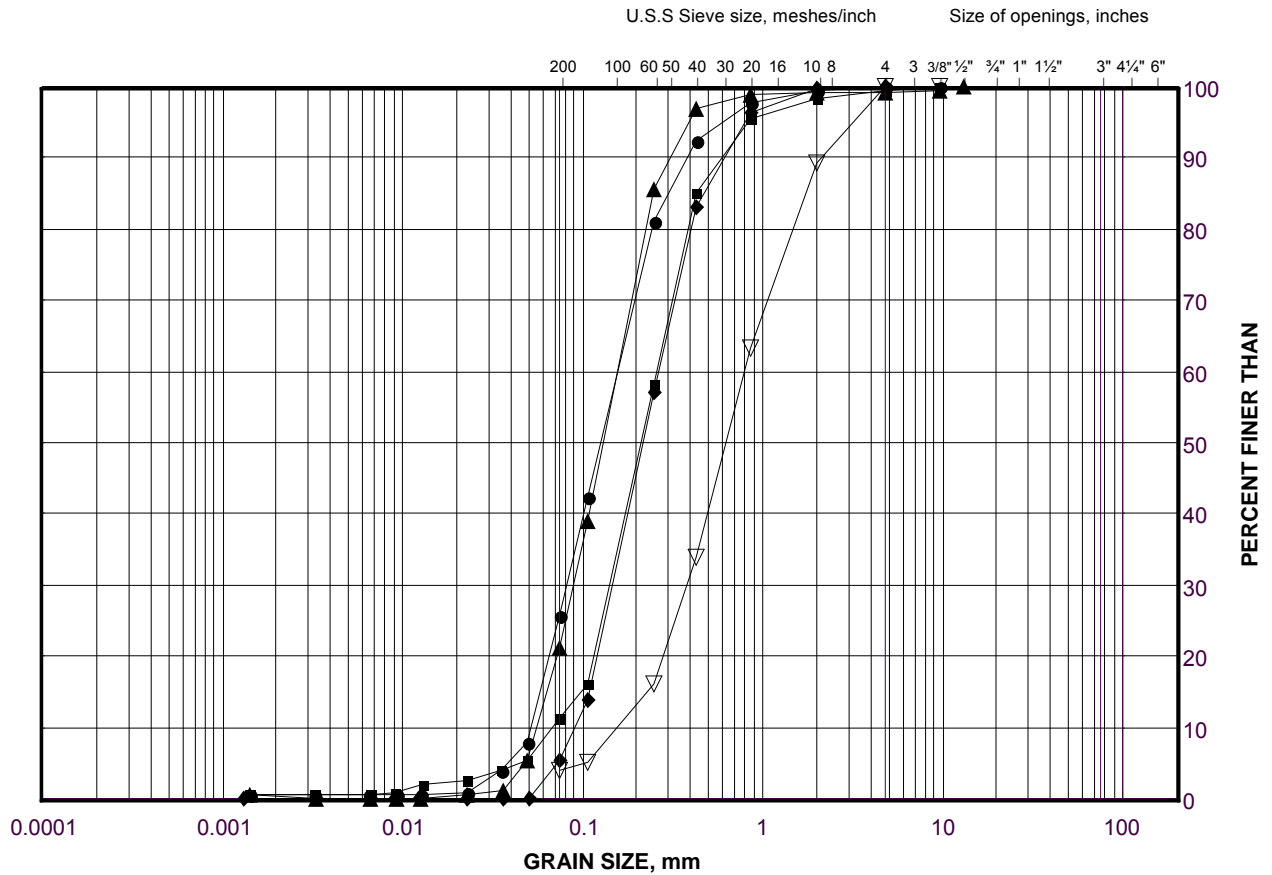
Golder Associates

Date: 19-Aug-14

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand
Highway 69 (NBL) STA 15+717

FIGURE F.C55-2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S23-10	4	206.1
■	S23-09	4	205.5
◆	S23-08	5	204.8
▲	S23-10	6	204.5
▽	S23-08	8	201.0

Project Number: 07-1111-0029

Checked By: TVA

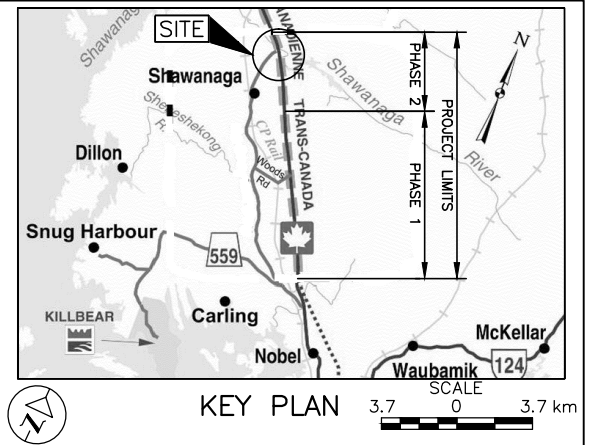
Golder Associates






Date: 19-Aug-14

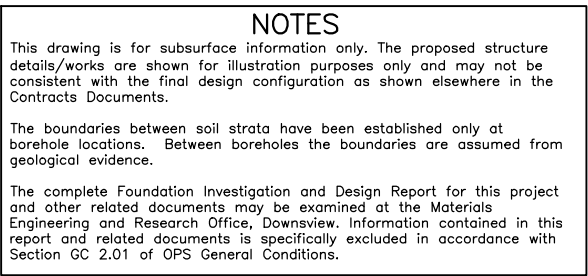


APPENDIX G

Highway 69 SBL and NBL – STA 16+345
(Culvert C57.1 – Site No. 44-621/C2 and 44-621/C1)



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



REFERENCE

Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.

Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.

Cross-section provided in digital format by MMM, drawing file no. S6878-340-117-001GA.dwg, received November 30, 2015.

The diagram shows two scales. The horizontal scale is labeled "HORIZONTAL SCALE" and has markings at 5, 0, 5, and 10 m. The vertical scale is labeled "VERTICAL SCALE" and has markings at 2, 0, 2, and 4 m.

-	-	-	-
NO.	DATE	BY	REVISION

Geocres No. 41H-160

Hwy. 69	PROJECT NO. 07-1111-0029	DIST. .
SUBM'D. AJS	CHKD. CN DATE: 3/17/2016	SITE: 44-621/C1&C2
DRAWN: MR	CHKD. JMAC APPD. JMAC	DWG. G1

PROJECT		RECORD OF BOREHOLE No C57.1-S1				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5044803.2; E 244378.8				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Continuous Flight 203 mm O.D. Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY KD											
DATUM Geodetic		DATE February 11, 2015				CHECKED BY MCK											
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									
207.3	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	6/0.15	▽	207							○			
0.3	SAND, trace to some silt, trace gravel Loose Brown to grey Wet Auger grinding at a depth of 1.4 m (Elev. 205.9 m)		1B	SS													
			2	SS	4		206										
			3	SS	4		205							○			0 81 19 0
204.9	Granite Gneiss (BEDROCK)		4	SS	6/0.15		205							○			
2.4	Bedrock cored from depths of 2.4 m to 5.7 m. For bedrock coring details refer to Record of Drillhole C57.1-S1.		1	RC	REC 100%		204										RQD = 96%
			2	RC	REC 100%		203										RQD = 100%
			3	RC	REC 100%		202										RQD = 100%
201.6	END OF BOREHOLE																
5.7	NOTE: 1. Water level in open borehole measured at a depth of 0.2 m below ground surface (Elev. 207.1 m) upon completion of drilling.																

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C57.1-S1

SHEET 1 OF 1

LOCATION: N 5044803.2 ;E 244378.8

DRILLING DATE: February 11, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: C.M.E 55

DRILLING CONTRACTOR: Landcore Drilling 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 m	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q' AVG.								
										B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr			Ja	Jn						
		Continued from Record of Borehole C57.1-S1		204.89 2.44																			
3	NW Casing	Slightly weathered, grey, white and black, strong to very strong GRANITE GNEISS			1																8.8 MPa (Axial)		
4	NORC February 11, 2015				2																		UC = 59.9 MPa 5.0 MPa (Axial)
5					3																		5.8 MPa (Axial)
6		END OF DRILLHOLE		201.60 5.73																			
7																							
8																							
9																							
10																							
11																							
12																							

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II\GFPJ GAL-MISS.GDT 03/25/16 DV

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C57.1-S2				SHEET 1 OF 1		METRIC									
G.W.P. 5111-07-00		LOCATION N 5044822.1 ; E 244380.1				ORIGINATED BY ID											
DIST HWY 69		BOREHOLE TYPE Continuous Flight 203 mm O.D. Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY KD											
DATUM Geodetic		DATE February 17, 2015				CHECKED BY MCK											
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									
208.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	6												
	SILTY SAND, trace to some gravel Loose to very dense Brown to grey Moist		1B														
			2	SS	52												
	Auger grinding at a depth of 1.4 m (Elev. 207.3 m)		3	SS	20												
206.4																	
2.3	SILT and SAND Loose to compact Brown to grey Wet		4	SS	12												
			5	SS	9												
204.9																	
3.8	SAND, some silt Compact Grey Wet		6	SS	13												
204.1																	
4.6	SAND and GRAVEL Compact Grey Wet		7	SS	27												
203.5																	
5.2	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 5.2 m to 6.8 m.		1	RC	REC 100%												
	For bedrock coring details refer to Record of Drillhole C57.1-S2.																
201.9																	
6.8	END OF BOREHOLE																
	NOTE: 1. Water level in open borehole measured at a depth of 1.5 m below ground surface (Elev. 207.2 m) upon completion of drilling.																

PROJECT		RECORD OF BOREHOLE				No C57.1-S3		SHEET 1 OF 1		METRIC							
G.W.P. 07-1111-0029		LOCATION		N 5044826.1 ; E 244395.2		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		Continuous Flight 203 mm O.D. Hollow Stem Augers		COMPILED BY		KD							
DATUM		Geodetic		DATE		February 18, 2015		CHECKED BY		MCK							
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									
209.0	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	8												
0.3	SILT and SAND, trace gravel Loose Light brown Moist		1B														
208.2			2	SS	44												
0.8	Gravelly SILTY SAND, trace to some clay, some cobbles Dense Light brown Moist																
207.5			3	SS	13												
1.5	SAND, some silt, some gravel Loose to compact Brown to grey Wet																
			4	SS	8												
			5	SS	5												
			6	SS	12												
			7A														
204.1			7B	SS	17												
4.9	Gravelly SILT and SAND, oxidation staining Compact Grey Wet																
203.1																	
5.9	SPoon SAMPLER AND AUGER REFUSAL END OF BOREHOLE																
	NOTE: 1. Water level in open borehole measured at a depth of 1.4 m below ground surface (Elev. 207.6 m) upon completion of drilling.																

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C57.1-S4				SHEET 1 OF 1		METRIC										
G.W.P. 5111-07-00		LOCATION N 5044820.2 ; E 244370.7				ORIGINATED BY I.D												
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR												
DATUM Geodetic		DATE June 15, 2015				CHECKED BY MCK												
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 (%)
207.9	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL		1A	SS	3													
207.6			1B															
0.3	Silty SAND, trace organics Loose to compact Brown to grey Moist to wet		2	SS	24									○				
			3	SS	19									○				
			4	SS	22									○				
			5	SS	14													
204.2			6	SS	15/0.08													
203.9	SAND and GRAVEL Compact Grey Wet																	
4.0	END OF BOREHOLE SPOON AND CASING REFUSAL																	
NOTE: 1. Water level measured in open borehole at a depth of 0.7 m below ground surface (Elev. 207.2 m) upon completion of drilling. * Split-spoon bouncing																		

PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No C57.1-S5		SHEET 1 OF 1		METRIC	
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5044829.9 ; E 244384.5</u>		ORIGINATED BY <u>I.D</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>ZR/MR</u>			
DATUM <u>Geodetic</u>		DATE <u>June 15, 2015</u>		CHECKED BY <u>MCK</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 (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE	20	40	60	80	100	w _p	w		w _L				
208.7	GROUND SURFACE																				
0.0	TOPSOIL		1A	SS	4								○								
0.3	SILT, some sand, trace to some clay, trace organics Brown to grey		1B																		
			2	SS	23																
207.2																					
1.5	SAND and GRAVEL, some silt, some cobbles Compact Grey Wet		3	SS	28								○								
206.5																					
2.2	SAND, some silt, some gravel Compact Grey Wet		4	SS	19								○								
			5	SS	10																
205.0																					
3.7	Silty SAND and GRAVEL Compact to dense Grey Wet		6	SS	16								○					38	40	21	1
			7	SS	41																
203.1																					
5.6	END OF BOREHOLE SPOON AND CASING REFUSAL		8	SS	35/0.0*																
	NOTE: 1. Water level measured in open borehole at a depth of 0.9 m below ground surface (Elev. 207.8 m) upon completion of drilling. * Split-spoon bouncing																				

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PROJECT		RECORD OF BOREHOLE				No C57.1-N1		SHEET 1 OF 1		METRIC							
G.W.P. 07-1111-0029		LOCATION		N 5044841.0 ; E 244393.6				ORIGINATED BY ID									
DIST		HWY 69		BOREHOLE TYPE		Continuous Flight 203 mm O.D. Hollow Stem Augers, Wash Boring				COMPILED BY KD							
DATUM Geodetic		DATE		February 18, 2015				CHECKED BY MCK									
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									
208.2	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	5												
0.2	SILTY SAND, trace gravel, trace organics, trace rootlets		1B	SS													
207.4	Loose Brown Moist		2	SS	54												
0.8	Auger grinding at a depth of 0.6 m (Elev. 207.6 m)																
206.7	SAND and GRAVEL, trace to some silt, trace clay		3	SS	11												
1.5	Very dense Brown Moist																
205.9	Auger grinding at a depth of 1.4 m (Elev. 206.8 m)		4	SS	27												
2.3	SILTY SAND, trace gravel																
205.5	Compact Brown to grey Wet		1	RC	REC 100%												
2.7	Gravelly SILT and SAND, trace clay																
	Compact Brown to grey Wet																
	Some cobbles below a depth of 2.4 m (Elev. 205.8 m)																
	Granite Gneiss (BEDROCK)		2	RC	REC 100%												
	Bedrock cored from depths of 2.7 m to 6.2 m.																
	For bedrock coring details refer to Record of Drillhole C57.1-N1.		3	RC	REC 100%												
202.0	END OF BOREHOLE																
6.2	NOTE: 1. Water level in open borehole measured at a depth of 0.9 m below ground surface (Elev. 207.3 m) upon completion of drilling.																

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C57.1-N1

SHEET 1 OF 1

LOCATION: N 5044841.0 ; E 244393.6

DRILLING DATE: February 18, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: C.M.E 55

DRILLING CONTRACTOR: Landcore Drilling Inc.

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 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja	Jn				10 ⁻⁶	10 ⁻⁵	10 ⁻⁴																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
3	NW Casing	Continued from Record of Borehole C57.1-N1		205.48																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GPJ GAL-MISS.GDT 03/25/16 DV

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C57.1-N2				SHEET 1 OF 1		METRIC										
G.W.P. 5111-07-00		LOCATION N 5044845.8 ; E 244409.3				ORIGINATED BY ID												
DIST _____ HWY 69		BOREHOLE TYPE Continuous Flight 203 mm O.D. Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY KD												
DATUM Geodetic		DATE February 19, 2015				CHECKED BY MCK												
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										WATER CONTENT (%)
207.8	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL		1A	SS	8	▽												
0.1	SILT, some sand, trace organics Firm Brown Moist		1B															
207.0	SAND, trace to some silt, trace to some gravel, trace clay Compact Brown to grey Wet		2	SS	21													8 84 6 2
206.3	Silty SAND, some gravel Compact Brown to grey Wet		3	SS	12													
205.5	SAND and GRAVEL, some silt, trace cobbles Compact Grey Wet		4	SS	16													
205.0	Granite Gneiss (BEDROCK)		1	RC	REC 100%													RQD = 83%
2.8	Bedrock cored from depths of 2.8 m to 6.2 m. For bedrock coring details refer to Record of Drillhole C57.1-N2.		2	RC	REC 100%													RQD = 100%
			3	RC	REC 100%													RQD = 100%
201.6	END OF BOREHOLE																	
6.2	NOTE: 1. Water level in open borehole measured at a depth of 0.5 m below ground surface (Elev. 207.3 m) upon completion of drilling.																	

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

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LOGGED: ID
CHECKED: MCK

PROJECT		RECORD OF BOREHOLE No C57.1-N3				SHEET 1 OF 1		METRIC									
G.W.P. 07-1111-0029		LOCATION N 5044866.7 ; E 244411.9				ORIGINATED BY ID											
DIST _____ HWY 69		BOREHOLE TYPE Continuous Flight 203 mm O.D. Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY KD											
DATUM Geodetic		DATE February 23, 2015				CHECKED BY MCK											
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									
209.0	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	6												
208.2	Sandy SILT, trace organics Loose Brown Moist		1B														
0.8	SAND and GRAVEL, trace to some silt, trace clay, trace organics to a depth of 1.5 m Very dense Grey Moist		2	SS	50/0.07												
			3	SS	55												
			4	SS	54												
206.1	Granite Gneiss (BEDROCK)																
2.9	Bedrock cored from depths of 2.9 m to 7.3 m. For bedrock coring details refer to Record of Drillhole C57.1-N3.		1	RC	REC 100%												
			2	RC	REC 100%												
			3	RC	REC 100%												
201.7	END OF BOREHOLE																
7.3	NOTE: 1. Water level in open borehole measured at a depth of 1.0 m below ground surface (Elev. 208.0 m) upon completion of drilling.																

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C57.1-N3

SHEET 1 OF 1

LOCATION: N 5044866.7 ;E 244411.9

DRILLING DATE: February 23, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: C.M.E 55

DRILLING CONTRACTOR: Landcore Drilling 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
3	NWC Casing	Continued from Record of Borehole C57.1-N3		206.06 2.90	1								5.1 MPa (Axial)
4		Slightly weathered, foliated, pink, white and grey, coarse grained, strong to very strong GRANITE GNEISS and MIGMATITE											UC = 78.2 MPa
5	NORC February 23, 2015				2								5.2 MPa 5.1 MPa (Axial)
6					3								5.6 MPa (Axial)
7		END OF DRILLHOLE		201.62 7.34									
8													
9													
10													
11													
12													

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

GTA-RCK 018 T:\PROJECTS\2007-11-11-0029 (MRC, PARRY SOUND)\LOG\07-11-11-0029-CULVERT-PHASE II\GFPJ GAL-MISS-GDT 03/25/16 DV

PROJECT 07-1111-0029			RECORD OF BOREHOLE No C57.1-N4				SHEET 1 OF 1		METRIC								
G.W.P. 5111-07-00			LOCATION N 5044836.5 ; E 244405.9				ORIGINATED BY ID										
DIST HWY 69			BOREHOLE TYPE Portable Equipment				COMPILED BY ZR/MR										
DATUM Geodetic			DATE June 16, 2015				CHECKED BY MCK										
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									
208.6	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1A	SS	10												
0.1	Sandy CLAYEY SILT, trace organics		1B														
0.7	Light brown Moist		2	SS	20												
207.9	Sandy SILT, some gravel, pockets of clay																
207.1	Compact Grey Wet		3	SS	12												
1.5	SAND, some silt, trace gravel																
	Compact Grey Wet		4	SS	12												
205.2			5A														
3.4	SAND and GRAVEL, trace silt		5B	SS	20												
	Compact to dense Grey Wet																
			6	SS	41												
203.9																	
4.7	END OF BOREHOLE SPOON AND CASING REFUSAL		7	SS	30/0.0*												
NOTE: 1. Water level measured in open borehole at a depth of 1.0 m below ground surface (Elev. 207.6 m) upon completion of drilling. * Split-spoon bouncing																	

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

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: C57.1-N5

SHEET 1 OF 1

LOCATION: N 5044847.0 ; E 244420.8

DRILLING DATE: June 16 and 17, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Motorized Tri-Pod

DRILLING CONTRACTOR: Landcore Drilling 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			R.Q.D. %	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 %	B Angle °			DIP w.r.t. CORE AXIS °	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
1	NORC June 16 and 17, 2015	Continued from Record of Borehole C57.1-N5		207.29 0.91	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: MCK

PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C57.1-DC01 SHEET 1 OF 1										METRIC			
G.W.P. <u>5111-07-00</u>					LOCATION <u>N 5044809.0 ; E 244370.6</u>					ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>CME 55, Dynamic Cone Penetration Test</u>					COMPILED BY <u>MR</u>													
DATUM <u>Geodetic</u>					DATE <u>February 11, 2015</u>					CHECKED BY <u>AJS</u>													
SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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					W _p	W											
207.3 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)						207																
							206																
							205																
204.3 3.0	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						

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<div style="display: flex; justify-content: space-between;"> PROJECT <u>07-1111-0029</u> RECORD OF DCPT No C57.1-DC02 SHEET 1 OF 1 METRIC </div>																		
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5044813.5; E 244386.2</u>		ORIGINATED BY <u>ID</u>														
DIST <u></u> HWY <u>69</u>		BOREHOLE TYPE <u>CME 55, Dynamic Cone Penetration Test</u>				COMPILED BY <u>MR</u>												
DATUM <u>Geodetic</u>		DATE <u>February 11, 2015</u>				CHECKED BY <u>MCK</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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa										
209.2 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 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>											
205.4 3.8	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV



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



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

PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No C57.1-DC05		SHEET 1 OF 1		METRIC	
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5044854.4 ;E 244403.2</u>		ORIGINATED BY <u>ID</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>CME 55, Dynamic Cone Penetration Test</u>		COMPILED BY <u>MR</u>			
DATUM <u>Geodetic</u>		DATE <u>February 11, 2015</u>		CHECKED BY <u>AJS</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			20	40	60	80	100	W _p	W	W _L		
207.3	GROUND SURFACE																
0.0	Dynamic Cone Penetration Test (DCPT)						207										
							206										
							205										
204.9	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																
2.4																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C57.1-DC06 SHEET 1 OF 1										METRIC			
G.W.P. <u>5111-07-00</u>					LOCATION <u>N 5044860.8 ;E 244420.0</u>					ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>CME 55, Dynamic Cone Penetration Test</u>					COMPILED BY <u>MR</u>													
DATUM <u>Geodetic</u>					DATE <u>February 11, 2015</u>					CHECKED BY <u>AJS</u>													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L								
209.1	GROUND SURFACE						209																
0.0	Dynamic Cone Penetration Test (DCPT)																						
208.0																							
1.1	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT <u>07-1111-0029</u>										RECORD OF DCPT No C57.1-DC07 SHEET 1 OF 1										METRIC			
G.W.P. <u>5111-07-00</u>					LOCATION <u>N 5044852.7 ;E 244416.7</u>					ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>69</u>					BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>					COMPILED BY <u>ZR/MR</u>													
DATUM <u>Geodetic</u>					DATE <u>June 16, 2015</u>					CHECKED BY <u>AJS</u>													
SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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	20			40	60	80	100	W _p	W	W _L								
208.0	GROUND SURFACE																						
0.0	Dynamic Cone Penetration Test (DCPT)																						
207.0																							
1.0	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																						

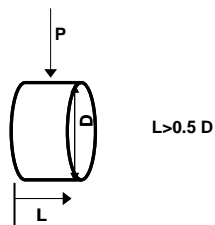
GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

TABLE G1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C57.1-S1	1	3.0	204.3	Granite Gneiss	Diametral	7.37
C57.1-S1	1	3.0	204.3	Granite Gneiss	Axial	8.82
C57.1-S1	2	4.3	203.0	Granite Gneiss	Diametral	4.45
C57.1-S1	2	4.3	203.0	Granite Gneiss	Axial	4.99
C57.1-S1	3	5.4	201.9	Granite Gneiss	Diametral	5.72
C57.1-S1	3	5.4	201.9	Granite Gneiss	Axial	5.80
C57.1-S2	1	6.1	202.6	Granite Gneiss	Diametral	6.83
C57.1-S2	1	6.1	202.6	Granite Gneiss	Axial	4.89
C57.1-N1	1	3.6	204.6	Granite Gneiss	Diametral	5.79
C57.1-N1	1	3.6	204.6	Granite Gneiss	Axial	7.76
C57.1-N1	2	5.2	203.0	Granite Gneiss	Diametral	9.25
C57.1-N1	2	5.2	203.0	Granite Gneiss	Axial	7.79
C57.1-N1	1	6.1	202.1	Granite Gneiss	Diametral	6.72
C57.1-N1	1	6.1	202.1	Granite Gneiss	Axial	5.49
C57.1-N2	1	3.5	204.4	Granite Gneiss	Diametral	6.25
C57.1-N2	1	3.5	204.3	Granite Gneiss	Axial	5.77
C57.1-N2	2	4.5	203.3	Granite Gneiss	Diametral	7.58
C57.1-N2	2	4.5	203.3	Granite Gneiss	Axial	7.94
C57.1-N2	3	6.1	201.7	Granite Gneiss	Axial	5.63
C57.1-N2	3	6.4	201.4	Granite Gneiss	Diametral	5.87
C57.1-N3	1	3.2	205.8	Granite Gneiss	Diametral	7.58
C57.1-N3	1	3.2	205.8	Granite Gneiss	Axial	5.06

DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

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

**AXIAL SPECIMEN SHAPE REQUIREMENTS**

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

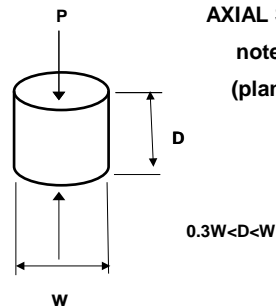
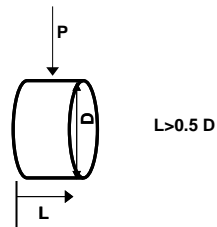


TABLE G1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

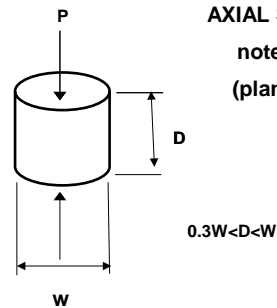
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C57.1-N3	2	5.5	203.5	Granite Gneiss	Diametral	5.15
C57.1-N3	2	5.5	203.5	Granite Gneiss	Axial	5.12
C57.1-N3	3	6.3	202.8	Granite Gneiss	Diametral	7.08
C57.1-N3	3	6.3	202.7	Granite Gneiss	Axial	5.55
C57.1-N5	1	1.0	207.2	Granite Gneiss	Diametral	4.90
C57.1-N5	1	1.0	207.2	Granite Gneiss	Axial	4.23
C57.1-N5	2	2.0	206.2	Granite Gneiss	Diametral	4.54
C57.1-N5	2	2.1	206.1	Granite Gneiss	Axial	2.62
C57.1-N5	3	4.0	204.3	Granite Gneiss	Diametral	4.98

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: MCK
Checked By: CN
Reviewed By: JMAC

Table G2
UNCONFINED COMPRESSION TEST (UC)

ASTM D7012

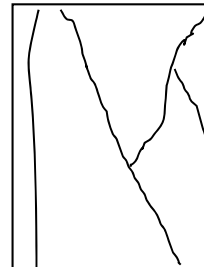
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	C57.1-S1	SAMPLE DEPTH, m	3.96

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.37

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.18	WATER CONTENT, (specimen) %	0.06
SAMPLE DIAMETER, cm	4.71	UNIT WEIGHT, kN/m ³	26.52
SAMPLE AREA, cm ²	17.44	DRY UNIT WT., kN/m ³	26.51
SAMPLE VOLUME, cm ³	195.03	SPECIFIC GRAVITY	-
WET WEIGHT, g	527.70	VOID RATIO	-
DRY WEIGHT, g	527.40		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	59.9

REMARKS:

DATE:

2015-03-11

Checked By: MCK

Golder Associates

Table G3
UNCONFINED COMPRESSION TEST (UC)

ASTM D7012

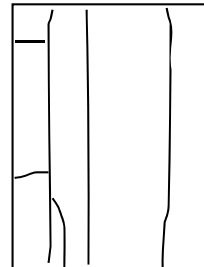
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	C57.1-N2	SAMPLE DEPTH, m	5.95

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.45

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.56	WATER CONTENT, (specimen) %	0.05
SAMPLE DIAMETER, cm	4.73	UNIT WEIGHT, kN/m ³	26.15
SAMPLE AREA, cm ²	17.53	DRY UNIT WT., kN/m ³	26.14
SAMPLE VOLUME, cm ³	202.68	SPECIFIC GRAVITY	-
WET WEIGHT, g	540.65	VOID RATIO	-
DRY WEIGHT, g	540.38		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	106.5

REMARKS:

DATE:

2015-03-11

Checked By: MCK

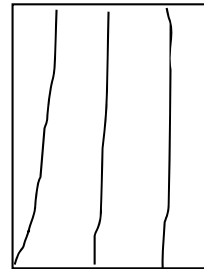
Golder Associates

Table G4**UNCONFINED COMPRESSION TEST (UC)****ASTM D7012**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	C57.1-N3	SAMPLE DEPTH, m	3.96

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.35

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	11.15	WATER CONTENT, (specimen) %	0.04
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m ³	26.34
SAMPLE AREA, cm ²	17.63	DRY UNIT WT., kN/m ³	26.33
SAMPLE VOLUME, cm ³	196.55	SPECIFIC GRAVITY	-
WET WEIGHT, g	528.15	VOID RATIO	-
DRY WEIGHT, g	527.95		

VISUAL INSPECTION**FAILURE SKETCH**

TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	78.2

REMARKS:

DATE:

2015-03-11

Checked By: MCK

Golder Associates

Table G5
UNCONFINED COMPRESSION TEST (UC)

ASTM D7012

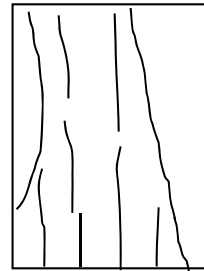
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	C57.1-N5	SAMPLE DEPTH, m	2.15

TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.23

SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	9.47	WATER CONTENT, (specimen) %	0.04
SAMPLE DIAMETER, cm	4.24	UNIT WEIGHT, kN/m ³	25.71
SAMPLE AREA, cm ²	14.11	DRY UNIT WT., kN/m ³	25.70
SAMPLE VOLUME, cm ³	133.71	SPECIFIC GRAVITY	-
WET WEIGHT, g	350.68	VOID RATIO	-
DRY WEIGHT, g	350.54		

VISUAL INSPECTION

FAILURE SKETCH



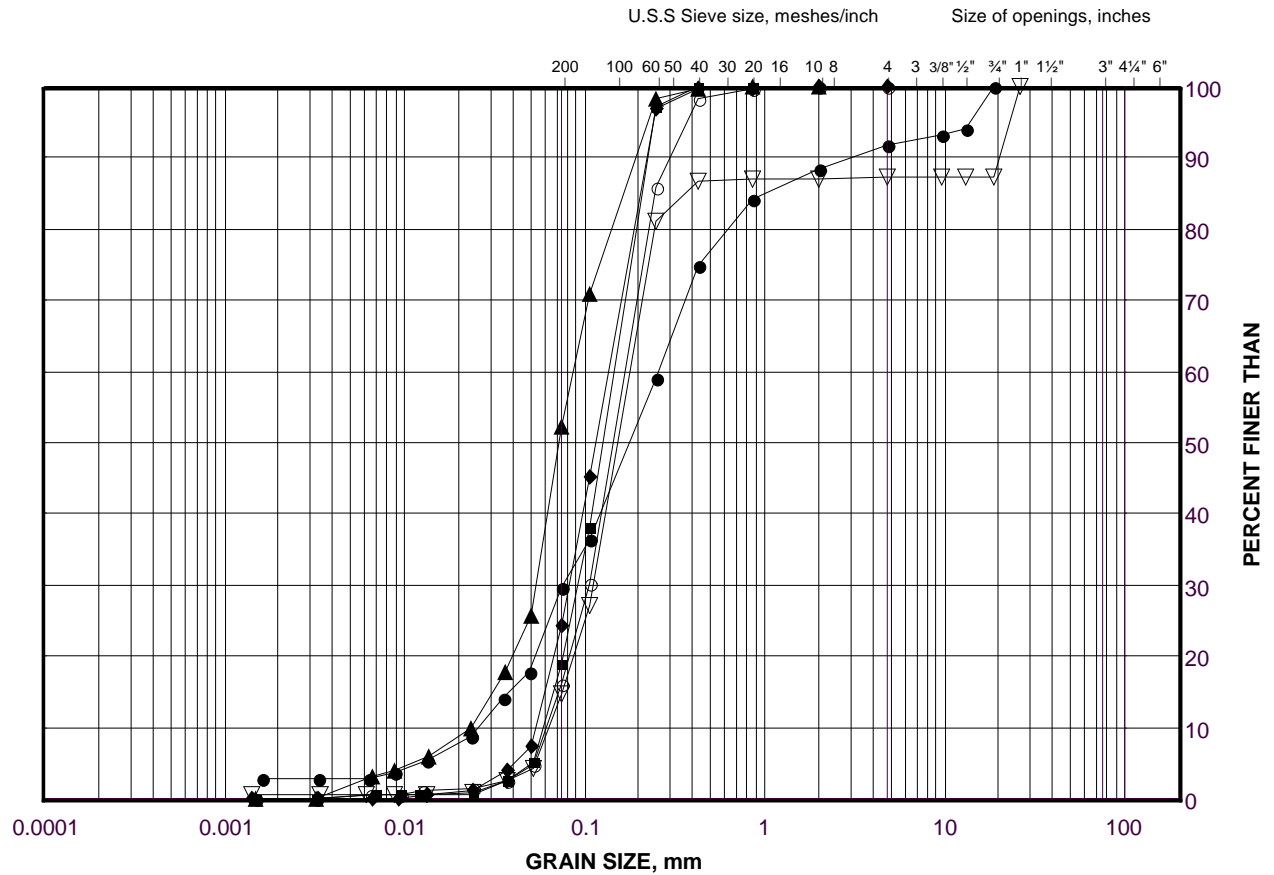
TEST RESULTS			
STRAIN AT FAILURE, %	0.0	COMPRESSIVE STRENGTH, MPa	72.5

REMARKS: DATE: 2015-06-25

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand
Highway 69 (SBL) STA 16+345

FIGURE G.C57.1-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C57.1-S2	2	207.6
■	C57.1-S1	3	205.6
◆	C57.1-S4	4	205.3
▲	C57.1-S2	4	206.1
▽	C57.1-S3	5	205.7
○	C57.1-S2	6	204.6

Project Number: 07-1111-0029

Checked By: AJS

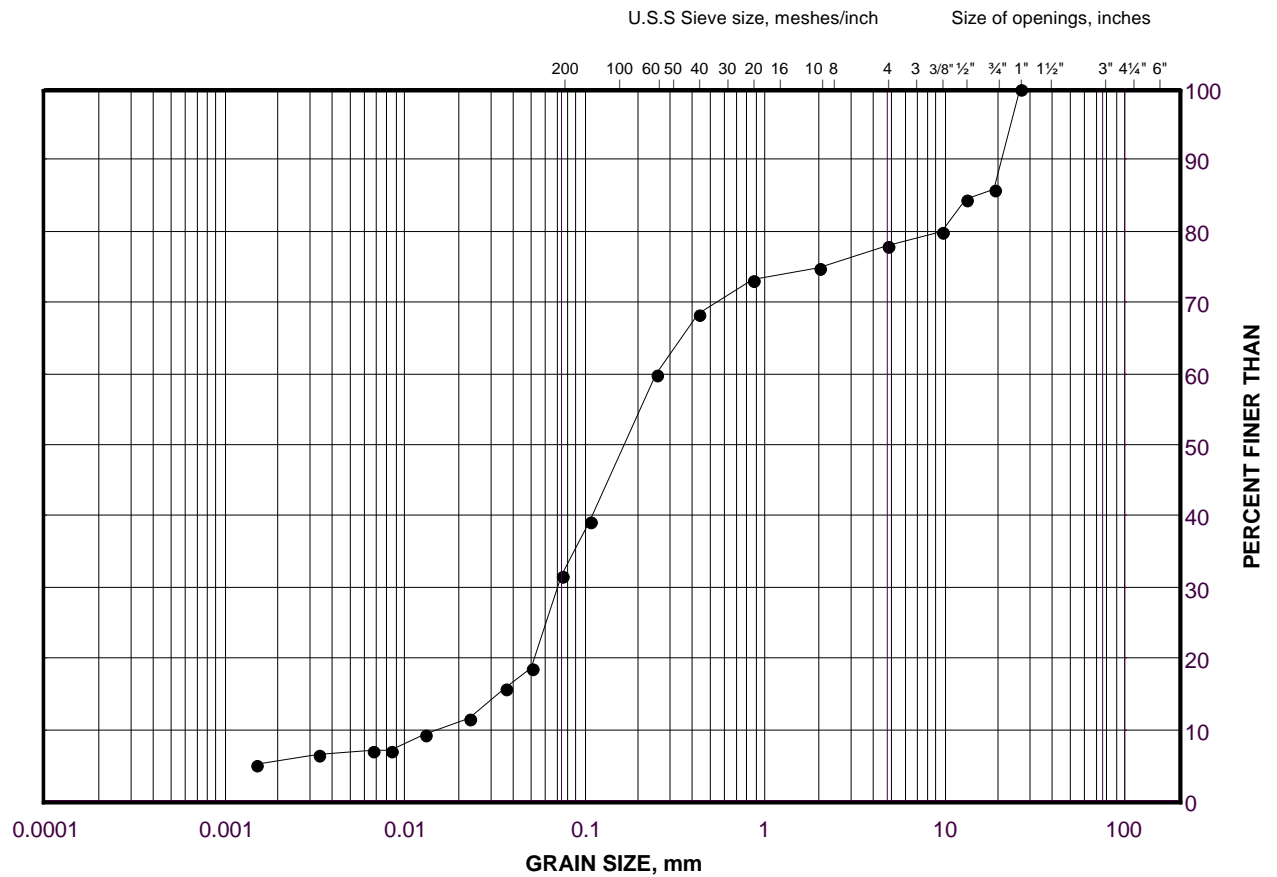
Golder Associates

Date: 17-Aug-15

GRAIN SIZE DISTRIBUTION

Gravelly Silty Sand (Pocket)
Highway 69 (SBL) STA 16+345

FIGURE G.C57.1-2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C57.1-S3	2	207.9

Project Number: 07-1111-0029

Checked By: AJS

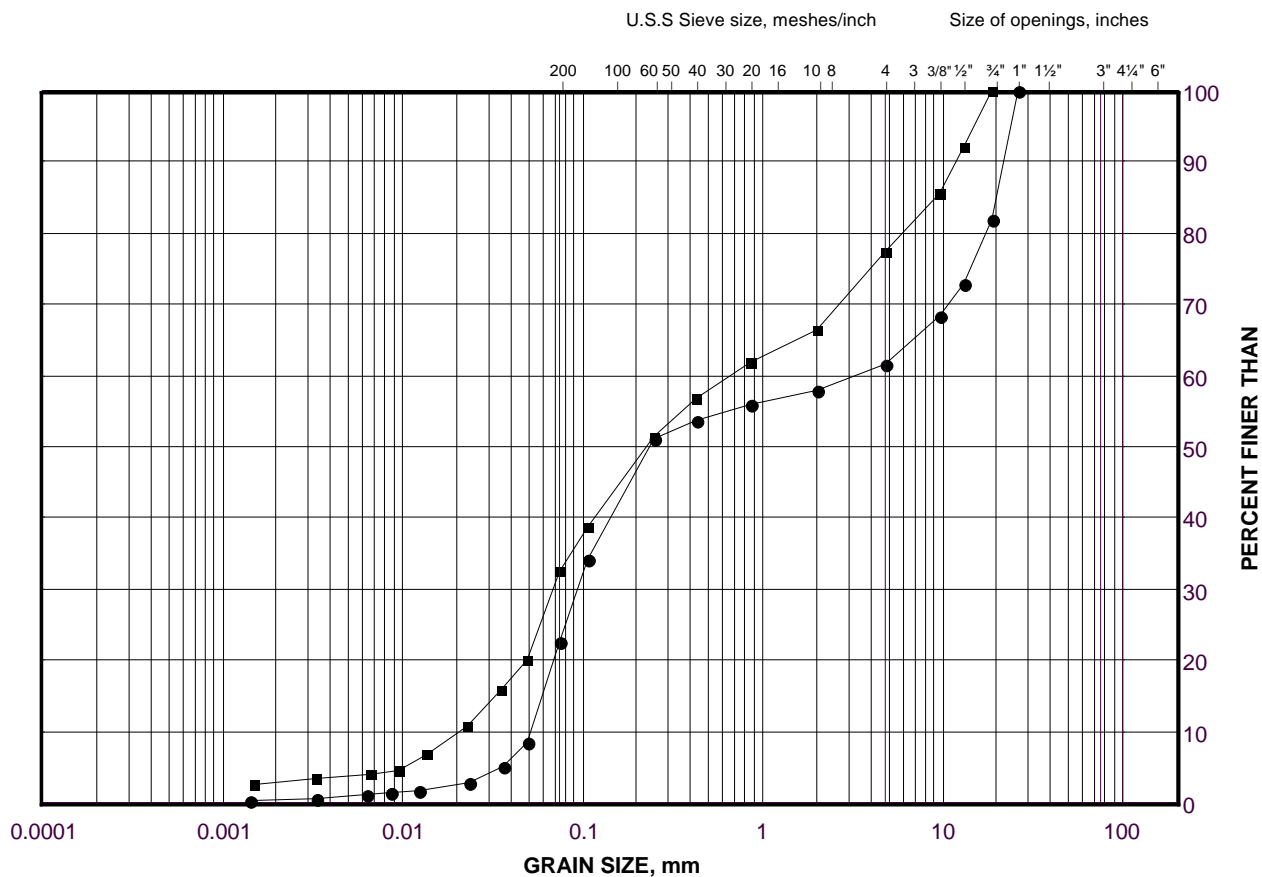
Golder Associates

Date: 17-Aug-15

GRAIN SIZE DISTRIBUTION

Gravelly Silt and Sand to Silty Sand and Gravel
Highway 69 (SBL) STA 16+345

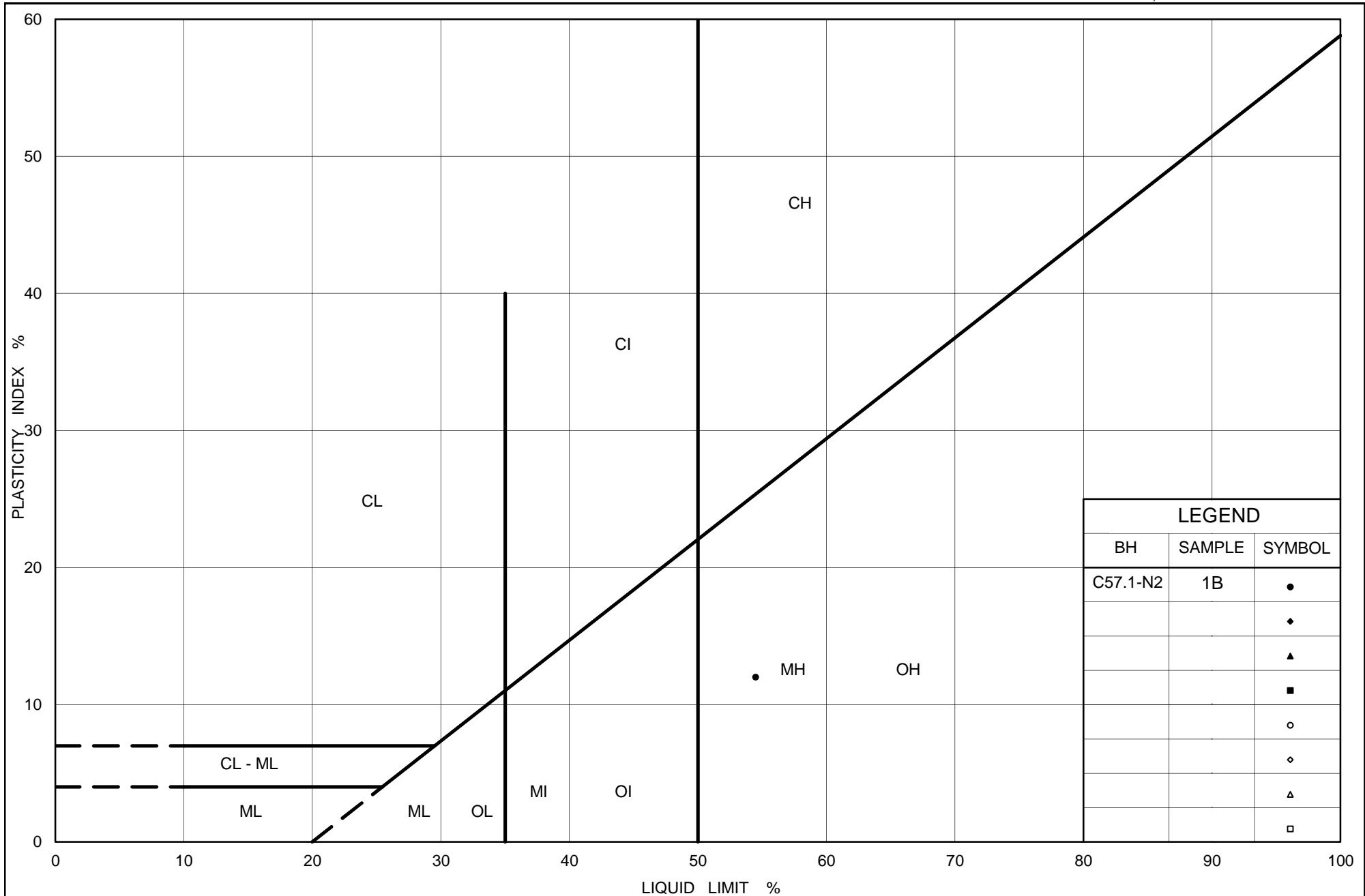
FIGURE G.57.1-3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C57.1-S5	6	204.6
■	C57.1-S3	7B	204.1



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt
Highway 69 (NBL) STA 16+345

Figure No. G.C57.1-4

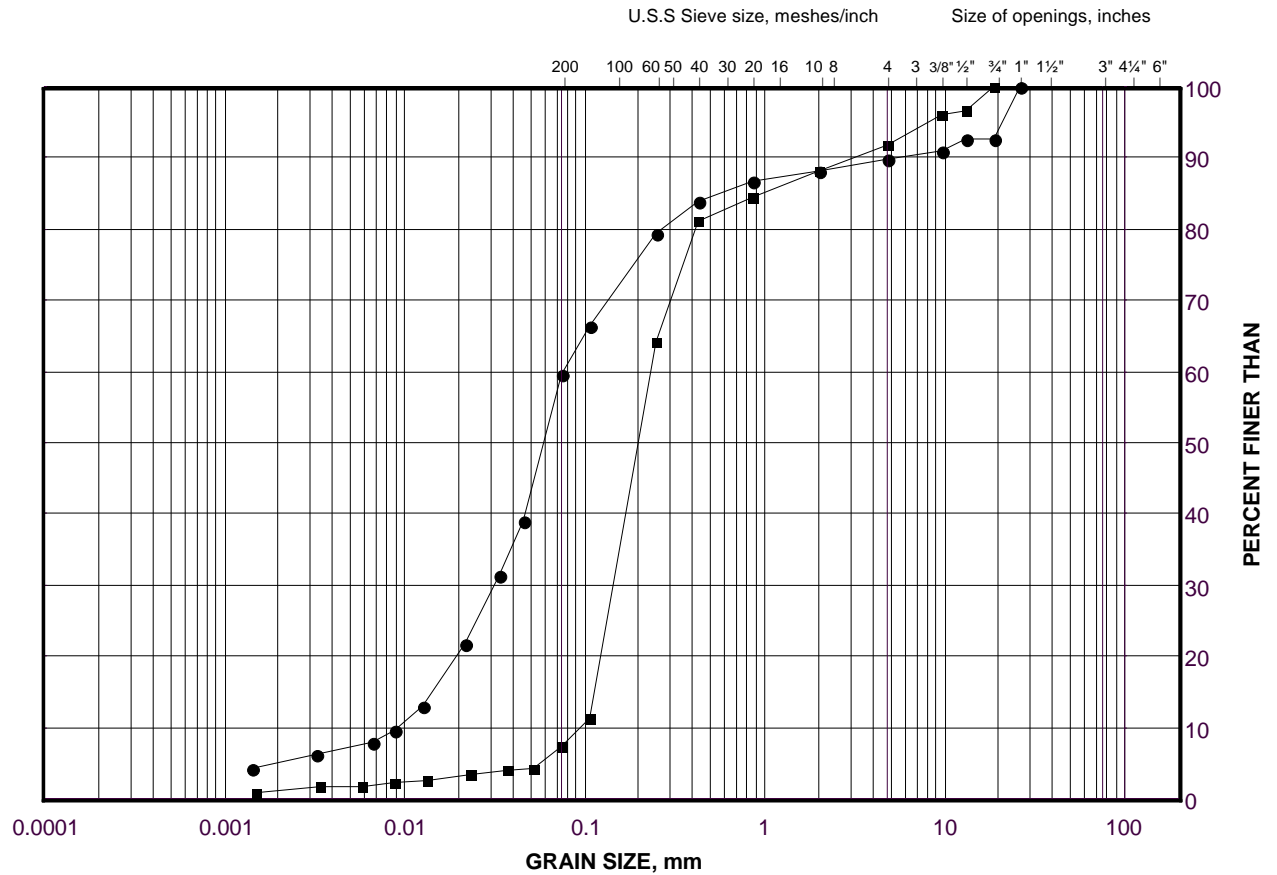
Project No. 07-1111-0029

Checked By: AJS

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand
Highway 69 (NBL) STA 16+345

FIGURE G.C57.1-5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C57.1-N4	2	207.5
■	C57.1-N2	2	206.7

Project Number: 07-1111-0029

Checked By: AJS

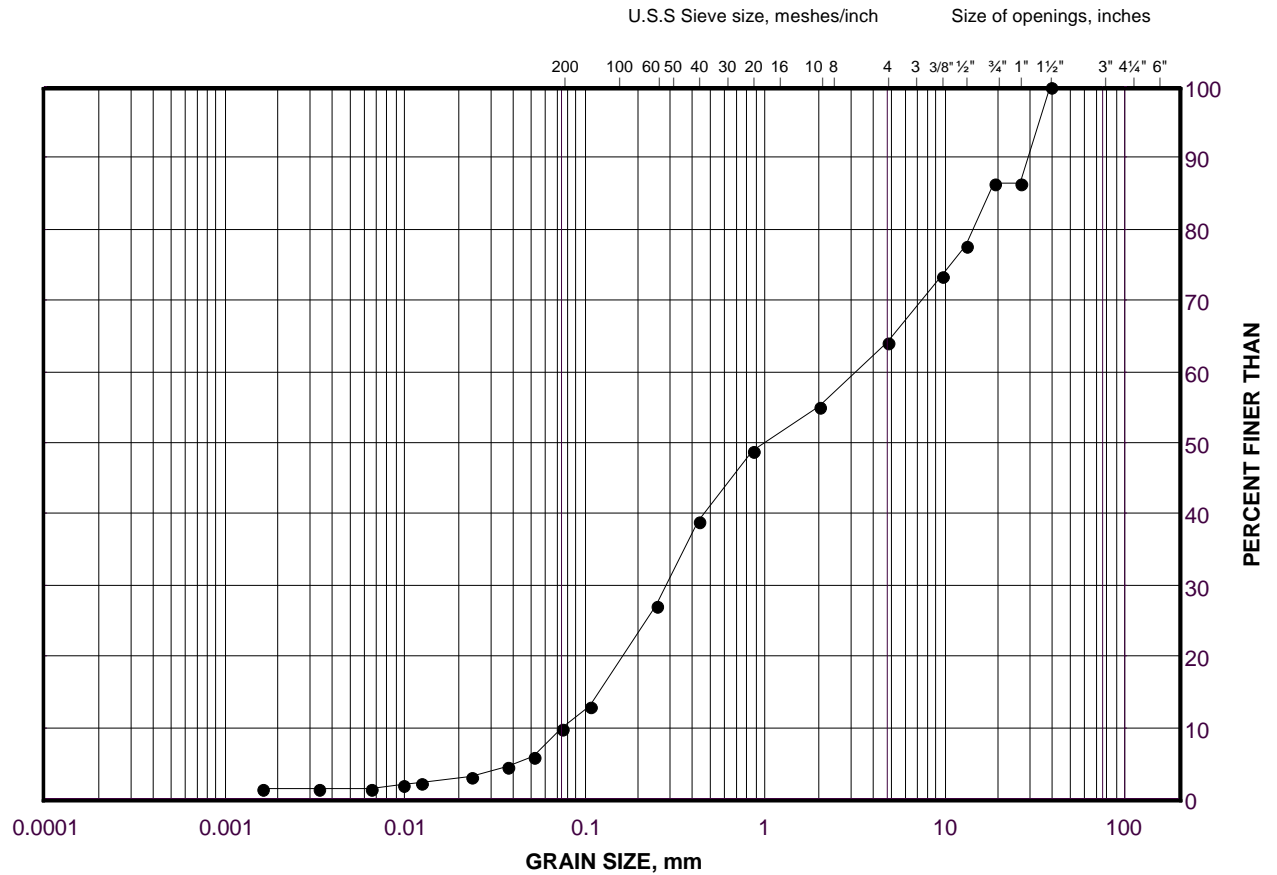
Golder Associates

Date: 16-Aug-15

GRAIN SIZE DISTRIBUTION

Sand and Gravel (Pocket)
Highway 69 (NBL) STA 16+345

FIGURE G.C57.1-6



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C57.1-N1	2	207.1

Project Number: 07-1111-0029

Checked By: AJS

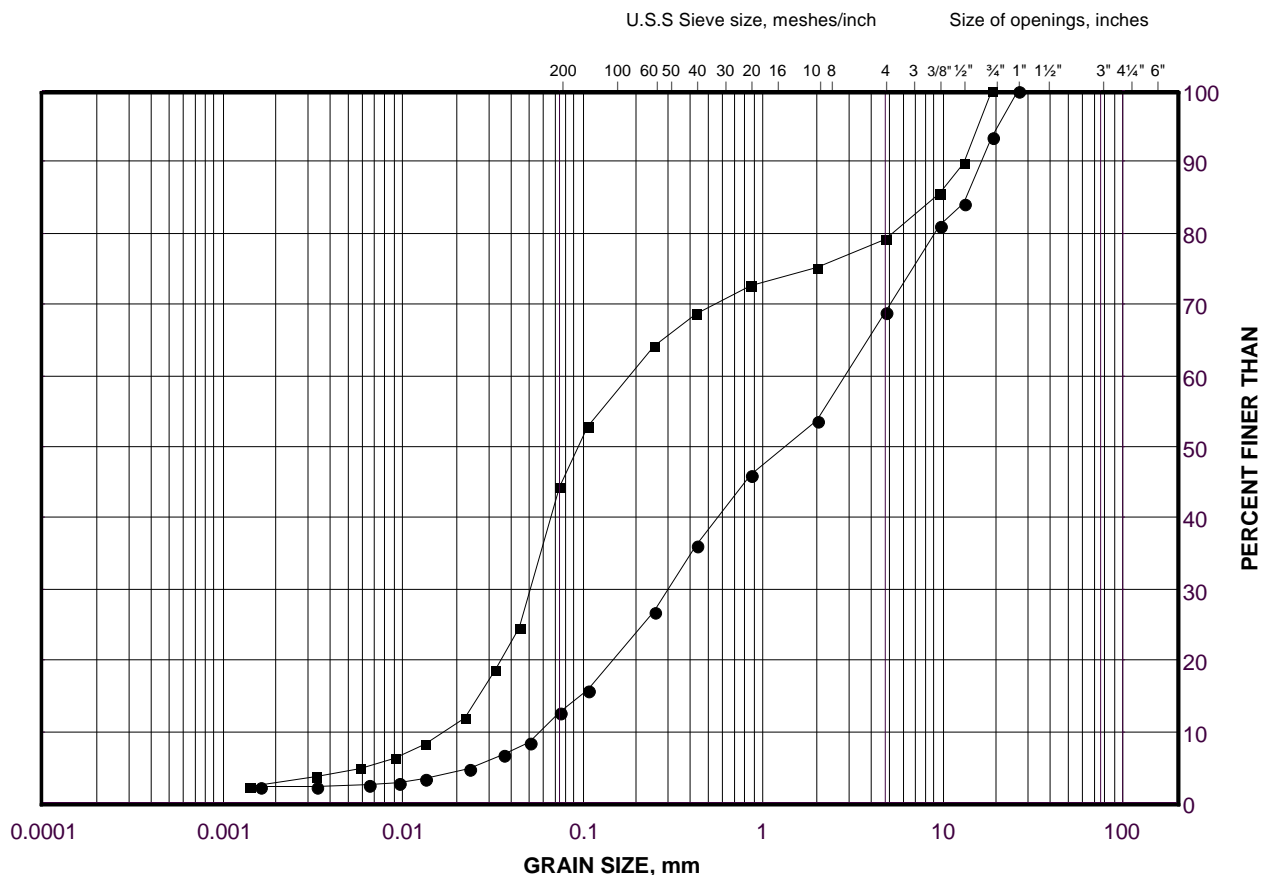
Golder Associates

Date: 16-Aug-15

GRAIN SIZE DISTRIBUTION

Gravelly Silt and Sand to Sand and Gravel
Highway 69 (NBL) STA 16+345

FIGURE G.C57.1-7



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C57.1-N3	3	207.2
■	C57.1-N1	4	205.8

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 16-Aug-15



APPENDIX H

**Highway 69 SBL and NBL – STA 16+499 and STA 16+485
(Culvert C57 – Site No. 44-622/C2 and 44-622/C1)**

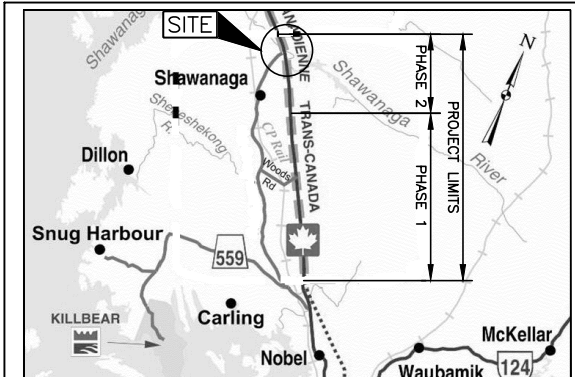
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. .
GWP No. 5077-13-13 (NBL) and
5077-13-14 (SBL)



HIGHWAY 69 (SBL AND NBL)
CULVERT C57 STA 16+499 AND STA 16+485
**BOREHOLE LOCATIONS AND SOIL
STRATA**

**SHEET
S18**



KEY PLAN 3.7 0 3.7 km

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation
- ⊕ Dynamic Cone Penetration Test
- ⊕ Dynamic Cone Penetration Test - Previous Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
S24-03	0.0	5044948.8	244290.3
S24-04	0.0	5044949.4	244265.1
S24-06	0.0	5044969.9	244298.4
S24-10	0.0	5044950.2	244335.4
S24-11	0.0	5044971.3	244343.7
S24-DC01	0.0	5044949.5	244312.9

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 MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.



A-A CULVERT C57 PROFILE STA 16+499 AND STA 16+485

HORIZONTAL SCALE
5 0 5 10 m
2 0 2 4 m
VERTICAL SCALE



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

PROJECT		RECORD OF BOREHOLE		No S24-04		SHEET 1 OF 1		METRIC																		
G.W.P.		LOCATION		ORIGINATED BY																						
DIST		BOREHOLE TYPE		COMPILED BY																						
DATUM		DATE		CHECKED BY																						
07-1111-0029		N 5044949.4 ; E 244265.1		MR																						
5111-07-00		115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring		MWK																						
Geodetic		January 28, 2009		VA/OK																						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	20	40	60	80	100	W _p	W	W _L	γ	GR	SA	SI	CL						
203.1	0.0	GROUND SURFACE					203																			
202.7	0.5	PEAT (Amorphous) Soft Dark brown Wet		1	SS	3																				
		SILT, trace sand, trace clay, trace organics Brown and grey Wet		2	SS	12																				
201.3	1.8	SAND, some silt, trace clay Loose to compact Grey to brownish grey Wet		3A	SS	9																				
		SAND, trace silt, trace clay Very loose to loose Grey Wet		3B																						
				4	SS	8																				
				5	SS	3																				
				6	SS	7																				
				7	SS	3																				
				8	SS	3																				
				9	SS	4																				
193.6	9.5	END OF BOREHOLE SPOON AND CASING REFUSAL		10	SS	100/0.02																				
		NOTE: 1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 202.8 m) upon completion of drilling.																								

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S24-06		SHEET 1 OF 1		METRIC															
G.W.P. 5111-07-00		LOCATION N 5044969.9 ; E 244298.4		ORIGINATED BY MR																	
DIST _____ HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY MWK																	
DATUM Geodetic		DATE January 19, 2009		CHECKED BY VA/OK																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
202.7	ICE SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60			kN/m ³					
0.0	Ice																				
	Water																				
0.4	Root mat																				
	SILT and SAND, trace clay, trace organics to a depth of 1.1 m, containing root mat and rootlets		1	SS	16		202						○						OC=1.3%		
	Loose to compact		2	SS	16		201														
	Brown and grey		3	SS	4		200						○						0 63 35 2		
	Wet		4	SS	6		199														
199.3																					
3.4	SAND, trace to some silt, trace clay		5	SS	18		198						○								
	Very loose to compact		6	SS	21		197														
	Grey		7	SS	3		196						○						0 91 8 1		
	Wet		8	SS	5		195						○								
			9	SS	7		194														
			10A	SS	10		193														
			10B	SS	10		192						○						2 96 2 0		
			11	SS	100/0.25		191														
190.6																					
12.1	END OF BOREHOLE SPOON AND AUGER REFUSAL																				
	NOTE:																				
	1. Water level in open borehole at ice surface (Elev. 202.7 m) upon completion of drilling.																				

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S24-10		SHEET 1 OF 2		METRIC															
G.W.P. 5111-07-00		LOCATION N 5044950.2 ; E 244335.4		ORIGINATED BY MR																	
DIST HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring		COMPILED BY MWK																	
DATUM Geodetic		DATE January 23, 2009		CHECKED BY VA/OK																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)								
								20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60			γ kN/m ³			GR SA SI CL		
202.4	ICE SURFACE																				
0.0	Ice																				
	Water		1A				202														
	PEAT (Amorphous)		1B	SS	14																
0.6	Stiff Dark brown Wet		1C																		
	SILT, trace sand, trace clay, trace rootlets		2	SS	23																
	Compact Grey Wet		3	SS	14		201									0 39 60 1					
	SILT and SAND, trace clay, trace rootlets to a depth of 0.8 m		4	SS	9		200														
	Loose to compact Grey Wet		5	SS	7																
199.0							199														
3.4	Silty SAND, trace clay		6	SS	17																
	Compact to dense Grey Wet		7	SS	31		198									0 76 21 3					
							197														
			8	SS	18		196														
							195														
			9	SS	24																
194.0							194														
8.4	SAND, some silt, trace gravel, trace clay		10	SS	49											3 80 15 2					
	Dense Grey Wet						193														
192.5							192														
9.9	SAND and GRAVEL, trace silt		11	SS	17																
	Compact Grey Wet						191														
191.1							190														
11.3	SILT and SAND, trace clay		12	SS	9																
190.2	Loose Grey Wet						189														
12.2	SILT, trace sand, trace clay																				
189.6	Loose Grey Wet																				
12.8	SILT and SAND, trace clay, some cobbles and boulder		13	SS	17											0 69 30 1					
	Compact Grey Wet						188														
187.9																					
14.5																					

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT		RECORD OF BOREHOLE		No S24-10		SHEET 2 OF 2		METRIC									
G.W.P. 07-1111-0029		LOCATION		N 5044950.2 ; E 244335.4		ORIGINATED BY		MR									
DIST		HWY 69		BOREHOLE TYPE		115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring		COMPILED BY									
DATUM		Geodetic		DATE		January 23, 2009		CHECKED BY									
								VA/OK									
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 ---							20	40	60	80	100					
186.3	SAND and GRAVEL, trace silt, containing cobbles and boulders between depths of 14.5 m and 14.8 m Dense Grey Wet	• • • • • • • • • • • • • • •	14	SS	33		187										
16.1	END OF BOREHOLE SPOON AND CASING REFUSAL		15	SS	50/0.03												
	NOTE: 1. Water level in open borehole at ice surface (Elev. 202.4 m) upon completion of drilling.																

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S24-11		SHEET 1 OF 1		METRIC														
G.W.P. 5111-07-00		LOCATION N 5044971.3; E 244343.7		ORIGINATED BY MR																
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring		COMPILED BY MWK																
DATUM Geodetic		DATE January 23, 2009		CHECKED BY VA/OK																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ	GR	SA	SI	CL
202.2	ICE SURFACE							20	40	60	80	100								
0.0	Ice						202													
0.3	Water						201													
200.8	PEAT, trace sand layers (Amorphous) Very soft Dark brown Wet		1	SS	1		201													
1.4	SILT and SAND, trace gravel, trace organics Very loose		2A	SS	3		200													
200.3	Grey Wet		2B				200													
1.9	Sandy SILT, trace clay Loose Grey Wet		3	SS	6		199													
			4	SS	9		199													
198.9	Silty SAND, trace clay Very loose to compact Grey Wet		5	SS	9		198													
3.3			6	SS	2		198													
							197													
			7	SS	12		196													
195.4	END OF BOREHOLE CASING REFUSAL																			
6.8	NOTES: 1. Water level in open borehole at ice surface (Elev. 202.2 m) upon completion of drilling.																			



PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No S24-DC-01		SHEET 1 OF 1		METRIC	
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5044949.5 ;E 244312.9</u>		ORIGINATED BY <u>MR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>D-25 Track Mount, Dynamic Cone Penetration Test</u>		COMPILED BY <u>MWK</u>			
DATUM <u>Geodetic</u>		DATE <u>January 24, 2009</u>		CHECKED BY <u>VA/OK</u>			

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	N° VALUES	GROUND WATER CONDITIONS
202.7	GROUND SURFACE				
0.0	Dynamic Cone Penetration Test (DCPT)				
188.3	END OF DCPT Refusal to Further Penetration (100 Blows / 0.03 m)				
14.4					

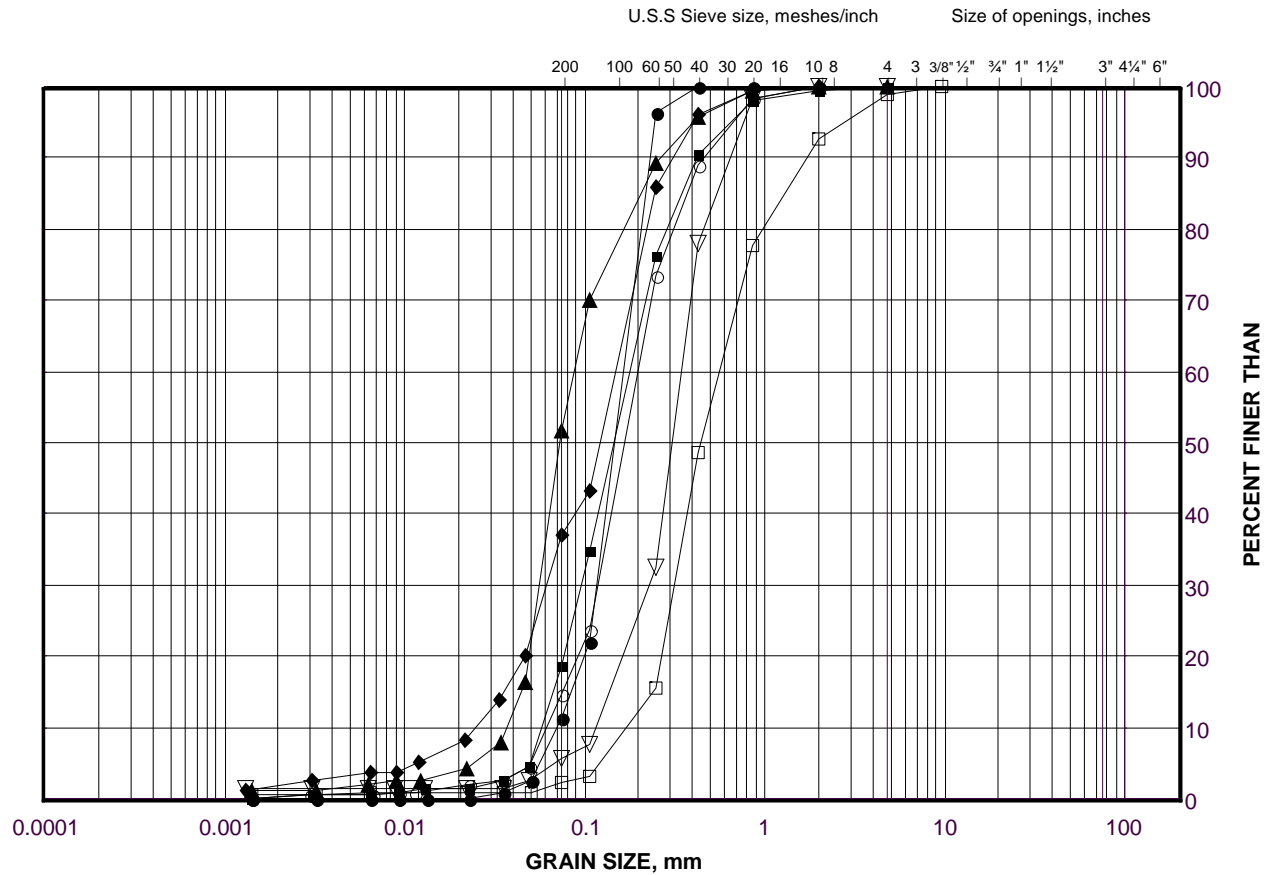
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand
Highway 69 (SBL) STA 16+475 to 16+550

FIGURE H.C57-1A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-03	10	192.3
■	S24-04	2	202.0
◆	S24-06	3	200.4
▲	S24-03	3	200.9
▽	S24-04	5	199.7
○	S24-03	7	196.9
□	S24-04	8	195.9

Project Number: 07-1111-0029

Checked By: TVA

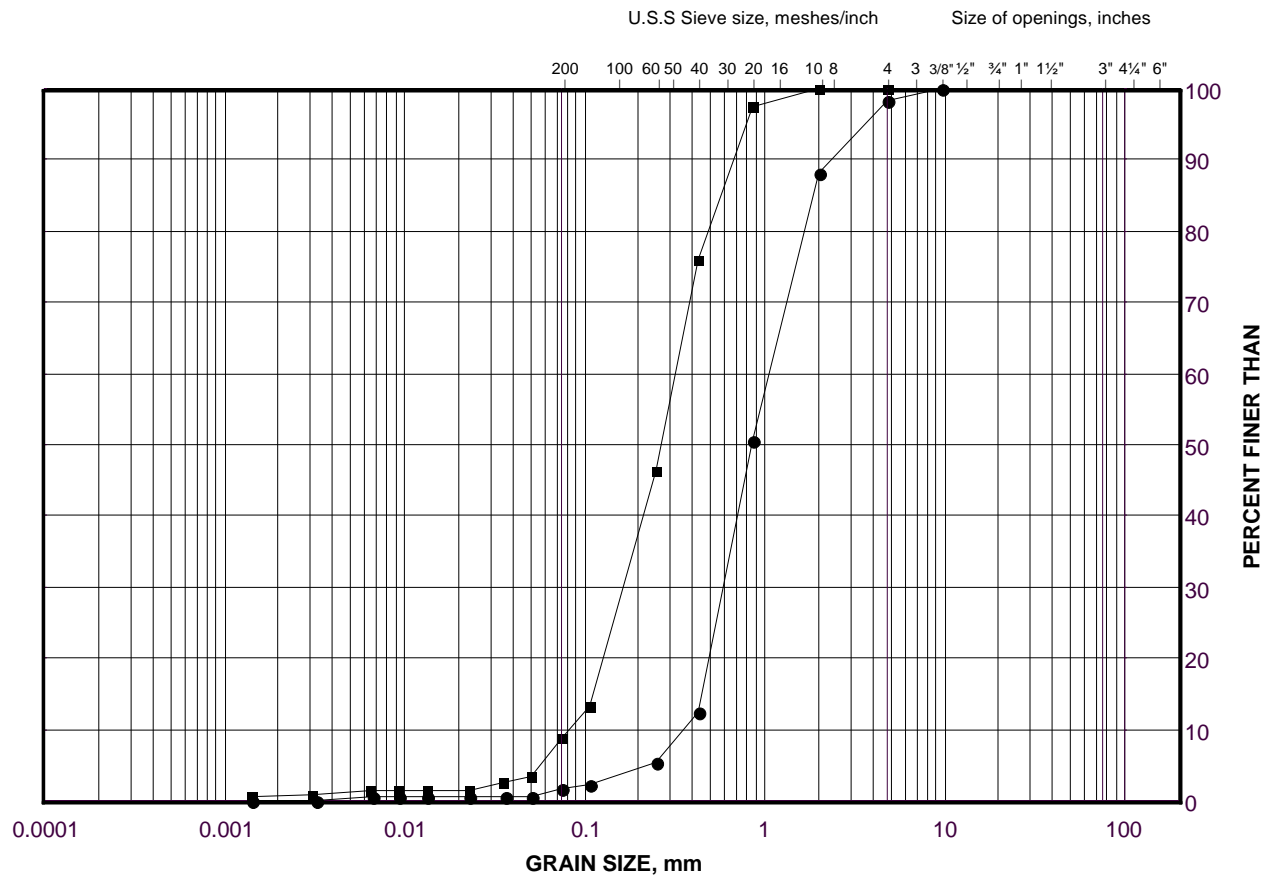
Golder Associates

Date: 14-Aug-15

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand
Highway 69 (SBL) STA 16+475 to 16+550

FIGURE H.C57-1B



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-06	10A	192.1
■	S24-06	7	196.6

Project Number: 07-1111-0029

Checked By: TVA

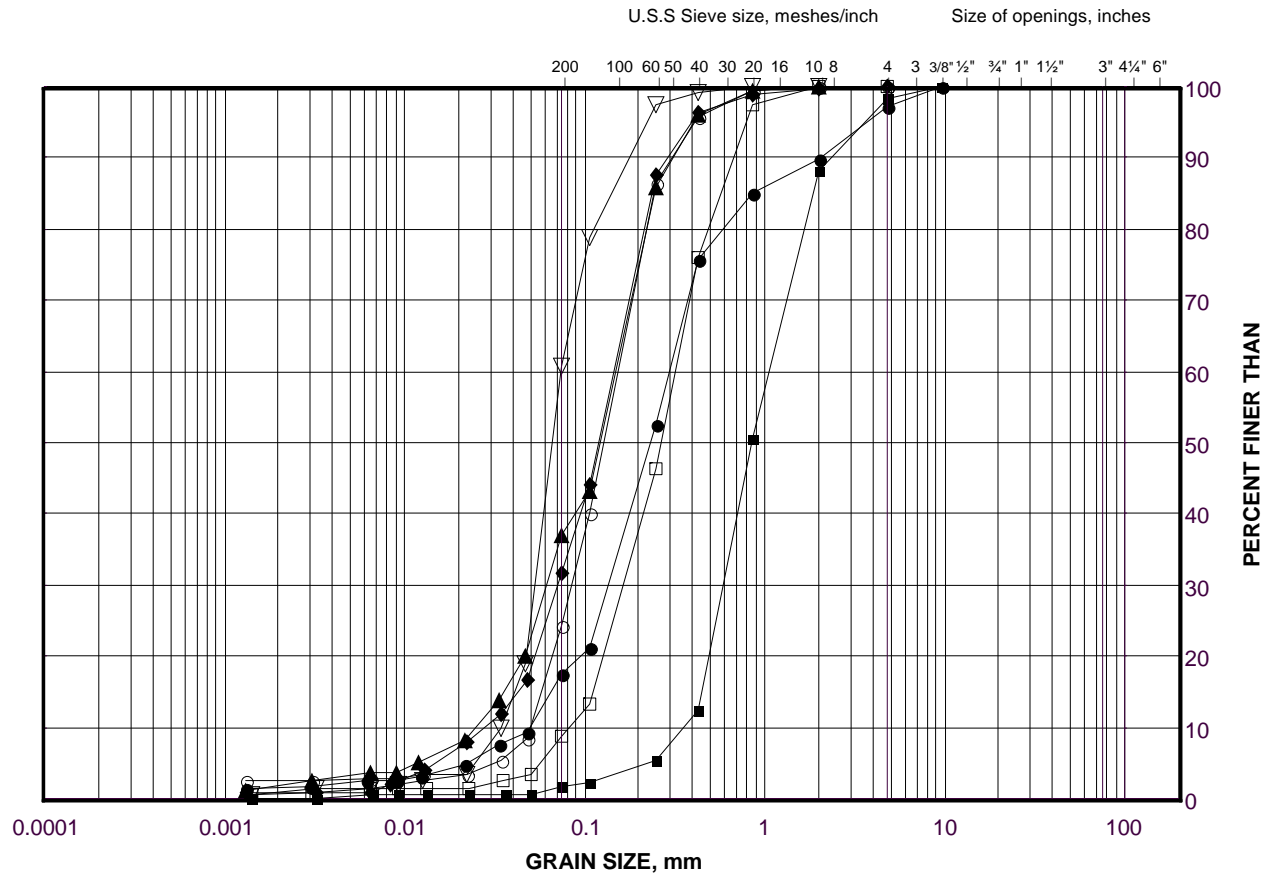
Golder Associates

Date: 14-Aug-15

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand
Highway 69 (NBL) STA 16+485

FIGURE H.C57-2A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-10	10	193.3
■	S24-06	10A	192.1
◆	S24-10	13	188.7
▲	S24-06	3	200.4
▽	S24-10	3	200.6
○	S24-10	7	197.8
□	S24-06	7	196.6

Project Number: 07-1111-0029

Checked By: TVA

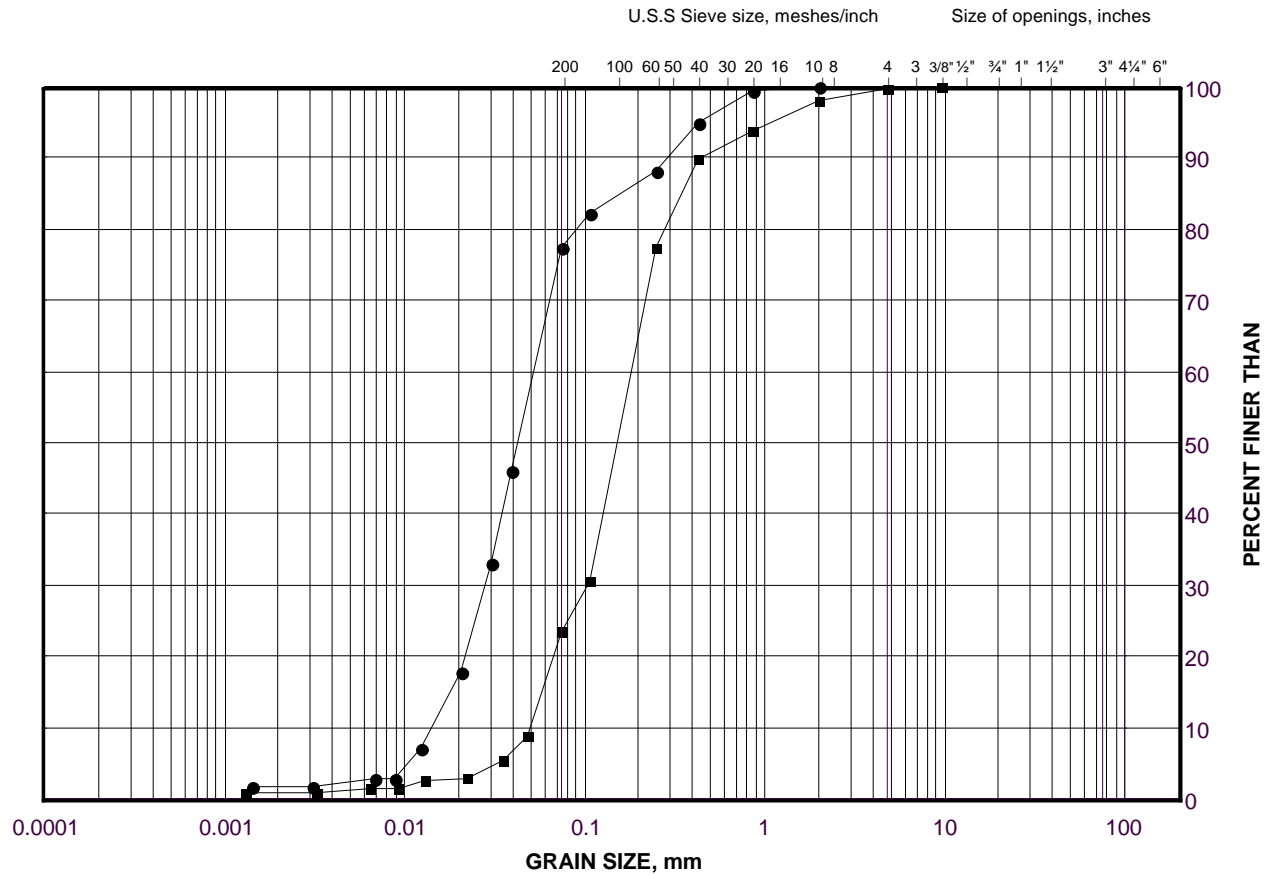
Golder Associates

Date: 14-Aug-15

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand
Highway 69 (NBL) STA 16+485

FIGURE H.C57-2B



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-11	3	199.9
■	S24-11	6	197.8

Project Number: 07-1111-0029

Checked By: TVA

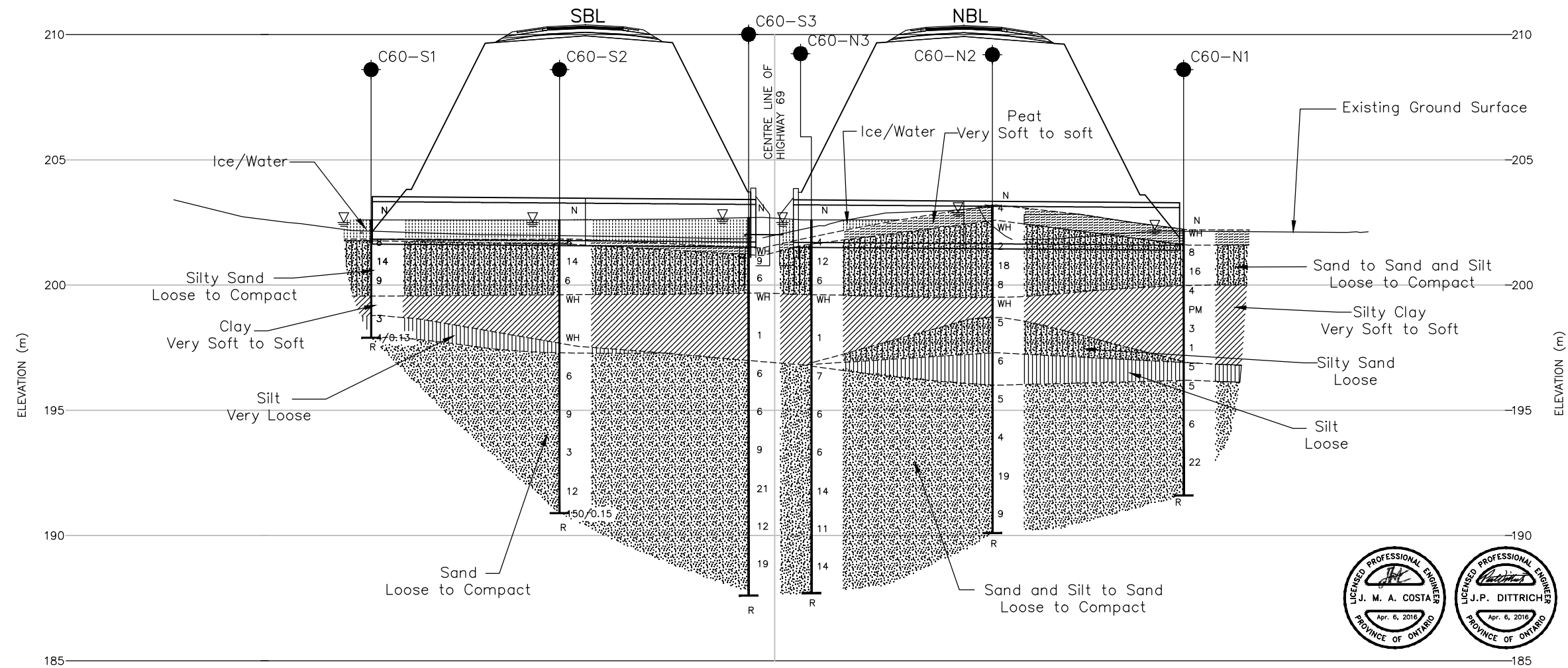
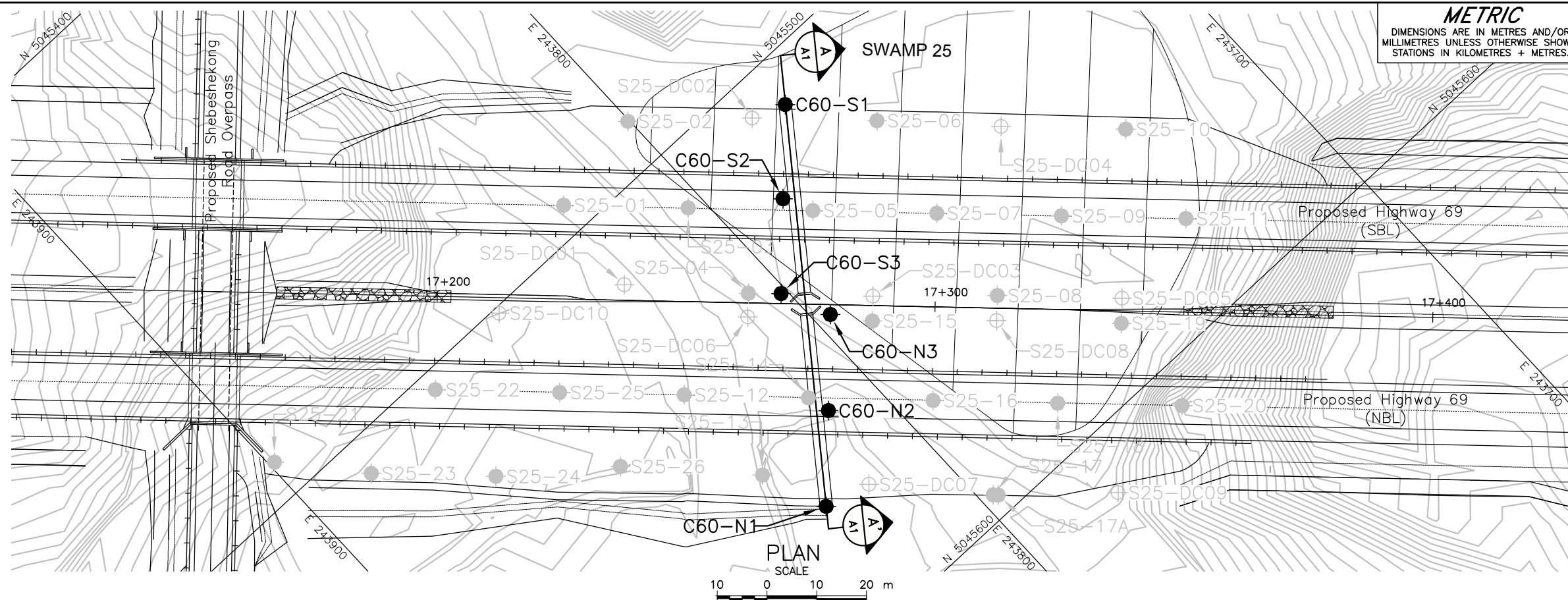
Golder Associates

Date: 14-Aug-15



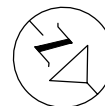
APPENDIX I

**Highway 69 SBL and NBL – STA 17+272 and STA 17+276
(Culvert C60)**

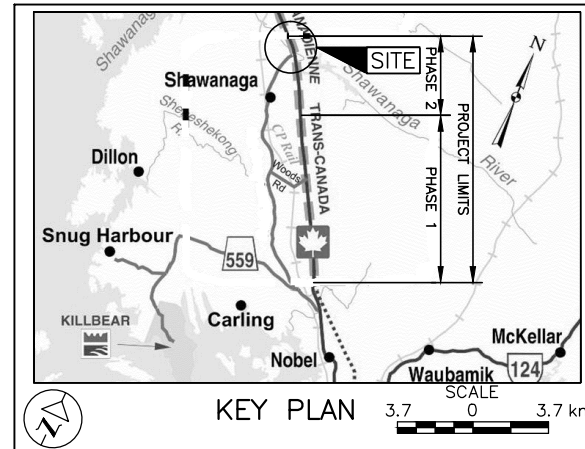


CONT No. GWP No. 5117-07-00

HIGHWAY 69 (SBL AND NBL)
CULVERT C60 STA 17+272 AND STA 17+276
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET S23



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation
- ⊕ Dynamic Cone Penetration Test
- ⊕ Dynamic Cone Penetration Test - Previous Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C60-N1	202.2	5045574.3	243823.6
C60-N2	203.2	5045560.5	243810.2
C60-N3	202.6	5045546.6	243796.8
C60-S1	202.6	5045509.5	243774.8
C60-S2	202.6	5045523.1	243788.0
C60-S3	202.7	5045536.8	243801.2

NOTES

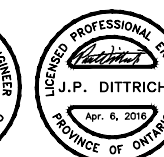
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.



NO.	DATE	BY	REVISION

Geocres No. 41H-160

HWY. 69	PROJECT NO. 07-1111-0029	DIST. .
SUBM'D. TVA/AJS	CHKD. TVA/AJS	DATE: 3/18/2016
DRAWN: JFC/MR	CHKD. CN	APPD. JMAC
		DWG. I1

PROJECT		RECORD OF BOREHOLE		No C60-S1		SHEET 1 OF 1		METRIC						
G.W.P. 07-1111-0029		LOCATION		N 5045509.5 ; E 243774.8		ORIGINATED BY		ID						
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		March 10, 2009		CHECKED BY						
								VA						
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						
202.6	ICE SURFACE													
0.0	Ice													
202.1														
201.8	Water													
0.9	PEAT (Fibrous) Soft Dark brown Wet		1	SS	8									
	Silty SAND, slightly organic to a depth of 1.5 m Loose to compact Brown to grey Wet		2	SS	14									
			3	SS	9									
199.6														
3.1	CLAY, some silt, trace sand Soft Brown and grey Wet													
198.8														
3.8	SILT, some sand, trace clay Very Loose Grey Wet		4	SS	3									
198.0			5	SS	4/0.13									
4.7	SAND, trace to some silt Very loose Grey Wet													
END OF BOREHOLE SPOON AND CASING REFUSAL NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling. 2. Borehole caved to a depth of 1.4 m below ice surface (Elev. 201.2 m) upon removal of casing.														

PROJECT		RECORD OF BOREHOLE		No C60-S2		SHEET 1 OF 1		METRIC								
G.W.P. 07-1111-0029		LOCATION		N 5045523.1 ; E 243788.0		ORIGINATED BY		ID								
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY								
DATUM		Geodetic		DATE		March 10, 2009		CHECKED BY								
								VA								
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								
202.6	ICE SURFACE															
0.0	Ice															
202.1	Water															
1.0	PEAT (Fibrous) Dark brown Wet		1	SS	6											
	Silty SAND, trace clay, slightly organic to a depth of 1.5 m Loose to compact Brown Wet		2	SS	14											0 74 25 1
			3	SS	6											
199.6	CLAY, some silt, trace sand Soft Brown Wet		4	TO	WH											
3.0																
197.6	SILT, trace clay Very loose Grey Wet		5	SS	WH											
197.3	SAND, trace to some silt Very loose to compact Grey Wet		6	SS	6											
			7	SS	9											0 81 19 0
			8	SS	3											
			9	SS	12											
	Containing some gravel below a depth of 10.5 m															
190.9	END OF BOREHOLE CASING REFUSAL		10	WS*	50/0 15											
11.7	NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling. 2. Borehole caved to a depth of 1.9 m below ice surface (Elev. 200.7 m) upon removal of casing. * Sample obtained from bottom of casing after the split spoon sampling attempt.															



PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE		No C60-S3	SHEET 1 OF 2	METRIC
G.W.P.	<u>5111-07-00</u>	LOCATION	<u>N 5045536.8 ;E 243801.2</u>		ORIGINATED BY <u>ID</u>	
DIST	<u>HWY 69</u>	BOREHOLE TYPE	<u>Portable Equipment, BW Casing, Wash Boring</u>		COMPILED BY <u>PKS</u>	
DATUM	<u>Geodetic</u>	DATE	<u>March 11, 2009</u>		CHECKED BY <u>VA</u>	

[illegible]

Continued Next Page

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

○ 3% STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE				No C60-S3		SHEET 2 OF 2		METRIC							
G.W.P. 07-1111-0029		LOCATION				N 5045536.8 ; E 243801.2				ORIGINATED BY ID							
DIST		HWY 69		BOREHOLE TYPE				Portable Equipment, BW Casing, Wash Boring				COMPILED BY PKS					
DATUM Geodetic		DATE		March 11, 2009				CHECKED BY VA									
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									
	--- CONTINUED FROM PREVIOUS PAGE ---																
187.6 15.1	END OF BOREHOLE CASING REFUSAL NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.6 m) upon completion of drilling. 2. An additional borehole was drilled 1.0 m north of Borehole C60-S3 to obtain a Shelby tube sample between depths of 4.6 m and 5.2 m (Elev. 198.1 m and 197.5 m).																

PROJECT		RECORD OF BOREHOLE		No C60-N1		SHEET 1 OF 1		METRIC								
G.W.P.		LOCATION		ORIGINATED BY												
DIST		BOREHOLE TYPE		COMPILED BY												
DATUM		DATE		CHECKED BY												
07-1111-0029		N 5045574.3 ; E 243823.6		MJR												
5111-07-00		Portable Equipment, BW Casing, Wash Boring		PKS												
Geodetic		March 10, 2009		VA												
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 (%)
202.2	GROUND SURFACE															
0.0	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	WH											
201.6																
0.6	SAND, some silt, trace clay, slightly organic, containing wood fragments Loose to compact Dark brown Wet		2	SS	8											
			3	SS	16											
200.0																
2.2	SILTY CLAY, some silt, trace sand Very soft to soft Brown to grey Wet		4	SS	4											
			5	TO	PM											
	Becoming grey below a depth of 3.7 m		6	SS	3											
			7	SS	1											
196.9																
5.3	Silt, some sand, trace clay Loose Grey Wet		8	SS	5											
196.2																
6.0	SAND, trace to some silt Loose to compact Grey Wet		9	SS	5											
			10	SS	6											
			11	SS	22											
191.6																
10.6	END OF BOREHOLE CASING REFUSAL															
NOTES: 1. Water level in open borehole at ground surface (Elev. 202.2 m) upon completion of drilling. 2. Borehole caved to a depth of 5.8 m below ground surface (Elev. 196.4 m) upon removal of casing.																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT 07-1111-0029		RECORD OF BOREHOLE No C60-N2		SHEET 1 OF 2		METRIC								
G.W.P. 5111-07-00		LOCATION N 5045560.5 ; E 243810.2		ORIGINATED BY MJR										
DIST _____ HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring		COMPILED BY PKS										
DATUM Geodetic		DATE March 11, 2009		CHECKED BY VA										
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			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	20 40 60		
203.2	GROUND SURFACE													
0.0	PEAT, containing rootlets (Fibrous)		1	SS	4		203							
202.6	Soft Dark brown Wet													
0.6	SAND, some silt, trace clay, slightly organic Very loose Dark brown Wet		2	SS	WH		202							
			3	SS	2									
201.0	Silty SAND, trace clay Loose to compact Brown Wet		4	SS	18		201							
2.2			5	SS	8		200							
199.5	SILTY CLAY, trace sand Very soft Grey Wet		6	SS	WH		199							
3.7			7	SS	5		198							
198.7	Silty SAND, trace gravel, trace clay Loose Grey Wet		8	SS	6		197							
4.5			9	SS	5		196							
197.3	SILT, some sand, trace clay Loose Grey and reddish brown Wet		10	SS	4		195							
5.9			11	SS	19		194							
196.0	SAND, trace to some silt Loose to compact Grey to brown Wet		12	SS	9		193							
7.2							192							
	Containing trace gravel below a depth of 10.7 m						191							
190.1	END OF BOREHOLE CASING REFUSAL													
13.1														

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT <u>07-1111-0029</u>		RECORD OF BOREHOLE No C60-N2				SHEET 2 OF 2		METRIC										
G.W.P. <u>5111-07-00</u>		LOCATION <u>N 5045560.5 ; E 243810.2</u>				ORIGINATED BY <u>MJR</u>												
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, BW Casing, Wash Boring</u>				COMPILED BY <u>PKS</u>												
DATUM <u>Geodetic</u>		DATE <u>March 11, 2009</u>				CHECKED BY <u>VA</u>												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>						
	NOTES: 1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 202.9 m) upon completion of drilling. 2. Unable to turn in situ vane at depths of 4.5 m and 6.8 m (Elev. 198.7 m and 196.4 m). 3. Borehole caved to a depth of 5.9 m below ground surface (Elev. 197.3 m) upon removal of casing.																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

PROJECT		RECORD OF BOREHOLE		No C60-N3		SHEET 1 OF 2		METRIC					
G.W.P. 07-1111-0029		LOCATION		N 5045546.6 ; E 243796.8		ORIGINATED BY		ID					
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY					
DATUM		Geodetic		DATE		March 12, 2009		CHECKED BY					
								VA					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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						
202.6	ICE SURFACE												
0.0	Ice												
202.1													
201.8	Water												
0.9	PEAT (Fibrous) Dark brown Wet		1	SS	4								
201.1	SAND, some silt, slightly organic to a depth of 1.5 m Very Loose Brown to grey Wet		2	SS	12								
1.5	SAND and SILT, trace clay Loose to compact Grey Wet		3	SS	6								
199.2			4A	TO	WH								
3.4	SILTY CLAY, trace sand Soft Brown Wet		4B										
			5	SS	1								
196.8			6	SS	7								
5.8	SAND and SILT Loose to compact Grey to brown Wet		7	SS	6								
			8	SS	6								
192.4			9	SS	14								
10.2	SAND, some gravel, some silt Compact Grey Wet		10	SS	11								
			11	SS	14								
187.7													

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV



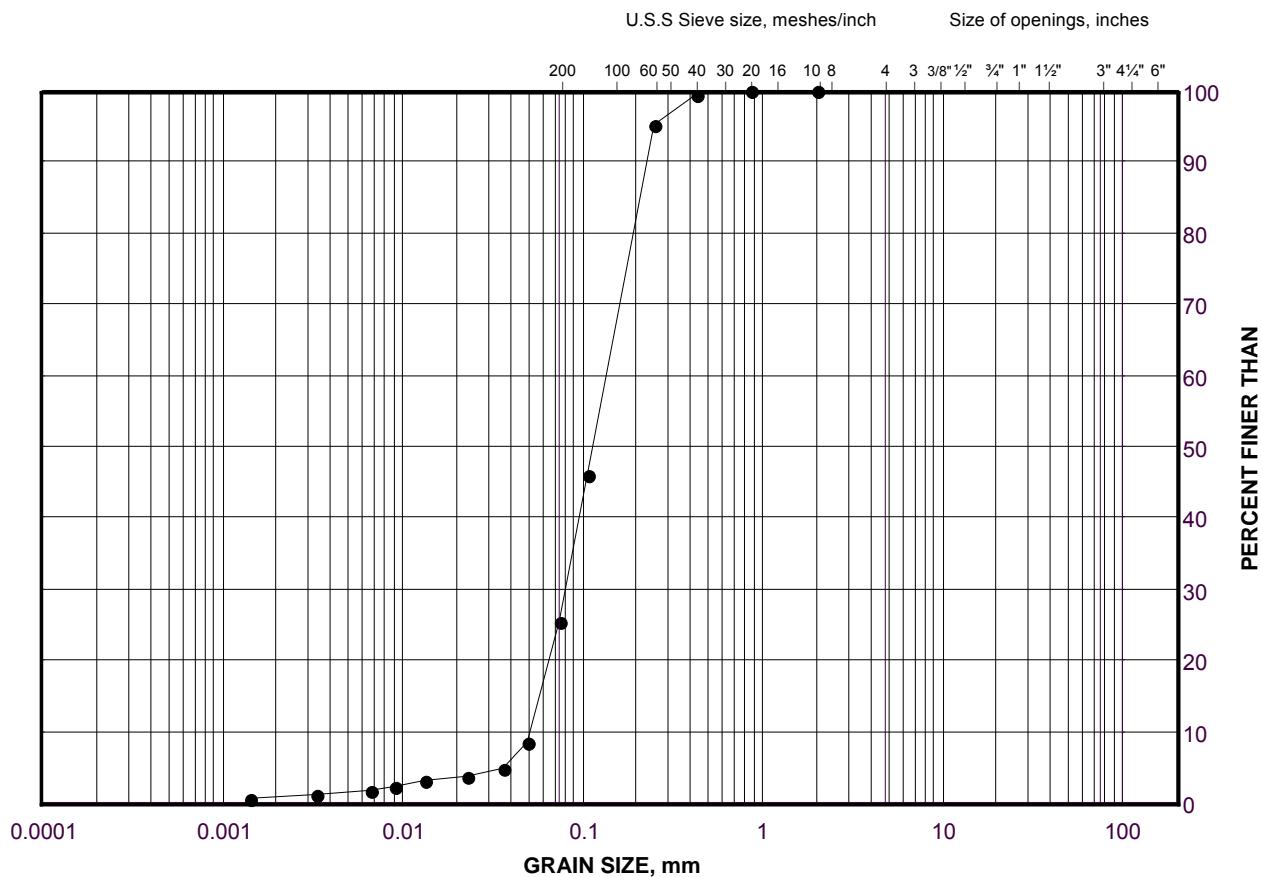
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

GRAIN SIZE DISTRIBUTION

Silty Sand
Highway 69 (SBL) STA 17+269

FIGURE I.C60-1



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

LEGEND

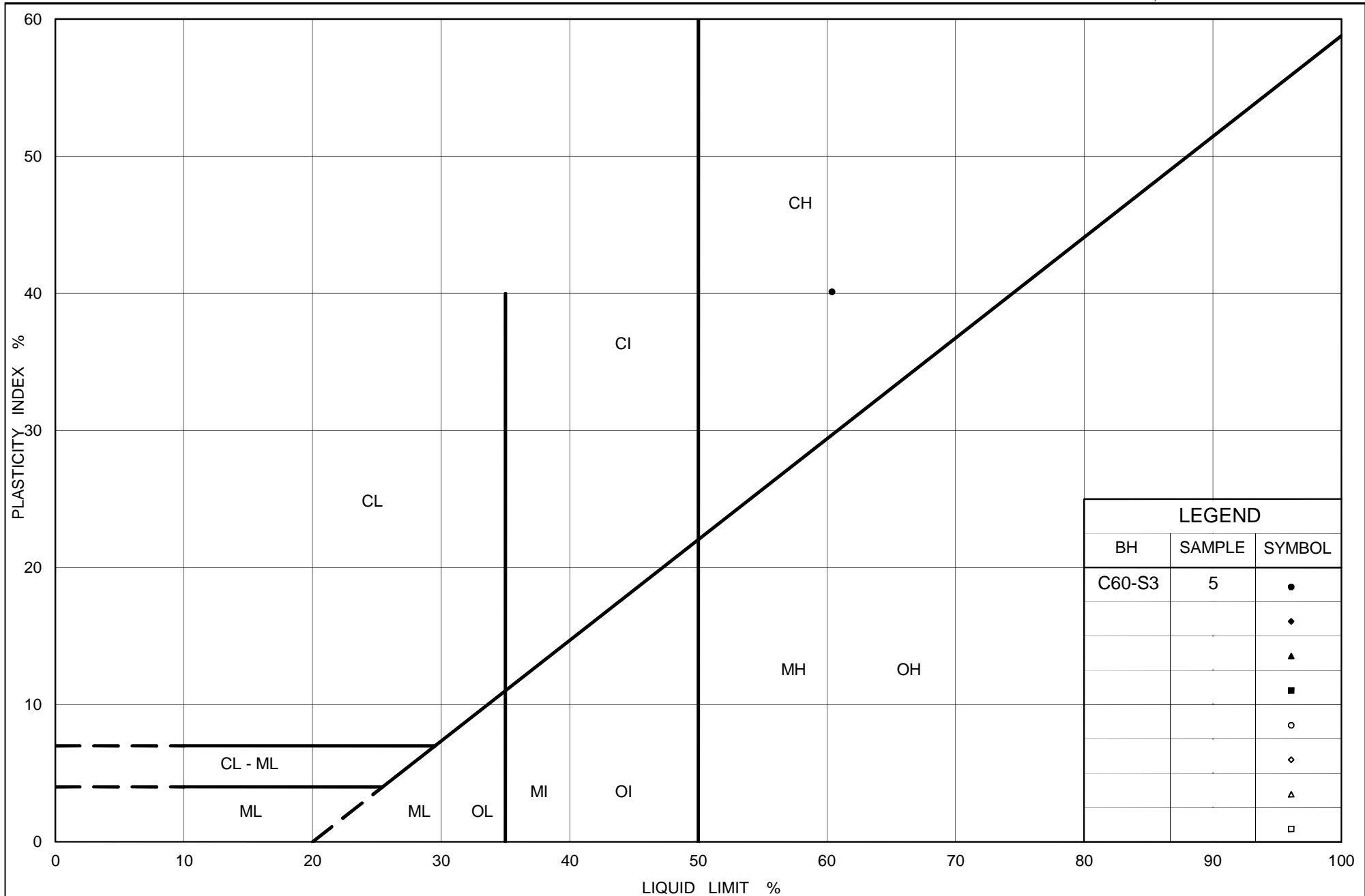
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C60-S2	2	199.9

Project Number: 07-1111-0029

Checked By: TVA

Golder Associates

Date: 25-Sep-09



Ministry of Transportation

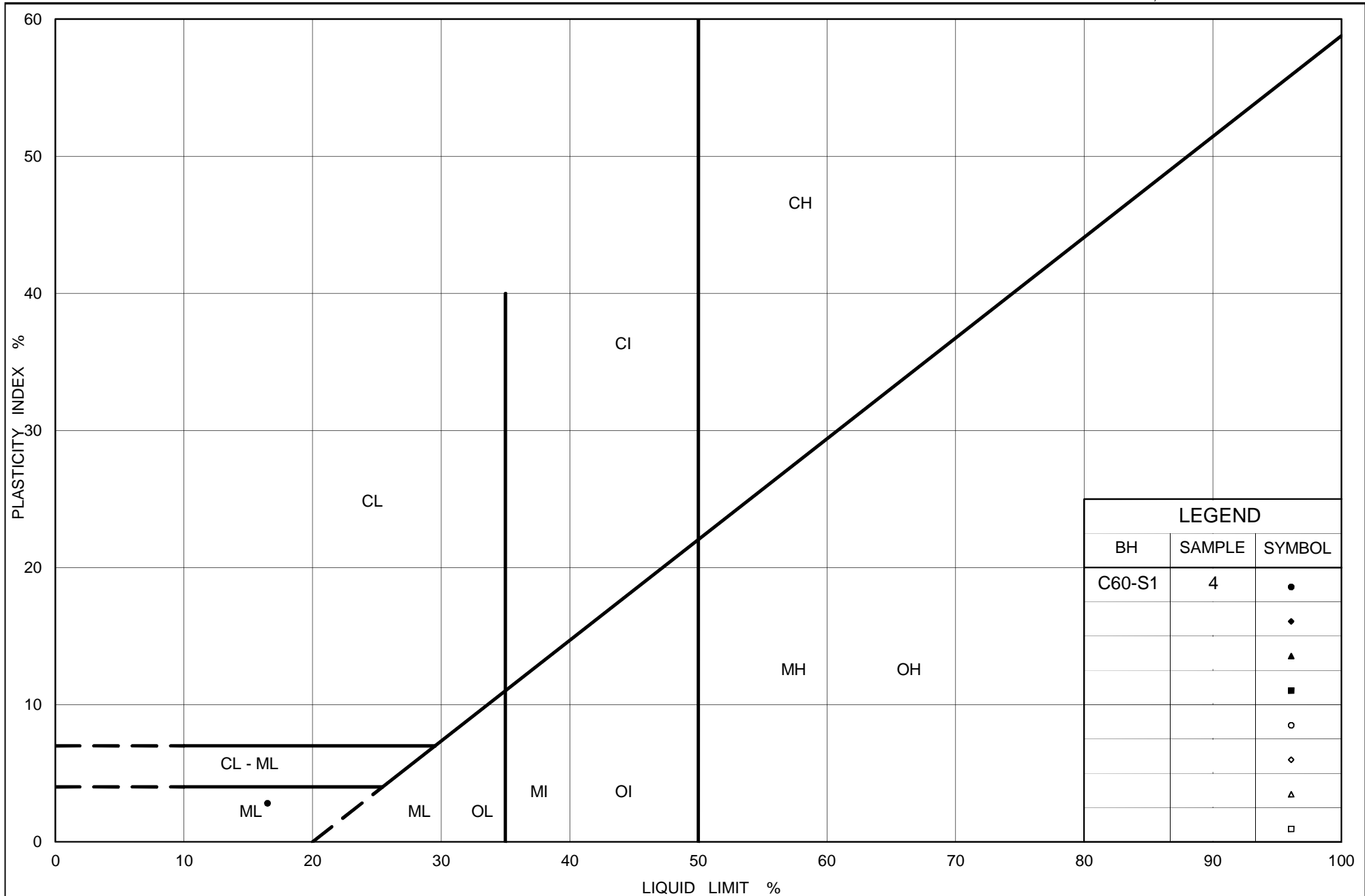
Ontario

PLASTICITY CHART
Clay
Highway 69 (SBL) STA 17+269

Figure No. I.C60-2

Project No. 07-1111-0029

Checked By: TVA



Ministry of Transportation

Ontario

PLASTICITY CHART
 Silt
 Highway 69 (SBL) STA 17+269

Figure No. I.C60-3

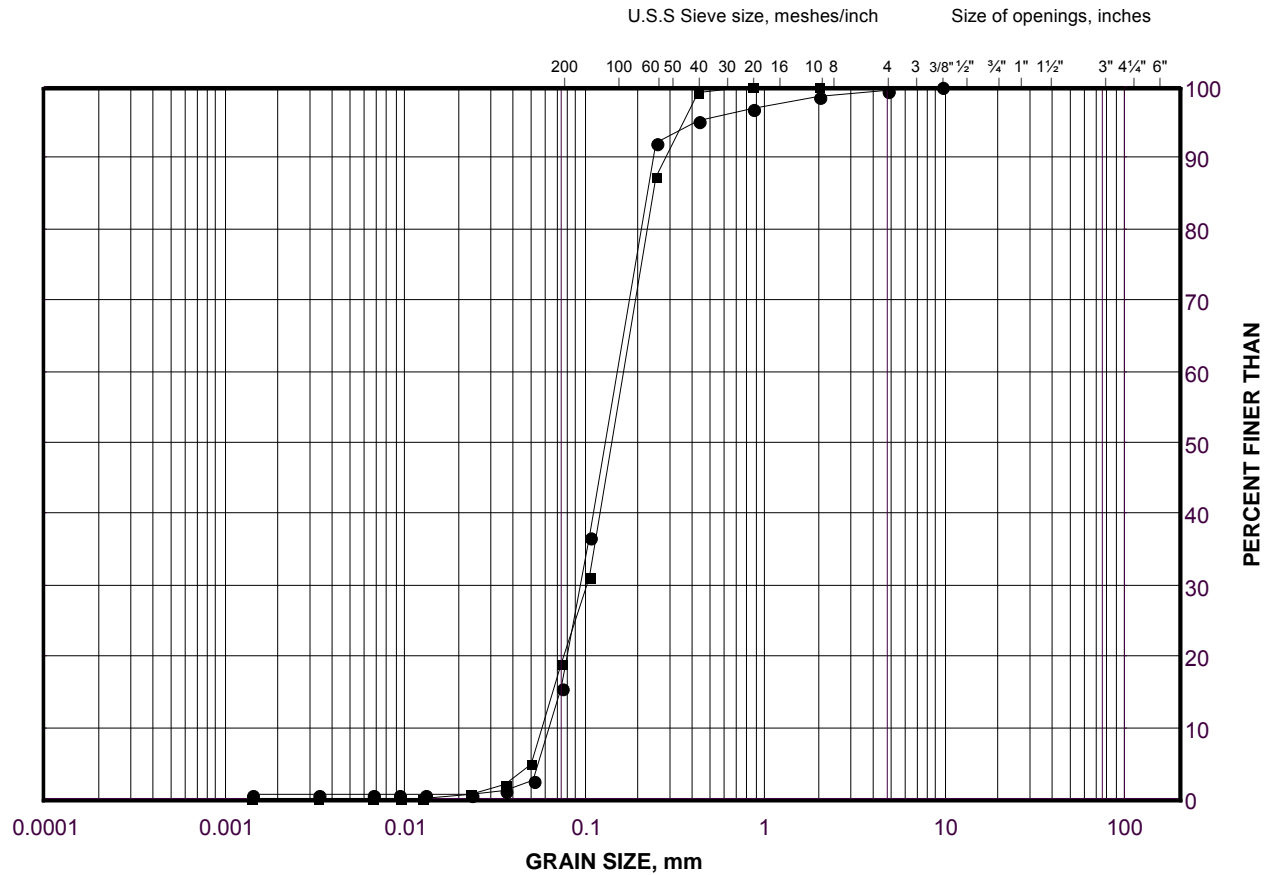
Project No. 07-1111-0029

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Sand
Highway 69 (SBL) STA 17+269

FIGURE I.C60-4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C60-S3	11	187.8
■	C60-S2	7	193.8

Project Number: 07-1111-0029

Checked By: TVA

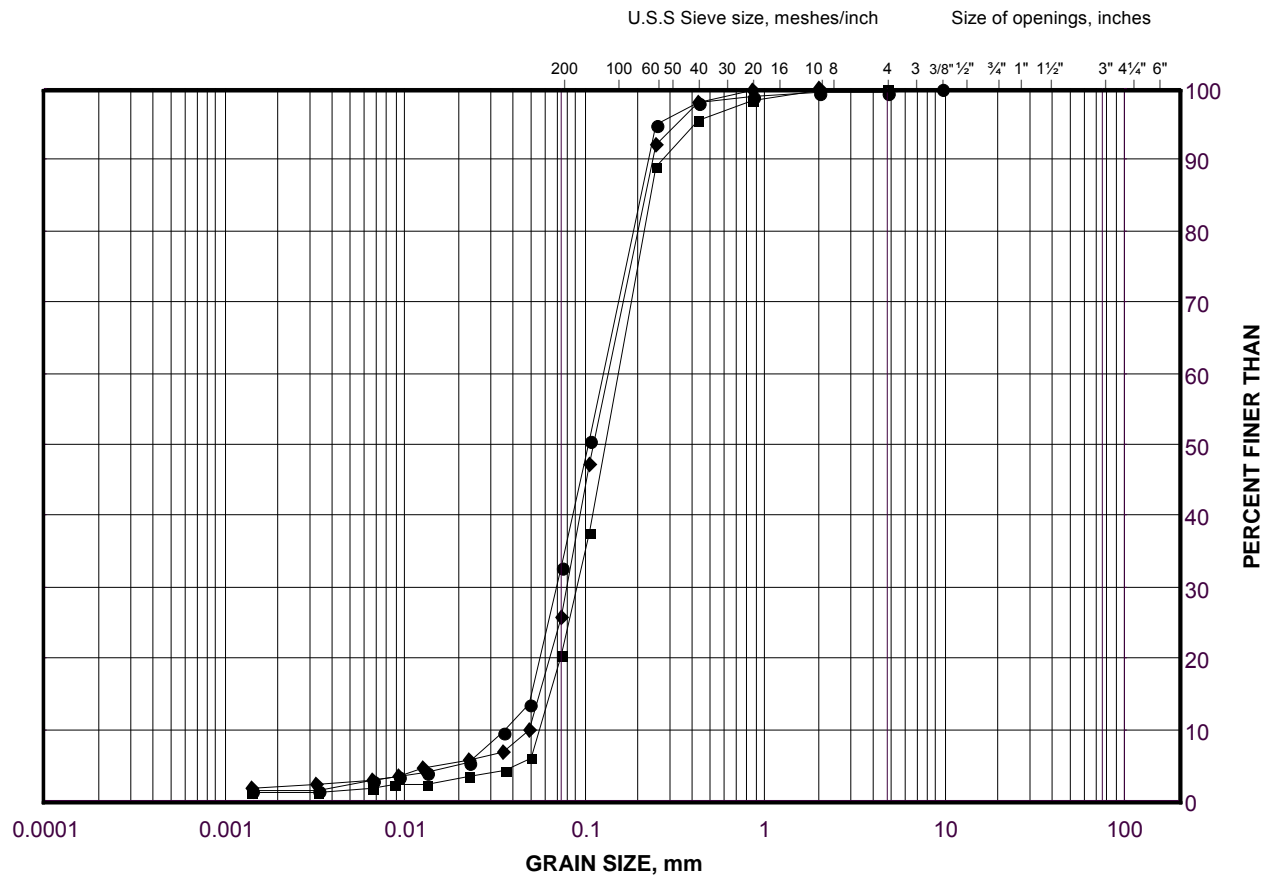
Golder Associates

Date: 25-Sep-09

GRAIN SIZE DISTRIBUTION

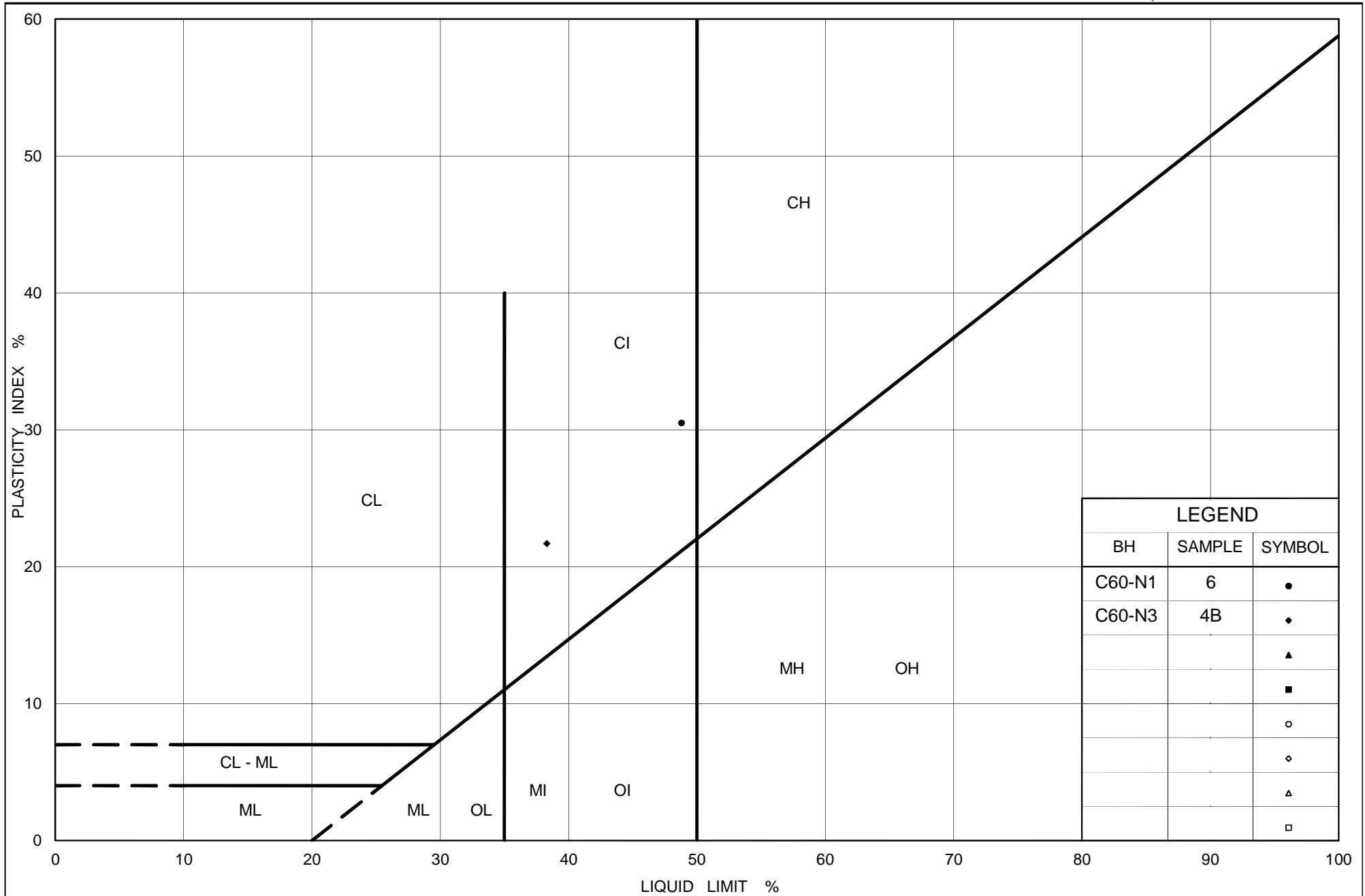
Silt and Sand to Sand (Upper)
Highway 69 (NBL) STA 17+279

FIGURE I.C60-5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C60-N3	3	199.1
■	C60-N1	3	199.5
◆	C60-N2	4	199.7



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PLASTICITY CHART
Silty Clay
Highway 69 (NBL) STA 17+279

Figure No. I.C60-6

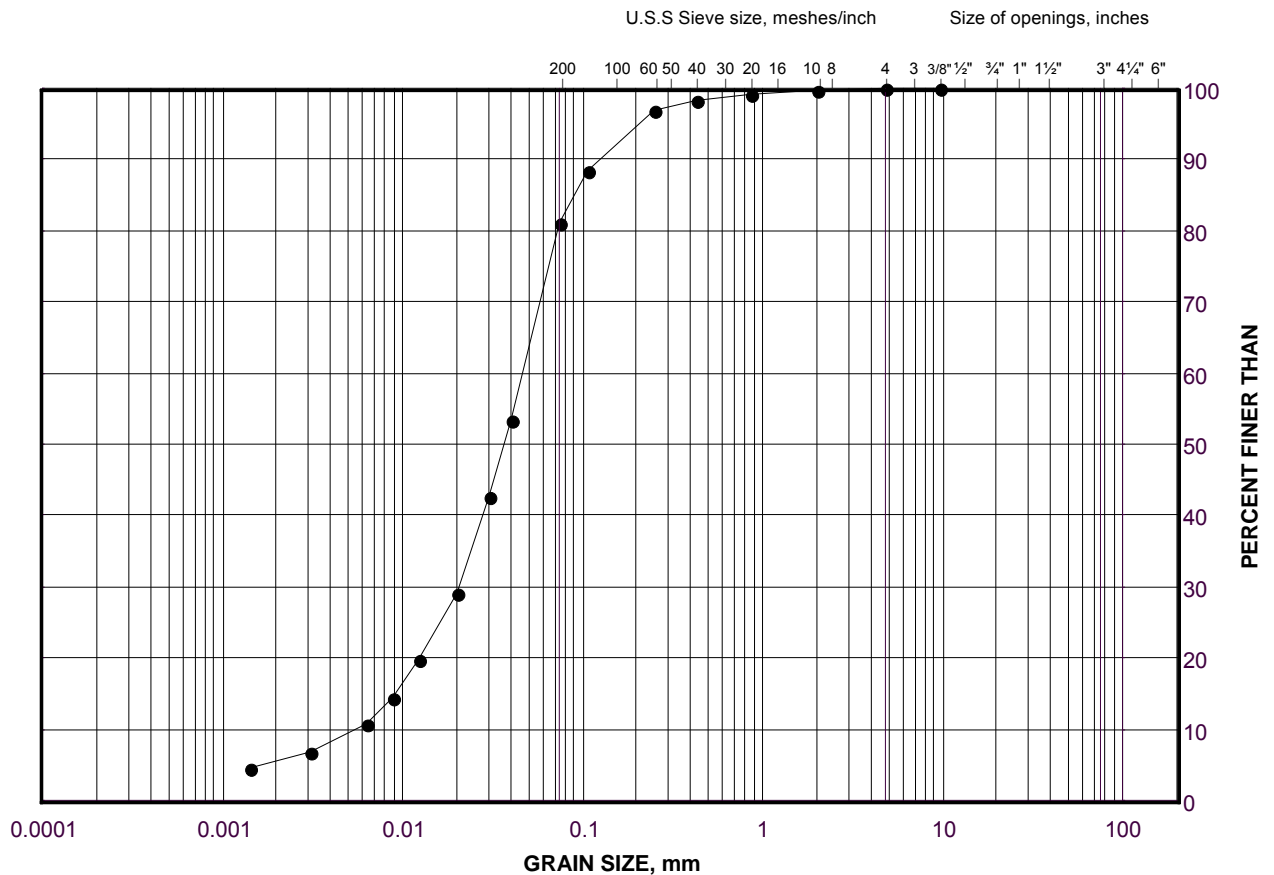
Project No. 07-1111-0029

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt
Highway 69 (NBL) STA 17+279

FIGURE I.C60-7



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

LEGEND

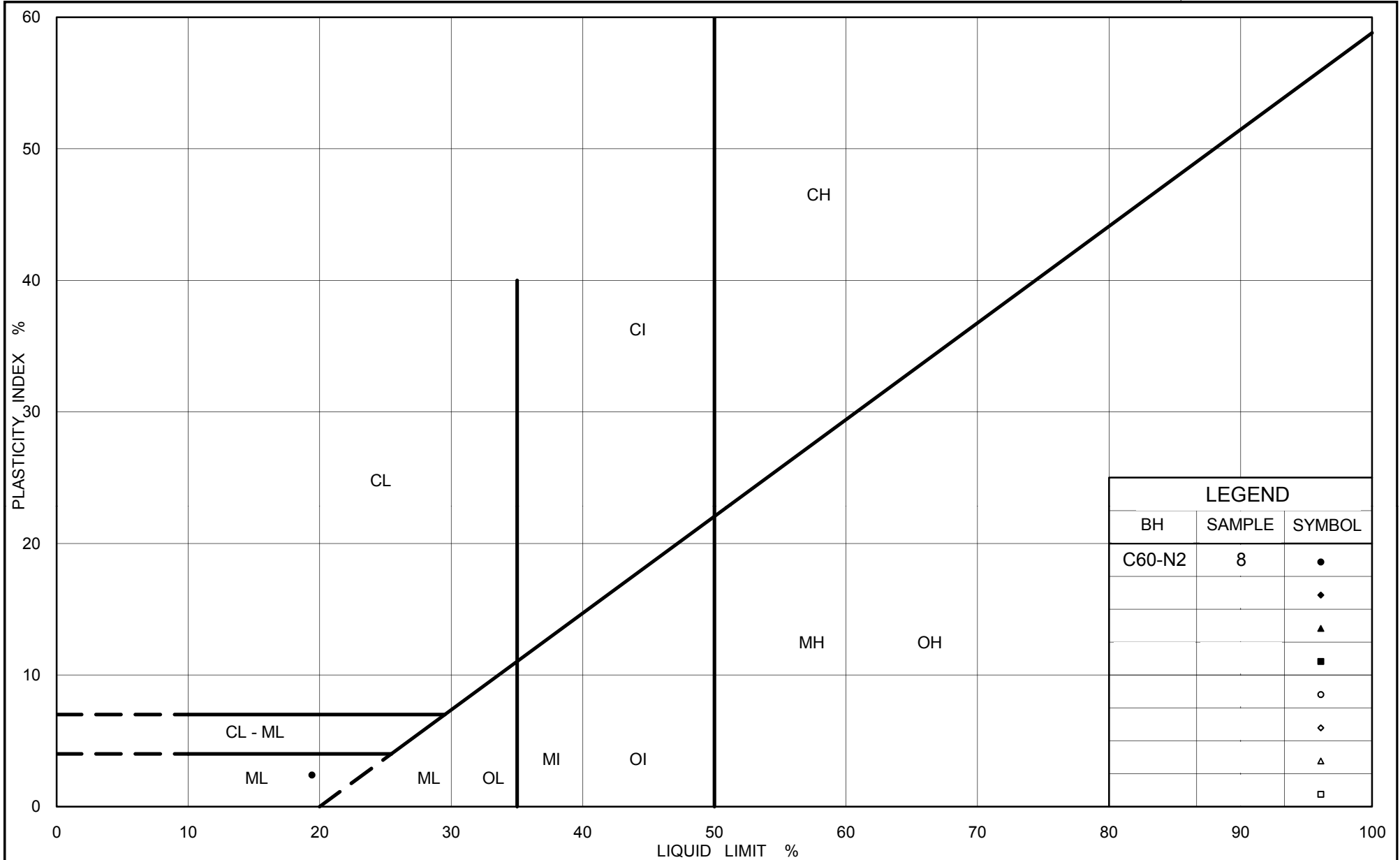
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C60-N1	8	195.7

Project Number: 07-1111-0029

Checked By: TVA

Golder Associates

Date: 25-Sep-09



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Ontario

PLASTICITY CHART
Silt
Highway 69 (NBL) STA 17+279

FigureNo. I.C60-8

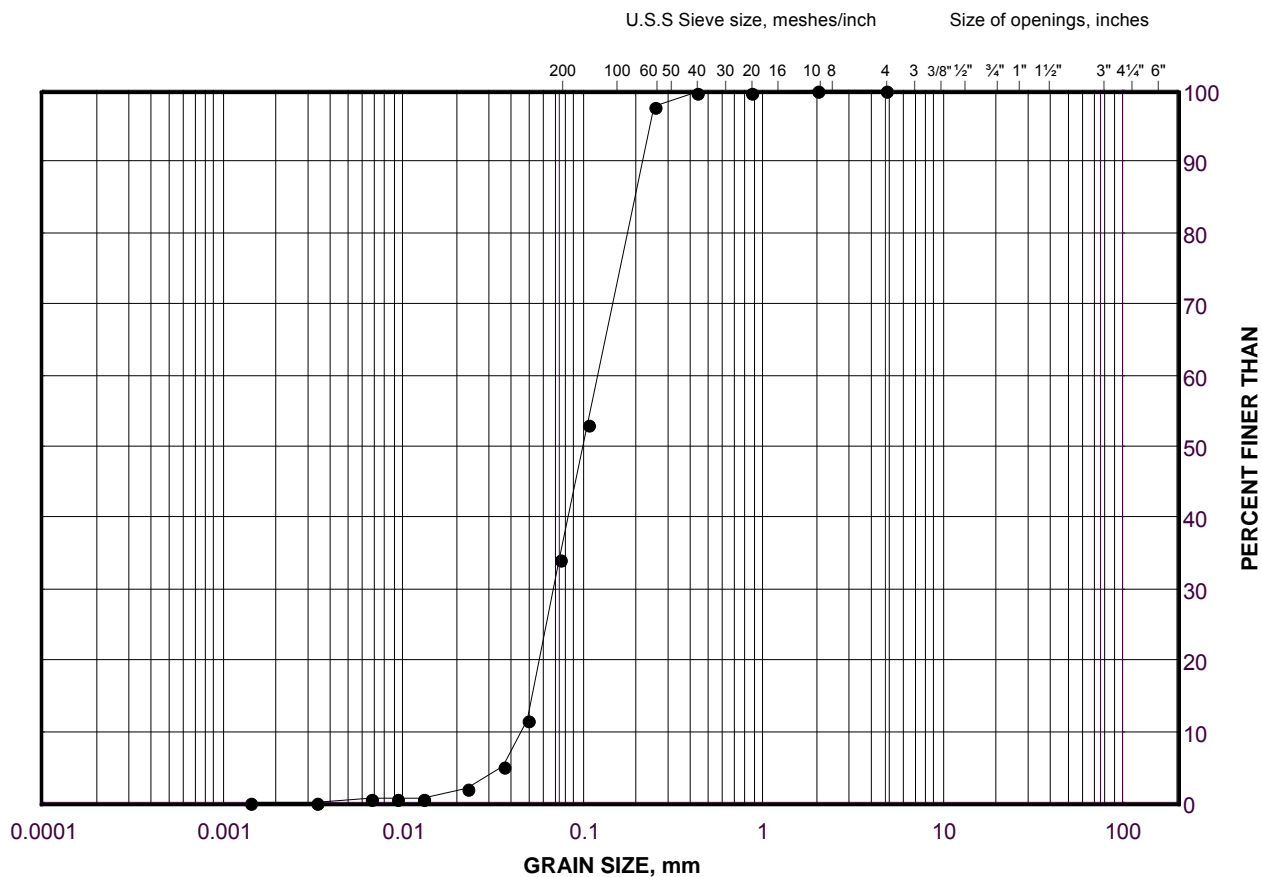
Project No. 07-1111-0029

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt and Sand (Lower)
Highway 69 (NBL) STA 17+279

FIGURE I.C60-9



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C60-N3	8	192.3

Project Number: 07-1111-0029

Checked By: TVA

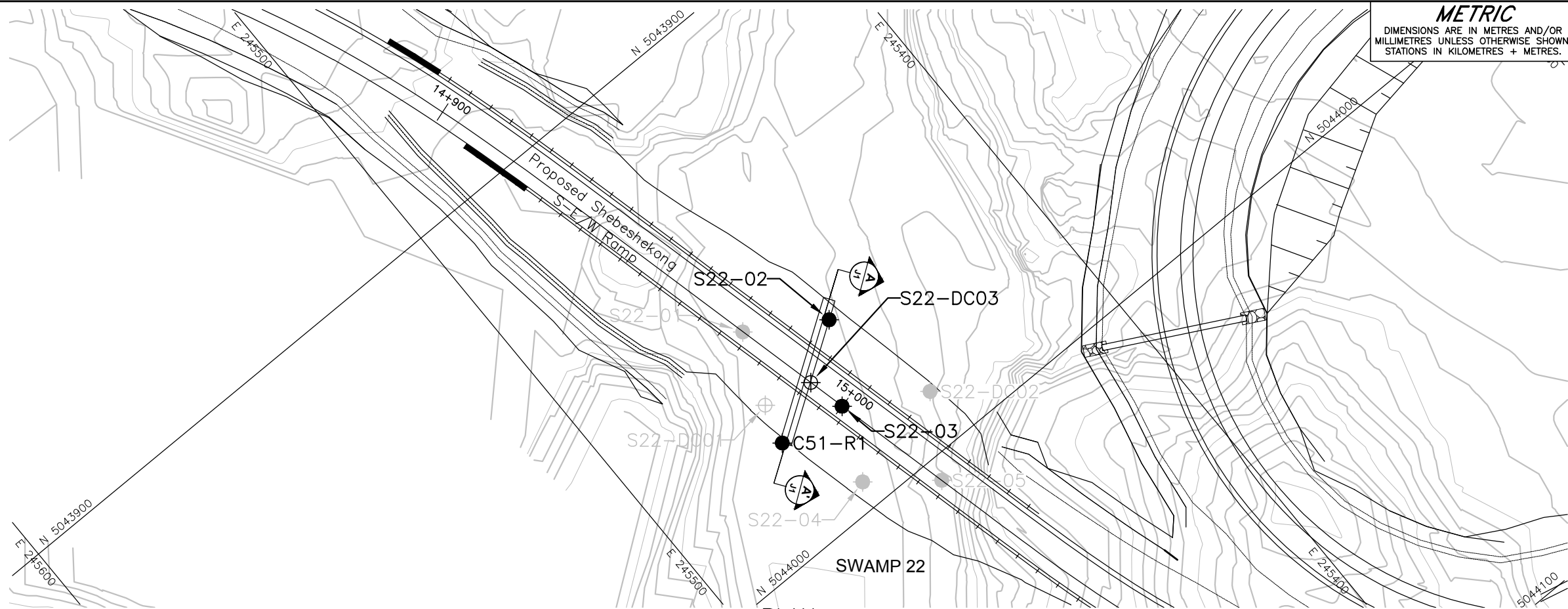
Golder Associates

Date: 25-Sep-09

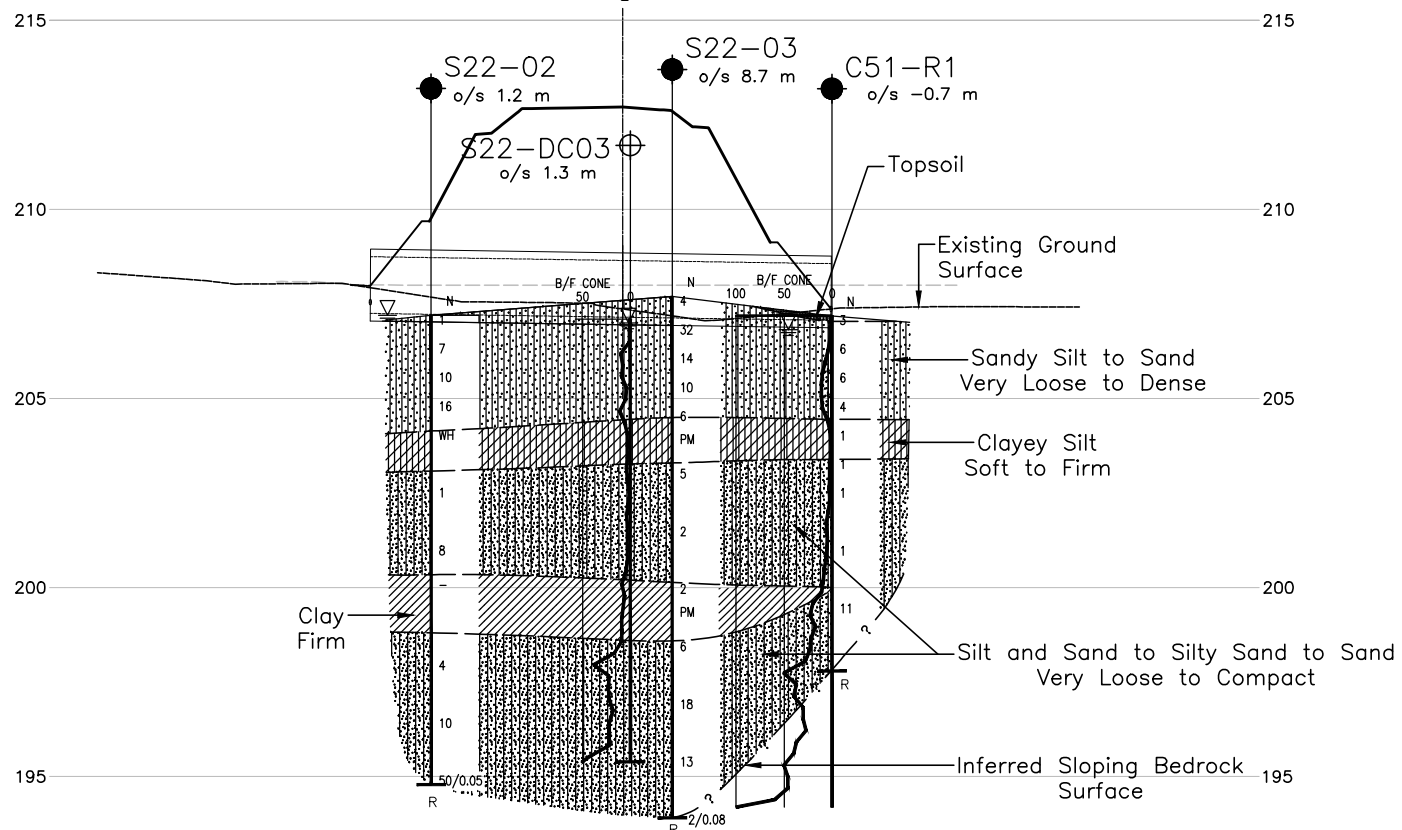


APPENDIX J

Shebeshekong S-E/W Ramp – STA 14+990 (Culvert C51)



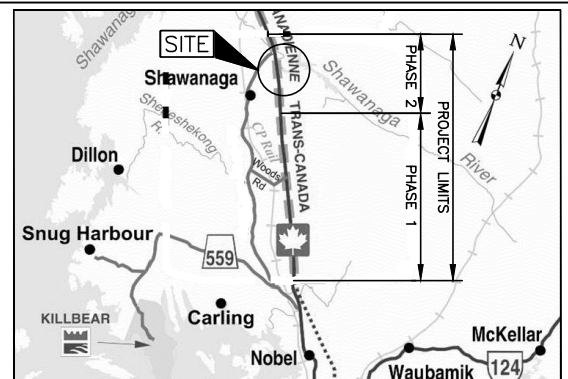
PLAN

Shebeshekong
S-E/W RampA-A
J1

CULVERT C51 PROFILE STA 14+990

HORIZONTAL SCALE
0 5 10 m
VERTICAL SCALE
0 2 4 m**METRIC**
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.CONT No.
GWP No. 5111-07-00HIGHWAY 69 SHEBESHEKONG S-E/W
TIE-IN CULVERT C51 STA 14+990
BOREHOLE LOCATIONS
AND SOIL STRATA

SHEET



KEY PLAN

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation
- ⊕ Dynamic Cone Penetration Test
- ⊕ Dynamic Cone Penetration Test - Previous Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C51-R1	207.2	5043978.2	245470.1
S22-02	207.2	5043965.1	245447.0
S22-03	207.7	5043980.2	245456.1
S22-DC03	207.1	5043972.5	245457.9

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 MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg received November 10, 2014, and h6878_PHASE2_XN1.dwg received May 15, 2015.
Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014.
Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.

NO.	DATE	BY	REVISION

Geocres No. 41H-160

HWY. 69	PROJECT NO. 07-1111-0029	DIST. .
SUBM'D. AJS	CHKD. CN	DATE: 6/5/2015
DRAWN: MR	CHKD. JMAC	APPD. JPD/JMAC
		SITE: .
		DWG. J1





GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

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

PROJECT 07-1111-0029		RECORD OF BOREHOLE No S22-02		SHEET 1 OF 2		METRIC												
G.W.P. 5402-05-00		LOCATION N 5043965.1 ; E 245447.0		ORIGINATED BY EHS														
DIST HWY 69		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring		COMPILED BY VO														
DATUM Geodetic		DATE March 26, 2008		CHECKED BY CN														
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 (%)					
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30	γ	GR	SA	SI	CL
207.2	GROUND SURFACE																	
0.0	Sandy SILT, trace gravel, trace organics Very loose to compact Dark brown to grey Wet		1	SS	1		207											
			2	SS	7		206											
			3	SS	10		205											
	Becoming grey at a depth of 2.3 m		4	SS	16		204											
204.2																		
3.1	CLAYEY SILT, trace sand Firm Reddish brown Wet		5	SS	WH		203											
203.1																		
4.1	SILT and SAND, trace to some clay Very loose to loose Grey Wet		6	SS	1		202											
							201											
			7	SS	8		200											
200.3																		
6.9	CLAY, some silt, trace sand Firm Reddish brown Wet		8	WS	-		199											
198.8																		
8.4	SILT and SAND, trace gravel, trace clay Loose to compact Grey Wet		10	SS	4		198											
							197											
	Reddish brown clay seams to a depth of 9.8 m		11	SS	10		196											
195.3																		
11.9	Silty SAND, some gravel Compact Grey Wet		12	SS	50/0.05		195											
194.8																		
12.4	END OF BOREHOLE SPOON REFUSAL																	
	NOTES: 1. Borehole caved to a depth of 11.6 m below ground surface (Elev. 195.6 m) upon removal of casing.																	

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE\GPJ GAL-GTA.GDT 03/25/16 DD/SAC



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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE I.GPJ GAL-GTA.GDT 03/25/16 DD/SAC



GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE I.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

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



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

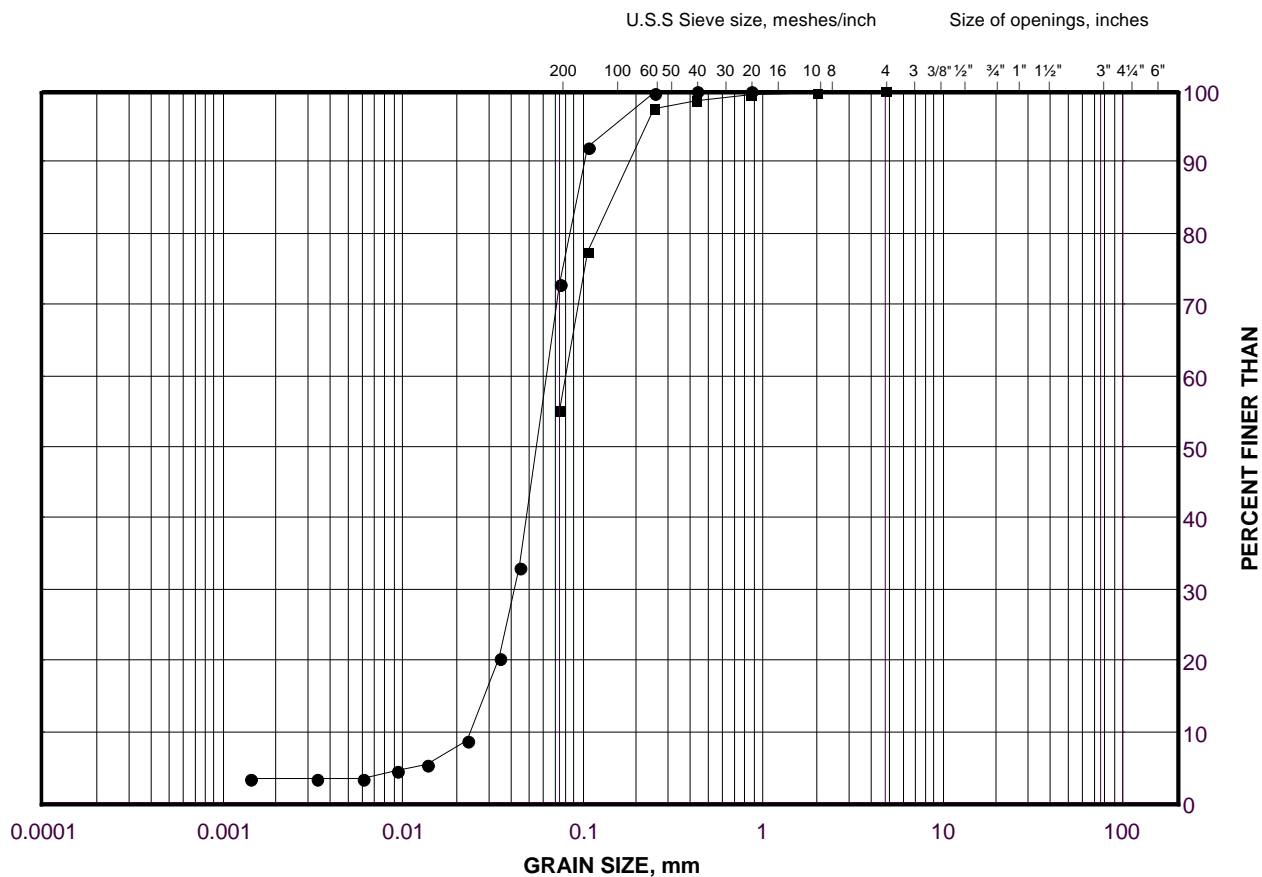
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PROJECT <u>07-1111-0029</u>		RECORD OF DCPT No S22-DC03		SHEET 1 OF 1		METRIC												
G.W.P. <u>5402-05-00</u>		LOCATION <u>N 5043972.5 ; E 245457.9</u>		ORIGINATED BY <u>ID</u>														
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>VO</u>														
DATUM <u>Geodetic</u>		DATE <u>March 19, 2008</u>		CHECKED BY <u>CN</u>														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
207.1	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>						
0.0	Dynamic Cone Penetration Test (DCPT)						207											
							206											
							205											
							204											
							203											
							202											
							201											
							200											
							199											
							198											
							197											
							196											
195.4 11.7	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)																	
NOTE: 1. DCPT advanced using portable drilling equipment with half weight hammer from ground surface to a depth of 7.3 m. Blows shown have been adjusted to infer values that would be obtained using a standard weight hammer.																		

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE\GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Sandy Silt to Silt and Sand
Shebeshekong Road S-E/W Ramp STA 14+990

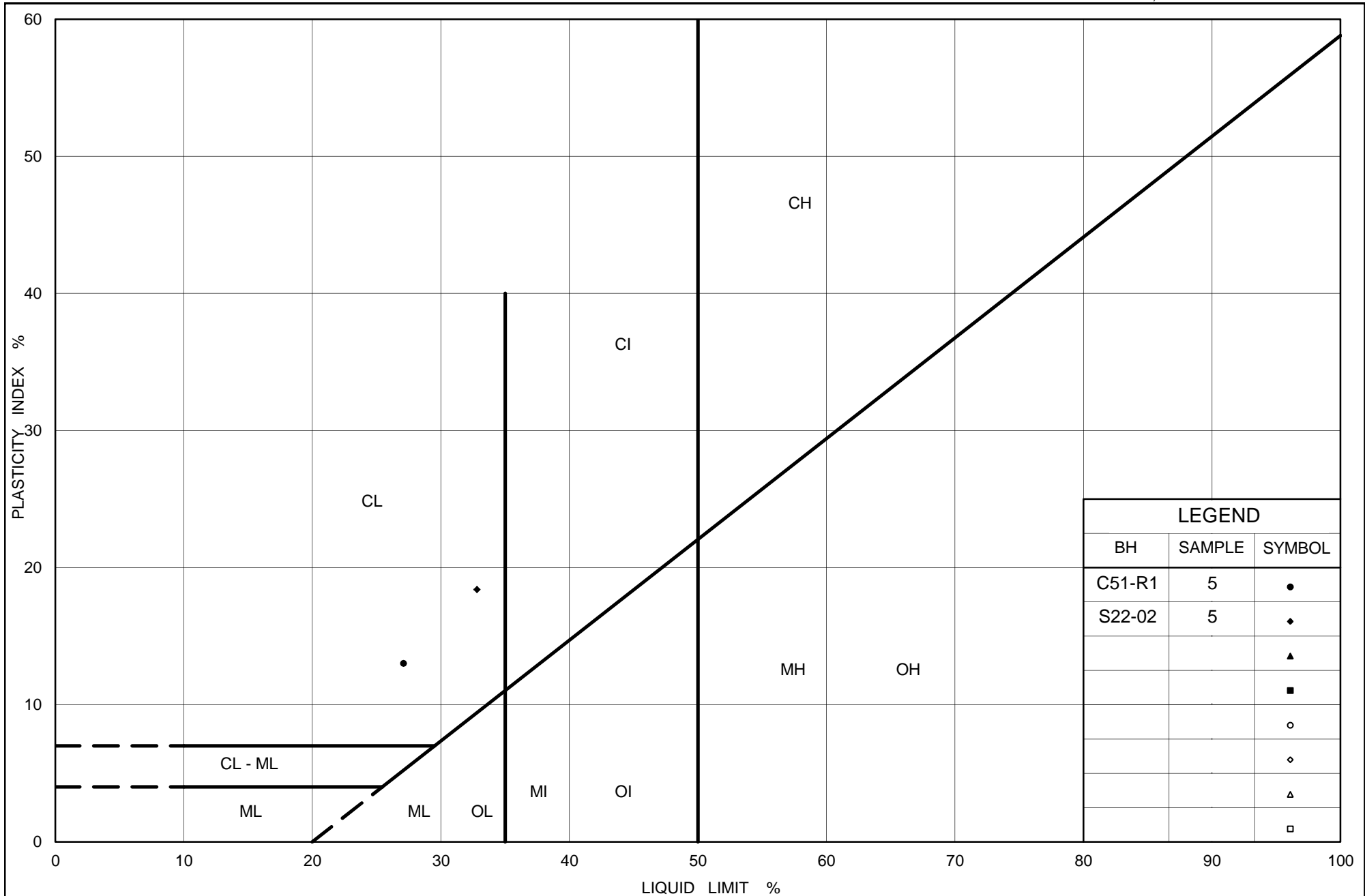
FIGURE J.C51-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C51-R1	2	206.1
■	S22-03	3	205.9



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PLASTICITY CHART
Clayey Silt
Shebeshekong Road S-E/W Ramp STA 14+990

Figure No. J.C51-2

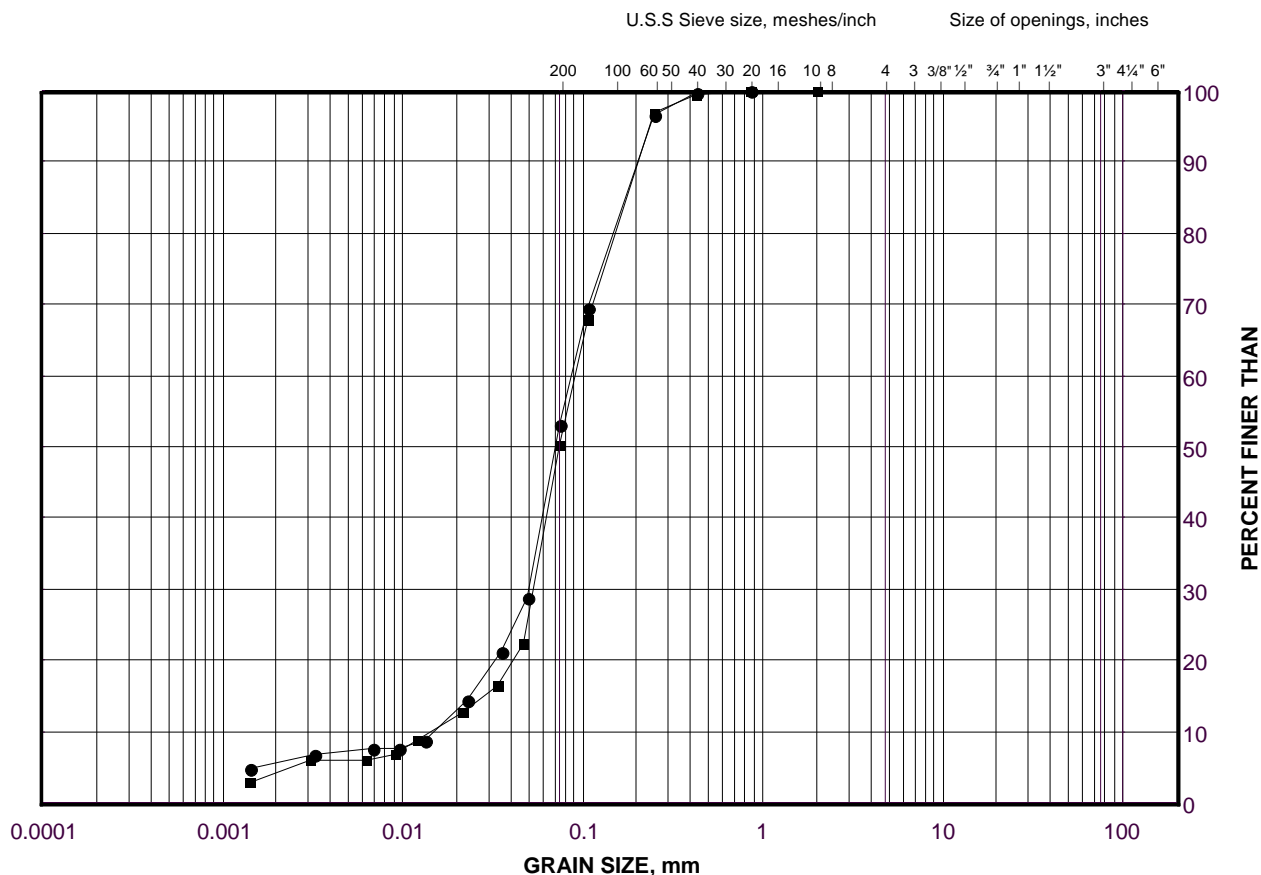
Project No. 07-1111-0029

Checked By: AJS

GRAIN SIZE DISTRIBUTION

Silt and Sand (Upper)
Shebeshekong Road S-E/W Ramp STA 14+990

FIGURE J.C51-3



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

LEGEND

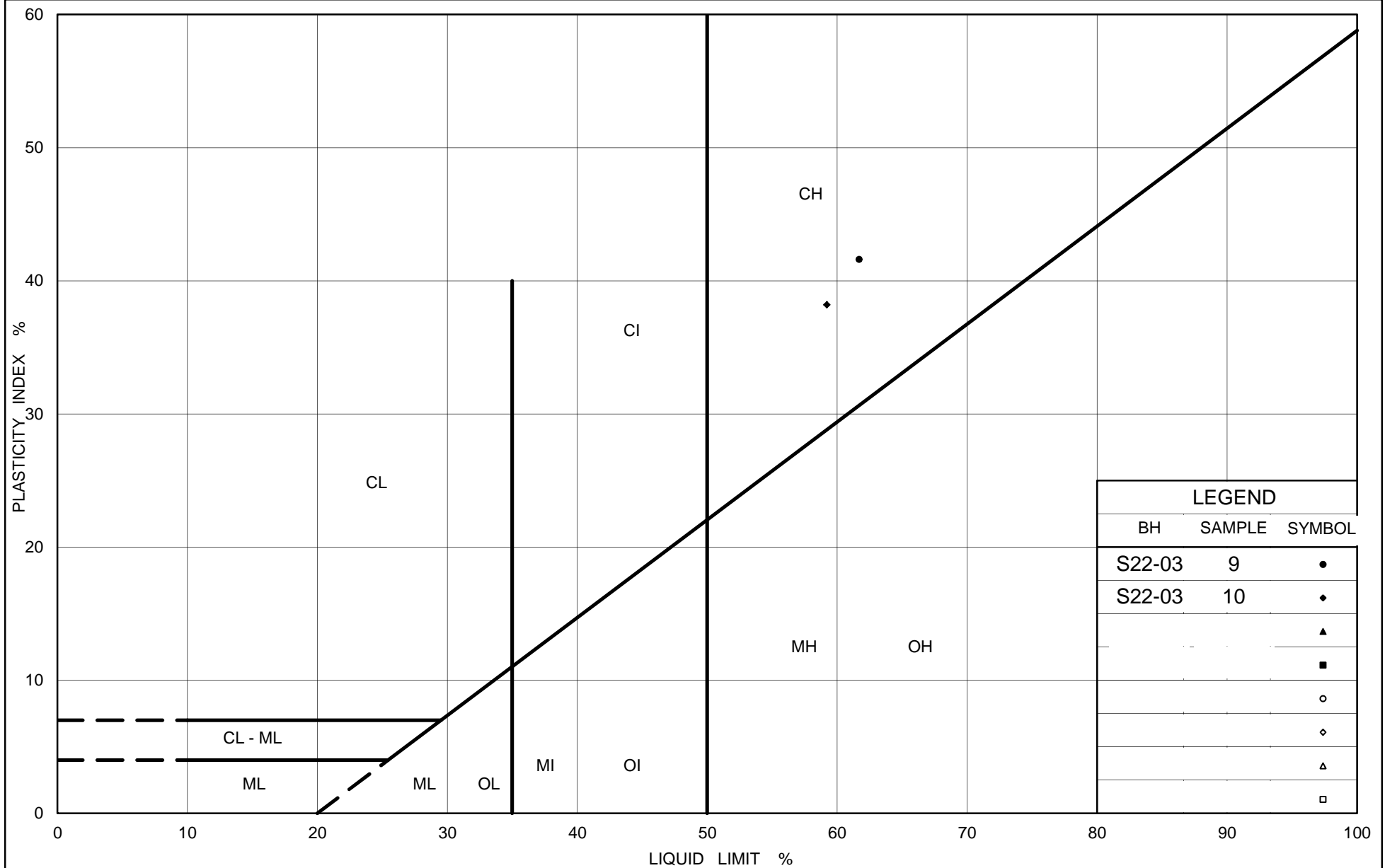
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C51-R1	7	202.3
■	S22-02	7	200.8

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 30-Jul-15



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PLASTICITY CHART Clay

Shebeshekong Road S-E/W Ramp STA 14+990

Figure No. J.C51-4

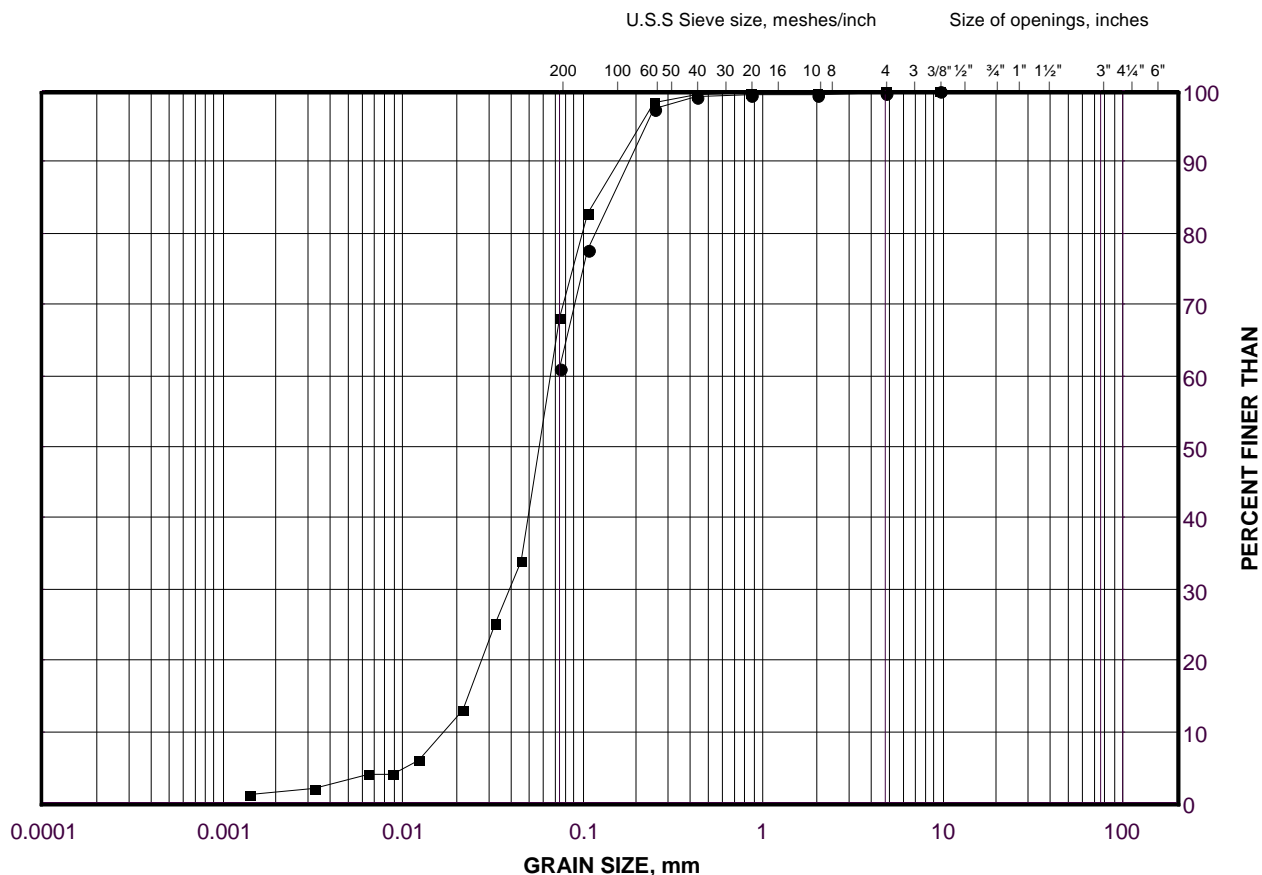
Project No. 07-1111-0029

Checked By: AJS

GRAIN SIZE DISTRIBUTION

Silt and Sand (Lower)
Shebeshekong Road S-E/W Ramp STA 14+990

FIGURE J.C51-5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S22-02	11	196.2
■	S22-03	12	196.7

Project Number: 07-1111-0029

Checked By: AJS

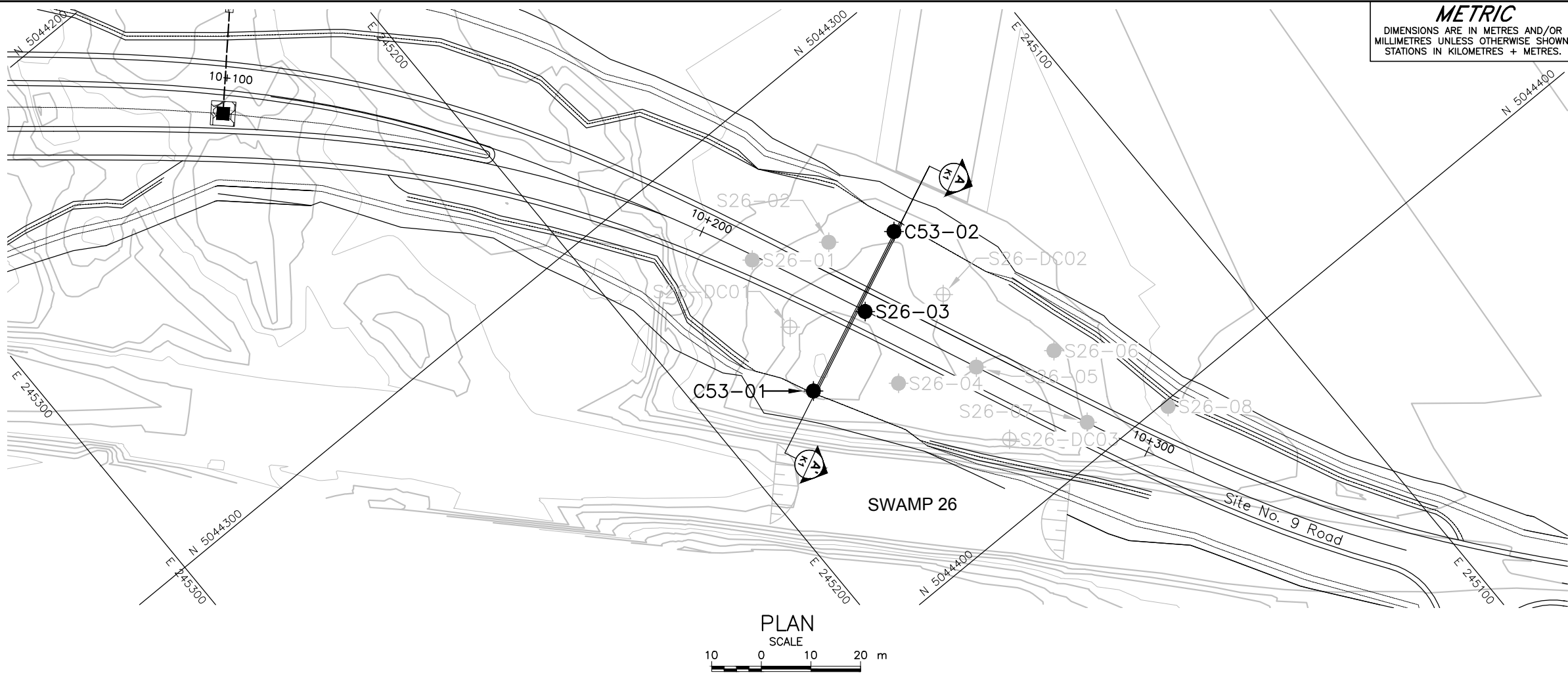
Golder Associates

Date: 30-Jul-15



APPENDIX K

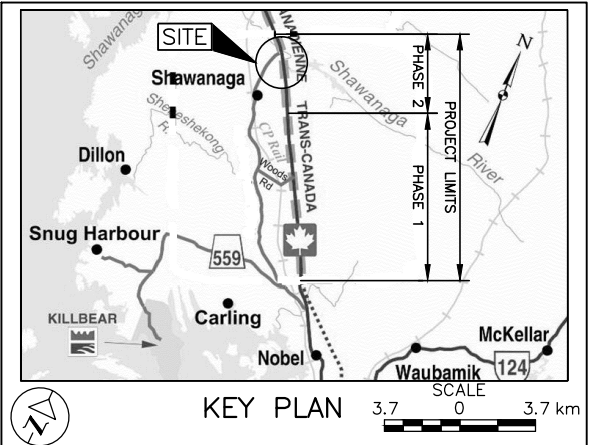
Site No. 9 Road – STA 10+235 (Culvert C53)



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

CONT No.
GWP No. 5111-07-00

HIGHWAY 69 TIE-IN
CULVERT C53 STA 10+235 (SITE No. 9 ROAD)
BOREHOLE LOCATIONS
AND SOIL STRATA



LEGEND

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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C53-01	211.0	5044353.2	245179.8
C53-02	210.8	5044338.8	245146.8
S26-03	210.9	5044347.5	245161.6

NOTES

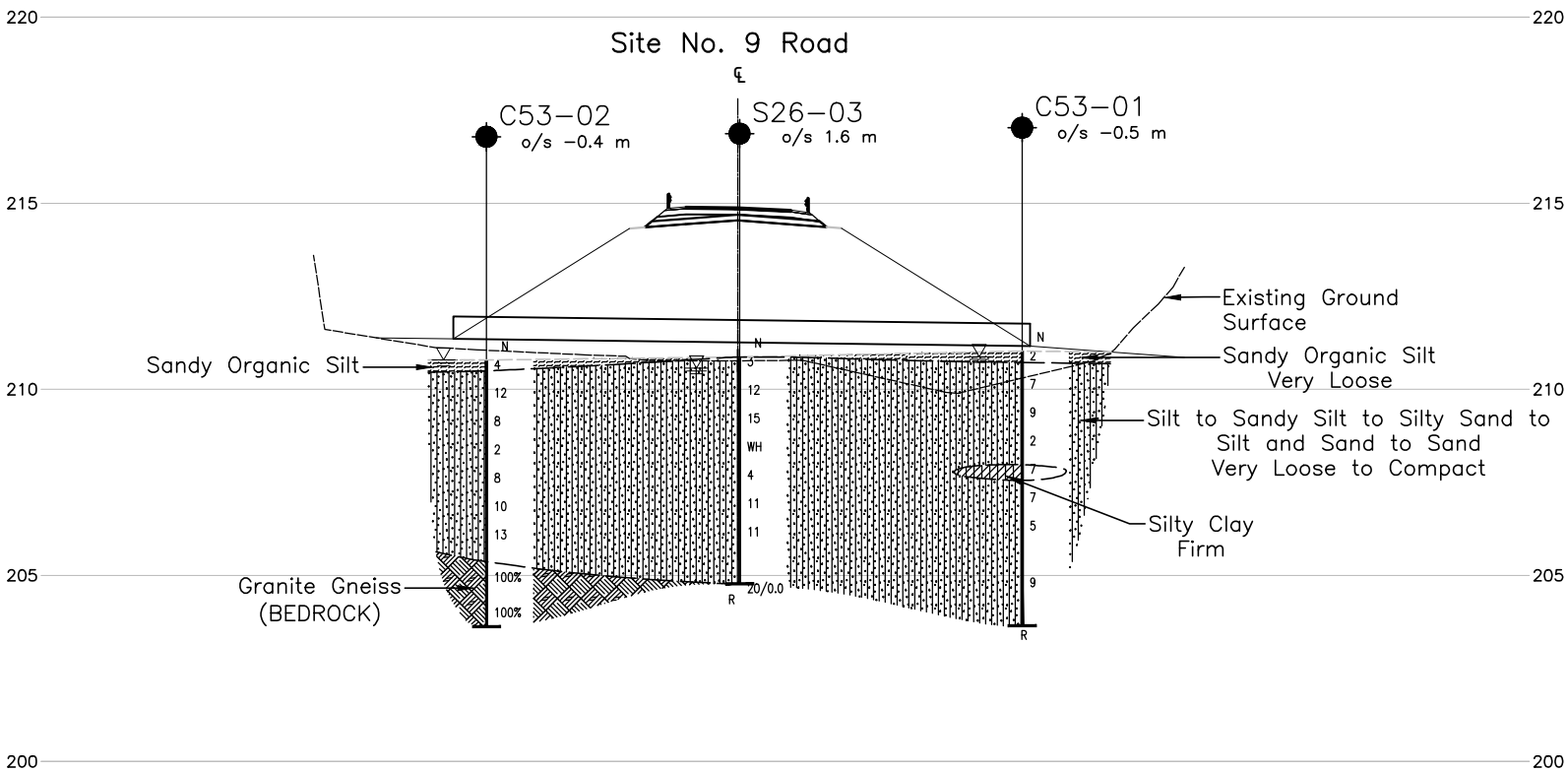
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

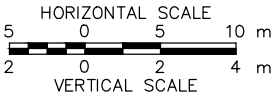
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, h6878_PHASE2_XD1 grading.dwg and h6878_PHASE2_XN1.dwg, received November 10, 2014. Contours provided in digital format by MRC, drawing file no. h6878xb07 Phase-2 contours 1m intervals.dwg, received October 31, 2014. Cross-section provided in digital format by MMM, drawing file no. 6878-Ph 2 Hwy 69 - Culvert XS-May 7, 2015.dwg, received May 15, 2015.



A-A CULVERT C53 PROFILE STA 10+235
K1



Geocres No. 41H-160			
NO.	DATE	BY	REVISION
HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. AJS	CHKD. CN	DATE: 3/18/2016	SITE: .
DRAWN: MR	CHKD. JMAC	APPD. JMAC	DWG. K1

PROJECT		RECORD OF BOREHOLE		No C53-01		SHEET 1 OF 1		METRIC								
G.W.P. 07-1111-0029		LOCATION		N 5044353.2 ; E 245179.8		ORIGINATED BY		ID								
DIST		HWY 69		BOREHOLE TYPE		Continuous Flight 203 mm O.D. Hollow Stem Augers		COMPILED BY								
DATUM		Geodetic		DATE		February 2, 2015		CHECKED BY								
								MCK								
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								
211.0	GROUND SURFACE															
0.0	Sandy ORGANIC SILT		1A	SS	2											
0.3	Brown Wet		1B													
210.2	Silty SAND, trace organics		2	SS	7											
0.8	Very loose Brown Wet															
	SILT and SAND, trace gravel, trace to some clay		3	SS	9											
	Very loose to loose Grey Wet															
			4	SS	2											
208.0																
3.0	SILTY CLAY, trace sand		5A	SS	7											
207.5	Firm Grey Wet		5B													
3.5	SILT, some sand, trace clay		6	SS	7											
	Loose Grey Wet															
			7	SS	5											
205.4																
5.6	SAND, trace silt															
	Loose Grey Moist		8	SS	9											
203.6																
7.4	AUGER REFUSAL END OF BOREHOLE															
	NOTE: 1. Water level measured in open borehole at a depth of 0.2 m below ground surface (Elev. 210.8 m) upon completion of drilling.															

PROJECT		RECORD OF BOREHOLE		No C53-02		SHEET 1 OF 1		METRIC								
G.W.P. 07-1111-0029		LOCATION		N 5044338.8 ; E 245146.8		ORIGINATED BY		ID								
DIST		HWY 69		BOREHOLE TYPE		Continuous Flight 203 mm O.D. Hollow Stem Augers		COMPILED BY								
DATUM		Geodetic		DATE		February 3 and 4, 2015		CHECKED BY								
								MCK								
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								
210.8	GROUND SURFACE															
0.0	Sandy ORGANIC SILT		1A	SS	4											
210.5	Very loose		1B	SS												
0.3	Brown															
	Wet															
	SAND, some silt, trace clay, trace															
	gravel, trace organics		2	SS	12											
	Very loose to compact															
	Brown															
	Wet		3	SS	8											
208.6																
2.2	SILT and SAND															
	Very loose to loose		4	SS	2											
	Brown to grey															
	Wet															
207.8																
3.0	SAND, trace to some clay															
	Loose to compact		5	SS	8											
	Brown to grey															
	Wet															
			6	SS	10											
			7	SS	13											
205.4																
5.4	Granite Gneiss (BEDROCK)		1	RC	REC 100%											
	Bedrock cored from depths of 5.4 m to 7.2 m.															
	For bedrock coring details refer to Record of Drillhole C53-02.		2	RC	REC 100%											
203.6																
7.2	END OF BOREHOLE															
	NOTE:															
	1. Water level encountered at ground surface (Elev. 210.8 m) upon completion of drilling.															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-CULVERT-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DV

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

[illegible]

LOGGED: ID
CHECKED: MCK

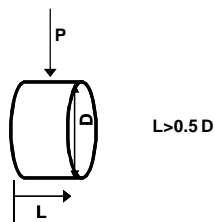
PROJECT 07-1111-0029		RECORD OF BOREHOLE No S26-03		SHEET 1 OF 1		METRIC															
G.W.P. 5111-07-00		LOCATION N 5044347.5 ; E 245161.6		ORIGINATED BY ID																	
DIST HWY 69		BOREHOLE TYPE Continuous Flight 108 mm I.D. Hollow Stem Augers		COMPILED BY KD/MR																	
DATUM Geodetic		DATE January 30, 2015		CHECKED BY AJS/MCK																	
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		
210.9 0.0	GROUND SURFACE Silty SAND, trace clay, trace organics to a depth of 0.8 m Very loose to compact Brown to grey Wet		1	SS	3	▽	210														
			2	SS	12		209												0 69 28 3		
208.6 2.3	Sandy SILT, trace clay Very loose to compact Brown to grey Wet		4	SS	WH		208														
			5	SS	4		207												0 22 75 3		
			6	SS	11		206														
			7	SS	11		205														
204.8 6.1	SPOON AND AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.3 m below ground surface (Elev. 210.6 m) upon completion of drilling.		8	SS	20/0.0																

TABLE K1
SUMMARY OF POINT LOAD TEST ON ROCK SAMPLES

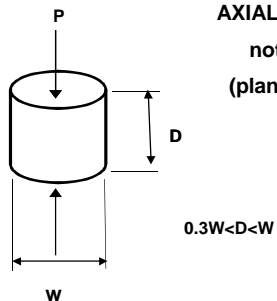
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C53-02	1	5.7	205.1	Granite Gneiss	Diametral	4.48
C53-02	2	6.0	204.8	Granite Gneiss	Axial	6.01
C53-02	2	6.1	204.7	Granite Gneiss	Axial	10.49
C53-02	2	6.7	204.1	Granite Gneiss	Diametral	4.25
C53-02	2	6.7	204.1	Granite Gneiss	Axial	3.70
C53-02	2	7.2	203.6	Granite Gneiss	Axial	4.89

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)



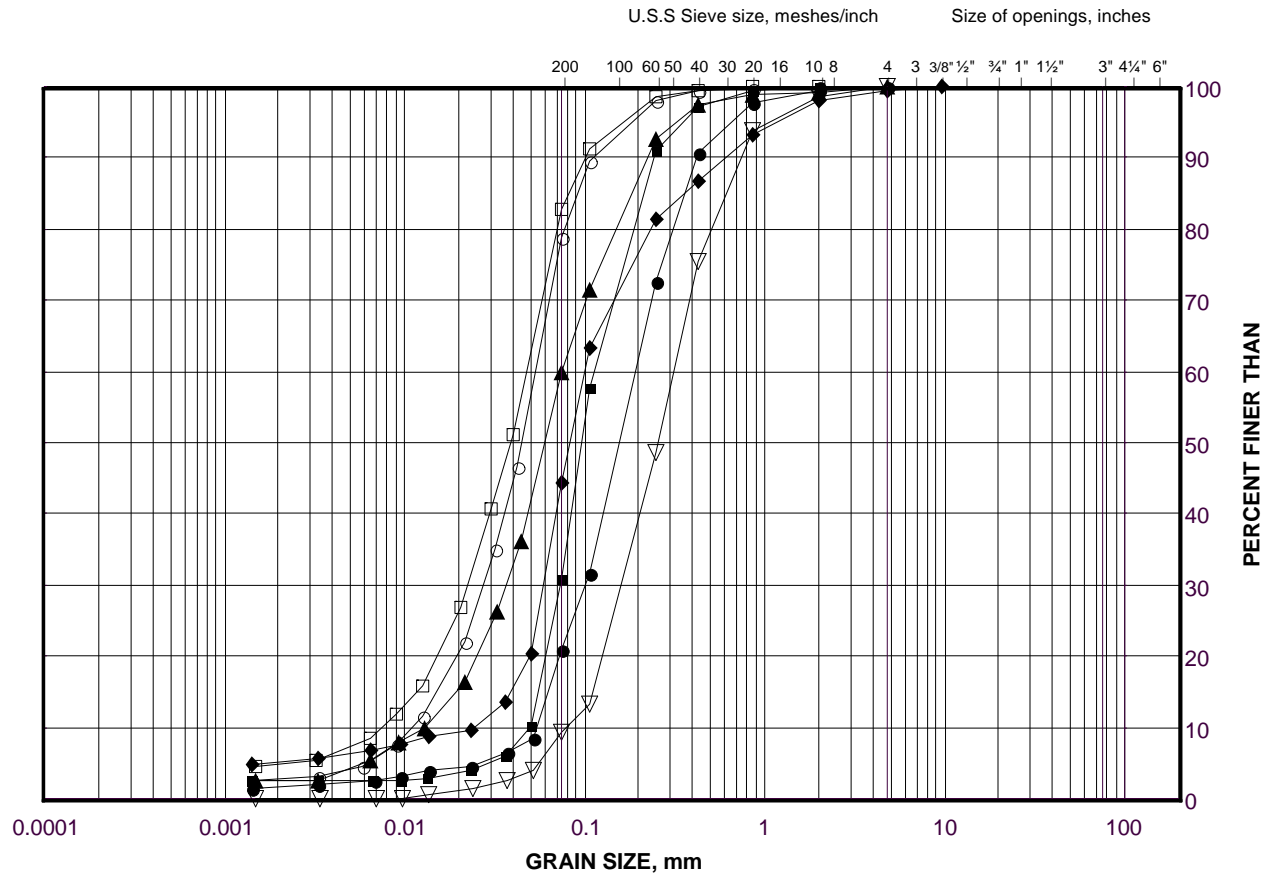
Compiled By: MCK
 Checked By: CN
 Reviewed By: JMAC

GRAIN SIZE DISTRIBUTION

Silt to Sand

Site No.9 Road STA 10+235

FIGURE K.C53-1



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

LEGEND

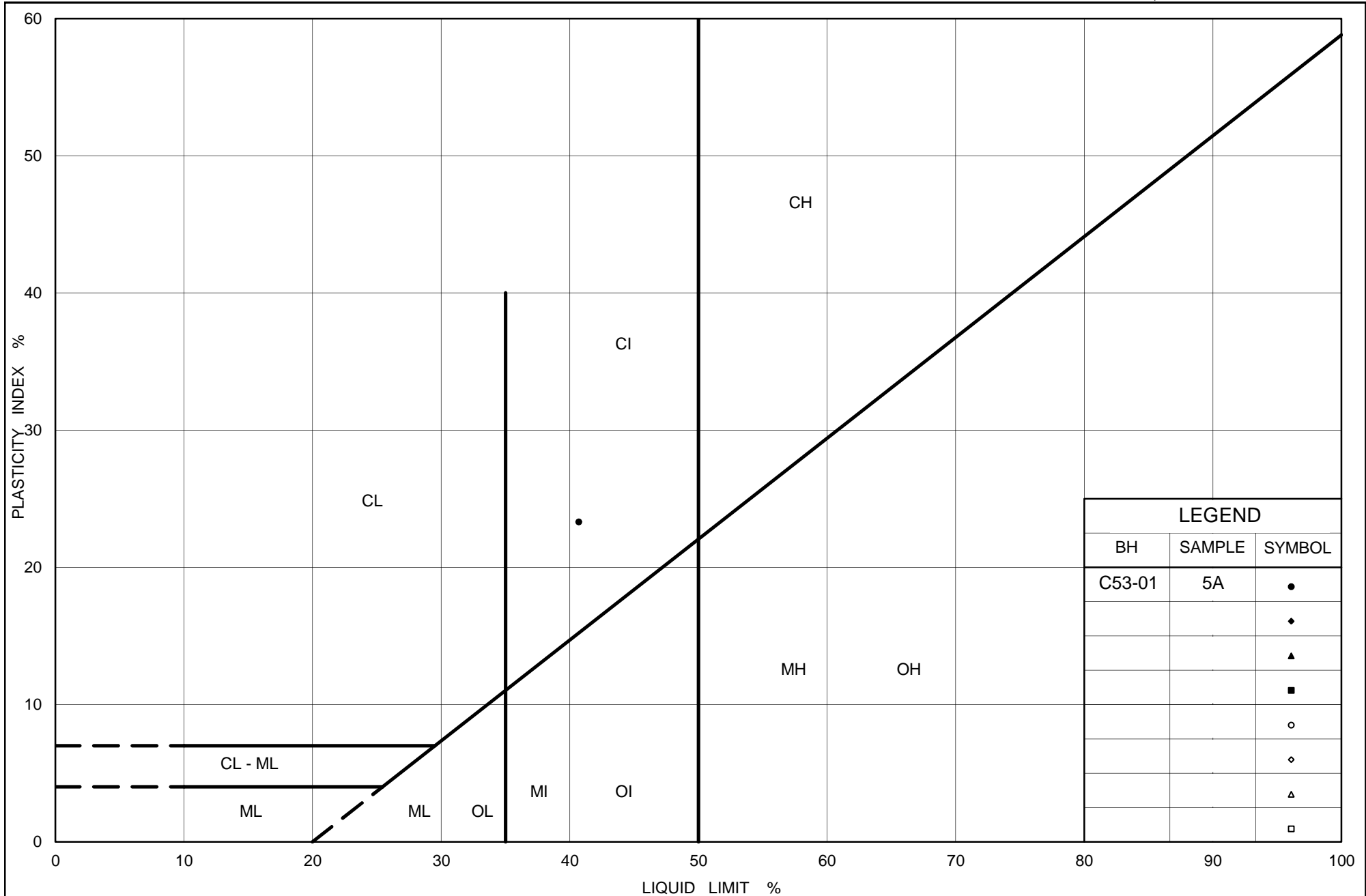
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C53-02	2	209.7
■	S26-03	3	209.1
◆	C53-01	3	209.2
▲	C53-02	4	208.2
▽	C53-02	6	206.7
○	S26-03	6	206.8
□	C53-01	7	206.1

Project Number: 07-1111-0029

Checked By: AJS

Golder Associates

Date: 17-Aug-15



Ministry of Transportation

Ontario

PLASTICITY CHART
Silty Clay (Pocket)
Site No. 9 Road STA 10+235

Figure No. K.C53-2

Project No. 07-1111-0029

Checked By: AJS



APPENDIX L

Non-Standard Special Provisions

DOWELS INTO ROCK - Item No.

Non-Standard Special Provision

Scope of Work

This special provision covers the requirements for the placement and field testing of dowels into rock.

Construction

Dowels into rock shall be constructed in accordance with OPSS.PROV 904 Concrete Structures. All reinforcing steel supplied shall be in accordance with OPSS.PROV 1440 Steel Reinforcement for Concrete (dowel bars conforming to CAN/CSA G30.18, Grade 400).

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

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

Rock Dowel Testing

All proposed testing procedures shall be in general conformance with ASTM D3689, ASTM D1143/D1143M and ASTM D4435. Field testing must be carried out in the presence of, and the results reviewed and approved by, the Contract Administrator.

Performance Tests

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

Culvert	Foundation	Number of Dowels for Performance Testing
C57.1 – STA 16+345	Culvert Footing	2

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

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

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

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

Displacement measurements shall be carried out at each load increment using calibrated displacement gauges capable of measuring movements of 0.0025 cm. Measurements shall be referenced to an independent fixed referenced pint.

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

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

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

Basis of Payment

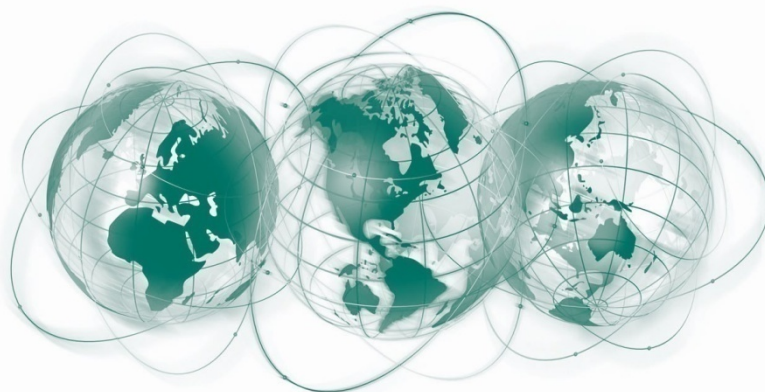
Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION

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

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