



May 31, 2016

FOUNDATION INVESTIGATION REPORT

**HIGHWAYS 17/94 ROUNDABOUT
FROM 1.0 KM WEST OF HIGHWAY 94 EASTERLY 1.5 KM
EAST FERRIS TOWNSHIP, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5153-11-00**

Submitted to:
MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario
L3T 0A1



GEOCRES NO.: 31L-195

Report Number: 10-1191-0041-R04

Distribution:

- 1 PDF Copy Ministry of Transportation, Ontario, North Bay, Ontario (Northeastern Region)
- 1 PDF Copy Ministry of Transportation, Ontario, Downsview, Ontario (Foundations Section)
- 1 Copy MMM Group Limited, Thornhill, Ontario
- 1 PDF Copy Golder Associates Ltd., Sudbury, Ontario



REPORT





Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	1
3.0 INVESTIGATION PROCEDURES	1
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS	3
4.1 Regional Geology	3
4.2 General Overview of Local Subsurface Conditions	4
4.3 Detour Embankment STA 14+650 to 14+900.....	4
4.3.1 Ice	4
4.3.2 Embankment Fill	4
4.3.3 Peat	5
4.3.4 Silty Clay to Clay.....	5
4.3.5 Silt and Sand to Gravelly Silt and Sand	6
4.3.6 Refusal.....	6
4.3.7 Groundwater Conditions	6
4.4 Culvert at STA 15+310	6
4.4.1 Embankment Fill	6
4.4.2 Peat	7
4.4.3 Silt and Sand.....	7
4.4.4 Clay.....	7
4.4.5 Sand and Gravel.....	8
4.4.6 Sandy Silt.....	8
4.4.7 Bedrock/Refusal.....	8
4.4.8 Groundwater Conditions	8
4.5 Southwest Quadrant of Roundabout	8
4.5.1 Fill	9
4.5.2 Silt and Sand to Silty Sand.....	9
4.5.3 Bedrock.....	9
4.5.4 Groundwater Conditions	9



4.6	Steel Column Supported Signs.....	9
4.6.1	Embankment Fill	10
4.6.2	Clay.....	10
4.6.3	Silt and Sand to Silty Sand.....	10
4.6.4	Refusal.....	11
4.6.5	Groundwater Conditions	11
5.0	CLOSURE	11

LIST OF SYMBOLS AND ABBREVIATIONS

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DRAWINGS

Drawing 1	Index Plan
Drawing 2	Detour Embankment STA 14+650 to 14+900 - Borehole Location and Soil Strata
Drawing 3	Culvert at STA 15+310 and Southwest Quadrant - Borehole Location and Soil Strata
Drawing 4	Southwest Quadrant – Soil Strata
Drawing 5	Steel Column Supported Signs - Borehole Locations

APPENDICES

Appendix A Detour Embankment STA 14+650 to 14+900

Record of Boreholes	15-1 to 15-5
Table A1	Summary of Analytical Testing of Creek Water
Figure A1	Grain Size Distribution – Sand (Fill)
Figure A2	Plasticity Chart – Silty Clay to Clay
Figure A3	Grain Size Distribution – Silty Clay
Figure A4	Consolidation Test Summary – Borehole 15-2 Sample 7
Figure A5	Grain Size Distribution – Silt and Sand to Gravelly Silt and Sand

Appendix B Culvert at STA 15+310

Record of Boreholes	C15-1 to C15-3
Record of Drillhole	C15-1
Pavement Borehole	STA 15+300 24 m RT C/L
Table B1	Summary of Analytical Testing of Creek Water
Figure B1	Grain Size Distribution – Sand (Fill)
Figure B2	Grain Size Distribution –Silt and Sand
Figure B3	Plasticity Chart – Clay

Appendix C Southwest Quadrant of Roundabout

Record of Boreholes	RA15-1 to RA15-3
Record of Drillholes	RA15-1 to RA15-3
Figure C1	Grain Size Distribution – Silt and Sand, Sand and Gravel (Fill)
Figure C2	Grain Size Distribution – Silt and Sand

Appendix D Steel Column Supported Signs

Record of Boreholes	SC-1 to SC-7
---------------------	--------------



FOUNDATION REPORT - HWY 17/94 ROUNDABOUT, GWP 5153-11-00

Figure D1	Grain Size Distribution – Sand to Gravelly Sand (Fill)
Figure D2	Plasticity Chart – Clay
Figure D3	Grain Size Distribution – Silt and Sand to Silty Sand



PART A

HIGHWAYS 17/94 ROUNDABOUT

FROM 1.0 KM WEST OF HIGHWAY 94 EASTERLY 1.5 KM

EAST FERRIS TOWNSHIP, ONTARIO

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5153-11-00



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed roundabout on Highway 17 at Highway 94. The roundabout is associated with rehabilitation of the section of Highway 17 from 1.0 km west of Highway 94 easterly 1.4 km in the Township of East Ferris east of North Bay, Ontario. Foundation engineering services are required for the following:

- proposed temporary detour crossing an approximately 200 m long swamp and an approximately 20 m wide pond located about 700 m and 500 m west of the roundabout, respectively;
- proposed replacement of the culvert located approximately 100 m west of the roundabout;
- cursory delineation of the depth/thickness of potential fill located within the southwest quadrant adjacent to the roundabout; and
- proposed steel column supported signs located in all four directions for traffic advancing the roundabout.

The locations of the investigated areas are shown on the Index Plan 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 September 2010. Golder's Change Requests 4, 8 and 10 are associated with the additional work relating to the culvert replacement, detour crossing the swamp (and pond) and the steel column supported signs. The work has been carried out in conformance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated January 5, 2011.

The purpose of this investigation is to obtain subsurface information specific to the proposed works associated with the roundabout by methods of borehole drilling, bedrock coring, in situ testing and laboratory testing on selected soil samples.

2.0 SITE DESCRIPTION

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely and moderately populated treed areas and numerous bedrock outcrops separated by swamps containing areas of standing water and various types of vegetation and organic soils. The ground surface at the borehole locations advanced within the limits of the study area varies between about Elevations 230 m and 220 m. Section 4 of this report presents a description of the topography in the vicinity of each investigated area.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the foundation investigation was carried out between March 31 and May 13, 2015, during which period a total of eighteen boreholes were advanced at the site. The locations of the boreholes in plan and profile/cross-sections advanced within each area of the proposed structures/facilities are shown on Drawings 2 to 5.

The field investigation was carried out using a track mounted CME550 and portable equipment supplied and operated by Landcore Drilling of Sudbury, Ontario.



The boreholes were advanced through the overburden using 108 millimetres (mm) inside diameter hollow-stem augers or NW casing with wash boring techniques. In general, soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m using a 50 mm outside diameter (O.D.) split spoon sampler operated by automatic hammers on the drill rig, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Boreholes advanced by portable equipment generally employed a full-weight hammer lifted manually and dropped from the standard SPT height. Samples of the cohesive soils were obtained at selected locations using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Coring using an 'NQ' core barrel was carried out at selected boreholes advanced by the drill rig to obtain core samples of the bedrock or to penetrate through blast rock fill zones. All open boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation (O.Reg.) 903 (Wells) (as amended).

The boreholes were terminated upon generally penetrating 3 m into competent soil material, or into bedrock, or upon encountering refusal to further auger, casing and/or split spoon advancement. Dynamic Cone Penetration Tests (DCPTs) were advanced adjacent to some boreholes or from the bottom of some boreholes at applicable locations to delineate refusal or suitable soil conditions, as shown on the Record of Borehole Sheets.

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 the respective appendices.

A sample of the creek water was obtained during the field investigation at two culvert locations, using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain-of-custody procedures for testing for a suite of parameters. The results of the analytical testing are summarized in Table A1 and B1 in Appendices A and B, respectively. The fieldwork 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 samples and rock core. The soil samples and rock core were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury geotechnical laboratory where the samples and core underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. Classification testing (water content, organic content, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing on the various samples are provided in the respective appendices.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)¹. The degree of weathering of the bedrock samples (e.g. fresh to slightly weathered) and the strength classification of the intact rock mass based on field identification (e.g. strong) are described in accordance with the International Society for Rock Mechanics (ISRM, 1981)² standard classification system.

In general, the boreholes were located in the field by Golder relative to stakes installed by MMM; several boreholes advanced for the steel column supported signs were measured relative to existing site features as specific stakes were not available at some sign locations. The as-drilled borehole locations were subsequently converted into MTM NAD 83 coordinates in AutoCAD®. Borehole elevations were surveyed by a member of our

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

² International Society for Rock Mechanics Commission on Test Methods, 1981. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.



FOUNDATION REPORT - HWY 17/94 ROUNDABOUT, GWP 5153-11-00

technical staff in reference to the ground surface elevations at the highway centreline. The borehole locations given on the Record of Borehole sheets and shown on the foundation drawings are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and depths drilled are as follows:

Location	Borehole	Location (m)		Ground/Ice Surface Elevation (m)	Depth of Borehole (m)
		Northing	Easting		
Detour Embankment STA 14+650 to STA 14+900	15-1	5127034.8	319297.7	219.6	4.4*
	15-2	5127021.9	319353.3	219.6	12.0* (DCPT from 12.0 to 16.8)
	15-3	5127031.7	319356.1	221.8	14.7
	15-4	5127011.6	319390.4	219.6	11.3*
	15-5	5126959.1	319529.8	223.9	2.1*
Culvert at STA 15+310	C15-1	5126884.3	319955.7	224.9	5.0**
	C15-2	5126864.3	319951.0	228.6	10.5
	C15-3	5126840.2	319945.2	224.7	5.5
Southwest Quadrant of Roundabout	RA15-1	5126829.7	319966.1	227.9	7.5**
	RA15-2	5126819.1	320007.8	228.7	4.6**
	RA15-3	5126777.7	320025.1	228.1	6.2**
Steel Column Supported Signs	SC-1	5126959.5	319595.5	230.2	1.1
	SC-2	5126850.8	319945.1	228.6	2.9
	SC-3	5126823.6	320137.2	229.0	2.7
	SC-4	5126732.8	320425.2	227.3	5.2
	SC-5	5126948.9	319995.5	227.5	2.0
	SC-6	5126676.6	320076.3	227.2	4.6
	SC-7	5126452.3	320161.8	225.9	1.2

Notes: *Includes 0.2 m to 0.3 m thick ice; At Borehole 15-5, also includes a 0.9 m water column.

**Includes 2.8 m to 3.5 m bedrock core.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on terrain mapping by the Ontario Geological Survey³, the topography throughout the project site generally consists of exposed rock knobs separated by peat/organic terrain.

The bedrock in the area typically consists of gneiss of the Powassan or Tilden Lake Domain, both within the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4⁴.

³ Northern Ontario Engineering Geology Terrain Study, Ontario Geological Society, Map 5044.

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



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 and rock core samples, are presented on the Record of Borehole and Drillhole sheets and the laboratory test sheets in the respective appendices. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing and are approximate. 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.

Detailed descriptions of the subsurface conditions at each investigated area are provided in the following sections of this report. Groundwater and creek water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

4.3 Detour Embankment STA 14+650 to 14+900

The plan and the profile along approximately the centreline of the detour and cross-section through the existing embankment and detour at STA 14+700 borehole locations and interpreted stratigraphy are presented on Drawing 2. The detour embankment crosses a swamp between about STA 14+625 and STA 14+775 and crosses a pond between about STA 14+890 and STA 14+910, with a bedrock outcrop separating the two areas. The embankment through the swamp is generally about 2.5 m high increasing in height slightly at the east limits of the swamp and the embankment is about 3 m high as it crosses the pond. At the time of drilling, the water level in the pond was measured to be about 4 m higher in elevation than the water surface in the swamp. A total of five boreholes were completed to investigate the subsurface conditions in the detour area: three boreholes at the toe of slope in the swamp (Borehole 15-1, 15-2 and 15-4); one borehole through the embankment adjacent to the swamp (Borehole 15-3); and one borehole at the toe of slope in the pond (Borehole 15-5). In general, the topography in this area consists of a low-lying swamp and small pond surrounded by bedrock outcrops.

4.3.1 Ice

A 0.2 m to 0.3 m thick layer of ice was encountered in Boreholes 15-1, 15-2, 15-4 and 15-5. In Borehole 15-5, a 0.9 m deep water column was encountered below the ice.

4.3.2 Embankment Fill

Borehole 15-3 encountered embankment fill consisting of 400 mm of asphalt, underlain by 1.5 m of sand fill in turn underlain by a 100 mm thick layer of asphalt and a 1.2 m thick layer of sand and gravel fill.

Three SPT 'N'-values measured within the embankment fill are 32 blows, 64 blows and 145 blows per 0.3 m of penetration, indicating a dense to very dense relative density.

The natural water content measured on two samples of the sand or sand and gravel fill are about 4 per cent and 15 per cent.

The result of a grain size distribution test completed on one sample of the sand fill is shown on Figure A1 in Appendix A.



4.3.3 Peat

A 0.6 m thick deposit of peat was encountered below the fill material at a depth of 3.2 m below the roadway surface in Borehole 15-3 and a 0.6 m to 1.4 m thick deposit of peat was encountered below the ice in Boreholes 15-1, 15-2 and 15-4.

One SPT 'N'-value measured within the peat below the embankment in Borehole 15-3 is 10 blows per 0.3 m of penetration suggesting a stiff consistency; and the SPT 'N'-values measured within the peat beyond the embankment toe range between 1 blow and 4 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

4.3.4 Silty Clay to Clay

A deposit of grey silty clay to clay was encountered below the peat in Boreholes 15-1 to 15-4. The thickness of the clay deposit ranges from 3.5 m to 10.3 m but the deposit was not penetrated in Borehole 15-3. A DCPT driven from the bottom of Borehole 15-2 suggests that the clay deposit may be at least 15.1 m thick as the DCPT did not fully penetrate the deposit to a depth of 16.8 m below ice surface.

The SPT 'N'-values measured within the deposit are between 0 blows (weight of hammer) and 14 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging between 30 kilopascals (kPa) and 58 kPa, and the sensitivity is calculated to range between 4 and 10 but typically between 5 and 7. The field vane test results indicate that the deposit has a firm to stiff consistency.

The natural water content measured on samples of the deposit are between 30 per cent and 65 per cent.

Atterberg limits were carried out on ten samples of the deposit and measured liquid limits ranging between 38 per cent and 60 per cent, plastic limits ranging between about 21 per cent and 26 per cent and plasticity indices ranging between about 17 per cent and 37 per cent. The results of the Atterberg limits tests are shown on the plasticity chart Figure A2 in Appendix A and indicate the material may be classified as a silty clay of intermediate plasticity to a clay of high plasticity and is typically a clay of high plasticity.

The result of a grain size distribution test completed on one sample of the silty clay deposit is shown on Figure A3 in Appendix A.

One laboratory consolidation (oedometer) test was carried out on a specimen of the silty clay to clay stratum obtained from Borehole 15-2 and the test results are shown on Figure A4. The preconsolidation stress was estimated from the Void Ratio versus logarithmic Pressure plots using the Casagrande method as well as from the Total Work versus Pressure plots. The relevant consolidation test results are summarized below.

Borehole/ Sample Number	Elevation (m)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm ² /s)
15-2/7	211.7	44	150	106	3.4	1.636	0.51	0.07	3.0×10^{-3}

Notes: *For approximate stress range of $70 \leq \sigma_v' \leq 140$ kPa

where: σ_{vo}' effective overburden stress in kPa

σ_p' preconsolidation stress in kPa

OCR overconsolidation ratio

e_o initial void ratio

C_c compression index (based on void ratio)

C_r recompression index (based on void ratio)

c_v coefficient of consolidation in cm²/s in the normally consolidated range



4.3.5 Silt and Sand to Gravelly Silt and Sand

A 0.9 m to 2.5 m thick deposit of grey silt and sand to gravelly silt and sand was encountered below the silty clay to clay deposit in Boreholes 15-3 and 15-4 at 12.2 m and 10.7 m below the ice surface, and below the water column in Borehole 15-5 at a depth of 1.2 m below the ice surface.

The SPT 'N'-values measured within the deposit range between 1 blow and 22 blows per 0.3 m of penetration indicating a very loose to compact relative density.

The natural water content measured on samples of the deposit range from about 12 per cent to 22 per cent.

The results of grain size distribution tests completed on three samples of the deposit are shown on Figure A5 in Appendix A.

4.3.6 Refusal

Refusal to further split spoon and/or casing advancement was encountered in Boreholes 15-1, 15-3 and 15-5 at depths of 4.4 m, 14.7 m and 2.1 m, respectively, below existing ground surface or ice surface, as applicable. A DCPT advanced to either side of Borehole 15-5 confirmed the refusal depth of the borehole.

4.3.7 Groundwater Conditions

The water level in Boreholes 15-1, 15-2 and 15-4 corresponds to the ice surface between Elevation 219.6 m and 219.8 m and the water level in Borehole 15-5 also corresponds to the ice surface at Elevation 223.9 m. The unstabilized water level in Borehole 15-3 upon completion of drilling is 2.3 m below ground surface (Elevation 219.5).

4.4 Culvert at STA 15+310

The plan and interpreted stratigraphy at the proposed replacement culvert at STA 15+310 are presented on Drawing 3. The height of the existing embankment at the location of the adjacent existing culvert is up to about 4.5 m and the existing CSP culvert is about 600 mm diameter and 43 m long. A total of three boreholes were completed to investigate the subsurface conditions along the culvert alignment: two boreholes (C15-1 and C15-3) were advanced near the ends of the culvert; and one borehole (C15-2) was advanced through the roadway embankment on the alignment of the culvert. A complementary borehole (Borehole SC-2) associated with the investigation for the steel column supported signs was also advanced from the roadway platform on the alignment of the culvert. In general, the topography in the area of the culvert consists of a relatively small low lying swampy area with bedrock outcrops surrounding the swamp.

4.4.1 Embankment Fill

Borehole C15-2 encountered 3.8 m of embankment fill consisting of 120 mm of asphalt underlain by 2.1 m thick layer of sand, a 1.8 m thick layer of blast rock/sand and gravel mixture and a 0.8 m thick layer of sand and gravel. Borehole SC-2 encountered a 2.9 m thick layer of sand fill at which depth refusal to auger advancement was met, inferred to be on rock fill.



SPT 'N'-values measured within the embankment fill range from 2 blows to 41 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The natural water content measured on three samples of the sand fill range from about 2 per cent to 8 per cent.

The results of grain size distribution tests completed on two samples of the sand fill are shown on Figure B1 and D1 in Appendices B and D, respectively.

4.4.2 Peat

A 0.8 m thick deposit of silty peat or peat was encountered at ground surface in Boreholes C15-1 and C15-3, respectively. The SPT 'N'-values reassured on the peat deposit are 27 blows and 1 blow per 0.3 m of penetration in the respective boreholes suggesting a very stiff consistency for the organic/mineral soil material and a very soft consistency for the organic material.

4.4.3 Silt and Sand

A 0.7 m to 0.8 m deposit of grey silt and sand was encountered below the peat in Borehole C15-1 and below the fill in Borehole C15-2.

Two SPT 'N'-values measured within the silt and sand deposit are 21 blows and 28 blows per 0.3 m of penetration indicating a compact relative density.

The natural water content measured on two samples of the deposit are about 18 per cent to 28 per cent. The organic content measured on one sample of the deposit is 0.7 per cent.

The results of the grain size distribution tests completed on two samples of the silt and sand deposit are shown on Figure B2 in Appendix B.

4.4.4 Clay

A 4.3 m and 4.2 m thick deposit of grey clay was encountered below the silt and sand in Borehole C15-2 at a depth of 4.6 m (Elevation 224.0 m) and below the peat in Borehole C15-3 at a depth of 0.8 m (Elevation 223.9 m), respectively.

The SPT 'N'-values measured within the deposit are between 2 blows and 11 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging between 33 kPa and greater than 100 kPa, and the sensitivity on 2 strength test values are calculated at 3 and 7. The field vane test results indicate that the deposit has a firm to very stiff consistency.

The natural water content measured on samples of the deposit are between 22 per cent and 58 per cent.

Atterberg limits were carried out on three samples of the deposit and measured liquid limits ranging between 51 per cent and 59 per cent, plastic limits ranging between about 23 per cent and 26 per cent and plasticity indices ranging between about 26 per cent and 36 per cent. The results of the Atterberg limits tests are shown on the plasticity chart Figure B3 in Appendix B and indicate the material is classified as a clay of high plasticity.



4.4.5 Sand and Gravel

A 0.7 m and 1.6 m thick deposit of grey sand and gravel was encountered underlying the silt and sand deposit and the clay deposit in Borehole C15-1 and C15-2, respectively, at Elevations 223.4 m and 219.7 m. In Borehole C15-1, cobbles were encountered within the sand and gravel deposit.

Two SPT 'N'-values measured within the deposit are 26 blows and 32 blows per 0.3 m of penetration indicating a compact to dense relative density.

A natural water content measured on a sample of the deposit is about 10 per cent.

4.4.6 Sandy Silt

A 0.5 m thick deposit of grey sandy silt was encountered underlying the clay deposit in Borehole C15-3. An SPT 'N'-value of 14 blows per 0.15 m of penetration was measured at the bottom of the deposit on refusal condition.

A natural water content measured on a sample of the deposit is about 59 per cent.

4.4.7 Bedrock/Refusal

In Borehole C15-1, bedrock was encountered at a depth of 2.2 m below ground surface, corresponding to Elevation 222.7 m and the bedrock was cored for a length of 2.8 m. The retrieved bedrock is described as fine grained, fresh, pinkish grey granitic gneiss. The Total Core Recovery of the bedrock core is 100 per cent. The RQD measured ranges from 49 per cent to 60 per cent, indicating a rock mass of poor to fair quality.

Refusal to further split spoon penetration was encountered at 10.5 m and 5.5 m below ground surface in Borehole C15-2 and C15-3, corresponding to Elevations 218.1 m and 219.2 m.

4.4.8 Groundwater Conditions

In Boreholes C15-1 and C15-3, the water level upon completion of drilling was noted to be at ground surface, corresponding to Elevations 224.9 m and 224.7 m, respectively. In Borehole C15-2, the unstabilized water level was measured at a depth of 2.9 m below ground surface, corresponding to Elevation 225.7 m.

4.5 Southwest Quadrant of Roundabout

The plan and the profiles along the south and west sides of the roadway showing the borehole locations and interpreted stratigraphy for the southwest quadrant of the roundabout are presented on Drawings 3 and 4. A detour will cross over the footprint of the existing fill platform in the southwest quadrant of the roundabout and the detour embankment will be about 0.5 m high above the existing ground surface. A total of three boreholes (RA-1 to RA-3) were advanced through the fill platform along the alignment of the proposed detour. In general, the topography in the southwest quadrant of the roundabout consists of a level area from previously placed fill with bedrock exposed to the south of the fill area and a relatively small low lying swampy area to the west of the fill area.



4.5.1 Fill

From ground surface, Borehole RA-1 encountered 3.5 m thick deposit of fill comprised of an upper 1.4 m thick layer of silt and sand and lower 2.1 m thick layer of sand and gravel, Borehole RA-2 encountered 50 mm of asphalt underlain by a 1.3 m thick layer of gravelly sand fill and Borehole RA-3 encountered a 1.5 m thick layer of sand and gravel fill. Cobbles were encountered within the sand and gravel and gravelly sand fill materials in Boreholes RA-1 and RA-2.

The SPT 'N'-values measured within the overall fill deposit range between 5 blows and 76 blows per 0.3 m of penetration, indicating a loose to very dense relative density.

The natural water content measured on nine samples of the fill range from about 5 per cent to 19 per cent.

The results of the grain size distribution test completed on four samples of the silt and sand to sand and gravel fill are shown on Figures C1A and C1B in Appendix C.

4.5.2 Silt and Sand to Silty Sand

A 0.8 m and 1.2 m thick deposit of grey silty sand to silt and sand was encountered below the fill in Boreholes RA-1 and RA-3, respectively.

The SPT 'N'-values measured within this deposit range between 10 blows and 43 blows per 0.3 m of penetration indicating a loose to dense relative density.

The natural water content measured on samples of the deposit range from about 9 per cent to 19 per cent.

The result of a grain size distribution test completed on one sample of the silt and sand portion of the deposit is shown on Figure C2 in Appendix C.

4.5.3 Bedrock

Bedrock was encountered at depths ranging between 1.3 m and 4.3 m below ground surface, corresponding to between Elevations 227.4 m and 223.6 m and the bedrock was cored for lengths between 3.2 m and 3.5 m. The retrieved bedrock core is described as fine grained, fresh, pinkish grey, granitic gneiss. The Total Core Recovery of the bedrock core is 100 per cent. The RQD measured on the core samples from the three boreholes ranges from 84 per cent to 100 per cent, indicating a rock mass of good to excellent quality.

4.5.4 Groundwater Conditions

The unstabilized water level in Boreholes RA-1, RA-2 and RA-3 upon completion of drilling as measured at depths ranging from 0.6 m to 2.1 m below ground surface, corresponding to between Elevations 228.1 m and 225.8 m.

4.6 Steel Column Supported Signs

The plan showing borehole locations for the steel column supported signs is presented on Drawing 5. A total of seven boreholes (Boreholes SC-1 to SC-7) were completed to investigate the subsurface conditions at the



proposed sign locations, one borehole advanced through the roadway shoulder adjacent to each proposed sign location. The topography adjacent to the roadway in the areas of the various signs either consists of low lying swampy ground or bedrock outcrops.

4.6.1 Embankment Fill

Boreholes SC-15 to SC-7 penetrated between 20 mm and 200 mm of asphalt, while Borehole SC-3 penetrated about 100 mm of road fill from the roadway surface. Underlying the roadway surface materials or from ground surface, the boreholes encountered embankment fill between 1.1 m and 2.9 m thick. The embankment fill consists of sand to gravelly sand to sand and gravel to sandy gravel. Boreholes SC-1, SC-2, SC-5 and SC-7 were terminated on refusal to further split spoon and for auger advancement in the fill depths.

The SPT 'N'-values measured within the embankment fill deposit range between 2 blows and 30 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of the sand to sandy gravel fill range from about 2 per cent to 15 per cent.

The results of the grain size distribution test completed on four samples of the sand to silt and sand fill are shown on Figure D1 in Appendix D.

4.6.2 Clay

A 1.5 m thick deposit of brown to grey varved clay was encountered below the fill in Boreholes SC-4 and SC-6 at Elevations 225.1 m and 225.8 m, respectively.

The SPT 'N'-values measured within the clay are between 8 blows and 12 blows per 0.3 m of penetration, suggesting the clay deposit has a stiff consistency.

The natural water content measured on two samples of the clay deposit are 39 per cent and 40 per cent.

Atterberg limits were carried out on two samples of the deposit and measured liquid limits of about 51 per cent and 65 per cent, plastic limits of about 23 per cent and 29 per cent and plasticity indices of about 28 per cent and 36 per cent. The results of the Atterberg limits tests are shown on the plasticity chart Figure D2 in Appendix D and indicate the material is classified as a clay of high plasticity.

4.6.3 Silt and Sand to Silty Sand

A .03 m to 1.7 m thick deposit of grey/brown silt and sand to silty sand was encountered underlying the fill in Boreholes SC-3 and underlying the clay deposit in Boreholes SC-4 and SC-6 at Elevations 226.6 m, 223.6 m and 224.3 m, respectively. Borehole SC-4 was terminated within the silty sand deposit, whereas Boreholes SC-3 and SC-6 were terminated upon encountering refusal to further auger advancement.

The SPT 'N'-values measured within this deposit range between 8 blows and 35 blows per 0.3 m of penetration indicating a loose to dense relative density.



The natural water content measured on samples of the silt and sand to silty sand deposit range from about 15 per cent to 19 per cent.

The results of the grain size distribution tests completed on three samples of the silt and sand to silty sand deposit are shown on Figure D3 in Appendix D.

4.6.4 Refusal

A summary of refusal to further split spoon or auger penetration as encountered in six of the seven boreholes as applicable is presented below.

Borehole	Refusal Depth (m)	Refusal Elevation (m)	Notes relating to refusal (as applicable)
SC-1	1.1	229.1	Split Spoon Refusal: adjacent to bedrock outcrop
SC-2	2.9	225.7	Auger Refusal: between culvert boreholes C15-2 and C15-3 which encountered bedrock at depths of 1.3 m (Elev. 227.4 m) and 2.7 m (Elev. 225.4 m), respectively
SC-3	2.7	226.3	Auger Refusal
SC-5	2.0	225.5	Split Spoon and Auger Refusal: Rock fill observed toe of embankment
SC-6	4.6	222.6	Auger Refusal
SC-7	1.2	224.7	Split Spoon and Auger Refusal: Adjacent to bedrock outcrop

4.6.5 Groundwater Conditions

A summary of the unstabilized water levels measured in the boreholes upon completion of drilling is presented below.

Borehole	Water Level Depth (m)	Water Level Elevation (m)
SC-1	Dry	
SC-2	2.6	226.0
SC-3	1.5	227.5
SC-4	2.8	224.5
SC-5	1.6	225.9
SC-6	2.2	225.0
SC-7	0.7	225.2

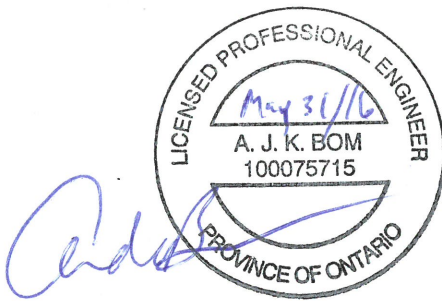
5.0 CLOSURE

The field drilling program was supervised by Mr. Indulis Dumpis and this report was prepared by Mr. André Bom, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge Costa, P.Eng., Senior Consultant and Golder's Designated MTO Foundations Contact, conducted an independent review of the report.

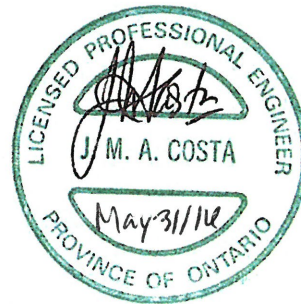


Report Signature Page

GOLDER ASSOCIATES LTD.



Andre Bom, P.Eng.
Geotechnical Engineer, Associate



Jorge M. A. Costa, P.Eng.
Designated MTO Contact, Senior Consultant

AB/JMAC/kp

n:\active\2010\1190 sudbury\10-1191-0041 mmm hwy 17 rehab east of nb\reporting\final\04 - roundabout\10-1191-0041-r04 rpt 16may31 fir hwy 17 roundabout.docx



LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

Notes: 1
2

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



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 (Cohesionless) Soils

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

(b) Cohesive Soils Consistency

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

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

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



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

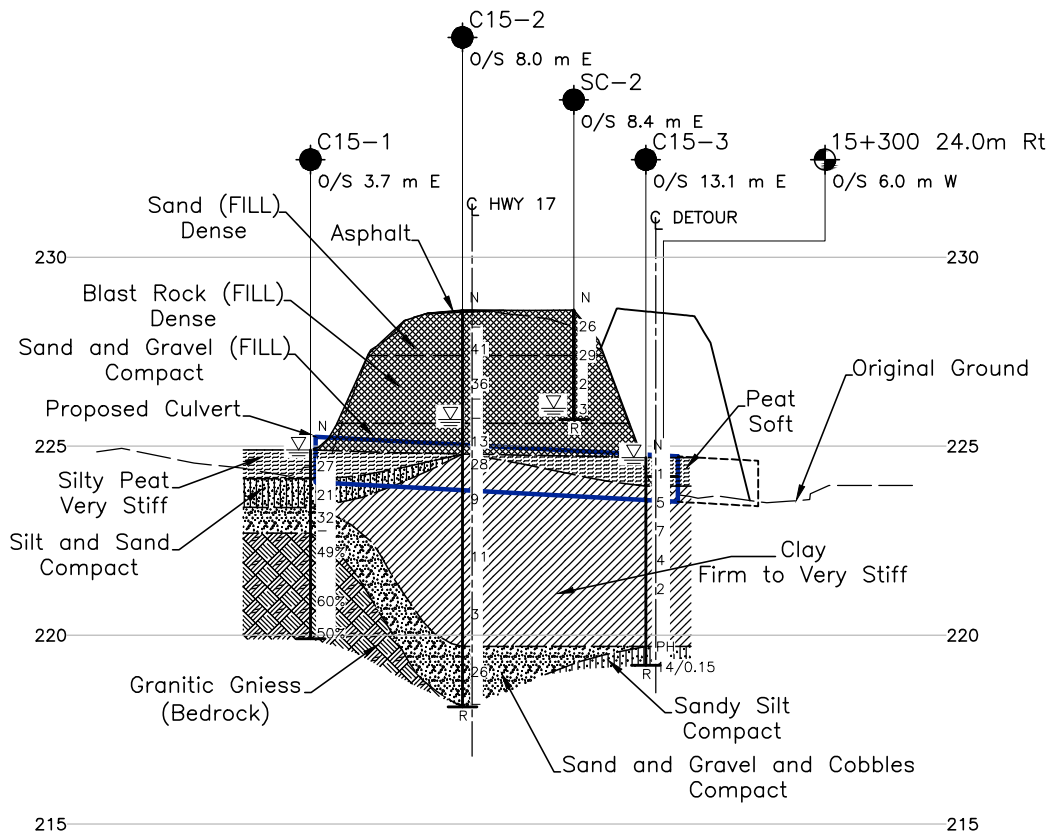
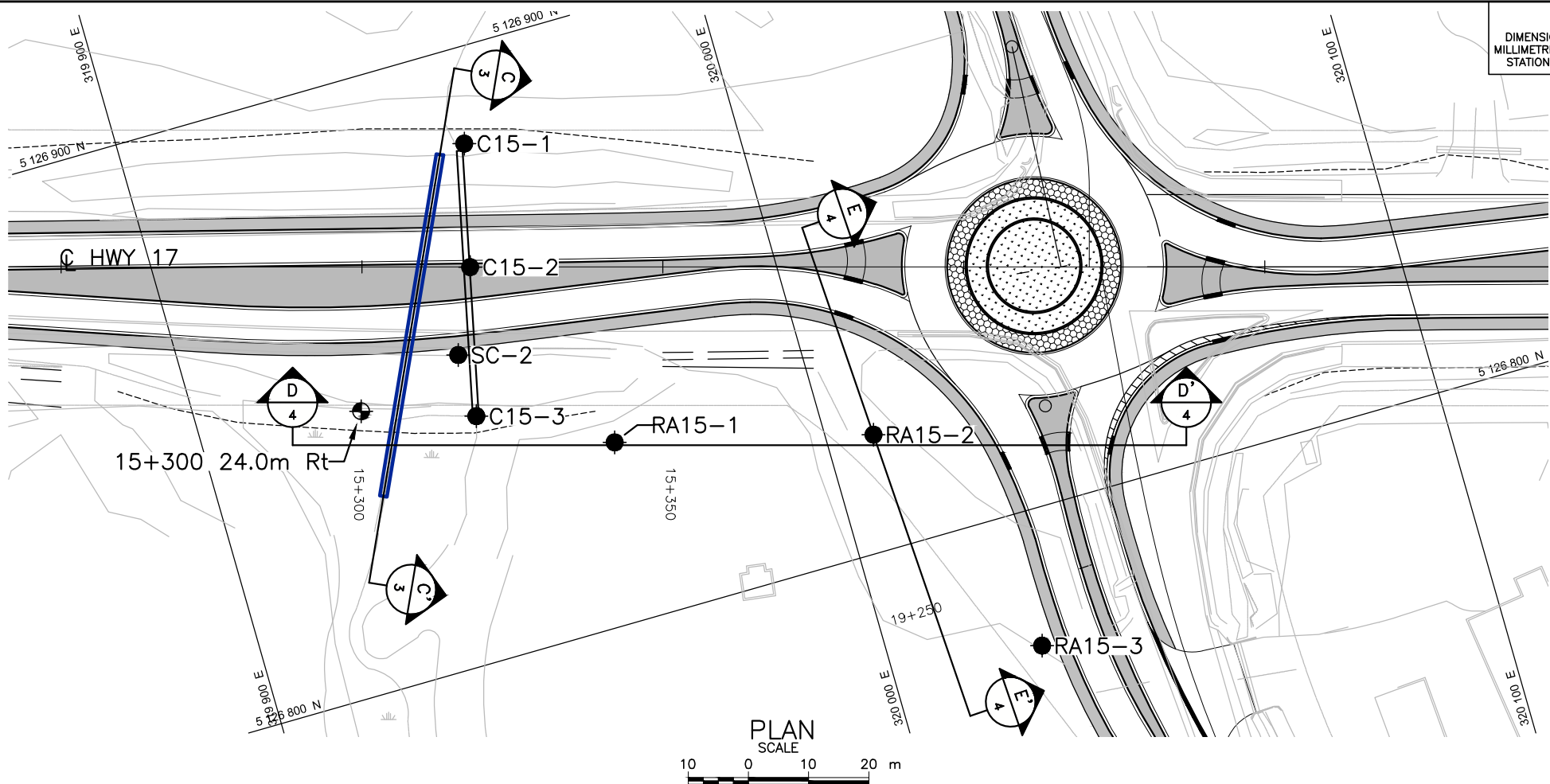
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

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

Abbreviations

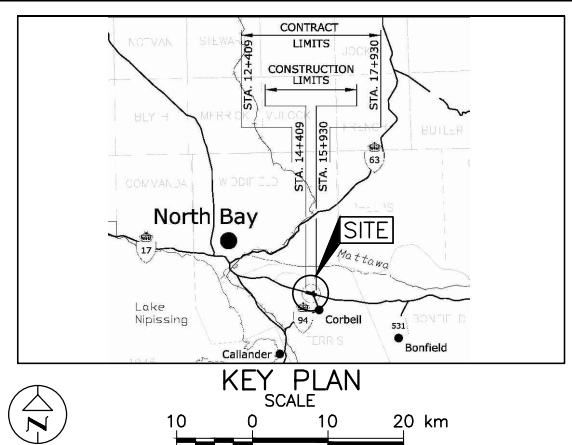
JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	



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

CONT No.
GWP No. 5153-11-00

HIGHWAY 17/94 ROUNDABOUT
CULVERT AT STA 15+310 AND SOUTHWEST QUADRANT
BOREHOLE LOCATIONS AND
SOIL STRATA



LEGEND

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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C15-1	224.9	5126884.3	319955.7
C15-2	228.6	5126864.3	319951.0
C15-3	224.7	5126840.2	319945.2
RA15-1	227.9	5126829.7	319966.1
RA15-2	228.7	5126819.1	320007.8
RA15-3	228.1	5126777.7	320025.1

NOTES

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

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

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

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. RA - Stage 3.dwg, received NOV 11, 2014.



NO.	DATE	BY	REVISION
Geocres No. 31L-195			
HWY. 17	PROJECT NO. 10-1191-0041		DIST. .
SUBM'D. MT	CHKD. .	DATE: 05/31/2016	SITE: .
DRAWN: JJL	CHKD. AB	APPD. JMAC	DWG. 3

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

CONT No.
GWP No.5153-11-00

HIGHWAY 17/94 ROUNDABOUT
SOUTHWEST QUADRANT

SOIL STRATA

SHEET



LEGEND

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

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C15-1	224.9	5126884.3	319955.7
C15-2	228.6	5126864.3	319951.0
C15-3	224.7	5126840.2	319945.2
RA15-1	227.9	5126829.7	319966.1
RA15-2	228.7	5126819.1	320007.8
RA15-3	228.1	5126777.7	320025.1

NOTES

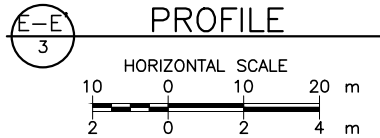
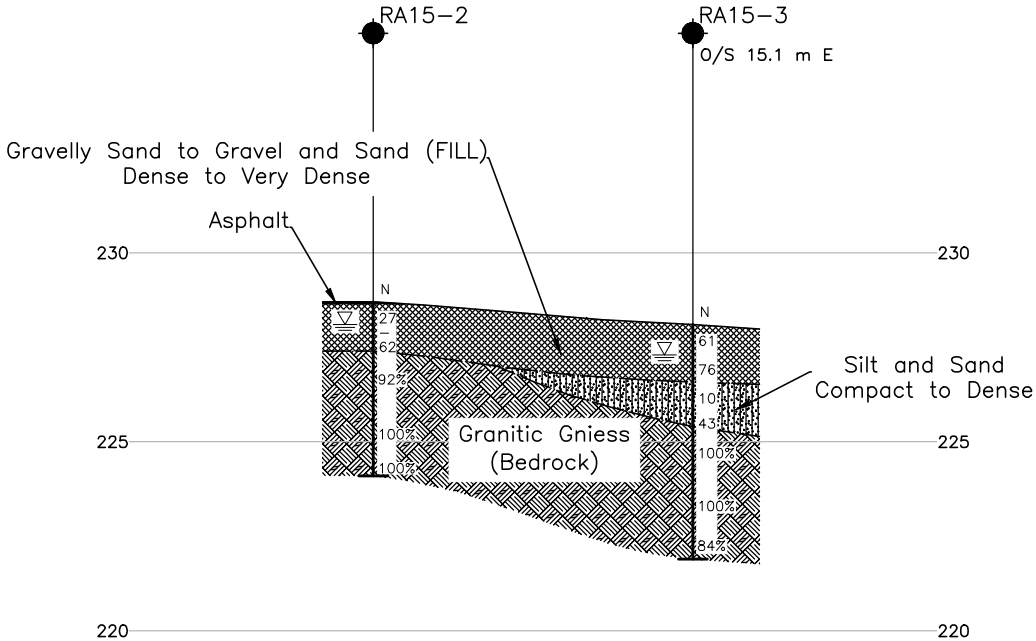
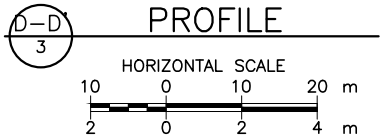
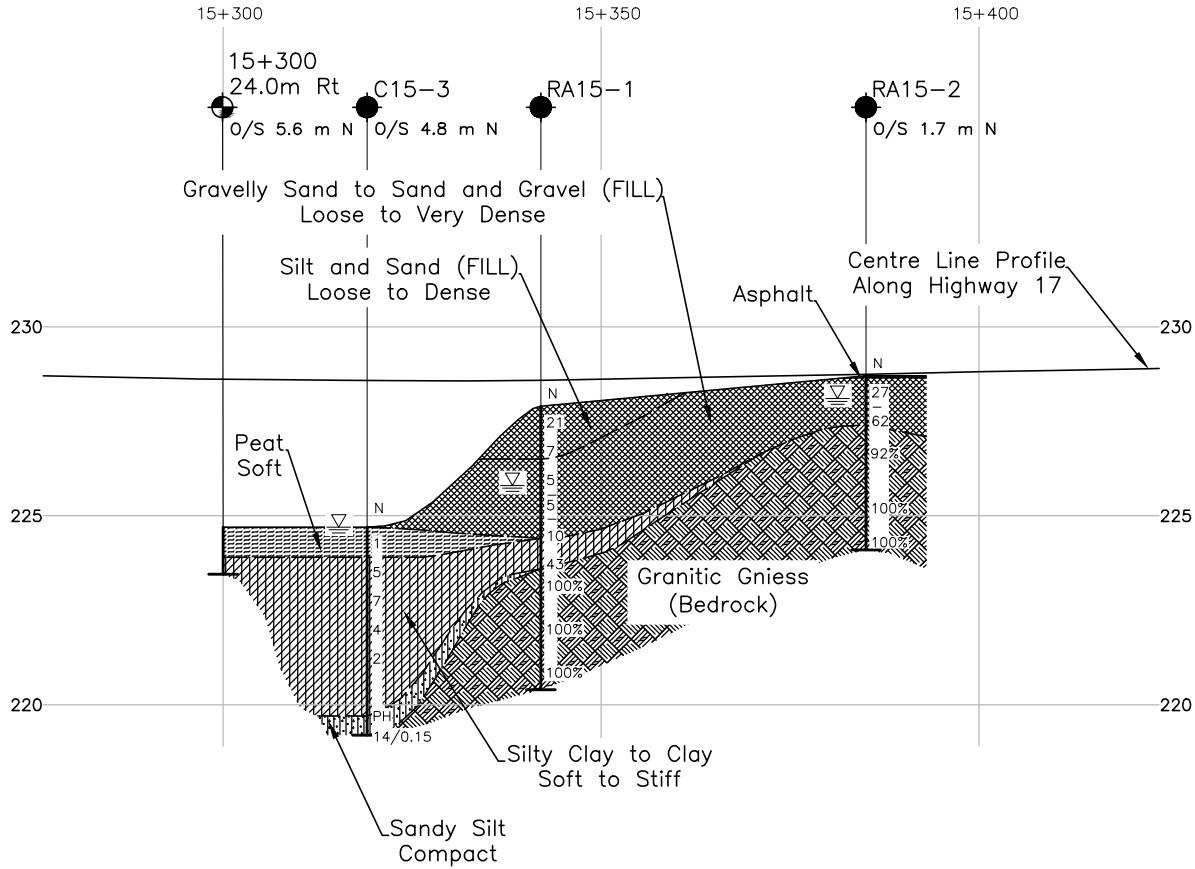
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

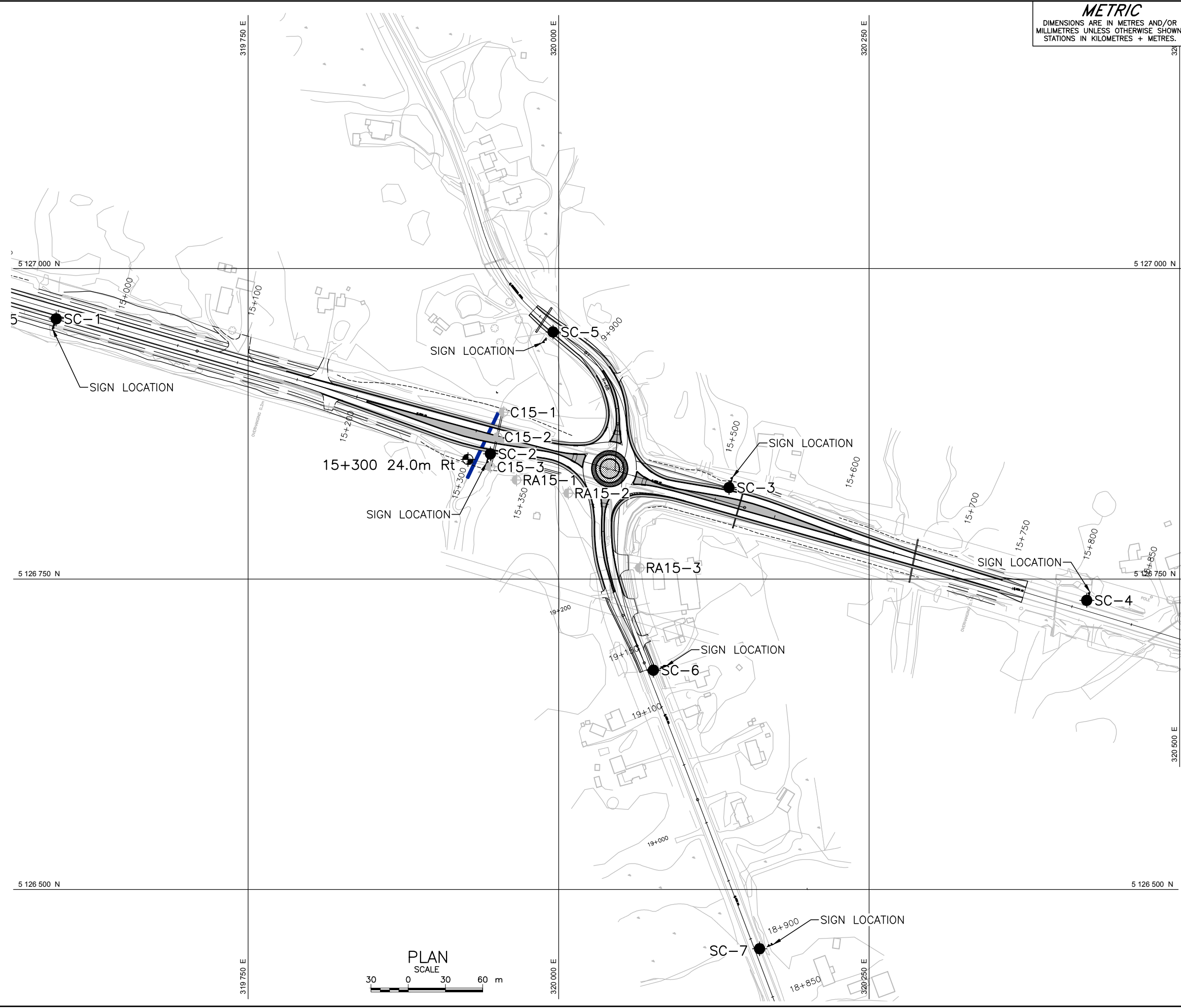
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. RA - Stage 3.dwg, received NOV 11, 2014.



NO.	DATE	BY	REVISION
Geocres No. 31L-195			
HWY. 17	PROJECT NO. 10-1191-0041		DIST. .
SUBM'D. MT	CHKD. .	DATE: 05/31/2016	SITE: .
DRAWN: JJL	CHKD. AB	APPD. JMAC	DWG. 4

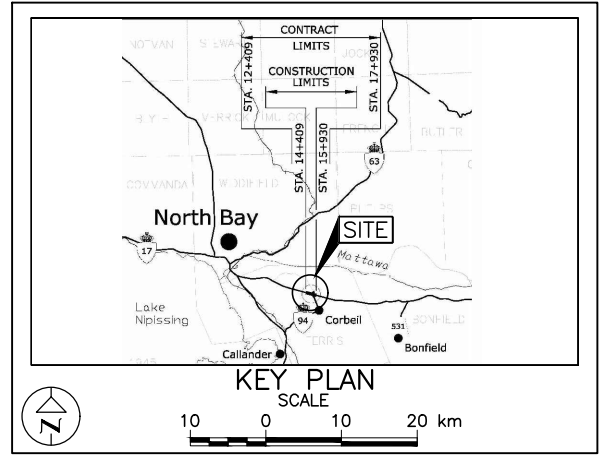


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.5153-11-00

HIGHWAY 17/94 ROUNDABOUT
STEEL COLUMN SUPPORTED SIGNS
BOREHOLE LOCATIONS

SHEET



LEGEND

Borehole Location

Pavement Borehole Location

Borehole Location Other Investigations

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
SC-1	230.2	5126959.5	319595.5
SC-2	228.6	5126850.8	319945.1
SC-3	229.0	5126823.6	320137.2
SC-4	227.3	5126732.8	320425.2
SC-5	227.5	5126948.9	319995.5
SC-6	227.2	5126676.6	320076.3
SC-7	225.9	5126452.3	320161.8

NOTES

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

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

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

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. RA - Stage 3.dwg, received NOV 11, 2014.

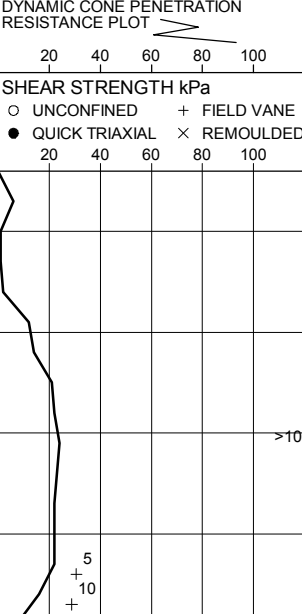


NO.	DATE	BY	REVISION
Geocres No. 31L-195			
HWY. 17	PROJECT NO. 10-1191-0041	DIST. .	
SUBM'D. MT	CHKD. .	DATE: 05/31/2016	SITE: .
DRAWN: J.J.L	CHKD. AB	APPD. JMAC	DWG. 5



APPENDIX A

Detour Embankment STA 14+650 to 14+900

PROJECT		10-1191-0041		RECORD OF BOREHOLE No 15-1		1 OF 1 METRIC							
G.W.P.		5153-11-00		LOCATION		N 5127034.8; E 319297.7							
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring							
DATUM		Geodetic		DATE		April 9, 2015							
						ORIGINATED BY ID							
						COMPILED BY JJL							
						CHECKED BY AB							
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								
219.6	ICE SURFACE												
0.0	ICE												
219.3													
0.3	Sandy PEAT (Amorphous) Firm Dark brown Wet		1	SS	4		219						
218.7													
0.9	CLAY Firm to very stiff Brown Wet		2	SS	4								
							218						
			3	SS	7								
							217						
							216						
			4	SS	2								
215.2	END OF BOREHOLE SPOON AND CASING REFUSAL DCPT REFUSAL												
4.4													
	Note: 1. DCPT advanced 1 m west of borehole. Refusal (hammer bouncing) at 4.5 m depth below ice surface.												

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 27/11/15 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No 15-2			1 OF 2 METRIC							
G.W.P. 5153-11-00			LOCATION N 5127021.9; E 319353.3			ORIGINATED BY ID							
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY JJL							
DATUM Geodetic			DATE April 9 and 13, 2015			CHECKED BY AB							
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		ELEVATION SCALE	SHEAR STRENGTH kPa					
219.6	ICE SURFACE							20 40 60 80 100					
0.0	ICE							20 40 60 80 100					
219.3													
0.3	Sandy PEAT Soft Grey Wet		1	SS	1								
217.9													
1.7	CLAY Firm to stiff Grey Wet		2	SS	3								
			3	SS	10								
			4	SS	3								
			5	TO	PH								
			6	SS	WH								
			7	TO	PH								
			8	SS	WH								
			9	SS	WH								
207.6	END OF BOREHOLE												
12.0	Note: 1. DCPT advanced from bottom of borehole to 16.8 m depth.												

Continued Next Page

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

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 27/11/15 DATA INPUT:



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

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 27/11/15 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No 15-3			1 OF 2 METRIC														
G.W.P. 5153-11-00			LOCATION N 5127031.7; E 319356.1			ORIGINATED BY ID														
DIST _____ HWY 17			BOREHOLE TYPE 108mm ID Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring			COMPILED BY JJL														
DATUM Geodetic			DATE March 30 and 31, 2015			CHECKED BY AB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m ³	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L								
221.8	GROUND SURFACE																			
0.0	ASPHALT (400 mm)		1	AS	-															
221.4																				
0.4	Sand, trace gravel (FILL) Very dense Brown Moist		2	SS	145		221										5 88 (7)			
219.9			3	SS	64		220													
2.0	ASPHALT (100 mm)																			
	Sand and gravel (FILL) Dense Brown Wet		4	SS	32		219													
218.6																				
3.2	PEAT, some sand Stiff Black Wet		5	SS	10		218													
218.0																				
3.8	CLAY Firm to stiff Grey Wet		6	SS	7		217													
			7	SS	14															
							216													
			8	SS	WH		215													
			9	TO	PH		214													
							213													
			10	SS	1		212													
			11	TO	PH		211													
							210													
209.6																				
12.2	Gravelly SILT and SAND, trace clay Loose to compact Grey Wet		12	SS	9		209													
			13	SS	14		208										25 42 32 1			
207.1																				
14.7																				

SUD-MTO 001 1011910041.GPJ GAL-MISS GDT 27/11/15 DATA INPUT:

Continued Next Page

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

PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No 15-3		2 OF 2 METRIC	
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5127031.7; E 319356.1</u>		ORIGINATED BY <u>ID</u>	
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring</u>		COMPILED BY <u>JJL</u>	
DATUM <u>Geodetic</u>		DATE <u>March 30 and 31, 2015</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	w _p	w	w _L		GR	SA	SI	CL
	<div>END OF BOREHOLE CASING REFUSAL</div> <div>Note:</div> <div>1. Water level at a depth of 2.3 m below ground surface (Elev. 219.5 m) upon completion of drilling.</div>																			

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 27/11/15 DATA INPUT:

PROJECT 10-1191-0041				RECORD OF BOREHOLE No 15-5				1 OF 1 METRIC									
G.W.P. 5153-11-00				LOCATION N 5126959.1; E 319529.8				ORIGINATED BY ID									
DIST _____ HWY 17				BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY JJL									
DATUM Geodetic				DATE April 16, 2015				CHECKED BY AB									
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									
223.9	ICE SURFACE																
0.0	ICE																
223.6																	
0.3	WATER																
222.7							223										
1.2	SILT and SAND, trace clay, trace gravel Very loose to compact Grey Wet		1	SS	1												
221.8			2	SS	11		222										5 54 34 7
2.1	END OF BOREHOLE SPOON REFUSAL																
	Note: 1. DCPTs advanced 1 m east and 1 m west of borehole and refusal at 2.1 m depth below ice surface.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 27/11/15 DATA INPUT:



Table A1 - Summary of Analytical Testing of Creek Water

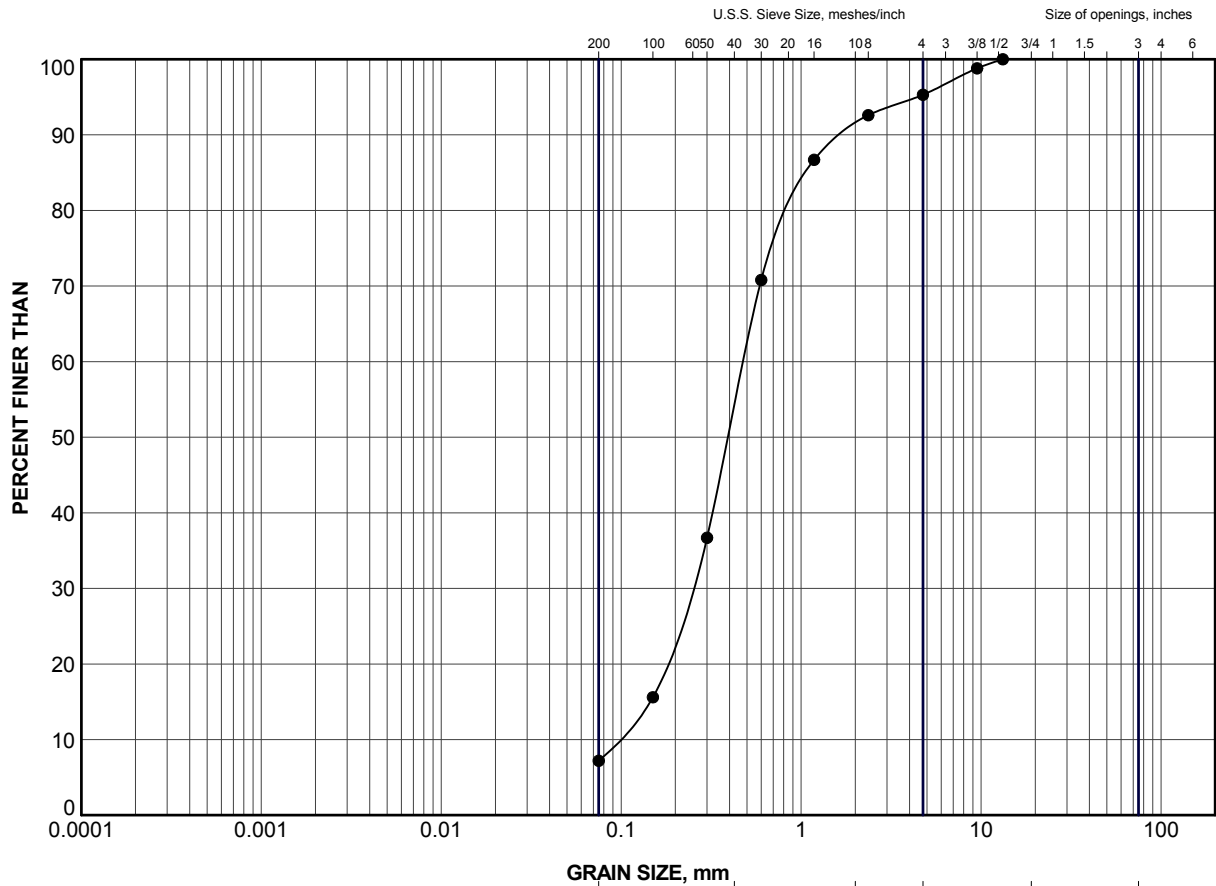
Parameter	Units	Result
Resistivity	ohm-cm	18,000
Conductivity	µmho/cm	55
pH	pH	6.11
Sulphate	mg/L	Not Detected
Chloride	mg/L	12

Notes:

1. Sample obtained April 16, 2015.

2. Analytical testing carried out by Maxxam Analytics Inc.


Reviewed by: AB

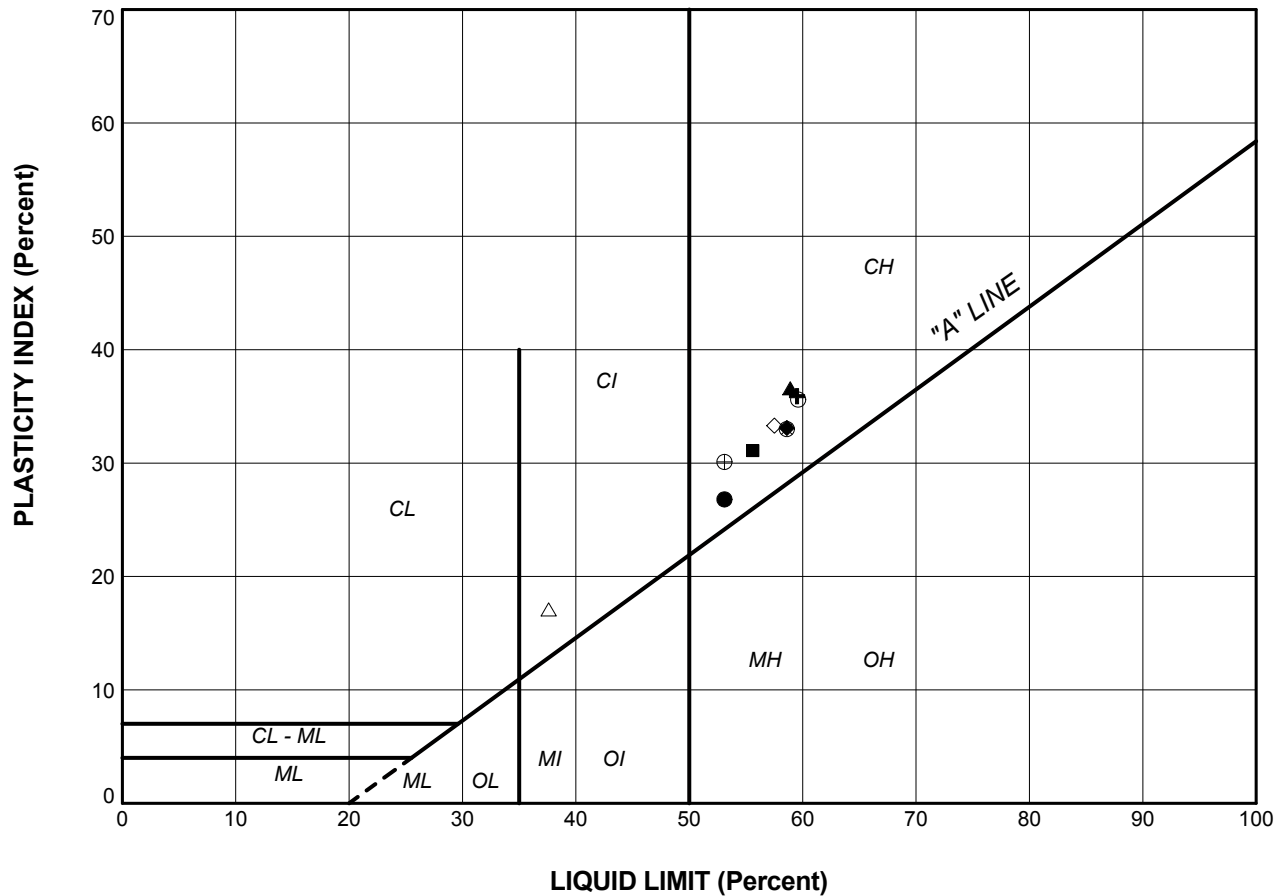


CLAY AND SILT	GRAIN SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
SAND SIZE				GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	15-3	2	220.7

PROJECT					
HIGHWAY 17/94 ROUNDABOUT DETOUR EMBANKMENT 14+650 TO 14+900					
TITLE					
GRAIN SIZE DISTRIBUTION SAND (FILL)					
		PROJECT No.		10-1191-0041	
		FILE No.		1011910041.GPJ	
		DRAWN	JJL	Jul 2015	SCALE N/A
		CHECK	AB	Jul 2015	REV.
		APPR	JMAC	Jul 2015	
FIGURE A1					




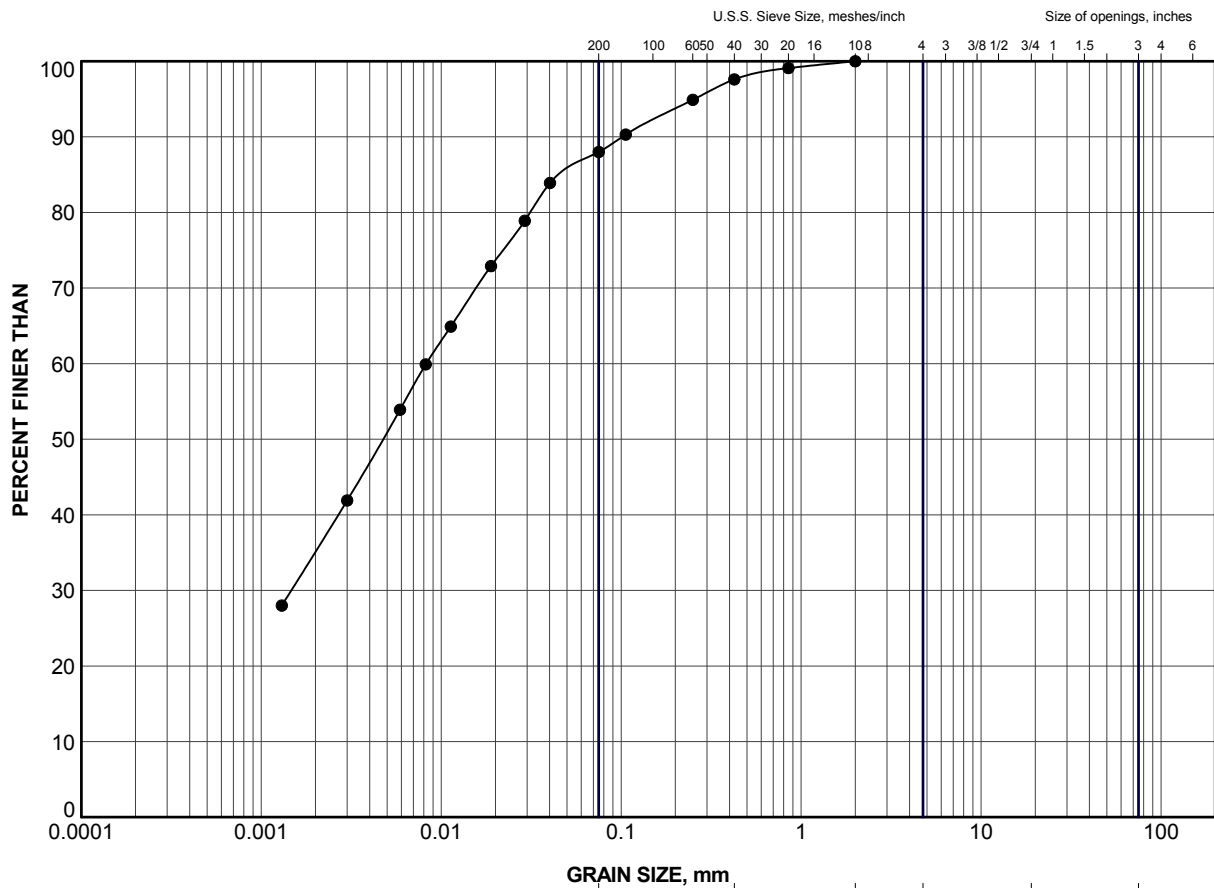
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	15-1	3	53.1	26.3	26.8
■	15-1	4	55.6	24.5	31.1
▲	15-2	6	58.9	22.3	36.6
+	15-2	7	59.5	23.6	35.9
◆	15-2	8	58.6	25.5	33.1
◇	15-3	7	57.5	24.2	33.3
○	15-3	10	59.6	24.0	35.6
△	15-4	2	37.6	20.5	17.1
⊗	15-4	7	58.6	25.6	33.0
⊕	15-4	9	53.1	23.0	30.1


PROJECT						
HIGHWAY 17/94 ROUNDABOUT DETOUR EMBANKMENT 14+650 TO 14+900						
TITLE						
PLASTICITY CHART SILTY CLAY to CLAY						
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 10-1191-0041		FILE No. 1011910041.GPJ		
		DRAWN	JJL	Jul 2015	SCALE	N/A
		CHECK	AB	Jul 2015	REV.	
		APPR	JMAC	Jul 2015		
FIGURE A2						



GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	15-4	2	218.5

PROJECT					
HIGHWAY 17/94 ROUNDABOUT DETOUR EMBANKMENT 14+650 TO 14+900					
TITLE					
GRAIN SIZE DISTRIBUTION SILTY CLAY					
PROJECT No.		10-1191-0041		FILE No.	1011910041.GPJ
DRAWN	JJL	Jul 2015	SCALE	N/A	REV.
CHECK	AB	Jul 2015			
APPR	JMAC	Jul 2015			
 Golder Associates SUDBURY, ONTARIO			FIGURE A3		

CONSOLIDATION TEST SUMMARY**FIGURE A4**
Pg. 1 of 4**SAMPLE IDENTIFICATION**

Project Number:	10-1191-0041	Sample Number:	7
Borehole Number:	15-2	Sample Depth, m:	7.9

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	May 7, 2014		
Date Completed	May 21, 2014		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.522	Unit Weight, kN/m ³	16.40
Sample Diameter, cm	6.358	Dry Unit Weight, kN/m ³	10.45
Area, cm ²	31.74	Specific Gravity, Measured	2.809
Volume, cm ³	80.06	Solids Height, cm	0.957
Water Content, %Wet	56.95	Volume of Solids, cm ³	30.37
Mass, g	133.88	Volume of Voids, cm ³	49.69
Dry Mass, g	85.30		

TEST COMPUTATIONS

Pressure kPa	Primary Consolidation	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv ² /kNm	k cm/s	Total Work kJ/m ³
0	0	2.522	1.636	2.522					
4	0.04	2.518	1.632	2.520	265	0.0051	3.70E-04	1.85E-07	0.003
13	0.02	2.516	1.630	2.517	154	0.0087	1.04E-04	8.89E-08	0.011
31	0.06	2.510	1.624	2.513	173	0.0077	1.22E-04	9.26E-08	0.059
66	0.15	2.495	1.608	2.503	317	0.0042	1.73E-04	7.08E-08	0.357
137	0.43	2.451	1.563	2.473	577	0.0022	2.45E-04	5.40E-08	2.124
277	1.76	2.275	1.379	2.363	2160	0.0005	4.97E-04	2.67E-08	16.977
558	1.33	2.142	1.239	2.209	1215	0.0009	1.88E-04	1.57E-08	41.400
1117	0.94	2.049	1.142	2.096	505	0.0018	6.63E-05	1.20E-08	77.959
558	-0.08	2.056	1.150	2.053					
137	-0.33	2.090	1.184	2.073					
31	-0.40	2.130	1.226	2.110					
4	-0.26	2.155	1.253	2.142					

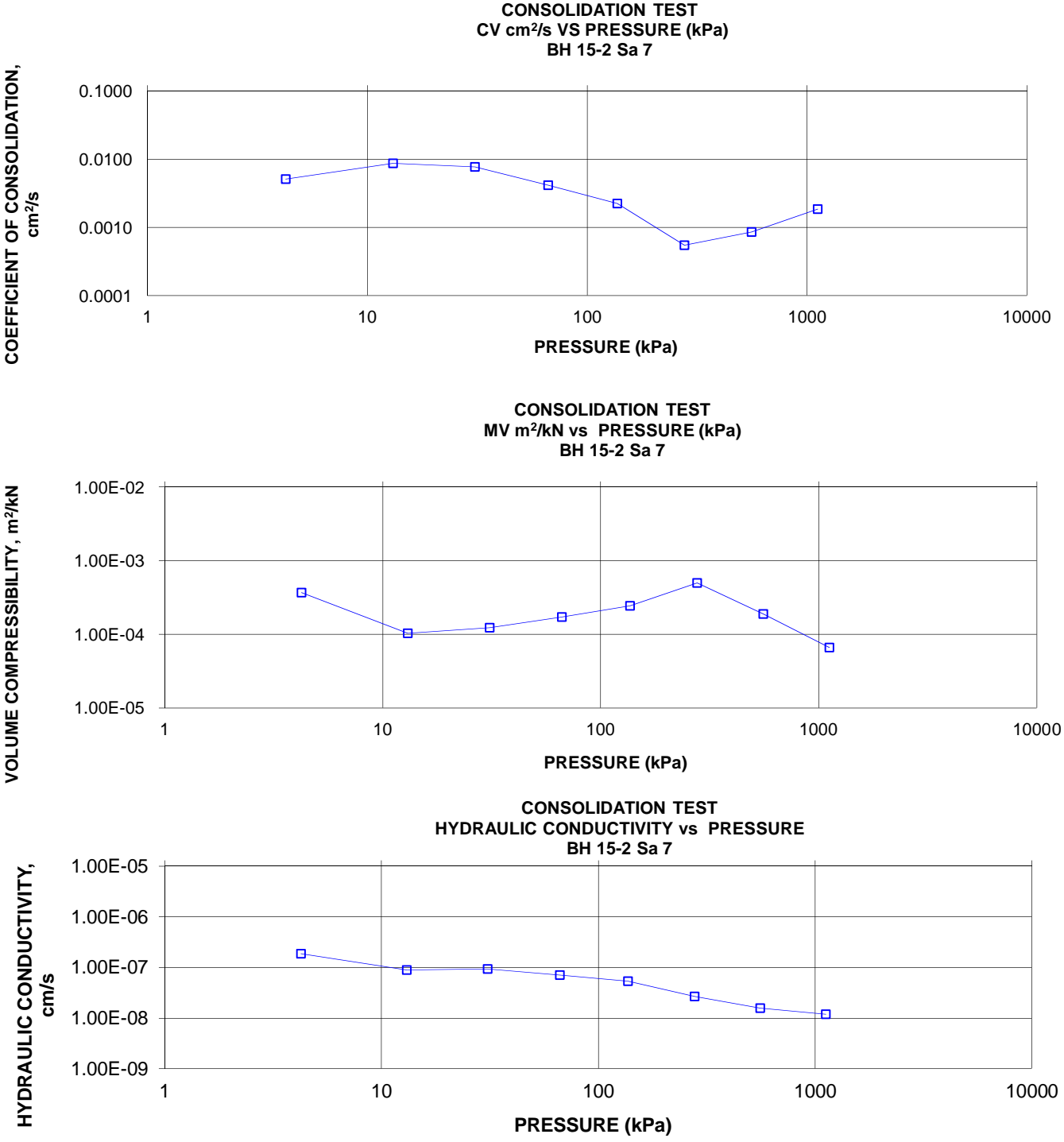
Note:
k calculated using cv based on t₉₀
values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.155	Unit Weight, kN/m ³	16.55
Sample Diameter, cm	6.36	Dry Unit Weight, kN/m ³	12.23
Area, cm ²	31.74	Specific Gravity, Measured	2.809
Volume, cm ³	68.42	Solids Height, cm	0.957
Water Content, %Wet	35.35	Volume of Solids, cm ³	30.37
Mass, g	115.45	Volume of Voids, cm ³	38.06
Dry Mass, g	85.30		

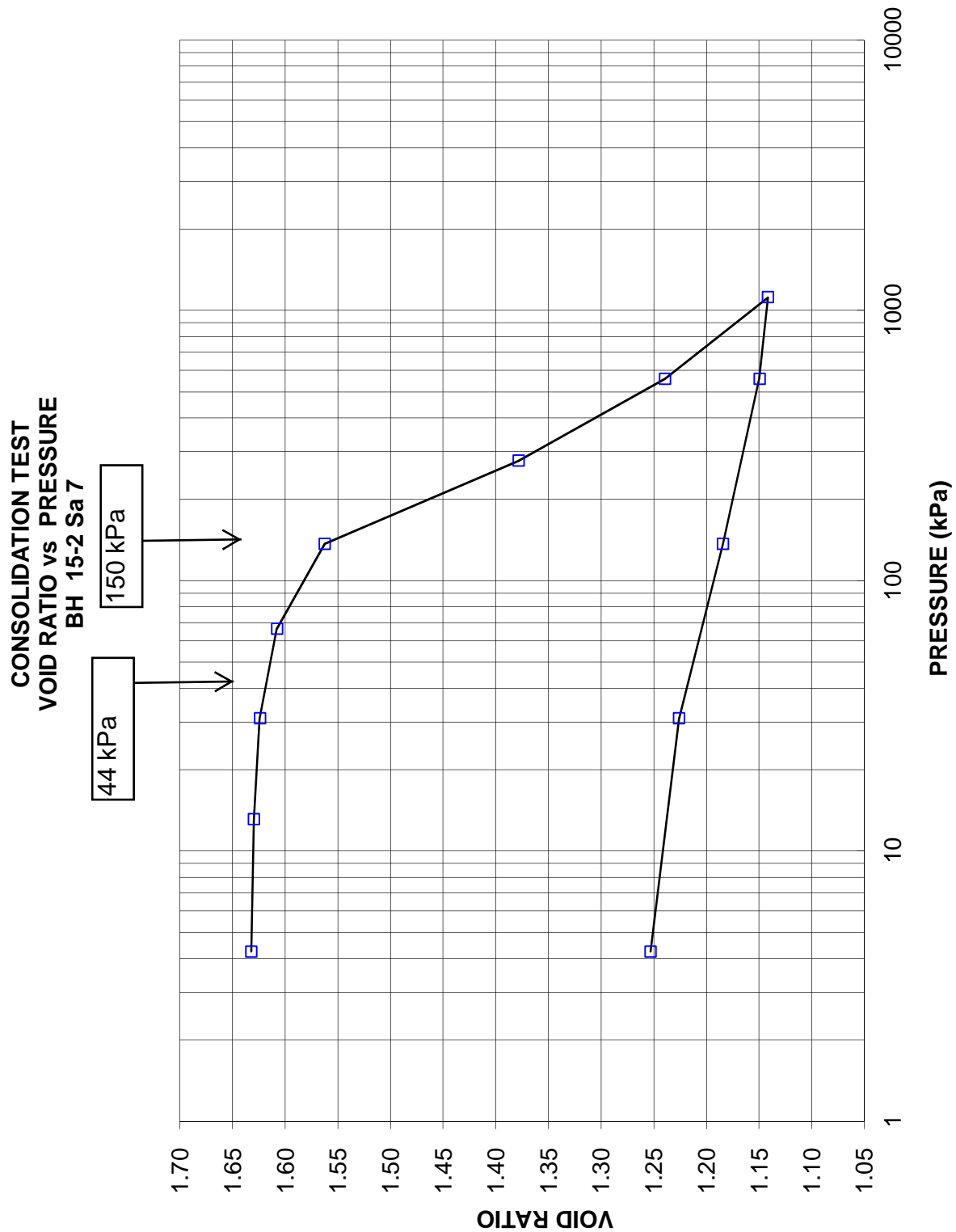
CONSOLIDATION TEST SUMMARY

FIGURE A4
Pg. 2 of 4



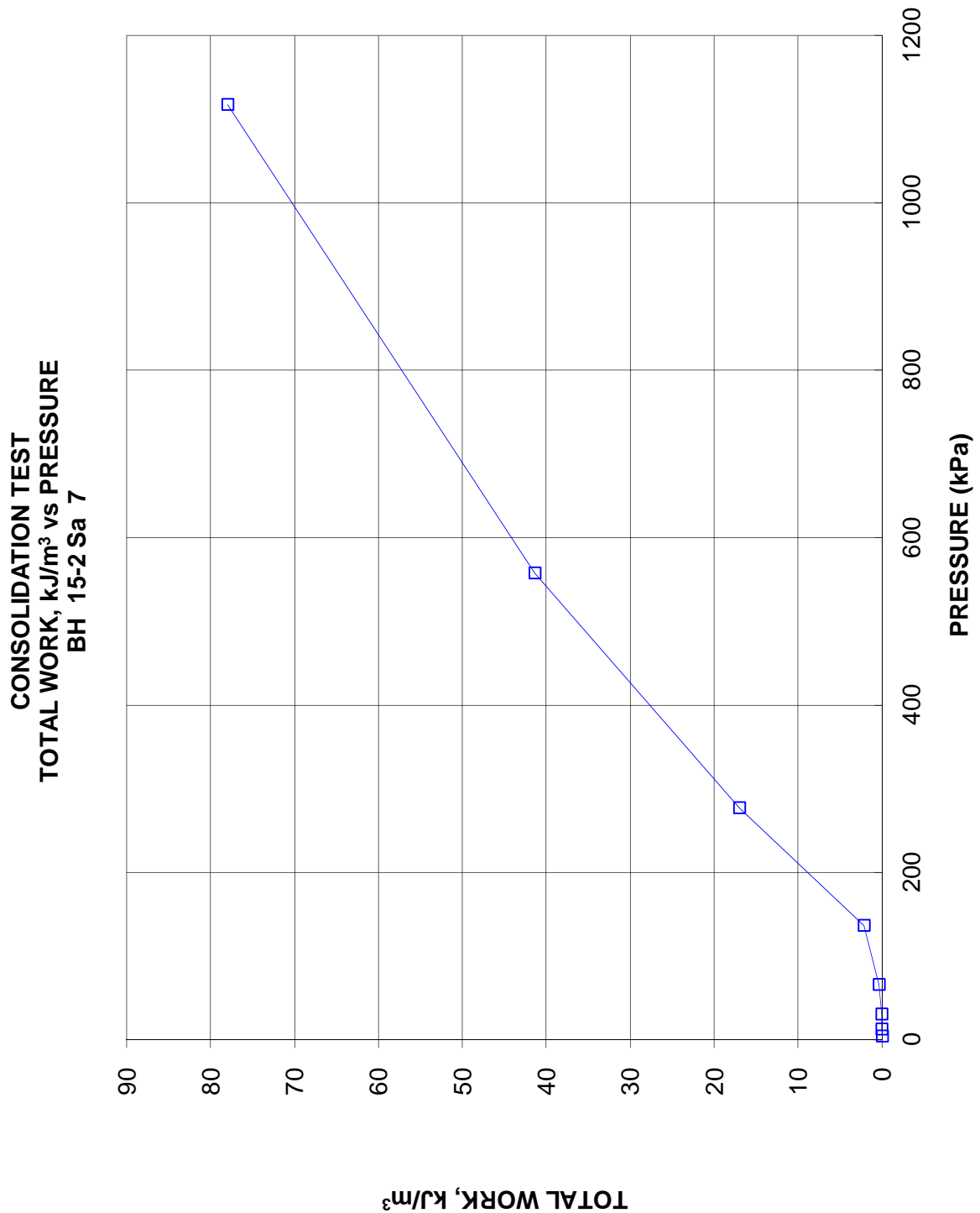
**CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE**

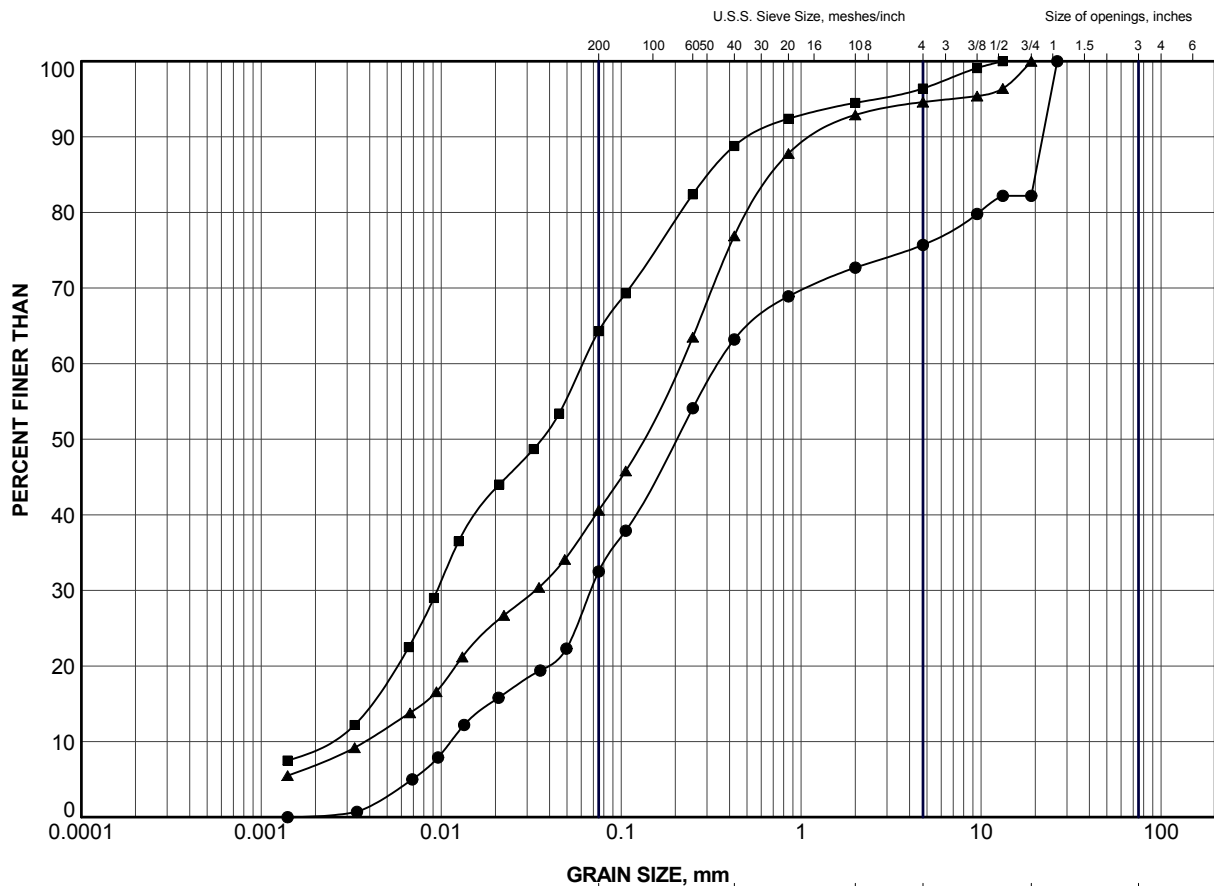
FIGURE A4
Pg. 3 of 4



**CONSOLIDATION TEST
TOTAL WORK VS PRESSURE**

FIGURE A4
Pg. 4 of 4





GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND





SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	15-3	13	207.8
■	15-4	10	208.6
▲	15-5	2	221.9

PROJECT				
HIGHWAY 17 DETOUR EMBANKMENT 14+650 TO 14+900				
TITLE				
GRAIN SIZE DISTRIBUTION SILT and SAND to GRAVELLY SILT and SAND				
PROJECT No.		10-1191-0041		FILE No.
DRAWN		JJL		Jul 2015
CHECK		AB		Jul 2015
APPR		JMAC		Jul 2015
SCALE		N/A		REV.
Golder Associates SUDBURY, ONTARIO		FIGURE A5		



APPENDIX B

Culvert at STA 15+310

PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No C15-1				1 OF 2 METRIC											
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126884.3; E 319955.7</u>				ORIGINATED BY <u>ID</u>											
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>				COMPILED BY <u>JJL</u>											
DATUM <u>Geodetic</u>		DATE <u>April 15 and 16, 2015</u>				CHECKED BY <u>AB</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									
224.9	GROUND SURFACE																
0.0	SILTY PEAT, trace to some clay, some gravel Very stiff Brown / black Wet		1	SS	27												
224.1																	
0.8	SILT and SAND, trace organics Compact Grey Wet		2	SS	21												
223.4																	
1.5	SAND and GRAVEL and COBBLES Dense Grey Wet		3	SS	32												
222.7			-	RC	-												
2.2	GRANITIC GNEISS (BEDROCK) Bedrock cored from 2.2 m depth to 5.0 m depth. For coring details see Record of Drillhole C15-1.		1	RC	REC 100%												
			2	RC	REC 100%												
			3	RC	REC 100%												
219.9	END OF BOREHOLE																
5.0	Note: 1. Water level at ground surface (Elev. 224.9 m) upon completion of drilling.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 28/07/15 DATA INPUT:

SHEET 2 OF 2

DATUM: Geodetic


DRILLING CONTRACTOR: Landcore

CHECKED: AB

SUD-RCK 1011910041.GPJ GAL-MISS.GDT 28/07/15 DATA INPUT:

PROJECT		RECORD OF BOREHOLE No C15-2				1 OF 1 METRIC								
10-1191-0041														
G.W.P. 5153-11-00		LOCATION N 5126864.3; E 319951.0				ORIGINATED BY ID								
DIST _____ HWY 17		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY JJL								
DATUM Geodetic		DATE March 31 and April 1, 2015				CHECKED BY AB								
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 (%)				
228.6	GROUND SURFACE													
0.0	ASPHALT (120 mm)		1	AS	-									5 90 (5)
	Sand, trace gravel (FILL) Dense Brown Moist		2	SS	41									
227.4														
1.2	Blast rock and sand and gravel (FILL) Dense Grey Moist		3	SS	36									
			-	RC	-									
			4	SS										
			-	RC	-									
225.6														
3.0	Sand and gravel (FILL) Compact Brown Wet		5	SS	13									
224.8														
3.8	SILT and SAND, some clay, trace gravel Compact Grey Wet		6	SS	28									6 51 30 13
224.0														
4.6	CLAY Firm to very stiff Grey Wet		7	SS	9									
			8	SS	11									
			9	SS	3									
219.7														
8.9	SAND and GRAVEL Compact Grey Wet		10	SS	26									
218.1														
10.5	END OF BOREHOLE		11	SS	-									
	Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 225.7 m) upon completion of drilling.													

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 28/07/15 DATA INPUT:

PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No C15-3				1 OF 1 METRIC								
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126840.2; E 319945.2</u>				ORIGINATED BY <u>ID</u>								
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment, NW Casing, Wash Boring</u>				COMPILED BY <u>JJL</u>								
DATUM <u>Geodetic</u>		DATE <u>April 14, 2015</u>				CHECKED BY <u>AB</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 (%)				
224.7	GROUND SURFACE							20 40 60 80 100						
0.0	PEAT Soft Black Wet		1	SS	1		224							
223.9							223							
0.8	CLAY Firm to stiff Grey Wet		2	SS	5									
			3	SS	7									
			4	SS	4									
			5	SS	2									
			6	TO	PH									
219.7	Sandy SILT, some gravel Compact Grey Wet		7	SS	14/0.15		220							
5.0														
219.2														
5.5	END OF BOREHOLE SPOON REFUSAL Note: 1. Water level at ground surface (Elev. 224.7 m) upon completion of drilling.													

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 28/07/15 DATA INPUT:

Hwy 17 and Hwy 94 Intersection Improvements (July 2011 Investigation)

10-1184-0148

Station 15+200 to 15+650, Referenced to C/L, Datum ref to Nearest E/P

April, 2015

15+260 18.70 Rt C/L D-1.65 HA

0 - 200 Blk Org M, Sat
200 - 700 Gry Si Cl, Wet, Soft
700 - 1.50 Gry Si Cl, Moist, Firm

15+300 24.00 Rt C/L D-5.50 HA

0 - 800 Blk Org M, Sat
800 - 1.30 Gry Si Cl, Wet, Soft
1.30 - 1.50 Gry Si Cl, Moist, Firm

15+300 5.60 Lt C/L D-0 PA

0 - 170 Asph
170 - 440 Br Cr Gran
440 - 1.30 Br Med Sa W Gr, Cob @ 1.0, Moist, Comp
- 1.30 NFP RF

15+350 5.50 Lt C/L D-0 PA

0 - 170 Asph
170 - 510 Br Cr Gran
510 - 1.50 Br F-Med Sa W Gr, Cob @ 1.3, Moist, Comp

15+300 7.70 Lt C/L D-0 PA

0 - 400 Br Cr Gran
400 - 1.20 Br Med-Co Sa W Gr, Moist, Comp
1.20 - 1.50 RF W Sa
- 1.50 NFP RF

15+350 7.70 Lt C/L D-0 PA

0 - 440 Br Cr Gran
440 - 710 Br Med Sa W Gr, Moist, Comp
710 - 980 Br Si Sa Tr Gr, Moist, Comp
980 - 1.30 Br Med Sa W Gr Occ Cob, Moist, Comp
- 1.30 NFP RF

15+300 10.20 Rt C/L D-0 PA

0 - 130 Asph
130 - 360 Br Cr Gran
360 - 1.70 Br F-Med Sa Tr Gr, Moist, Comp
- 1.70 NFP RF

15+350 10.00 Rt C/L D-0 PA

0 - 150 Asph
150 - 220 Br Cr Gran
220 - 280 Asph
280 - 460 Br Cr Gran
460 - 950 Br Si Sa Tr Gr, Moist, Comp
- 950 NFP RF

15+300 13.00 Rt C/L D-050 PA

0 - 080 RAP
080 - 340 Br Cr Gran
340 - 1.70 Br F-Med Sa Tr Gr, Moist, Comp
- 1.70 NFP RF

15+350 13.40 Rt C/L D-0 PA

0 - 090 Asph
090 - 300 Br Cr Gran
300 - 1.10 Br Si Sa Tr Gr, Moist, Comp
- 1.10 NFP RF

15+300 19.00 Rt C/L D-750 Ex RF

0 - 0 RF



Table B1 - Summary of Analytical Testing of Creek Water

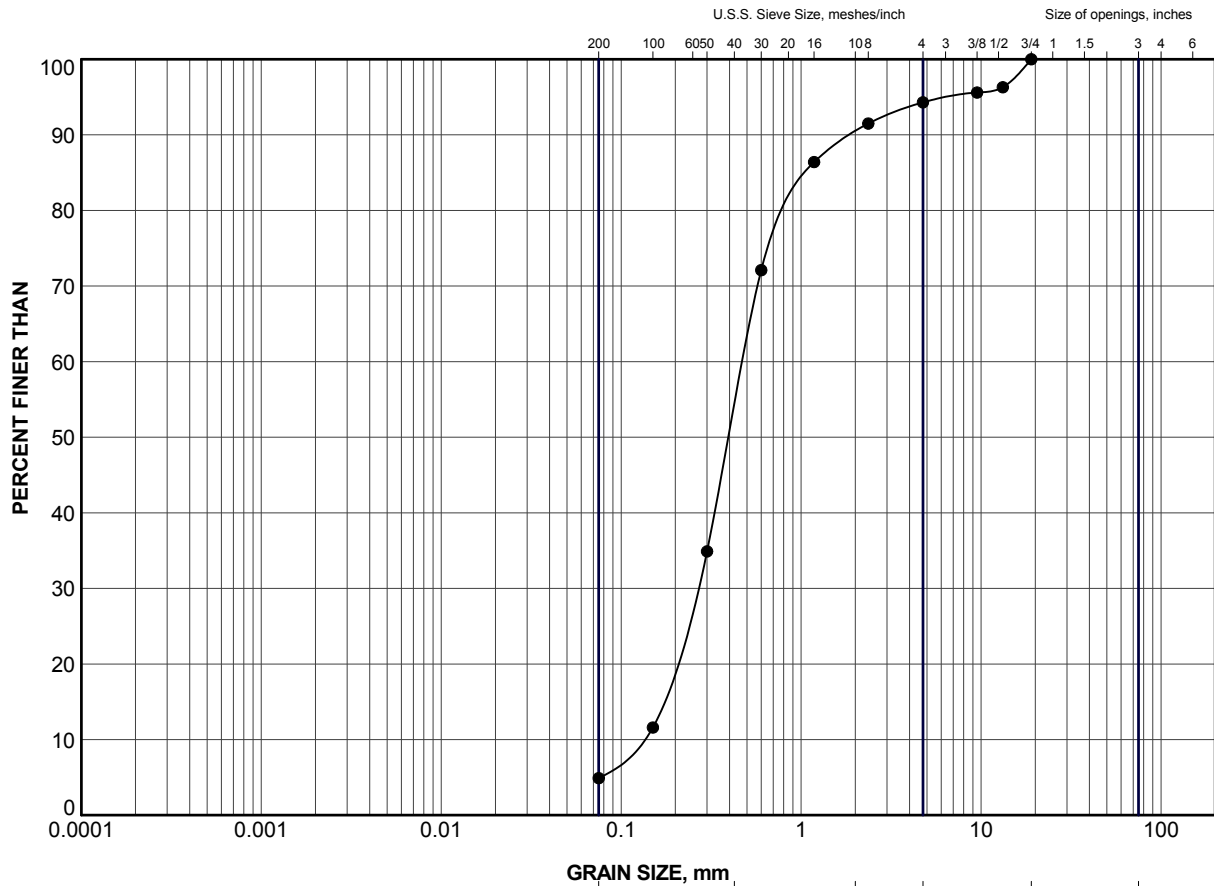
Parameter	Units	Result
Resistivity	ohm-cm	2300
Conductivity	µmho/cm	430
pH	pH	6.61
Sulphate	mg/L	4
Chloride	mg/L	110

Notes:

1. Sample obtained April 16, 2015.

2. Analytical testing carried out by Maxxam Analytics Inc.


Reviewed by: AB

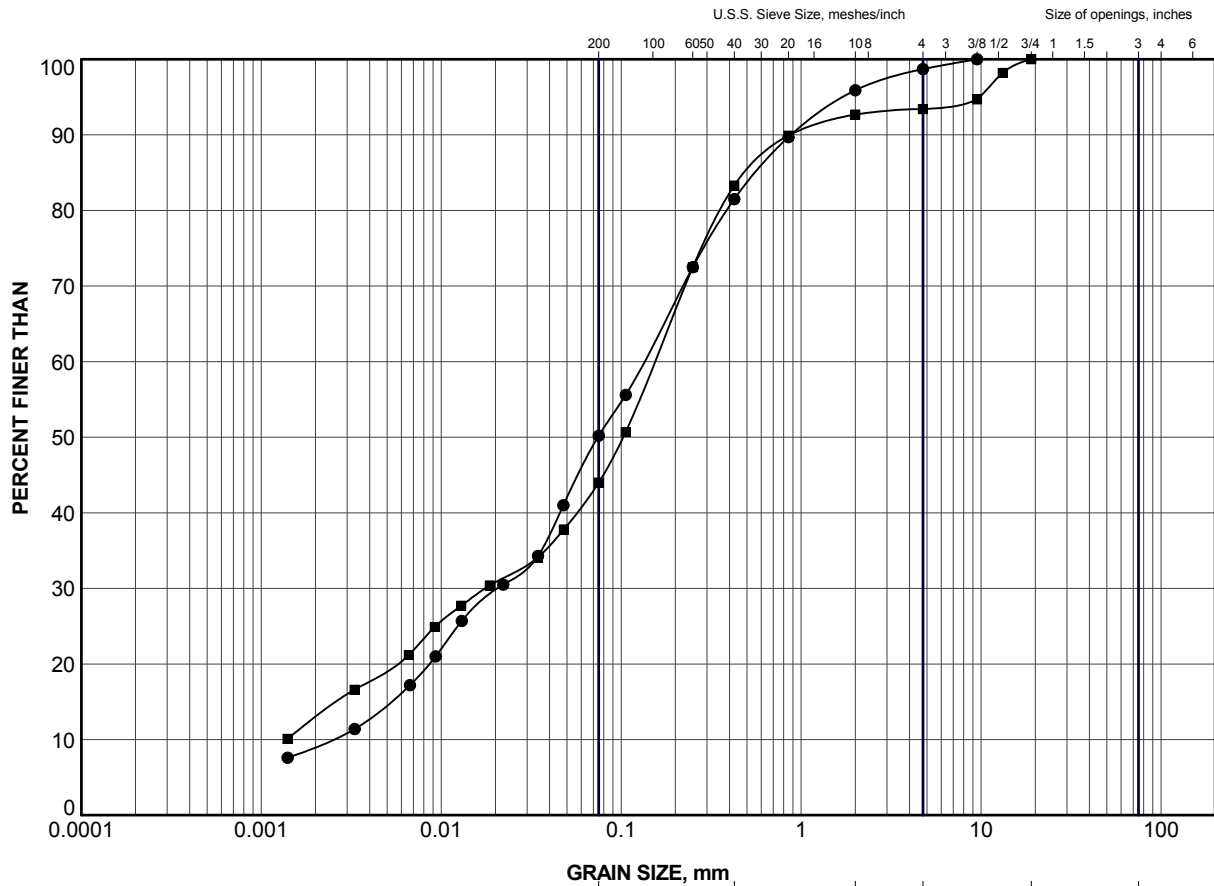


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C15-2	1	228.3


PROJECT					
HIGHWAY 17/94 ROUNDABOUT CULVERT AT STA 15+310					
TITLE					
GRAIN SIZE DISTRIBUTION SAND (FILL)					
		PROJECT No. 10-1191-0041		FILE No. 1011910041.GPJ	
		DRAWN	JJL	Jul 2015	SCALE N/A
		CHECK	AB	Jul 2015	REV.
		APPR	JMAC	Jul 2015	
<div style="display: flex; justify-content: space-between;"> FIGURE B1 </div>					

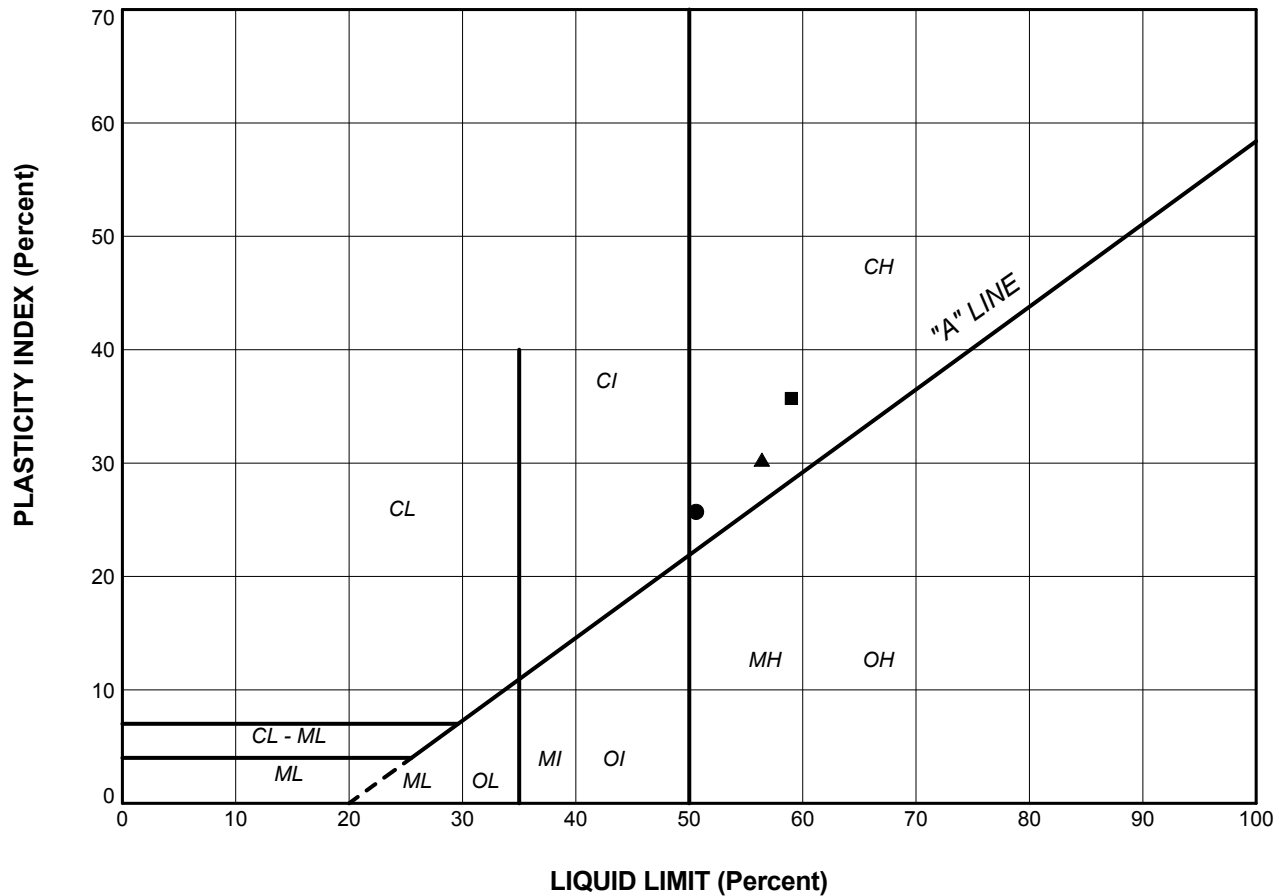


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND


SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C15-1	2	223.8
■	C15-2	6	224.6

PROJECT					
HIGHWAY 17/94 ROUNDABOUT CULVERT AT STA 15+310					
TITLE					
GRAIN SIZE DISTRIBUTION SILT and SAND					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 10-1191-0041		FILE No. 1011910041.GPJ	
		DRAWN	JJL	Jul 2015	SCALE N/A
		CHECK	AB	Jul 2015	REV.
		APPR	JMAC	Jul 2015	
FIGURE B2					



LEGEND





SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C15-2	9	50.6	24.9	25.7
■	C15-3	4	59.0	23.3	35.7
▲	C15-3	5	56.4	26.1	30.3

PROJECT					
HIGHWAY 17/94 ROUNDABOUT CULVERT AT STA 15+310					
TITLE					
PLASTICITY CHART CLAY					
PROJECT No.		10-1191-0041		FILE No.	
DRAWN		JJL		Jul 2015	
CHECK		AB		Jul 2015	
APPR		JMAC		Jul 2015	
 Golder Associates SUDBURY, ONTARIO				SCALE N/A REV.	
FIGURE B3					



APPENDIX C

Southwest Quadrant of Roundabout

PROJECT 10-1191-0041		RECORD OF BOREHOLE No RA15-1				1 OF 2 METRIC													
G.W.P. 5153-11-00		LOCATION N 5126829.7; E 319966.1				ORIGINATED BY ID													
DIST _____ HWY 17		BOREHOLE TYPE 108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring				COMPILED BY JJL													
DATUM Geodetic		DATE April 2, 2015				CHECKED BY AB													
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 (%)	
227.9	GROUND SURFACE							20	40	60	80	100							
0.0	Silt and sand to sand, some clay (FILL) Loose to dense Brown to grey Moist to wet		1	SS	21												8 48 29 15		
			2	SS	7														
226.5	Sand and gravel, trace silt (FILL) Loose to compact Grey Wet		3	SS	5														38 57 (5)
1.4	Cobbles at 2.3 m and 2.7 m depths.		-	RC	-														
			4	SS	5														
			-	RC	-														
224.4			5	SS	10														
3.5	SILTY SAND, some gravel Dense Grey Wet		6	SS	43														
223.6																			
4.3	GRANITIC GNEISS (BEDROCK) Bedrock cored from 4.3 m depth to 7.5 m depth. For coring details see Record of Drillhole RA15-1.		1	RC	REC 100%														RQD = 100%
			2	RC	REC 100%												RQD = 100%		
			3	RC	REC 100%												RQD = 100%		
220.4	END OF BOREHOLE Note: 1. Water level at a depth of 2.1 m below ground surface (Elev. 225.8 m) upon completion of drilling.																		
7.5																			

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT		RECORD OF BOREHOLE				No RA15-2		1 OF 2		METRIC							
G.W.P.		LOCATION		ORIGINATED BY		ID											
DIST		HWY		BOREHOLE TYPE		COMPILED BY		JUL									
DATUM		DATE		CHECKED BY		AB											
PROJECT 10-1191-0041		N 5126819.1; E 320007.8				ID											
G.W.P. 5153-11-00		LOCATION		ORIGINATED BY		ID											
DIST		HWY 17		BOREHOLE TYPE 108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring		COMPILED BY		JUL									
DATUM Geodetic		DATE April 8, 2015		CHECKED BY		AB											
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									
228.7	GROUND SURFACE							20	40	60	80	100					
0.9	ASPHALT (50 mm)		1	SS	27												27 63 (10)
	Gravelly sand, cobble at 0.6 m (FILL)		-	RC	-												
	Dense to very dense		2	SS	62												
	Brown																
	Moist to wet																
227.4	GRANITIC GNEISS (BEDROCK)																
1.3	Bedrock cored from 1.3 m depth to 4.6 m depth.		1	RC	REC 100%												RQD = 92%
	For coring details see Record of Drillhole RA15-2.		2	RC	REC 100%												RQD = 100%
			3	RC	REC 100%												RQD = 100%
224.1	END OF BOREHOLE																
4.6	Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 228.1 m) upon completion of drilling.																

PROJECT: 10-1191-0041

RECORD OF DRILLHOLE: RA15-2

SHEET 2 OF 2

LOCATION: N 5126819.1 ;E 320007.8

DRILLING DATE: April 8, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 550

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SHR - 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 MB - Mechanical Break				BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.				NOTES WATER LEVELS INSTRUMENTATION							
								RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY k, cm/s				DIP W/LT CORE AXIS	B Angle	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10°	10°	10°	10°	2	4	0	RMC -Q' AVG.		
								TOTAL CORE %	SOLID CORE %																										
		REFER TO PREVIOUS PAGE		227.4																															
2	CME 550 NO CORING	GRANITIC GNEISS Fine grained Pinkish grey Fresh		1.3	1	GREY	100%																												
3					2	GREY	100%																												
4					3	GREY	100%																												
5	NW	END OF DRILLHOLE		224.1																															
6																																			
7																																			
8																																			
9																																			
10																																			
11																																			

DEPTH SCALE




1 : 50



LOGGED: ID

CHECKED: AB

SUD-RCK 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT <u>10-1191-0041</u>				RECORD OF BOREHOLE No RA15-3				1 OF 2 METRIC													
G.W.P. <u>5153-11-00</u>				LOCATION <u>N 5126777.7; E 320025.1</u>				ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>17</u>				BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>				COMPILED BY <u>JJL</u>													
DATUM <u>Geodetic</u>				DATE <u>April 8, 2015</u>				CHECKED BY <u>AB</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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED										WATER CONTENT (%)			
228.1 0.0	GROUND SURFACE Sand and gravel (FILL) Very dense Grey / brown Moist		1	SS	61	▽	228										○	31 60 (9)			
			2	SS	76		227														
226.6 1.5	SILT and SAND, trace gravel, trace clay Compact to dense Wet		3	SS	10		226													○	1 55 38 6
			4	SS	43																
225.4 2.7	GRANITIC GNEISS (BEDROCK) Bedrock cored from 2.7 m depth to 6.2 m depth. For coring details see Record of Drillhole RA15-3.		1	RC	REC 100%		225											RQD = 100%			
			2	RC	REC 100%		224											RQD = 100%			
			3	RC	REC 100%		223											RQD = 84%			
221.9 6.2	END OF BOREHOLE Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 227.3 m) upon completion of drilling.							222													

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT: 10-1191-0041

RECORD OF DRILLHOLE: RA15-3

SHEET 2 OF 2

LOCATION: N 5126777.7 ;E 320025.1

DRILLING DATE: April 8, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 550

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q- AVG.	NOTES WATER LEVELS INSTRUMENTATION		
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k, cm/s	10 ⁰				10 ¹	10 ²
JN - Joint FLT - Fault SHR- 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 MB- Mechanical Break	BR - Broken Rock	NOTE: For additional abbreviations refer to list of abbreviations & symbols.																			

		REFER TO PREVIOUS PAGE		225.4																		
3	CME 550 NO CORING	GRANITIC GNEISS Fine grained Pinkish grey Fresh		2.7	1	GREY 100%																
4																						
5																						
6					2	GREY 100%																
6					3	GREY 100%																
	NW	END OF DRILLHOLE		221.9	6.2										JNIRRO JNIRRO JNIRRO							
7																						
8																						
9																						
10																						
11																						
12																						

DEPTH SCALE

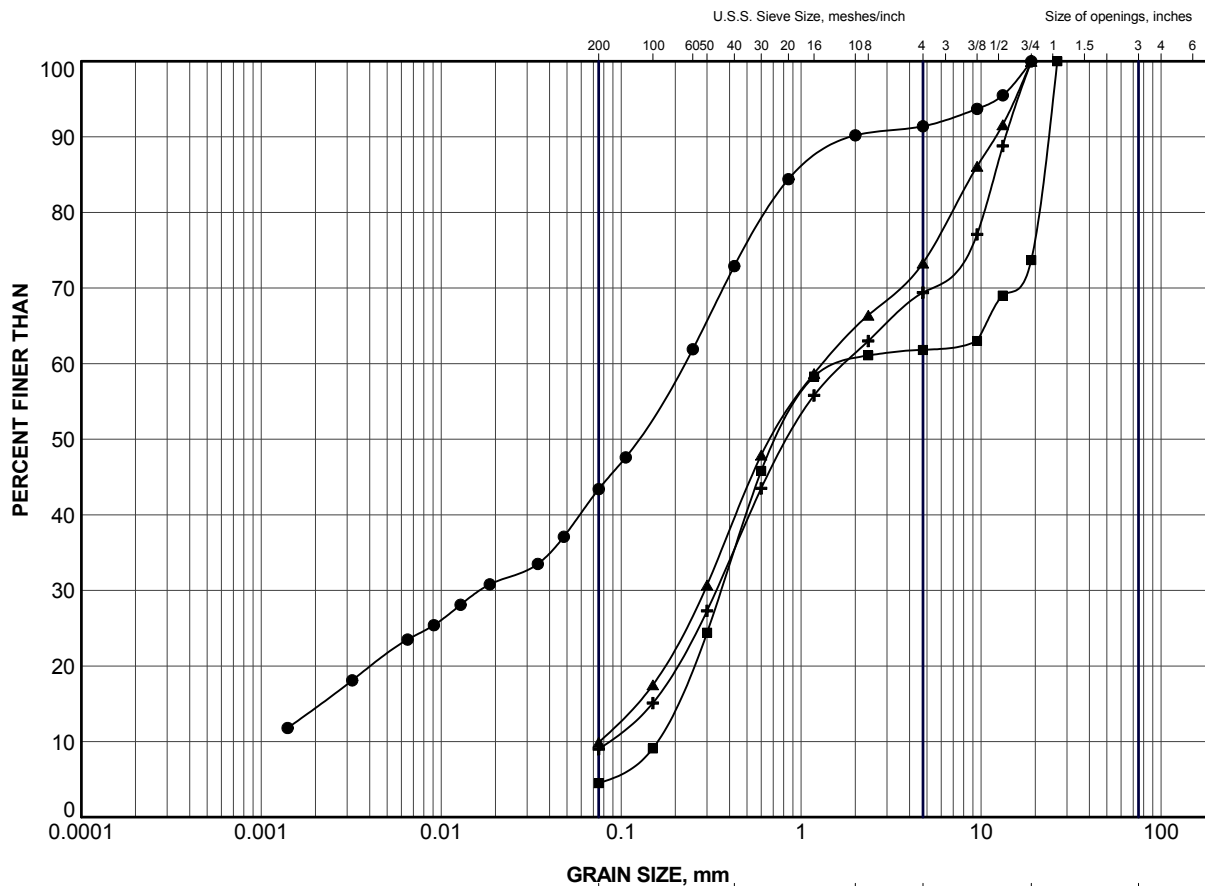
1 : 50



LOGGED: ID

CHECKED: AB


SUD-RCK 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

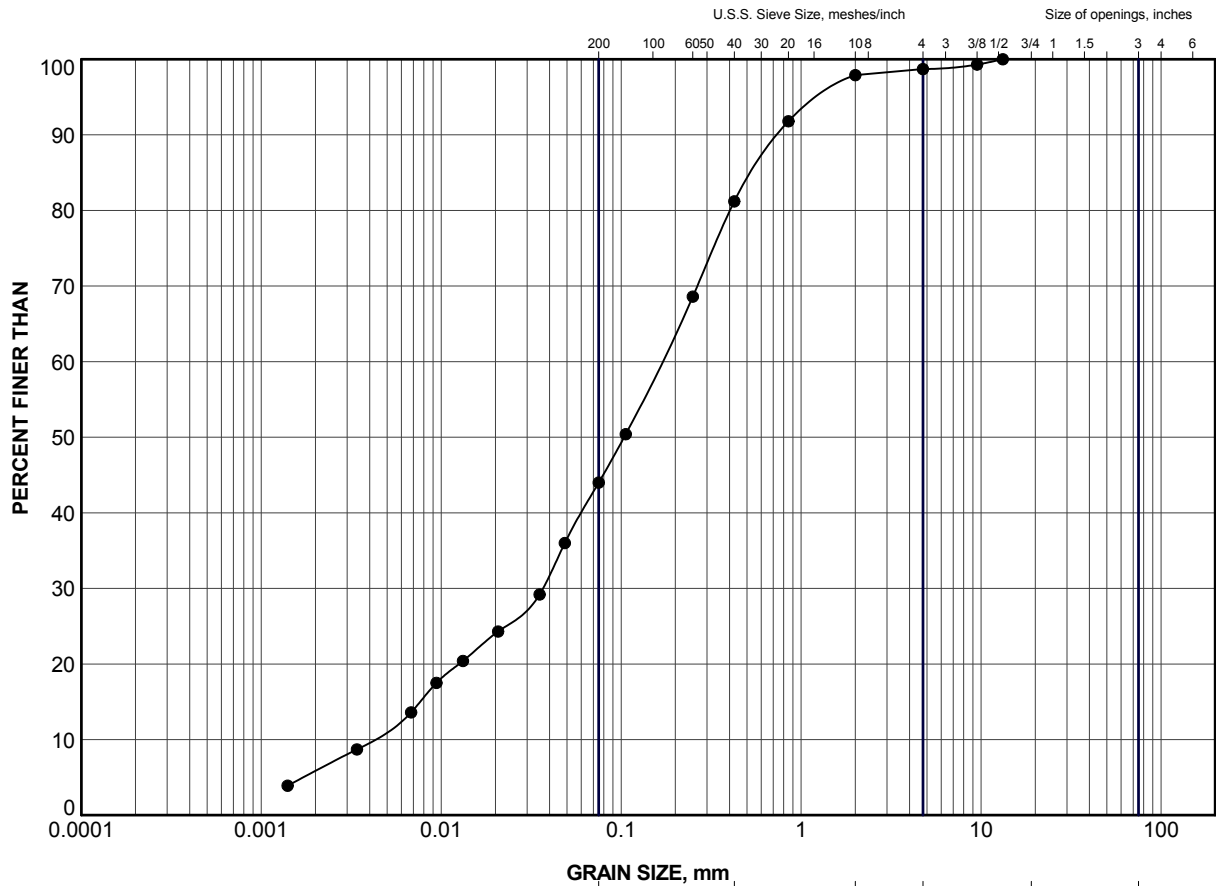


GRAVEL SIZE, mm						Cobble Size
CLAY AND SILT	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	RA15-1	1	227.6
■	RA15-1	3	226.1
▲	RA15-2	1	228.4
+	RA15-3	1	227.8


PROJECT						
HIGHWAY 17/94 ROUNDABOUT SOUTH WEST QUADRANT						
TITLE						
GRAIN SIZE DISTRIBUTION SILT and SAND, SAND and GRAVEL (FILL)						
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 10-1191-0041		FILE No. 1011910041.GPJ		
		DRAWN	JJL	Jul 2015	SCALE	N/A
		CHECK	AB	Jul 2015	REV.	
		APPR	JMAC	Jul 2015		
FIGURE C1						



CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	RA15-3	3	226.3

PROJECT					HIGHWAY 17/94 ROUNDABOUT SOUTH WEST QUADRANT				
TITLE					GRAIN SIZE DISTRIBUTION SILT and SAND				
PROJECT No.			10-1191-0041		FILE No.			1011910041.GPJ	
DRAWN	JJL	Jul 2015	SCALE	N/A	REV.				
CHECK	AB	Jul 2015							
APPR	JMAC	Jul 2015							
 Golder Associates SUDBURY, ONTARIO			FIGURE C2						

SUD-MTO GSD (NEW) GLDR_LDN.GDT



APPENDIX D

Steel Column Supported Signs

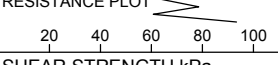



PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No SC-1				1 OF 1 METRIC							
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126959.5; E 319595.5</u>				ORIGINATED BY <u>ID</u>							
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>JJL</u>							
DATUM <u>Geodetic</u>		DATE <u>May 11, 2015</u>				CHECKED BY <u>AB</u>							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL	
230.2 0.0	GROUND SURFACE Gravelly sand (FILL) Compact to dense Brown Moist		1	SS	20		230						24 68 (8)
229.1 1.1	END OF BOREHOLE SPOON REFUSAL Note: 1. Borehole dry upon completion of drilling.		2	SS	36/0.15								

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT <u>10-1191-0041</u>				RECORD OF BOREHOLE No SC-2				1 OF 1 METRIC									
G.W.P. <u>5153-11-00</u>				LOCATION <u>N 5126850.8; E 319945.1</u>				ORIGINATED BY <u>ID</u>									
DIST <u> </u> HWY <u>17</u>				BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>JJL</u>									
DATUM <u>Geodetic</u>				DATE <u>May 12, 2015</u>				CHECKED BY <u>AB</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									
228.6	GROUND SURFACE							20	40	60	80	100					
0.0	Sand, trace gravel (FILL) Very loose to compact Brown Moist		1	SS	26												
			2	SS	29												
			3	SS	2												
			4	SS	3												
225.7	END OF BOREHOLE AUGER REFUSAL - INFERRED ROCK FILL																
2.9	Note: 1. Water level at a depth of 2.6 m below ground surface (Elev. 226.0 m) upon completion of drilling.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No SC-3			1 OF 1 METRIC														
G.W.P. 5153-11-00			LOCATION N 5126823.6; E 320137.2			ORIGINATED BY ID														
DIST _____ HWY 17			BOREHOLE TYPE 108mm ID Continuous Flight Hollow Stem Augers			COMPILED BY JJL														
DATUM Geodetic			DATE May 13, 2015			CHECKED BY AB														
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 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p W W _L			γ	GR SA SI CL			
229.0	GROUND SURFACE							20 40 60 80 100												
229.0	ROCKFILL (FILL) Sand and gravel (FILL) Compact Brown Wet		1	SS	26		228													
			2	SS	21															
			3	SS	30		227													
226.6	SILT and SAND, trace clay Compact Brown Moist		4a	SS	27															
226.3	END OF BOREHOLE AUGER REFUSAL		4b																	
2.7																				
Note: 1. Water level at a depth of 1.5 m below ground surface (Elev. 227.5 m) upon completion of drilling.																				



PROJECT <u>10-1191-0041</u>			RECORD OF BOREHOLE No SC-4			1 OF 1 METRIC						
G.W.P. <u>5153-11-00</u>			LOCATION <u>N 5126732.8; E 320425.2</u>			ORIGINATED BY <u>ID</u>						
DIST <u> </u> HWY <u>17</u>			BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>			COMPILED BY <u>JJL</u>						
DATUM <u>Geodetic</u>			DATE <u>May 13, 2015</u>			CHECKED BY <u>AB</u>						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  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	"N" VALUES							
227.3	GROUND SURFACE											
0.0	Sandy gravel (FILL) Very loose to compact Brown Wet		1	SS	11		227					9 56 30 5
			2	SS	20		226					
			3a	SS	2							
			3b									
225.1	CLAY, varved Stiff Grey / brown Moist to wet		4	SS	8		225					
2.2			5	SS	12		224					
223.6	Silty SAND, trace gravel, trace clay Loose to compact Grey Wet		6	SS	26		223					
3.7		7	SS	8								
222.1	END OF BOREHOLE											
5.2	Note: 1. Water level at a depth of 2.8 m below ground surface (Elev. 224.5 m) upon completion of drilling.											

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

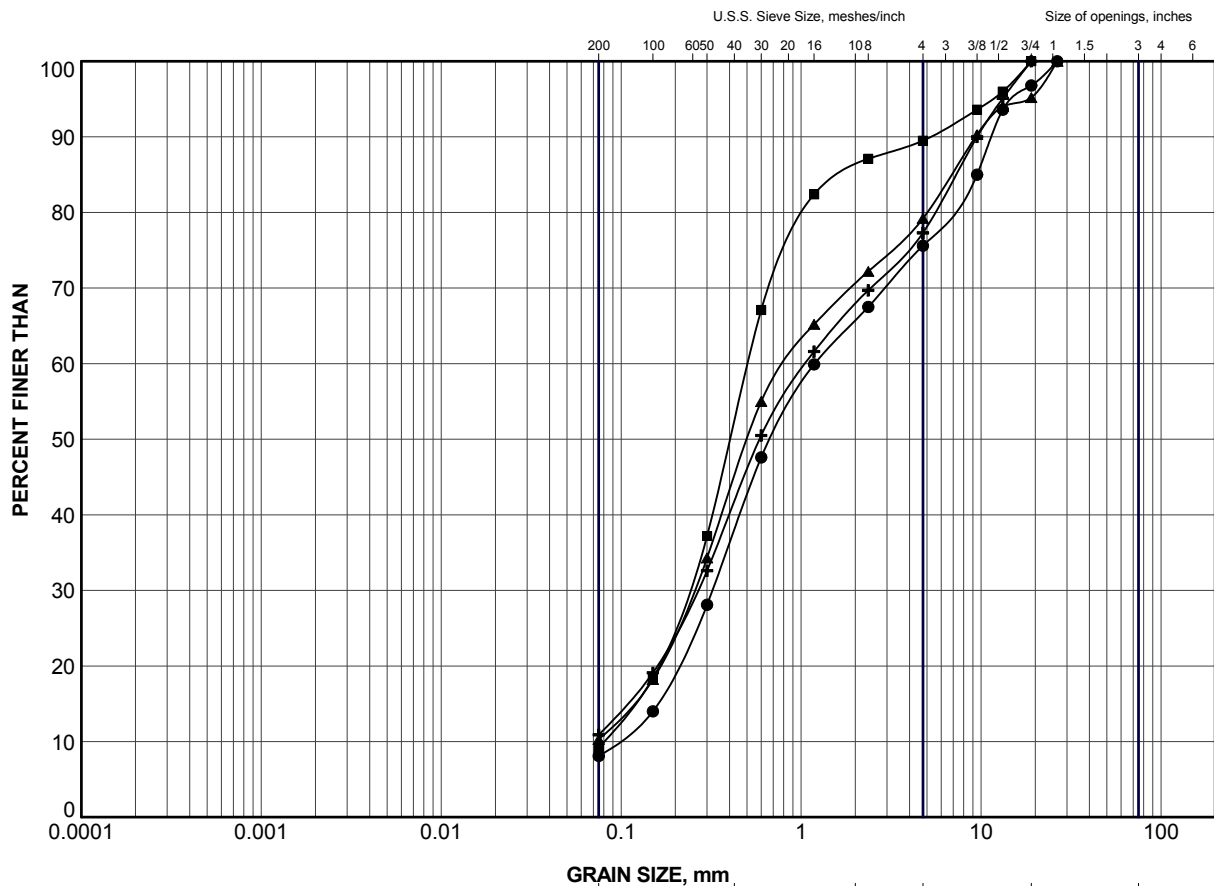
PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No SC-5				1 OF 1 METRIC							
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126948.9; E 319995.5</u>				ORIGINATED BY <u>ID</u>							
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>JJL</u>							
DATUM <u>Geodetic</u>		DATE <u>May 12, 2015</u>				CHECKED BY <u>AB</u>							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL	
227.5	GROUND SURFACE												
0.0	ASPHALT (20 mm) Gravelly sand (FILL) Compact Brown Moist to wet		1	SS	25		227					21 68 (11)	
			2	SS	23		226						
			3	SS	27/0.4								
225.5	END OF BOREHOLE SPOON AND AUGER REFUSAL												
2.0	Note: 1. Water level at a depth of 1.6 m below ground surface (Elev. 225.9 m) upon completion of drilling.												

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:

PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No SC-6		1 OF 1 METRIC													
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126676.6; E 320076.3</u>		ORIGINATED BY <u>ID</u>													
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>JJL</u>													
DATUM <u>Geodetic</u>		DATE <u>May 11, 2015</u>		CHECKED BY <u>AB</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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
227.2	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT (150 mm)						227										
0.2	Sand and gravel (FILL) Compact Brown Wet		1	SS	20									○			
			2	SS	7		226										
225.8																	
1.4	CLAY, varved Stiff Grey Wet		3	SS	11		225										
			4	SS	10												
224.3																	
2.9	SILT and SAND, trace clay, trace gravel Compact to dense Brown Wet		5	SS	21		224										
			6	SS	35		223							○			
222.6																	
4.6	END OF BOREHOLE AUGER REFUSAL																
Note: 1. Water level at a depth of 2.2 m below ground surface (Elev. 225.0 m) upon completion of drilling.																	


PROJECT <u>10-1191-0041</u>		RECORD OF BOREHOLE No SC-7				1 OF 1 METRIC							
G.W.P. <u>5153-11-00</u>		LOCATION <u>N 5126452.3; E 320161.8</u>				ORIGINATED BY <u>ID</u>							
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>JJL</u>							
DATUM <u>Geodetic</u>		DATE <u>May 11, 2015</u>				CHECKED BY <u>AB</u>							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL	
225.9	GROUND SURFACE												
0.0	ASPHALT (150 mm)												
0.2	Gravelly sand (FILL) Compact to dense Brown Moist to wet		1	SS	12							22 67 (11)	
224.7	END OF BOREHOLE SPOON AND AUGER REFUSAL		2	SS	36/0.4		225						
1.2	Note: 1. Water level at a depth of 0.7 m below ground surface (Elev. 225.2 m) upon completion of drilling.												

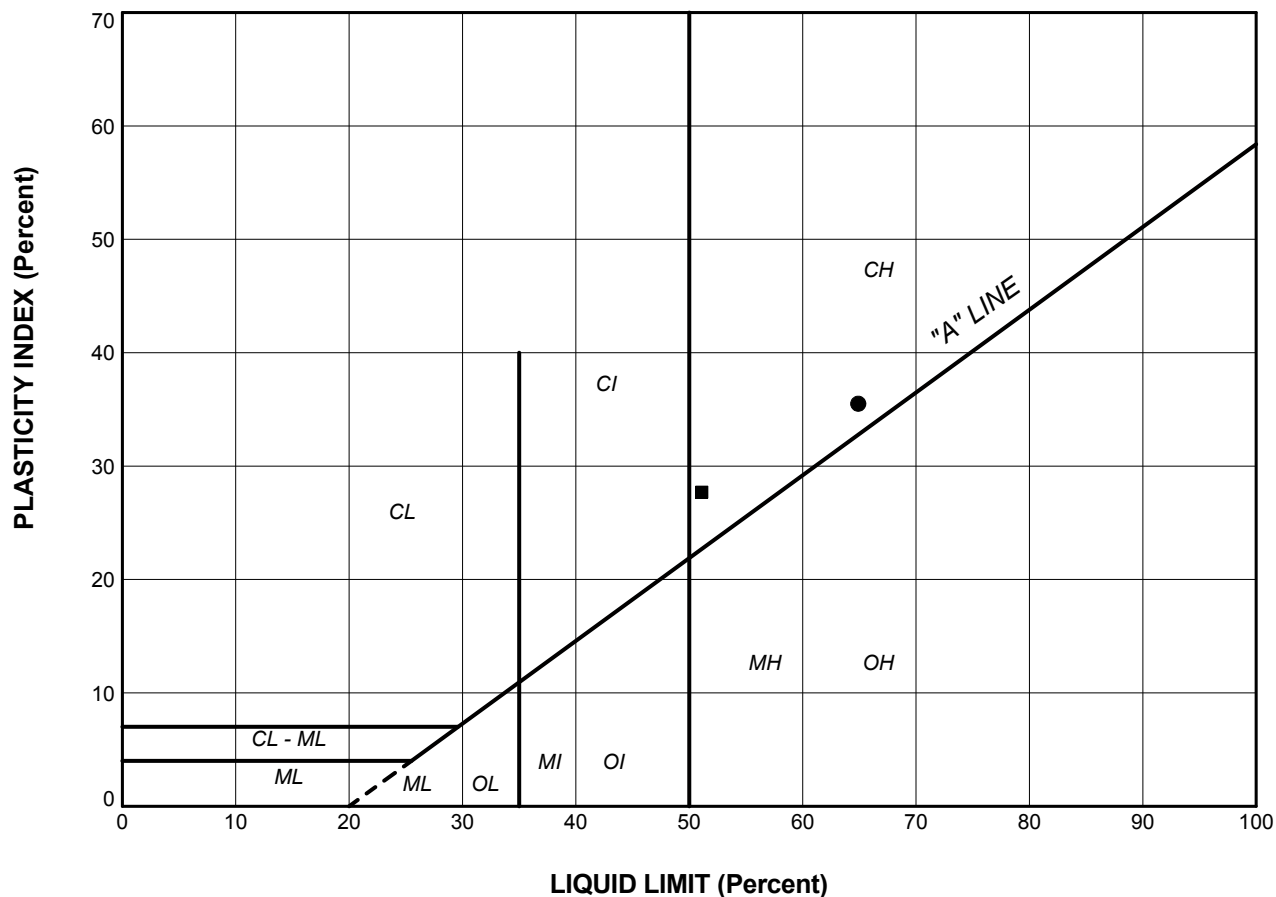
SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 09/07/15 DATA INPUT:




LEGEND

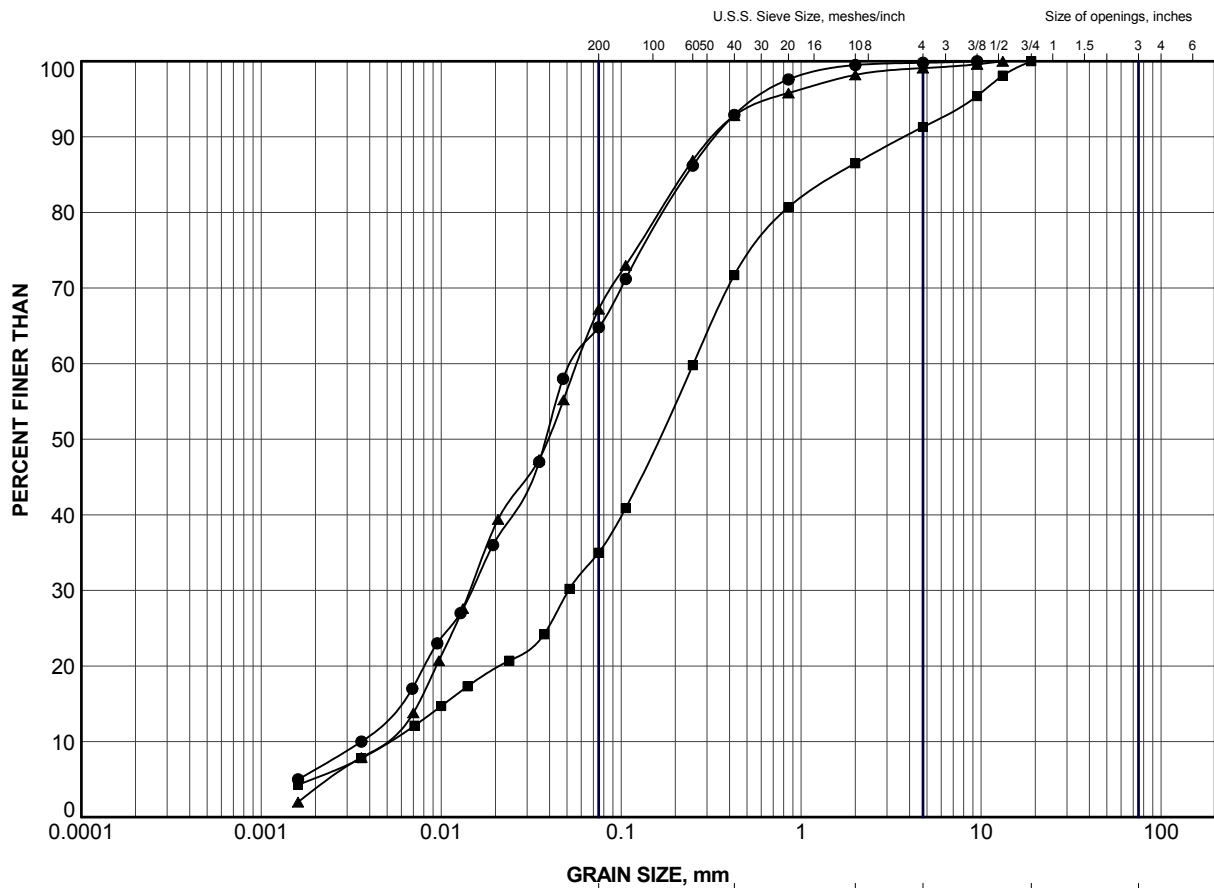
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	SC-1	1	229.9
■	SC-2	2	227.5
▲	SC-5	1	227.2
+	SC-7	1	225.5

PROJECT				
HIGHWAY 17/94 ROUNDABOUT STEEL COLUMN SUPPORTED SIGNS				
TITLE				
GRAIN SIZE DISTRIBUTION SAND to GRAVELLY SAND (FILL)				
PROJECT No.		10-1191-0041		FILE No.
DRAWN		JJL	Jul 2015	SCALE N/A
CHECK		AB	Jul 2015	REV.
APPR		JMAC	Jul 2015	
 Golder Associates SUDBURY, ONTARIO		FIGURE D1		



LEGEND					
SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	SC-4	5	64.9	29.4	35.5
■	SC-6	4	51.1	23.4	27.7


PROJECT					
HIGHWAY 17/94 ROUNDABOUT STEEL COLUMN SUPPORTED SIGNS					
TITLE					
PLASTICITY CHART CLAY					
PROJECT No.		10-1191-0041		FILE No.	
DRAWN		JLJ		Jul 2015	
CHECK		AB		Jul 2015	
APPR		JMAC		Jul 2015	
 Golder Associates SUDBURY, ONTARIO				SCALE N/A REV.	
FIGURE D2					



CLAY AND SILT		SAND SIZE, mm			GRAVEL SIZE, mm		Cobble Size
		fine	medium	coarse	fine	coarse	
		SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	SC-3	4B	226.4
■	SC-4	6	223.2
▲	SC-6	6	223.1

PROJECT				
HIGHWAY 17/94 ROUNDABOUT STEEL COLUMN SUPPORTED SIGNS				
TITLE				
GRAIN SIZE DISTRIBUTION SILT and SAND to SILTY SAND				
PROJECT No.		10-1191-0041		FILE No.
DRAWN		JJL	Jul 2015	SCALE N/A
CHECK		AB	Jul 2015	REV.
APPR		JMAC	Jul 2015	
 Golder Associates SUDBURY, ONTARIO		FIGURE D3		

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
33 Mackenzie Street, Suite 100
Sudbury, Ontario, Canada
P3C 4Y1
T: +1 (705) 524 6861

