



September 10, 2014

FOUNDATION INVESTIGATION REPORT

**REPLACEMENT OF NAGAGAMI RIVER BRIDGE - SITE NO. 39W-005
HIGHWAY 11, TOWNSHIP OF MCMILLAN, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5307-04-00**

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REPORT





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PART A

**FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF NAGAGAMI RIVER BRIDGE - SITE NO. 39W-005
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by LEA Consulting Ltd. (LEA) on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the replacement of the Nagagami River Bridge (Site No. 39W-005), located on Highway 11 about 2 km west of Highway 631 (west of Hearst) in the Township of McMillan, Ontario. Foundation engineering services and also required for: the proposed culvert replacement and a section of high fill embankment for the highway realignment and culvert extension to the west of the bridge; and a section of a deep cut for the highway realignment to the east of the bridge.

The Terms of Reference and Scope of Work for the Foundation Investigation are outlined in MTO's Request for Proposal dated March 2011. Golder's proposal for foundation engineering services associated with replacement of the Nagagami River Bridge structure is contained in Section 6.8 of LEA's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundations engineering services for this project, dated August, 2011.

This report addresses the results of the detail level subsurface investigation carried out at the following sites as shown on Drawing 1, Index Plan:

- the proposed Nagagami River Bridge replacement, including the west and east abutments and pier, the associated west and east approach embankments and the roadway protection;
- the proposed Culvert replacement at about STA 20+585, approximately 320 m west of the bridge on the relocated alignment;
- the proposed High Fill embankment between about STA 20+650 and STA 20+775, approximately 200 m west of the bridge on the relocated alignment;
- the proposed Deep Cut between about STA 21+050 and STA 21+150 approximately 50 m east of the bridge on the relocated alignment; and
- the proposed Culvert extension at about STA 20+070, approximately 830 m west of the bridge.

2.0 SITE DESCRIPTION

The Nagagami River Bridge is situated in the Township of McMillan on Highway 11 approximately 2 km west of Highway 631 and approximately 60 km west of Hearst, Ontario. The surrounding land is generally flat but slopes down towards the riverbanks, and is of rural development with moderate tree-covered terrain beyond the highway right-of-way limits. The riverbanks adjacent to the existing bridge area are vegetated with grass and small shrubs. The river flows in a northerly direction and is about 60 m wide at the existing bridge location.

The existing structure consists of an approximately 12 m wide, 83 m long, five-span two-lane bridge constructed in 1958. The steel girder bridge structure is supported at the abutments and piers on shallow foundations consisting of spread footings, inferred from the original design drawings, founded on the native cohesionless soils.



The river water level shown on the General Arrangement (GA) drawing is Elevation 204.6 m (September, 2011). The water level of Nagagami River measured at the bridge site during the field investigation, which took place in July and August 2012, varied between Elevation 205.4 m and 205.1 m. The high water level is reported to be Elevation 206.4 m. The existing highway embankment grade is between about Elevation 213 m at the west approach and Elevation 216 m at the east approach, corresponding to about 8 m and 11 m above the water level measured during the field investigation, respectively.

3.0 INVESTIGATION PROCEDURES

The fieldwork for this subsurface investigation was carried out between July 26 and August 1, 2012, at the Preliminary Foundation Investigation phase of the project, and between July 18 and August 27, 2013, and March 21 and April 17, 2014, at the Detail Foundation Investigation phase, during which time thirty-three (33) boreholes (Boreholes N1 to N17, N1a, N8a, NCU1 to NCU4, NHF1 to NHF6, NDC1 and NDC2, 1 and 2) were advanced at the site. As Boreholes N2 and N4 were drilled to the south of the existing structure and are no longer pertinent to the new bridge alignment to the north of the existing structure, these two boreholes are not referred to any further. The investigation was carried out using the following drilling equipment:

- Boreholes N5, N6, N13 to N15, N17, NCU1 to NCU3 and NHF1 to NHF3 were advanced using a CME-55 track-mounted drill rig supplied and operated by Landcore Drilling Inc. of Sudbury, Ontario; and
- Boreholes N1, N1a, N3, N12, N16, NCU4, NDC1, NDC2, 1 and 2 located on land and Boreholes N7 to N11, N8a and NHF4 to NHF6 located in the river were advanced using a D-25 semi-portable drill rig, mounted on a truck, skid or a track machine where drilled on land and placed on a raft or on the ice where drilled in the river. The D-25 was supplied and operated by Walker Drilling Ltd. of Barrie, Ontario. Boreholes N2 and N4 were drilled to the south of the existing structure at the Preliminary Phase of the project and are not relevant to the Detail Phase of the project.

The borehole locations are shown on Drawings A1 to E1 in Appendices A to E.

The boreholes were advanced using 108 mm inner diameter hollow-stem augers and/or HQ/NW casing and wash boring. Where coring through boulders/bedrock was required, a NQ size core barrel was used. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler operated by an automatic hammer on the CME-55 drilling and a manual hammer (Cathead) on the D-25 drill rig, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586).

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and a standpipe piezometer was installed in Borehole N17 at the bridge site to permit monitoring of the groundwater level. The piezometer consists of a 30 mm diameter polyvinyl chloride (PVC) pipe, with a slotted screen, sealed within a sand filter pack at a selected depth interval within the borehole. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipe was backfilled with bentonite pellets to create a seal to the ground surface. The water level readings are indicated on the Record of Borehole sheets contained in Appendices A to E. The piezometer installation details are presented on the Record of Borehole sheet in Appendix A. The boreholes were backfilled with bentonite as per Ontario Regulation 903 (as amended) upon completion of drilling or the day after drilling and the piezometer was decommissioned in accordance with Ontario Regulation 903 (as amended) on August 27, 2013.



The fieldwork was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, cleared the site for buried services, directed the drilling and sampling operations and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers and transported to Golder's Sudbury Laboratory for further examination and laboratory testing. Index and classification tests consisting of water content, Atterberg limits and grain size distribution were carried out on selected soil samples and Uniaxial Compressive Strength (UCS) tests were carried out on select bedrock core samples.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) and UCS are described based on Table 3.10 and Table 3.5, respectively, of the Canadian Foundation Engineering Manual (CFEM, 2006¹). The degree of weathering of the bedrock samples (i.e., fresh to slightly weathered) and the strength classification of the intact rock mass based on field identification (i.e., strong to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM²) standard classification system.

A sample of the river water was obtained during the field investigation using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of inorganic parameters.

The borehole locations and elevations were measured in the field by Golder personnel, relative to existing site features and surveyed to stakes placed in the field by JD Barnes Ltd., except for Boreholes NDC1 and NDC2, which were referenced to cross-section drawings provided by LEA as they are located along the proposed realigned roadway on relatively high ground about 8 m above the existing roadway embankment. The borehole locations (referenced to the MTM NAD83 co-ordinate system), ground surface elevations (referenced to Geodetic datum) and borehole depths are presented on the Record of Borehole sheets in Appendices A to D, and are summarized below.

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

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



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Location (Reference Appendix)	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground/Water or Ice Surface Elevation (m)	Borehole Depth (m) (* includes water)
Bridge and Approach Embankments (Appendix A)	N1	5 515 137.5	266 116.3	211.9	23.2
	N1a	5515139.8	266 113.0	211.9	43.3
	N3	5 515 079.8	266 178.6	206.8	7.8
	N5	5 515 145.6	266 096.9	211.8	5.2
	N6	5 515 127.5	266 106.9	211.2	24.8
	N7	5 515 111.6	266 144.5	205.2	14.1*
	N8	5 515 108.3	266 149.6	205.2	9.9*
	N8a	5 515 107.5	266 150.3	204.8	14.7*
	N9	5 515 103.6	266 142.9	205.4	12.7*
	N10	5 515 100.1	266 136.7	205.1	11.0*
	N11	5 515 094.0	266 140.7	205.1	8.0*
	N12	5 515 068.9	266 170.4	209.3	11.6
	N13	5 515 061.1	266 189.1	213.2	8.2
	N14	5 515 138.8	266 091.0	212.1	9.6
	N15	5 515 129.6	266 101.5	211.3	15.8
	N16	5 515 068.8	266 166.0	208.1	8.1
	N17	5 515 055.8	266 184.5	213.9	14.3
Culvert Replacement STA 20+585 (Appendix B)	NCU1	5 515 358.2	265 872.6	206.4	14.3 (DCPT: 14.3 - 17.4)
	NCU2	5 515 348.0	265 856.2	206.2	15.8 (DCPT: 15.8 - 16.3)
	NCU3	5 515 334.1	265 850.9	211.8	18.9
	NCU4	5 515 329.1	265 859.9	211.9	15.8
High Fill STA 20+650 to 20+775 (Appendix C)	NHF1	5 515 281.3	265 915.5	211.2	18.6
	NHF2	5 515 255.0	265 945.6	211.0	17.4
	NHF3	5 515 228.7	265 975.7	211.0	13.0
	NHF4	5 515 301.3	265 932.6	204.0	12.8*
	NHF5	5 515 274.0	265 963.4	203.6	12.3*
	NHF6	5 515 247.9	265 992.7	203.2	5.9*
Deep Cut STA 21+050 to 21+150 (Appendix D)	NDC1	5 515 039.2	266 237.4	225.1	13.9
	NDC2	5 515 000.3	266 274.5	224.8	12.6
Culvert Extension STA 20+070 (Appendix E)	1	5 515 505.1	265 379.6	233.2	6.7
	2	5 515 513.4	265 379.2	230.7	4.8



4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on NOEGTS³ Mapping, the subsoils in the vicinity of the Nagagami River Bridge site generally consist of clayey till deposited as a ground moraine.

Published literature indicates that the site is located in the Quetico Subprovince of the Superior Province (OGS, 1991)⁴. The bedrock of this domain consists of muscovite-bearing granitic rocks (peraluminous), and may include biotite granite. Beyond the muscovite-bearing granitic boundary, bedrock consists of meta-sedimentary rocks.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced in the vicinity of Nagagami River Bridge, Culvert Replacement and Extension, High Fill and Deep Cut areas, together with the results of the laboratory tests carried out on selected soil samples, are presented on the Record of Borehole sheets and the laboratory test sheets in Appendices A to E. The results of the analytical testing on a sample of the river water are summarized in Table A1 in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets, and on the interpreted stratigraphic profile and cross-sections shown on the drawings presented in Appendices A to E are inferred from non-continuous sampling, observations of drilling progress and soil cuttings returns and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

Detailed descriptions of the subsurface conditions at each investigated area are provided in the subsequent sections of this report.

Groundwater levels/conditions encountered in the boreholes during and shortly after drilling may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized. Groundwater levels in the area are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt.

4.3 Nagamami River Bridge

The plan and profile along the Nagagami River Bridge centreline showing the borehole locations and interpreted stratigraphy, as well as cross-sections and profiles along the abutments and roadway protection centreline are shown on Drawings A1 and A2 in Appendix A. A total of fifteen boreholes were advanced at the bridge site:

- Boreholes N1, N1A, N5, N6, N14 and N15 were advanced at the west side of the bridge for the new abutment, approach embankment and roadway protection;
- Boreholes N7 to N11 and N8a were advanced for the centre pier; and

³ Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Map Reference Number 42GNW.

⁴ Ontario Geological Survey, 1991, Geology of Ontario.. ,Special Volume 4, Part 1. Eds P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott, Ministry of Northern Development and Mines, Ontario.



- Boreholes N3, N12, N13, N16 and N17 were advanced at the east side of the bridge for the new abutment, approach embankment and roadway protection.

Water/Ice

Boreholes N7 to N11 were advanced from the Nagagami River water surface, ranging from Elevation 205.4 m to Elevation 205.1 m and the water column was between 0.7 m and 1.3 m deep (measured between August 8 and 20, 2013). Borehole N8a was drilled over about 0.5 m of ice with surface at Elevation 204.8 m.

Fill

A 0.1 m to 0.7 m thick layer of peat/topsoil fill was encountered from ground surface in Boreholes N1, N3, N5, N6 and N14. Below the peat/topsoil fill in Boreholes N1, N3, N6 and N14 and from ground surface in Boreholes N12 to N17, a variety of fill material was encountered, consisting of sand and gravel, silty sand, sandy silt, silt and/or clayey silt, with peat pockets/seams in several samples as noted on the borehole logs recovered. The overall thickness of the fill deposit, including the surface layer of peat/topsoil, ranges from 0.6 m to 6.7 m with the ground surface encountered from Elevation 213.9 m to 206.8 m.

Two SPT 'N'-values measured within the peat/topsoil fill are 3 blows and 4 blows per 0.3 m of penetration, suggesting a soft to firm consistency. SPT 'N'-values measured within cohesionless fill deposit (sand and gravel, sand, silt) range from 0 blows (weight of hammer) to 78 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. In the cohesive soil fill strata (silt to clayey silt), the SPT 'N'-values range from 1 blow to 22 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency.

The natural water content measured on one sample of the peat fill is about 32 per cent. The natural water content measured on samples of the sand and gravel, sand and silt fill strata range from 3 per cent to 18 per cent. The natural water content measured on samples of the silt to clayey silt fill strata range from 12 per cent to 37 per cent.

The grain size distribution of three samples of the sand to sand and gravel fill strata are presented on Figure A1 in Appendix A. The grain size distributions of four samples of the sandy silt to silt and sand clayey silt fill strata are presented on Figure A2.

Atterberg limits tests were carried out on four samples of the sandy silt to clayey silt fill strata and measured liquid limits ranging from about 17 per cent to 30 per cent, plastic limits ranging from about 14 per cent to 17 per cent and plasticity indices ranging from about 3 per cent to 16 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A3 and indicate the fill materials in places consist of sandy silt of slight plasticity to clayey silt of low plasticity.

Cobbles and Boulders

Cobbles and boulders were observed in the river bed in the vicinity of Boreholes N7 to N11. In Borehole N16, a 0.3 m size boulder was recovered from below the fill material at a depth of 1.2 m below ground surface (Elevation 206.9 m).



Sand and Gravel (Upper Deposit)

A 0.1 m to 0.7 m deposit of sand and gravel was encountered underlying the fill in Borehole N12 at a depth of 3.0 m below ground surface (Elevation 206.3 m), below the boulder in Borehole N16 at a depth of 1.5 m below ground surface (Elevation 206.6 m) and from the riverbed in Boreholes N8 to N11 (Elevation 204.4 m to 204.0 m).

The SPT 'N'-values measured within the sand and gravel deposit range from 15 blows to 107 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

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

The grain size distribution of one sample of the sand and gravel deposit is presented on Figure A4 in Appendix A.

Sandy Silt to Silt and Sand (Till)

A till deposit comprised of sandy silt to silt and sand was encountered below the fill below the upper deposit of sand and gravel and below the silt deposit (described in the next section) in Boreholes N1/N1a, N3, N5, N6 and N12 to N17, which were advanced on land, with the surface of the deposit encountered at a depth between 0.2 m and 6.7 m below ground surface, corresponding to between Elevations 211.2 m and 204.6 m. The thickness of the till deposit ranges from 6.5 m to 8.7 m where fully penetrated in Boreholes N1, N6, N12 and N15. In the remaining boreholes (i.e., N3, N5, N13, N14, N16 and N17), the deposit was not fully penetrated after exploring the deposit between 2.6 m and 7.6 m. Cobbles were encountered or inferred by auger grindings to be present within the till deposit as follows:

- Borehole N3 below a depth of 6.3 m (Elevation 200.5 m);
- Borehole N5, augers were grinding from 1.5 m to 2.1 m and at 3.0 m depth (Elevations 210.3 m to 209.7 m and 208.8 m);
- Borehole N6 at a depth of 2.6 m (Elevation 208.6 m); and
- Borehole N15 at a depth of 4.2 m (Elevation 207.1 m).

Difficult auger and casing advancement was noted throughout this deposit and coring techniques were required to advance some boreholes at various depths throughout this deposit.

The SPT 'N'-values measured within the till deposit range from 15 blows to greater than 100 blows per 0.3 m of penetration indicating a compact to very dense relative density, however the majority of SPT 'N'-values indicate very dense relative density.

The natural water content measured on samples of this deposit ranges from about 8 per cent to 19 per cent.

The grain size distributions of eighteen samples of the sandy silt to silt and sand till are presented on Figures A5.1 and A5.2.

Atterberg limits testing was carried out on fifteen samples of the till deposit and yielded liquid limits ranging from about 17 per cent to 24 per cent, plastic limits ranging from about 11 per cent to 17 per cent, and plasticity



indices ranging from about 4 per cent to 9 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A6, and indicate the material to be sand/silt of slight plasticity.

Silt

A silt deposit was encountered in most boreholes immediately below the water column, underlying and within the till deposit, or as a pocket underlying the fill deposit, as follows:

- In Borehole N1 and N6, a 10.7 m and 12.9 m thick deposit of silt was encountered at Elevations 201.7 m and 204.0 m, respectively. In Borehole N6, a cobble was encountered at a depth of 8.7 m below ground surface (Elevation 202.5 m);
- In Boreholes N7 to N11, a 3.2 m to 8.4 m thick deposit of silt was encountered from the riverbed or below the sand and gravel deposit between Elevation 204.1 m and 203.8 m. Below depths between 3.0 m and 5.3 m below ground surface, clay seams/layers were noted within the deposit in each of the boreholes;
- In Borehole N14, a 2.3 m thick deposit of silt was encountered interlayered within the silt and sand till deposit at a depth of 3.8 m below ground surface (Elevation 208.3 m);
- In Borehole N15, the silt deposit was encountered at Elevation 204.0 m and not fully penetrated after exploring the deposit for 8.5 m;
- In Borehole N16, a 0.4 m thick layer of silt was encountered below the upper deposit of sand and gravel at a depth of 2.2 m below ground surface (Elevation 205.9 m).
- In Boreholes N7, N8 and N9, clay seams/layers were noted within the silt samples obtained.

The SPT 'N'-values measured within the silt deposit range from 15 blows to greater than 100 blows per 0.3 m of penetration, indicating a compact to very dense relative density and generally dense to very dense.

The natural water content measured on samples of this deposit ranges from about 15 per cent to 26 per cent.

The grain size distribution of twenty-one samples of the silt deposit are presented on Figure A7.1 and A7.2.

Atterberg limits tests were carried out on nineteen samples of the silt deposit and the clay seams and measured liquid limits ranging from about 22 per cent to 37 per cent, plastic limits ranging from about 16 per cent to 22 per cent, and plasticity indices ranging from about 5 per cent to 19 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A8 in Appendix A, and indicate the material to be silt of slight plasticity and the seams to consist of clayey silt of low plasticity. One Atterberg limits test indicate a non-plastic result.

Silt and Sand to Silty Sand and Gravel (Till), Lower Deposit

A till deposit comprised of silt and sand to silty sand and gravel intermixed with cobbles and boulders in places was encountered below the silt or sandy silt deposits in Boreholes N1/N1a and N6, at depths of 20.9 m and 20.1 m below ground surface, respectively and in Boreholes N7, N8/N8a, N9, N10 and N11, at depths between 4.5 m and 9.0 m below the water surface. The surface of the deposit was encountered between Elevations 200.6 m



and 191.0 m and the thickness of the deposit is 19.3 m in Borehole N1a and ranges from 0.3 m to 2.6 m in Boreholes N8a, N9, N10 and N11 where fully penetrated and up to 5.4 m where not fully penetrated in Borehole N7.

Difficult casing advancement was noted throughout this deposit and coring techniques were required to advance the boreholes through the cobbles and/or boulders present at various depths/locations within this deposit.

The SPT was generally terminated before penetrating 0.3 m due to the hammer bouncing or measuring 100 blows or greater, indicating a very dense relative density.

The natural water content measured on samples of this deposit is between about 7 per cent and 10 per cent.

The grain size distribution of six samples of this deposit are presented on Figure A9.

Atterberg limits tests were carried out on four samples of this deposit and measured liquid limits ranging from about 16 per cent to 20 per cent, plastic limits ranging from about 10 per cent to 12 per cent, and plasticity indices ranging from about 5 per cent to 9 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A10, and indicate the material to be sand/silt of slight plasticity.

Bedrock/Refusal

In Borehole N1a, bedrock was encountered at a depth of 40.2 m below ground surface, corresponding to Elevation 171.7 m and the bedrock was cored for a length of 3.1 m.

In Boreholes N8a and N9 to N11, bedrock was encountered at depths ranging from 6.0 m to 11.6 m below water/ice surface, corresponding to between Elevations 199.1 m and 193.2 m and the bedrock was cored for lengths ranging from 2.0 m to 3.2 m.

In Borehole N12, bedrock was encountered at a depth of 10.4 m below ground surface (Elevation 198.9 m) and was cored for a length of 1.2 m.

The retrieved bedrock is described as fine to very coarse grained, fresh, grey and pink (where applicable) gneiss in Boreholes N1a, N8a and N9 to N11 and very coarse grained, slightly weathered, pink pegmatite in Borehole N12. Photographs of the retrieved bedrock cores are shown on Figure A11.

The Total Core Recovery of the bedrock core is 100 per cent. The RQD measured ranges from 81 per cent to 100 per cent, indicating a rock mass of good to excellent quality.

Laboratory UCS testing was carried out on four samples of the bedrock core. The UCS values are presented on the Record of Drillhole sheets in Appendix A and summarized below and indicate that the bedrock is considered medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa). The laboratory test sheet is presented as Table A2 in Appendix A.



Borehole/ Core Sample	Elevation (m)	UCS (MPa)
N8a/Run 1	193.0	70
N9/Run 1	195.4	102
N10/Run 2	196.0	76
N11/Run 2	198.0	110
N12/Run 1	198.3	41

Groundwater Conditions

Groundwater levels were measured in the open boreholes during and upon completion of drilling and a piezometer was installed in Borehole N17, sealed within the fill deposit, to monitor the groundwater level. The groundwater level in the open boreholes ranges from Elevation 210.0 m to 201.7 m measured at the following depths:

- In the boreholes advanced on land (Boreholes N1, N3, N5, N6 and N12 to N17), the depth to the groundwater level was measured between 0.3 m and 10.2 m below ground surface; and
- In the boreholes advanced in the river (Boreholes N7 to N11 and N8a), the groundwater level inside the drill casing was measured between 0.3 m below and 1.0 m above the river water surface.

In the piezometer at Borehole N17, the depth to the groundwater level was measure at 3.1 m below ground surface, corresponding to Elevation 210.8 m on August 27, 2013.

The river water surface was measured at between about Elevations 205.4 m and 205.1 m, between August 8 and 20, 2013. The ice surface was measured at about Elevation 204.8 m on March 21, 2014.

4.4 Culvert Replacement – STA 20+585

The plan and profile along the centreline of the culvert at STA 20+585 showing the borehole locations and interpreted stratigraphy are shown on Drawing B1 in Appendix B. The existing embankment at this location is approximately 6 m high and the existing timber box culvert is 1.8 m wide by 1.3 m high and 31 m long. A total of four boreholes (NCU1 to NCU4) were advanced at the culvert location.

Embankment Fill

In Borehole NCU3, a 300 mm thick layer of asphalt was encountered at the ground surface (Elevation 211.8 m). A 2.6 m to 2.7 m thick layer of gravelly sand to sand and gravel fill was encountered in Borehole NCU3 underlying the asphalt and in Borehole NCU4 from ground surface. Underlying the granular fill in both boreholes, a 2.0 m to 2.3 m thick layer of clayer silt fill was encountered.

The SPT 'N'-values measured within the gravelly sand fill range from 13 blows to 40 blows per 0.3 m of penetration, indicating a compact to dense relative density. SPT 'N'-values up to 75 blows per 0.3 m of penetration were recorded in Borehole NCU4 but are likely due to the frozen nature of the fill. The



SPT 'N'-values measured within the clayey silt fill range from 6 blows to 16 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

The natural water content measured on two samples of the gravelly sand fill is about 3 per cent and 7 per cent and of one sample of the clayey silt fill is about 18 per cent.

The grain size distributions of two samples of the gravelly sand fill are presented on Figure B1 in Appendix B.

An Atterberg limits test was carried out on a sample of the clayey silt portion of the fill deposit and measured a liquid limit of about 27 per cent, aplastic limit of about 17 per cent, and plasticity index of about 10 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B2 and indicate that the material is clayey silt of low plasticity.

The grain size distribution of one sample of the clayey silt portion of the fill is presented in Figure B3.

Peat

A 0.3 m and 0.6 m thick deposit of fibrous peat was encountered from ground surface in Boreholes NCU1 and NCU2, respectively and an approximately 0.6 m and 0.1 m thick layer of peat was encountered below the clayey silt fill in Boreholes NCU3 and NCU4. The surface of the peat was encountered between Elevation 206.8 m and 206.2 m.

One SPT 'N'-value measured within the peat deposit is 3 blows per 0.3 m of penetration, suggesting a soft consistency.

Sandy Silt to Silt and Sand (Till)

Underlying the peat in the four boreholes, a deposit of sandy silt to silt and sand till was encountered at depths ranging from 0.3 m to 5.6 m below ground corresponding to between Elevation 206.9 m and 205.6 m. All boreholes were terminated within this deposit, penetrating between 10.8 m and 15.2 m into the deposit.

The SPT 'N'-values measured within the sandy silt to silt and sand till deposit range between 4 blows and 92 blows per 0.3 m of penetration, indicating a loose to very dense relative density, but generally a compact to dense relative density.

The natural water content measured on ten samples of this deposit ranges from about 8 per cent to 11 per cent.

The grain size distribution of twelve samples of the sandy silt to silt and sand till deposit are shown on Figure B4.

Atterberg limits tests were carried out on twelve samples of this deposit and measured liquid limits ranging from about 15 per cent to 19 per cent, plastic limits ranging from about 12 per cent to 13 per cent, and plasticity indices ranging from about 3 per cent to 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5 and indicate that the material is silt of slight plasticity.



Groundwater Conditions

Boreholes NCU1, NCU3 and NCU4 were dry upon completion of drilling. In Borehole NCU2, the depth to the the water level measured upon completion of drilling is 11.0 m below ground surface, corresponding to Elevation 195.2 m.

4.5 High Fill – STA 20+650 to 20+775

The plan and profile along the high fill embankment on the relocated alignment between STA 20+650 and STA 20+775 showing the borehole locations and the interpreted stratigraphy are shown on Drawing C1 in Appendix C. The existing embankment at this location is approximately 8 m high above the adjacent river water level. A total of six boreholes (NHF1 to NHF6) were advanced to investigate the subsurface conditions under the proposed high fill embankment.

Water

Boreholes NHF4 to NHF6 were advanced in the Nagagami River and encountered a water column between 0.8 m and 1.1 m deep. The surface of the water at the time of drilling ranges between Elevations 204.0 m and 203.2 m.

Embankment Fill

In Boreholes NHF1 to NHF3, a 400 mm thick layer of asphalt was encountered at the ground surface (Elevations 211.2 m to 211.0 m) underlain by 2.6 m to 5.2 m of embankment fill consisting of sand to gravelly sand to sand and gravel, silt and/or silt and sand.

The SPT 'N'-values measured within the embankment fill deposit range between 4 blows and 42 blows per 0.3 m of penetration, indicating a loose to dense relative density, but generally a compact relative density.

The natural water content measured on five samples of the fill deposit ranges from about 3 per cent to 10 per cent.

The grain size distributions of three samples of the embankment fill are presented on Figure C1.

Sand and Gravel

In Boreholes NHF3, an approximately 1.6 m thick deposit of sand and gravel was encountered below the embankment fill at a depth of 5.6 m below ground surface (Elevation 205.4 m). In Borehole NHF4 to NHF6, an approximately 0.1 m to 2.5 m thick deposit of sand and gravel was encountered from the river bed, with the surface of the deposit between Elevations 202.9 m and 202.4 m.

The SPT 'N'-values measured within this deposit range from 13 blows to 61 blows per 0.3 m of penetration, indicating a compact to very dense relative density. In Borehole NHF6, split spoon refusal (hammer bouncing)



was encountered at a depth at 1.2 m below the river water surface and NQ coring techniques were required to recover the remaining 0.4 m thick portion of the deposit.

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

The grain size distribution of a sample of the sand and gravel deposit is presented on Figure C2.

Silt and Sand (Till)

A deposit of sandy silt to silt and sand till was encountered either below the embankment fill or below the sand and gravel deposit with the surface of the deposit at depths ranging from of 3.0 m to 7.2 m below the ground surface in Boreholes NHF1 to NHF3 (Elevations 208.2 m to 203.8 m) and at depths of 1.2 m and 3.6 m below the water surface in Boreholes NHF4 and NHF5, respectively (Elevations 202.8 m and 200.0 m). The thickness of the deposit in Boreholes NHF2, NHF3 and NHF5 is between approximately 0.9 m and 4.2 m and Boreholes NHF1 and NHF4 were terminated within the till deposit, penetrating 15.6 m and 11.6 m into the deposit, respectively, upon auger refusal in Borehole NHF1,.

The SPT 'N'-values measured within this deposit range from 14 blows to 81 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The natural water content measured on samples of the silt and sand till ranges from about 8 per cent and 11 per cent.

The grain size distributions of nine samples of the deposit are shown on Figure C3.

Atterberg limits tests were carried out on eight samples of this deposit and measured liquid limits ranging between about 16 per cent and 17 per cent, plastic limits ranging between about 12 per cent and 13 per cent and plasticity indices ranging from about 3 per cent to 5 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C4 in Appendix C, and indicate the material to be a silt of slight plasticity.

Silt to Clayey Silt

Underlying the silt and sand till deposit in Boreholes NHF2, NHF3, NHF5 and NHF6, a 1.4 m to 7.5 m thick deposit of silt to clayey silt was encountered at depths between 1.5 m and 8.7 m below ground surface, between Elevations 203.8 m and 199.1 m. The bottom of the deposit is inferred from auger refusal in Borehole NHF3.

The SPT 'N'-values measured within the silt to clayey silt deposit range from 26 blows to 62 blows per 0.3 m of penetration, suggesting a compact to very dense relative density/very stiff to hard consistency.

The natural water content measured of six samples of the silt to clayey silt ranges from about 15 per cent and 22 per cent.

The grain size distribution of six samples of the silt to clayey silt deposit is shown on Figure C5 in Appendix C.

Atterberg limits tests were carried out on six samples of the silt to clayey silt deposit and measured liquid limits ranging from about 19 per cent to 29 per cent, plastic limits ranging from about 6 per cent to 19 per cent and plasticity indices ranging from about 5 per cent to 15 per cent. The results of the Atterberg limits tests are shown



on the plasticity chart on Figure C6, and indicate the composition of the deposit ranges from silt of slight plasticity to clayey silt of low plasticity.

Bedrock

In Boreholes NHF5 and NHF6, bedrock was encountered at depths of 11.9 m and 2.9 m below the river water surface, corresponding to Elevations 191.7 m and 200.3 m, respectively, and the bedrock was cored for lengths of 0.3 m and 3.0 m, respectively.

In Borehole NHF5, the bedrock is described as gneiss, and in Borehole NHF6 the bedrock is described as very coarse grained, granitic pegmatite. A photograph of the retrieved bedrock core from Borehole NHF6 is shown on Figure C7.

The Total Core Recovery of the bedrock is 100 per cent. The Rock Quality Designation in Borehole NHF6 is 100 per cent, indicating a rock mass of excellent quality.

Groundwater Conditions

The depth to the groundwater level was measured in Borehole NHF3 at 9.8 m below ground surface (Elevation 201.2 m) upon completion of drilling.

The river water surface at Boreholes NHF4 to NHF6 was measured between Elevations 204.0 and 203.2 m between July 25 and 29, 2013.

4.6 Deep Cut – STA 21+050 to 21+150

The plan and profile along the deep cut of the highway realignment between STA 21+050 and 21+150 showing the borehole locations and the interpreted stratigraphy are shown on Drawing D1 in Appendix D. The depth of the cut is up to approximately 8 m relative to the proposed highway centreline. A total of two boreholes (NDC1 and NDC2) were advanced to investigate the subsurface conditions within the deep cut area through which the section of realigned highway will extend.

Topsoil

A 0.2 m and 0.3 m thick deposit of topsoil was encountered from ground surface in Boreholes NDC1 and NDC2, at approximately Elevations 225.1 m and 224.8 m, respectively.

Clayey Silt

A 2.1 m and 2.0 m thick deposit of clayey silt to silty clay was encountered underlying the topsoil at Elevations 224.8m and 224.6 m in Boreholes NDC1 and NDC2, respectively.



The SPT 'N'-values measured within the cohesive deposit range from about 3 blows to 8 blows per 0.3 m of penetration, suggesting a firm consistency.

The natural water content measured on two samples of the clayey silt is about 27 per cent and 28 per cent.

The grain size distributions of two samples of the clayey silt to silty clay deposit are shown on Figure D1 in Appendix D.

Atterberg limits tests were carried out on two samples of the cohesive deposit and the measured liquid limits are about 33 per cent and 36 per cent, the plastic limits are about 18 per cent and 19 per cent and the plasticity indices are about 14 per cent and 18 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D2, and indicate the material tested to be clayey silt of low plasticity.

Gravelly Silty Sand

A 3.2 m and 0.8 m thick deposit of gravelly silty sand was encountered underlying the clayey silt to silty clay deposit in Boreholes NDC1 and NDC2, respectively, at a depth of 2.4 m and 2.2 m below ground surface corresponding to Elevations 222.7 m and 222.6 m.

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

The SPT 'N'-values measured within the gravelly silty sand deposit range from about 12 blows to 59 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The grain size distribution of one sample of the gravelly silty sand is shown on Figure D3.

Silt and Sand (Till)

Underlying the gravelly silty sand in Boreholes NDC1 and NDC2, a deposit of silt and sand till was encountered at a depth of 5.6 m and 3.0 m below ground surface, corresponding to Elevations 219.5 m and 221.8 m, respectively. Both boreholes were terminated within this deposit after penetrating 8.3 m and 9.6 m into the deposit.

The SPT 'N'-values measured within the silt and sand till deposit range from 73 blows per 0.3 m of penetration to 60 blows per 0.1 m of penetration, indicating a very dense relative density.

The natural water content measured on five samples of the sand and silt deposit is about 9 per cent.

The grain size distributions of five samples of the till deposit are shown on Figure D4 in Appendix D.

Atterberg limits tests were carried out on five samples of the till deposit and measured liquid limits ranging from about 16 per cent to 18 per cent, plastic limits ranging from about 12 per cent to 13 per cent and plasticity indices ranging from about 4 per cent to 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D5 in Appendix D, and classify the fines material of the till deposit as silt of slight plasticity.



Groundwater Conditions

The water level in Borehole NDC1 and NDC2 upon completion of drilling was measured at is 1.4 m and 2.0 m below ground surface, corresponding to Elevations 223.7 m and 222.8 m.

4.7 Culvert Extension – STA 20+070

The plan and profile along the centreline of the culvert at STA 20+070 showing the borehole locations and interpreted stratigraphy are shown on Drawing E1 in Appendix E. The existing embankment at this location is approximately 2.5 m high and the existing timber box culvert is 1.3 m wide by 900 mm high and 20 m long. A total of two boreholes (Boreholes 1 and 2) were advanced at the culvert location.

Embankment Fill

In Borehole 1, a 300 mm thick layer of asphalt was encountered from the pavement surface (Elevation 233.2 m) underlain by a 2.3 m thick layer of sand and gravel to sand fill with a 75 mm thick layer of Styrofoam at a depth of 0.8 m. In Borehole 2, a 0.2 m thick layer of sand fill was encountered from ground surface at Elevation 230.7 m.

Two SPT 'N'-values measured within the fill are 23 blows and 24 blows per 0.3 m of penetration, indicating a compact relative density.

Clayey Silt

An approximately 1 m thick stratum of clayey silt was encountered in Borehole 1 at Elevation 230.8 m.

One SPT 'N'-value measured within the clayey silt is 7 blows per 0.3 m of penetration. An in situ field vane test carried out at the interface with the underlying silt and sand deposit measuring an undrained shear strength test of about 75 kPa, suggesting a stiff consistency. The sensitivity of the vane shear test is 40 suggesting a high influence of the less cohesive underlying deposit at the test depth.

The natural water content measured on a sample of the clayey silt stratum is about 22 per cent.

An Atterberg limits test was carried out on a sample of this deposit and measured a liquid limit of about 30 per cent, a plastic limit of about 17 per cent, and a plasticity index of about 13 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure E1 and indicate that the material is a clayey silt of low plasticity.

The grain size distribution of a sample of the clayey silt stratum is shown on Figure E2.



Sandy Silt to Silt and Sand (Till)

Underlying the clayey silt in Borehole 1 and the fill in Borehole 2, a deposit of silt and sand till was encountered at Elevation 229.8 m and 230.5 m, respectively. The boreholes were terminated after penetrating 3.3 m and 4.6 m into the deposit.

The SPT 'N'-values measured within the deposit range between 45 blows and greater than 100 blows per 0.3 m of penetration, indicating a dense to very dense relative density, with one near surface N-value of 6 blows per 0.3 m of penetration indicating a loose relative density.

The natural water content measured on samples of this deposit ranges from about 8 per cent to 12 per cent.

The grain size distributions of three samples of the deposit are shown on Figure E3.

Atterberg limits tests were carried out on three samples of this deposit and measured liquid limits ranging from about 17 per cent to 20 per cent, plastic limits ranging from about 12 per cent to 15 per cent, and plasticity indices of about 5 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure E4 and indicate that the material is silt of slight plasticity.

Groundwater Conditions

Boreholes 1 and 2 were dry upon completion of drilling.

5.0 CLOSURE

The field drilling program was supervised by Messers Ed Savard, Indulis Dumpis and Shane Albert. This report was prepared by Adam Core E.I.T., and the technical aspects were reviewed by Mr. André Bom, P.Eng. Mr. Jorge Costa, P.Eng., Principal and Golder's Designated MTO Foundations Contact for this project, conducted an independent review of this report.



Report Signature Page

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LIST OF SYMBOLS

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

I.	GENERAL	(a)	Index Properties (continued)
π	3.1416	w	water content
$\ln x$,	natural logarithm of x	w_l or LL	liquid limit
\log_{10}	x or log x, logarithm of x to base 10	w_p or PL	plastic limit
g	acceleration due to gravity	I_p or PI	plasticity index = $(w_l - w_p)$
t	time	w_s	shrinkage limit
FoS	factor of safety	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)
II.	STRESS AND STRAIN	(b)	Hydraulic Properties
γ	shear strain	h	hydraulic head or potential
Δ	change in, e.g. in stress: $\Delta \sigma$	q	rate of flow
ε	linear strain	v	velocity of flow
ε_v	volumetric strain	i	hydraulic gradient
η	coefficient of viscosity	k	hydraulic conductivity (coefficient of permeability)
ν	Poisson's ratio	j	seepage force per unit volume
σ	total stress	(c)	Consolidation (one-dimensional)
σ'	effective stress ($\sigma' = \sigma - u$)	C_c	compression index (normally consolidated range)
σ'_{vo}	initial effective overburden stress	C_r	recompression index (over-consolidated range)
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)	C_s	swelling index
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$	C_α	secondary compression index
τ	shear stress	m_v	coefficient of volume change
u	porewater pressure	C_v	coefficient of consolidation (vertical direction)
E	modulus of deformation	C_h	coefficient of consolidation (horizontal direction)
G	shear modulus of deformation	T_v	time factor (vertical direction)
K	bulk modulus of compressibility	U	degree of consolidation
		σ'_p	pre-consolidation stress
III.	SOIL PROPERTIES	OCR	over-consolidation ratio = σ'_p / σ'_{vo}
(a)	Index Properties	(d)	Shear Strength
$\rho(\gamma)$	bulk density (bulk unit weight)*	τ_p, τ_r	peak and residual shear strength
$\rho_d(\gamma_d)$	dry density (dry unit weight)	ϕ'	effective angle of internal friction
$\rho_w(\gamma_w)$	density (unit weight) of water	δ	angle of interface friction
$\rho_s(\gamma_s)$	density (unit weight) of solid particles	μ	coefficient of friction = $\tan \delta$
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)	c'	effective cohesion
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)	C_u, S_u	undrained shear strength ($\phi = 0$ analysis)
e	void ratio	p	mean total stress $(\sigma_1 + \sigma_3)/2$
n	porosity	p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
S	degree of saturation	q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
		q_u	compressive strength $(\sigma_1 - \sigma_3)$
		S_t	sensitivity

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

Notes: 1
2

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



LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

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.

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

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

	<u>kPa</u>	<u>C_u, S_u</u>	<u>psf</u>
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.



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. 5307-04-00

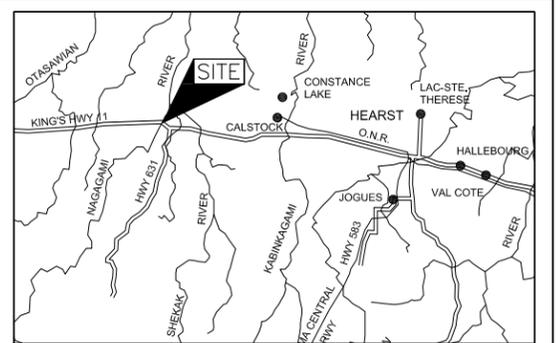
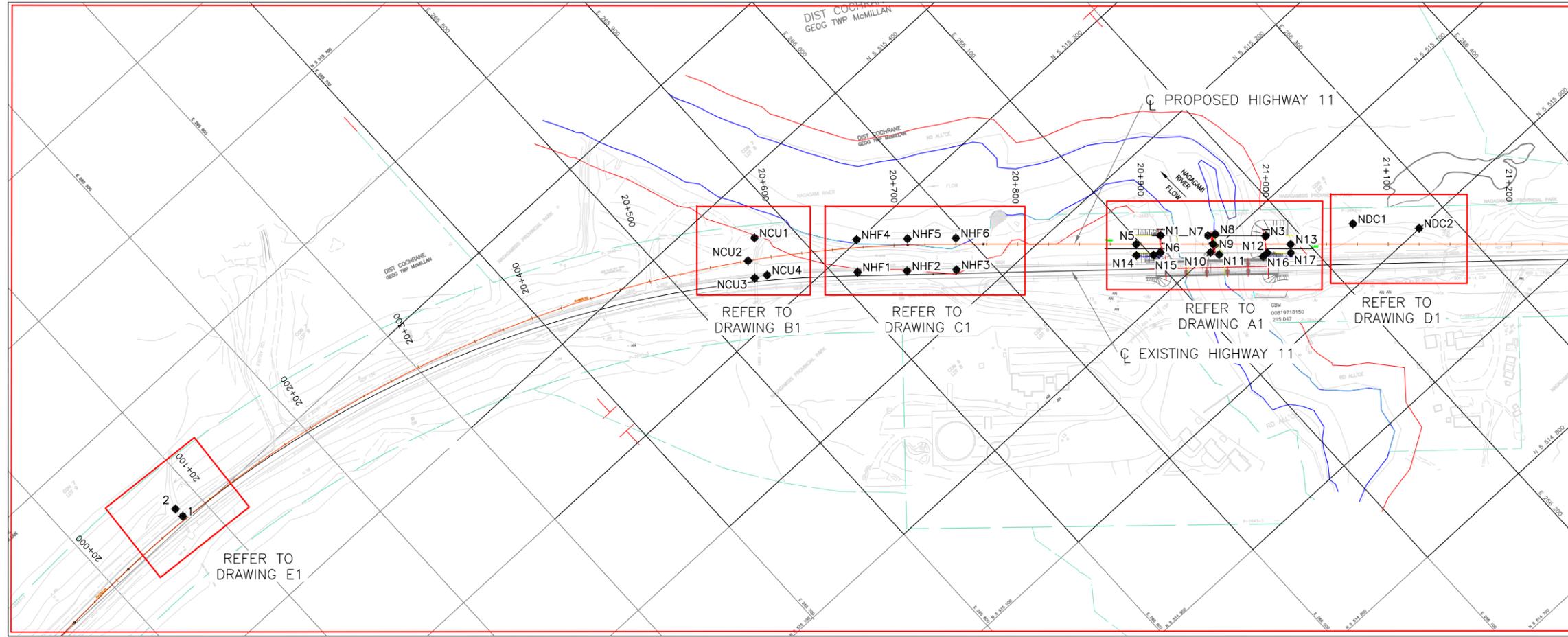


HIGHWAY 11
 NAGAGAMI RIVER BRIDGE
 INDEX PLAN

SHEET



Golder Associates Ltd.
 SUDBURY, ONTARIO, CANADA



KEY PLAN
 SCALE
 0 20 40 km

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.

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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 LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.

PLAN



PLOT FILE: S:\Subarea 11_2014\FILENAME: \gwp\gwp\Sudbury\CAD-CIS\CAD\Projects\2011\11-1191-0008 8 Bridges\Area1\2- Nagagami Index.dwg

NO.	DATE	BY	REVISION
Geocres No. 42F-28			
HWY. 11	PROJECT NO. 11-1191-0008		DIST.
SUBM'D.	CHKD.	DATE: SEP 2014	SITE: 39W-005
DRAWN: TB	CHKD. AB	APPD. JMAC	DWG. 1



APPENDIX A

Nagagami River Bridge

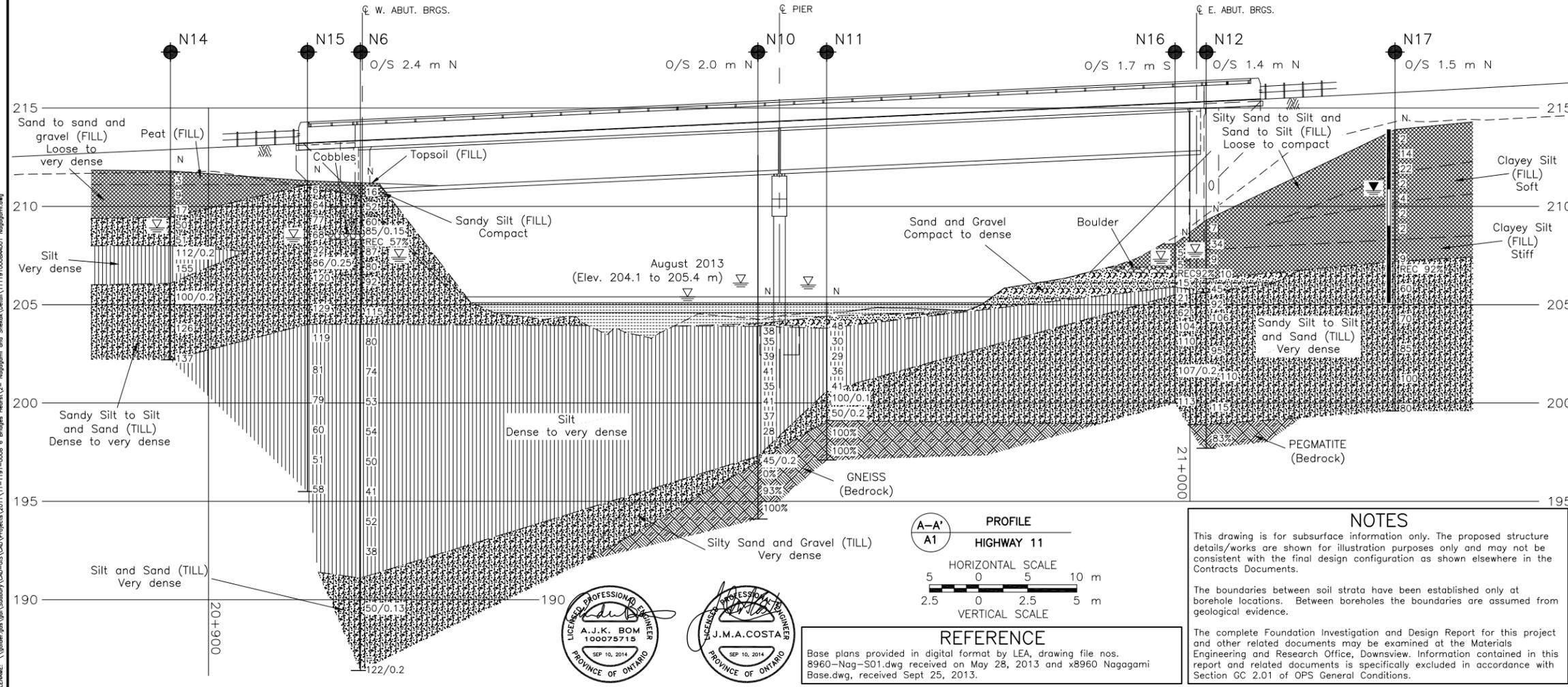
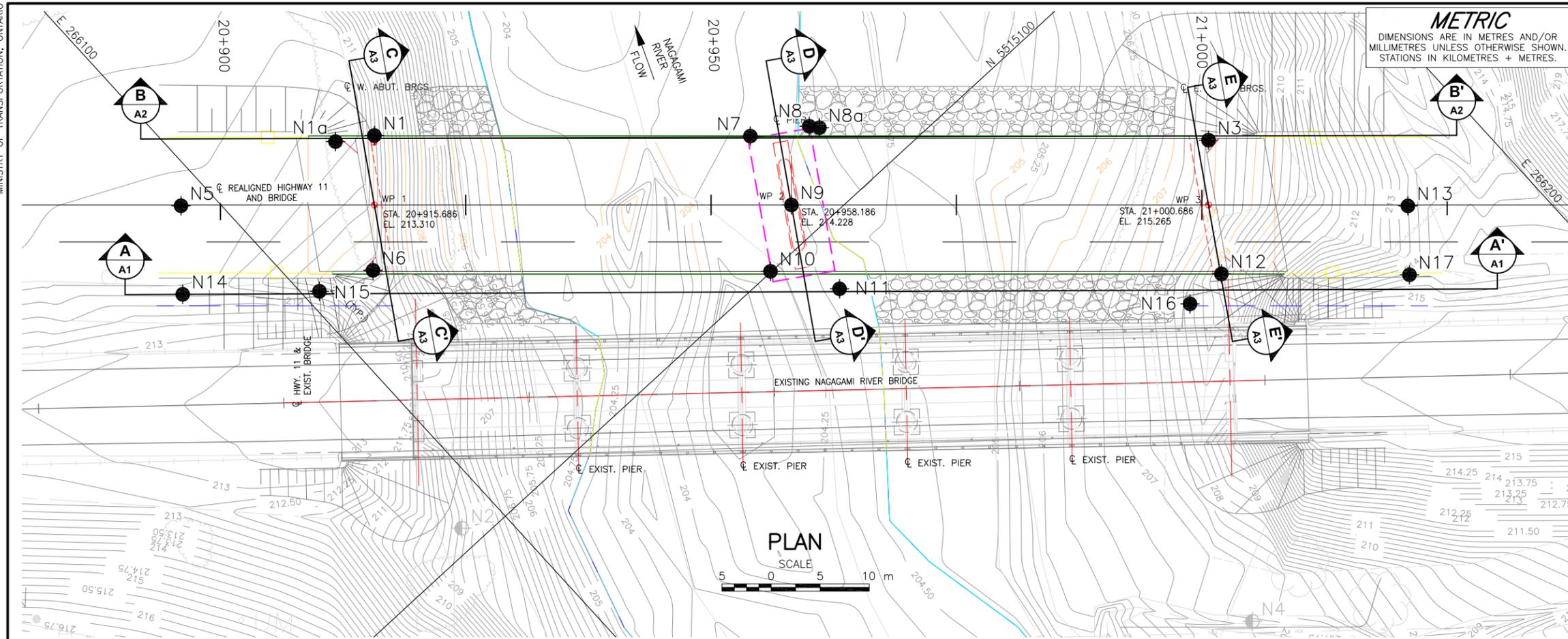
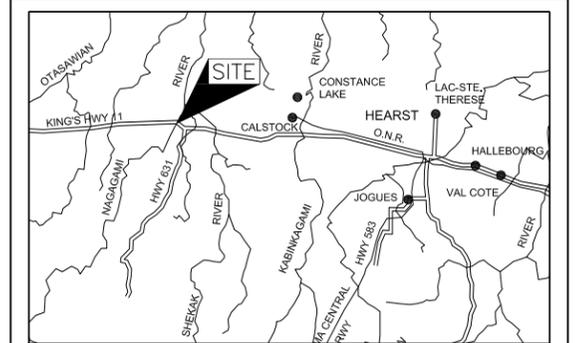


HIGHWAY 11
NAGAGAMI RIVER BRIDGE
BOREHOLE LOCATIONS AND
SOIL STRATA

SHEET



Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



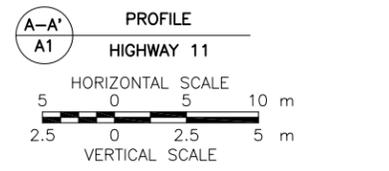
BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
N1	211.9	5515137.5	266116.3
N1a	211.9	5515139.8	266113.0
N2	208.8	5515102.1	266095.9
N3	206.8	5515079.8	266178.6
N4	207.2	5515040.7	266148.9
N5	211.8	5515145.6	266096.9
N6	211.2	5515127.5	266106.9
N7	205.2	5515111.6	266144.5
N8	205.2	5515108.3	266149.6
N8a	204.8	5515107.5	266150.3
N9	205.4	5515103.6	266142.9
N10	205.1	5515100.1	266136.7
N11	205.1	5515094.0	266140.7
N12	209.3	5515068.9	266170.4
N13	213.2	5515061.1	266189.1
N14	212.1	5515138.8	266091.0
N15	211.3	5515129.6	266101.5
N16	208.1	5515068.8	266166.0
N17	213.9	5515055.8	266184.5

NOTES

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REFERENCE

Base plans provided in digital format by LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.



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

CONT No.
 GWP No. 5307-04-00

HIGHWAY 11
 NAGAGAMI RIVER BRIDGE
 SOIL STRATA

SHEET



LEGEND

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

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
N1	211.9	5515137.5	266116.3
N1a	211.9	5515139.8	266113.0
N3	206.8	5515079.8	266178.6
N5	211.8	5515145.6	266096.9
N7	205.2	5515111.6	266144.5
N8	205.2	5515108.3	266149.6
N8a	204.8	5515107.5	266150.3
N13	213.2	5515061.1	266189.1

NOTES

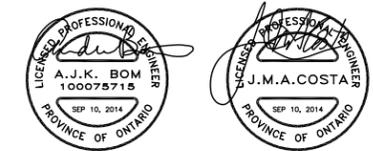
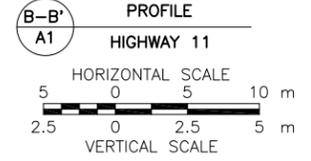
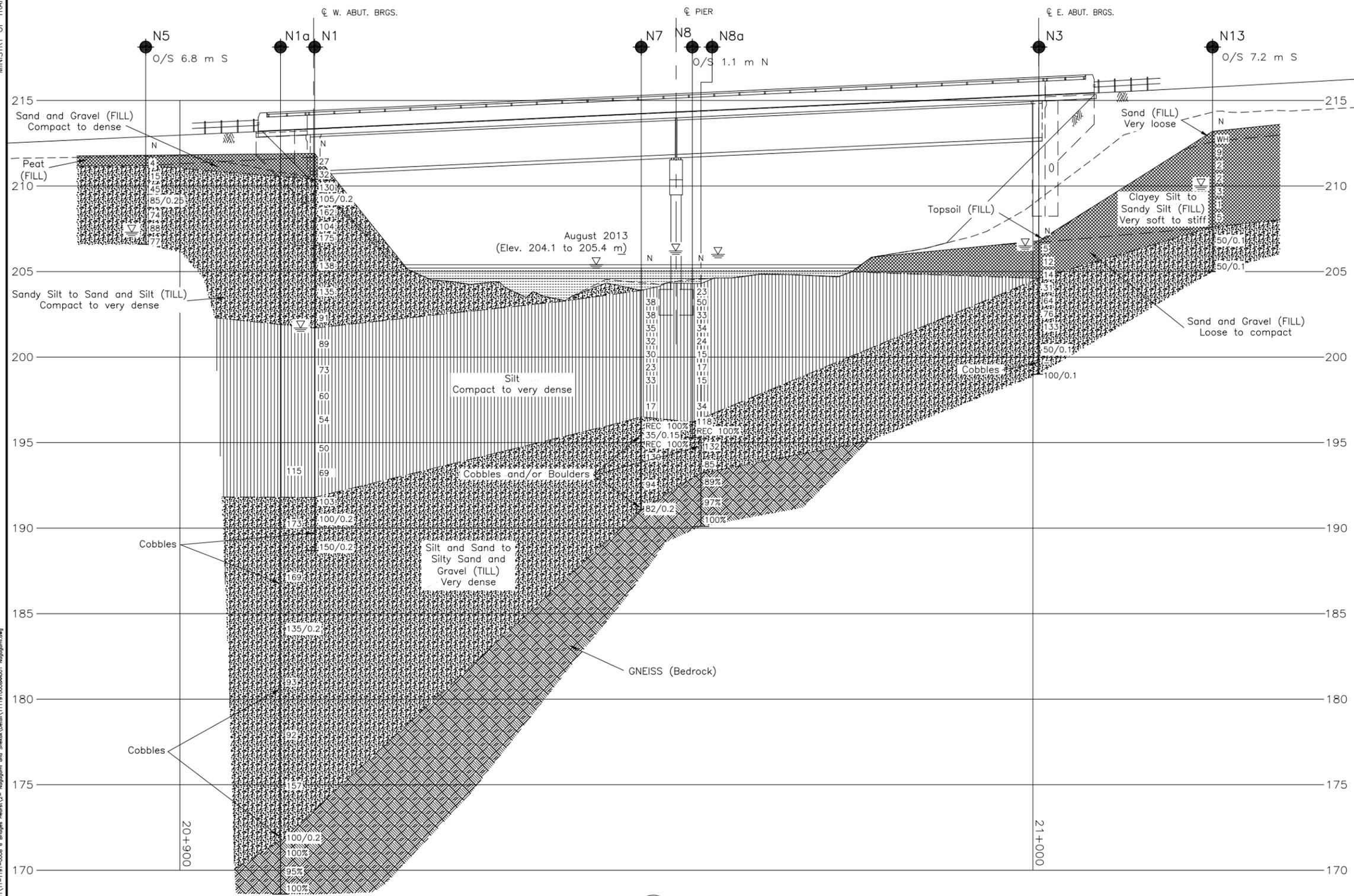
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

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REFERENCE

Base plans provided in digital format by LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.



NO.	DATE	BY	REVISION

Geocres No. 42F-28

HWY. 11	PROJECT NO. 11-1191-0008	DIST.
SUBM'D. AC	CHKD.	DATE: SEP 2014
DRAWN: TB	CHKD. AB	APPD. JMAC
		SITE: 42F-28
		DWG. A2

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

CONT No.
GWP No. 5307-04-00

HIGHWAY 11
NAGAGAMI RIVER BRIDGE
SOIL STRATA SHEET



Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA

LEGEND

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

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
N1	211.9	5515137.5	266116.3
N1a	211.9	5515139.8	266113.0
N3	206.8	5515079.8	266178.6
N6	211.2	5515127.5	266106.9
N8	205.2	5515108.3	266149.6
N8a	204.8	5515107.5	266150.3
N9	205.4	5515103.6	266142.9
N11	205.1	5515094.0	266140.7
N12	209.3	5515068.9	266170.4

NOTES

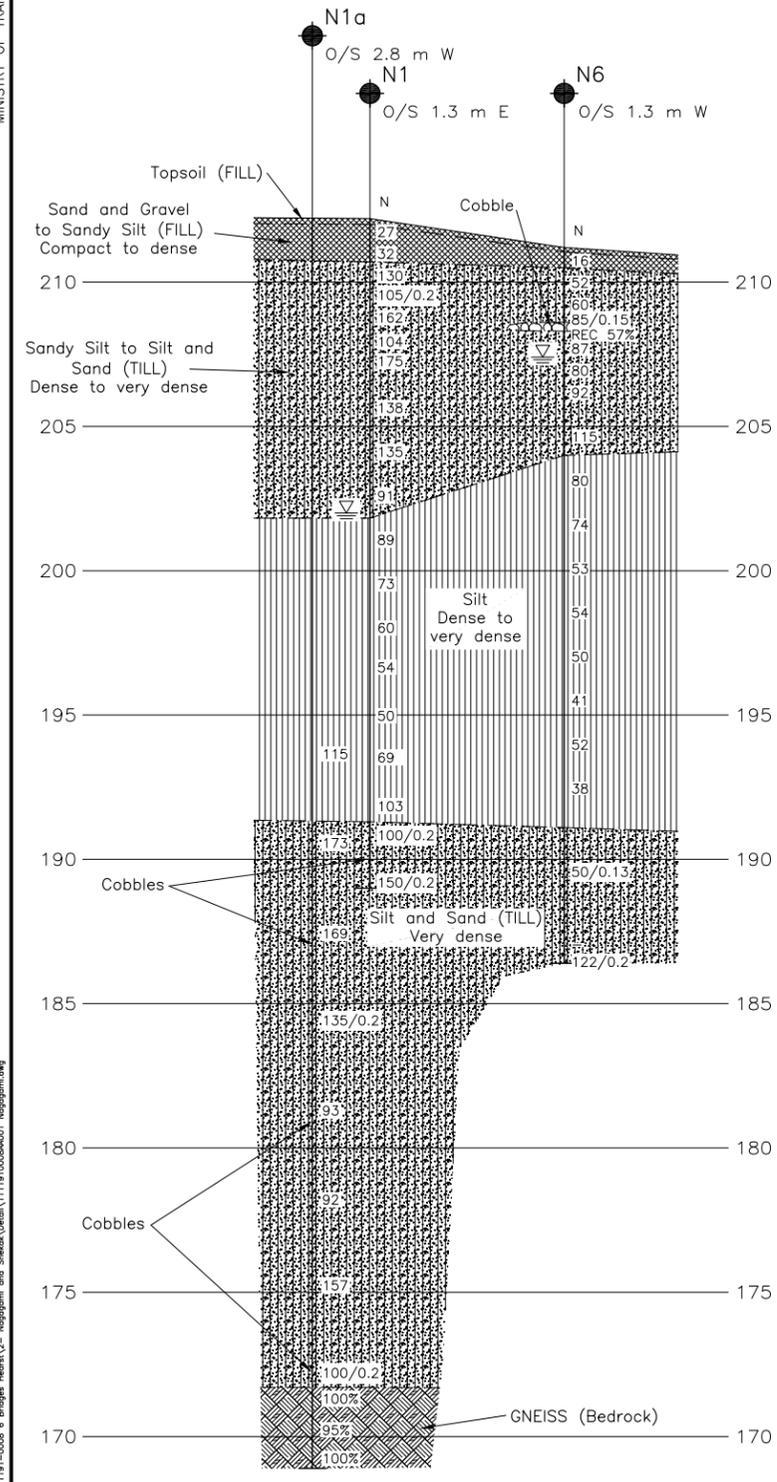
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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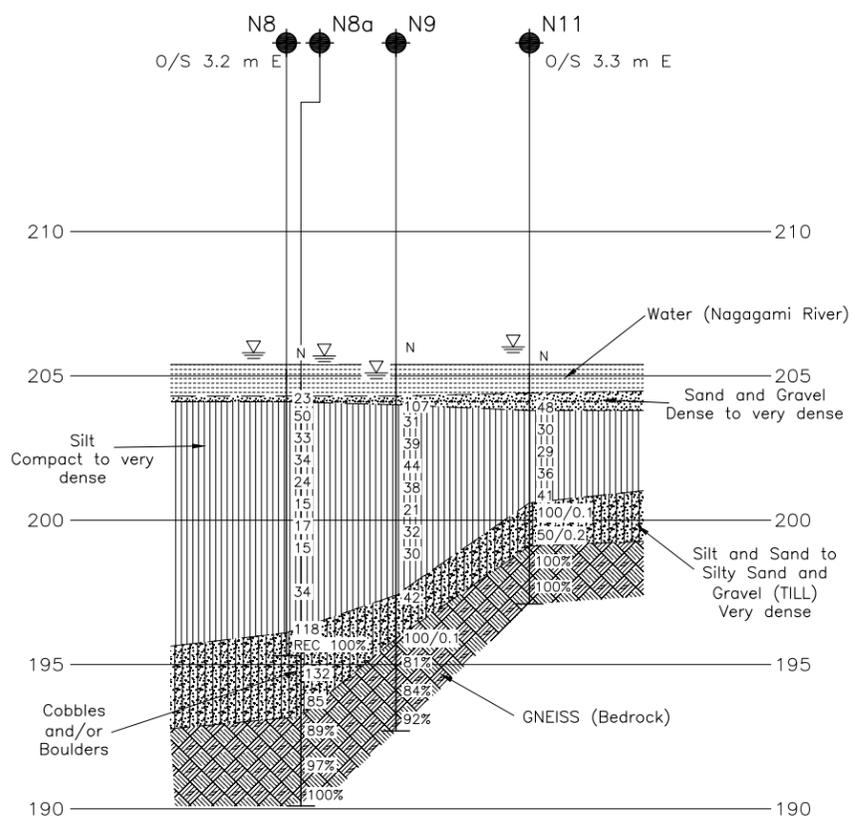
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

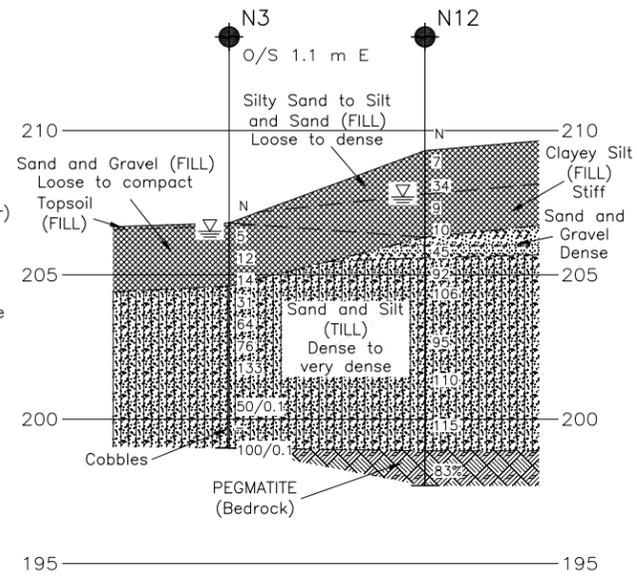
Base plans provided in digital format by LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.



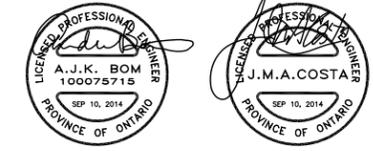
C-C' WEST ABUTMENT SECTION
A1
HIGHWAY 11
HORIZONTAL SCALE: 1:1000
VERTICAL SCALE: 1:100



D-D' PIER SECTION
A1
HIGHWAY 11
HORIZONTAL SCALE: 1:1000
VERTICAL SCALE: 1:100



E-E' EAST ABUTMENT SECTION
A1
HIGHWAY 11
HORIZONTAL SCALE: 1:1000
VERTICAL SCALE: 1:100



NO.	DATE	BY	REVISION

Geocres No. 42F-28

HWY. 11	PROJECT NO. 11-1191-0008	DIST.
SUBM'D. AC	CHKD.	DATE: SEP 2014
DRAWN: TB	CHKD. AB	APPD. JMAC
		SITE: 39W-005
		DWG. A3



Table A1 - Summary of Analytical Testing of River Water

Parameter	Units	Result
Resistivity	ohm-cm	5,700
Conductivity	µmho/cm	180
pH	pH	7.92
Sulphate	mg/L	Not Detected
Chloride	mg/L	3

Notes:

1. Sample obtained July 6, 2013
2. Analytical testing carried out by Maxxam Analytics Inc.

Prepared by: AC
Reviewed by: AB

Golder Associates Ltd.
 1010 Lorne Street
 Sudbury, Ontario, Canada P3C 4R9
 Telephone: (705) 524-6861
 Fax: (705) 524-1984

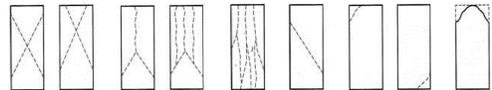


TABLE A2 - SUMMARY OF ROCK CORE TEST DATA

PROJECT NO.: 11-1191-0008
JOB NAME: Nagagami River Bridge
TYPE OF UNIT: Bedrock Core

BOREHOLE	N8	N9	N10	N11	N12
GOLDER LAB #	G0252	GA 1049	GA 1050	GA 1051	GA 1052
DATE TESTED	Apr. 10, 2014	Oct. 22, 2013	Oct. 22, 2013	Oct. 22, 2013	Oct. 22, 2013
TESTED BY	JM	TDM	TDM	TDM	TDM
DEPTH OF TESTED CORE (m)	11.8	10.0	9.1	7.1	11.0
LENGTH (mm)	99.1	99.1	101.2	100.5	100.6
DIAMETER (mm)	47.1	47.3	47.2	47.1	47.3
DENSITY (kg/m3)	2747	2727	2712	2739	2631
COMPRESSIVE STRENGTH (MPa)	69.5	102.2	76.2	109.7	41.1
TYPE OF FRACTURE	3	3	3	4	4

Type of Fracture



1 2 3 4 5 6

Reviewed by : TG

PROJECT 11-1191-0008 **RECORD OF BOREHOLE No N1** **1 OF 2 METRIC**
G.W.P. 5307-04-00 **LOCATION** N 5515137.5; E 266116.3 **ORIGINATED BY** ID
DIST _____ **HWY** 11 **BOREHOLE TYPE** 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring **COMPILED BY** AC
DATUM GEODETIC **DATE** July 26 and 27, 2012 **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	20	40	60	80						100	20	40
211.9	GROUND SURFACE																		
0.0	Topsoil (FILL) Brown Moist		1a	SS	27														
0.2	Sand and gravel, some silt (FILL) Compact to dense Brown Moist to wet		1b	SS														39 46 (15)	
			2	SS	32														
210.4	Sandy SILT to SILT and SAND, some clay, trace gravel (TILL) Very dense Brown, grey below 3 m depth Moist to wet		3	SS	130														
			4	SS	105/0.2														
			5	SS	162														2 33 50 15
			6	SS	104														
			7	SS	175														
			8	SS	138														
			9	SS	135														2 24 57 17
			10	SS	91														
			11	SS	89														
201.7		SILT, some clay, trace sand Very dense Brown Moist		12	SS	73													0 2 82 16
10.2			13	SS	60														

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

Continued Next Page

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N1	2 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515137.5; E 266116.3</u>	ORIGINATED BY <u>ID</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 26 and 27, 2012</u>	CHECKED BY <u>AB</u>

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
191.0	SILT, some clay, trace sand Very dense Brown Moist		14	SS	54									
196														
195			15	SS	50									
194														
193			16	SS	69									
192			17	SS	103									
20.9	SILT and SAND, some gravel, trace to some clay (TILL) Very dense Grey Moist Cobbles from 21.2 m to 23.2 m depth.		18	SS	100/0.2									
190			-	RC	-									
188.7	END OF BOREHOLE - SEE BOREHOLE N1a (EXTENSION) Note: 1. Water level at a depth of 10.2 m below ground surface (Elev. 201.7 m) on July 28, 2012 after leaving borehole open overnight.		19	SS	150/0.2									

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

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

RECORD OF BOREHOLE No N1a 2 OF 3 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515139.8; E 266113.0 ORIGINATED BY EHS

DIST HWY 11 BOREHOLE TYPE NW Casing, NQ Coring COMPILED BY AC

DATUM GEODETIC DATE March 24 to 26 and April 1, 2014 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									
						20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	WATER CONTENT (%)						
						20 40 60 80 100					20 40 60						
191.0	Refer to Borehole N1 for soil stratigraphy.		1	SS	115												
20.9			2	SS	173												
			3	SS	169												
			4	SS	135/0.2							OH				10 31 44 15	
	SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Grey Moist A 50 mm clay seam encountered in Sample 2. A 275 mm cobble encountered at 25.0 m depth.					196											
						195											
						194											
						193											
						192											
						191											
						190											
						189											
						188											
						187											
						186											
						185											
						184											
						183											
						182											

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

Continued Next Page

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

PROJECT 11-1191-0008 **RECORD OF BOREHOLE No N1a** 3 OF 3 **METRIC**
 G.W.P. 5307-04-00 LOCATION N 5515139.8; E 266113.0 ORIGINATED BY EHS
 DIST HWY 11 BOREHOLE TYPE NW Casing, NQ Coring COMPILED BY AC
 DATUM GEODETIC DATE March 24 to 26 and April 1, 2014 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	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
	--- CONTINUED FROM PREVIOUS PAGE ---																
	SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Grey Moist	5	SS	93		181											
	A 150 mm cobble encountered at 31.7 m depth.					180											
						179											
		6	SS	92		178											
						177											
						176											
		7	SS	157		175					4	1					3 28 46 23
						174											
						173											
	A 150 mm cobble encountered at 39.7 m depth.	8	SS	100/0.2		172											
171.7	GNEISS (BEDROCK)					171											RQD = 100%
40.2	Bedrock cored from 40.2 m depth to 43.3 m depth. For coring details see Record of Drillhole N1a.	1	RC	REC 100%		170											RQD = 95%
		2	RC	REC 100%		169											RQD = 100%
		3	RC	REC 100%													
168.6	END OF BOREHOLE																
43.3	Note: 1. Borehole N1a located 4 m west of Borehole N1.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:



PROJECT 11-1191-0008 **RECORD OF BOREHOLE No N2** 2 OF 2 **METRIC**
 G.W.P. 5307-04-00 LOCATION N 5515102.1; E 266095.9 ORIGINATED BY ID
 DIST HWY 11 BOREHOLE TYPE 108 mm Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY AC
 DATUM GEODETIC DATE July 28 and 29, 2012 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	20	40	60	80						100	20
	--- CONTINUED FROM PREVIOUS PAGE ---																	
	Sandy SILT to SILT, some clay Dense to very dense Grey Moist to wet Clayey silt seams in sample 14 (15.2 m to 15.8 m).		14	SS	31													0 1 86 13
			15	SS	30													
190.3			16	SS	100/0.1													
189.9	GRAVEL and COBBLES Dense Grey Wet		-	RC	-													
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 3.3 m below ground surface (Elev. 205.5 m) upon completion of drilling.																	

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N3	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515079.8; E 266178.6</u>	ORIGINATED BY <u>ID</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 1, 2012</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
206.8	GROUND SURFACE																
0.0	Topsoil (FILL) Brown Moist		1	SS	5	▽											
	Sand and gravel, some silt, trace clay (FILL) Loose to compact Brown to grey Moist to wet		2	SS	12		206										35 47 16 2
			3	SS	14		205										
204.6	SILT and SAND, some clay, trace gravel (TILL) Dense to very dense Grey Moist to wet		4	SS	31		204										
			5	SS	64		203										1 30 52 17
			6	SS	76		202										
			7	SS	133		201										
			8	SS	50/0.1		200										1 30 51 18
	Cobbles encountered below 6.3 m depth.		-	RC	-		199										
199.0	END OF BOREHOLE		9	SS	100/0.1												
7.8	Note: 1. Water level at a depth of 0.3 m below ground surface (Elev. 206.5 m) upon completion of drilling.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N5	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515145.6; E 266096.9</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 7, 2013</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	20	40	60	80						100	20
211.8	GROUND SURFACE																	
0.0	Peat (FILL) Soft to firm Brown Moist		1	SS	4													
211.2																		
0.6	Sandy SILT, trace to some gravel, trace clay (TILL) Compact to very dense Brown, grey below 2 m depth. Moist to wet		2	SS	15													
	Augers grinding between 1.5 m and 2.1 m depth and at 3.0 m depth.		3	SS	45													
			4	SS	85/0.25													8 28 49 15
			5	SS	74													
			6	SS	88													5 26 54 15
			7	SS	77													
206.6	END OF BOREHOLE																	
5.2	Note: 1. Water level in open borehole at a depth of 4.5 m below ground surface (Elev. 207.3 m) upon completion of drilling.																	

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N6	1 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515127.5; E 266106.9</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 8 and 9, 2013</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									WATER CONTENT (%)		
						20	40	60	80	100									
211.2	GROUND SURFACE																		
0.0	Topsoil (FILL)																		
0.2	Sandy silt, some gravel (FILL)		1	SS	16														
210.5	Compact Brown to grey Moist																		
0.7	Sandy SILT, some clay (TILL) Very dense Grey Moist		2	SS	52														
	Auger grinding at 1.4 m depth.		3	SS	60														
208.6	COBBLE		4A	SS	85/0.15														
208.3			4B	RC	REC 57%														
2.9	Sandy SILT, some clay, trace gravel (TILL) Dense to very dense Brown to grey Moist to wet		5	SS	87														
			6	SS	80														
			7	SS	92														
			8	SS	115														
204.0	SILT, some clay, trace sand, trace gravel Dense to very dense Brown Moist to wet		9	SS	80														
7.2	125 mm cobble encountered at 8.7 m depth.		10	SS	74														
			11	SS	53														
			12	SS	54														
			13	SS	50														

SUD-MTO 001 11-1191-0008 DETAIL GP J GAL-MISS.GDT 30/07/14 DATA INPUT:

Continued Next Page

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N7	1 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515111.6; E 266144.5</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 10, 2013</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									WATER CONTENT (%)			
						20	40	60	80	100				20	40	60		GR SA SI CL		
205.2	WATER SURFACE																			
0.0	WATER																			
203.9	Cobbles and boulders observed on river bed.																			
1.3	SILT, some clay, trace sand Compact to dense Brown to grey Wet		1	SS	38															
			2	SS	38												0	1	83	16
			3	SS	35															
			4	SS	32															
			5	SS	30												0	1	79	20
	Clay layers (25 mm to 50 mm thick) below 5.3 m depth.		6	SS	23															
			7	SS	33												0	0	77	23
			8	SS	17															
196.5	Sandy SILT, some clay (TILL) Very dense Grey Wet		-	RC	REC 100%															
8.7	GRAVEL and COBBLES and BOULDERS (including two 0.5 m boulders) to 10.5 m depth.		9	SS	35/0.15															
			-	RC	REC 100%															
			10	SS	130												0	29	53	18
			11	SS	94															
			12	SS	82/0.2															
191.1																				
14.1																				

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

Continued Next Page

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N7	2 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515111.6; E 266144.5</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 10, 2013</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			20	40	60	80	100					
	--- CONTINUED FROM PREVIOUS PAGE ---															
	END OF BOREHOLE Note: 1. Water level at 1.0 m above river surface (Elev. 206.2 m) inside casing upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N8	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515108.3; E 266149.6</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HQ Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 11 and 12, 2013</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
							20	40	60	80	100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	GR SA SI CL	
205.2	WATER SURFACE															
0.0	WATER						205									
204.3	Cobbles and boulders observed on river bed.															
1.1	SAND and GRAVEL Brown Wet		1	SS	23		204									
	SILT, some clay, trace sand Compact to very dense Brown to grey Wet		2	SS	50											
							203								0	1 82 17
			3	SS	33											
			4	SS	34		202									
	Clay layers (25 mm to 50 mm thick) below 3.7 m depth.		5	SS	24		201								0	1 49 50
			6	SS	15		200									
			7	SS	17		199								0	0 75 25
			8	SS	15		198									
	A 150 mm cobble was encountered at 7.9 m depth.		9	SS	34		197								0	4 78 18
196.2							196									
9.0	SILT and SAND, some clay, trace to some gravel (TILL) Very dense Grey Moist		10	SS	118											
195.3			-	RC	REC 100%											
9.9	Boulder (400mm) at 9.5 m depth. END OF BOREHOLE - SEE BOREHOLE N8a (EXTENSION) Note: 1. Water level inside casing at 1.0 m above river surface (Elev. 206.2 m) upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N8a	2 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515107.5; E 266150.3</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HQ Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>March 21 and 22, 2014</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			20	40	60	80	100					
--- CONTINUED FROM PREVIOUS PAGE ---																
	END OF BOREHOLE Note: 1. Water level inside casing at 0.8 m above ice surface (Elev. 205.6 m) after leaving casing open overnight. 2. Borehole located 1 m east of Borehole N8.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N9	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515103.6; E 266142.9</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HQ Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 8 and 9, 2013</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								
						20	40	60	80	100						
205.4	WATER SURFACE															
0.0	WATER															
204.3	Cobbles and boulders observed on river bed.															
204.0	SAND and GRAVEL Very dense Brown Wet		1	SS	107											
1.4	SILT, some clay, trace sand Compact to dense Brown to grey Wet		2	SS	31											0 1 83 16
			3	SS	39											
			4	SS	44											
			5	SS	38											
	Clay layers (25 mm to 50 mm thick) below 4.5 m depth.		6	SS	21											1 1 50 48
			7	SS	32											
			8	SS	30											
197.4			9A	SS	42											
8.0	Silty SAND and GRAVEL (TILL) Very dense Grey Wet		9B													39 33 24 4
195.9			10	SS	100/0.1											
9.5	GNEISS (BEDROCK) Bedrock cored from 9.5 m to 12.7 m depth. For coring details see Record of Drillhole N9.		1	RC	REC 100%											RQD = 81%
			2	RC	REC 100%											RQD = 84%
			3	RC	REC 100%											RQD = 92%
192.7	END OF BOREHOLE															
12.7	Note: 1. Water level inside casing at a depth of 0.3 m below river surface (Elev. 205.1 m) upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL GP J GAL-MISS.GDT 30/07/14 DATA INPUT:

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

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: N9

SHEET 1 OF 1

LOCATION: N 5515103.6 ;E 266142.9

DRILLING DATE: August 8 and 9, 2013

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D-25 BARGE

DRILLING CONTRACTOR: Walker Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRALLIC CONDUCTIVITY k, cm/s	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
							FLUSH														
		REFER TO PREVIOUS PAGE		195.9																	
10	NW	GNEISS with pegmatite sills Very strong Fine to very coarse grained Fresh Grey		9.5	1	GREY 100%											UCS=102 MPa				
11	NQ				2	GREY 100%															
12					3	GREY 100%															
13		END OF DRILLHOLE		192.7 12.7																	

SUD-RCK 11-1191-0008/DETAIL GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N10	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515100.1; E 266136.7</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HQ Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 13 and 19, 2013</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
205.1	WATER SURFACE																
0.0	WATER						205										
204.0	Cobbles and boulders observed on river bed.						204										
1.2	SAND and GRAVEL Brown Wet		1	SS	38		204										
	SILT, some clay, trace sand Compact to dense Brown to grey Wet		2	SS	35		203										0 1 81 18
			3	SS	39		203										
			4	SS	41		202										
			5	SS	35		201										0 1 82 17
			6	SS	41		200										
	Clay layers (25 mm thick) below 5.3 m depth.		7	SS	37		200										
			8	SS	28		199										0 0 77 23
197.3	Silty SAND and GRAVEL (TILL) Very dense Grey Wet		9	SS	45/0.2		197										
197.0	GNEISS (BEDROCK)						197										RQD = 0%
8.1	Bedrock cored from 8.1 m to 11.0 m depth.		1	RC	REC 100%		197										
	For coring details see Record of Drillhole N10.		2	RC	REC 100%		196										RQD = 93%
			3	RC	REC 100%		195										RQD = 100%
194.1	END OF BOREHOLE						195										
11.0	Note: 1. Water level inside casing at 1.0 m above river surface (Elev. 206.1 m) upon completion of drilling.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 3007/14 DATA INPUT:

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: N10

SHEET 1 OF 1

LOCATION: N 5515100.1 ;E 266136.7

DRILLING DATE: August 13 and 19, 2013

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D-25 BARGE

DRILLING CONTRACTOR: Walker

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRALLIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC -Q AVG.	NOTES WATER LEVELS INSTRUMENTATION	
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION		Jr	Ja	Jun	k, cm/s				?
								80	80			B Angle	DIP w/L AXIS	10	10	10	10				2
		REFER TO PREVIOUS PAGE		197.0																	
	NW	GNEISS Strong Fine to very coarse grained Fresh Grey		8.1	1	GREY	100%														
9					2	GREY	100%														
10	NO				3	GREY	100%														
11		END OF DRILLHOLE		194.1																	
				11.0																	
12																					
13																					
14																					
15																					
16																					
17																					
18																					

SUD-RCK 11-1191-0008/DETAIL GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:



PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N11	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515094.0; E 266140.7</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 19 and 20, 2013</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	20	40	60	80						100	20
205.1	WATER SURFACE																	
0.0	WATER																	
204.4	Cobbles and boulders observed on river bed.																	
0.7	SAND and GRAVEL																	
203.8	Dense Brown Wet		1	SS	48													
1.3	SILT, some clay, trace sand, trace gravel Compact to dense Brown to grey Wet		2	SS	30													0 2 82 16
	Clay layers (25 mm to 50 mm thick) below 3.0 m depth.		3	SS	29													
			4	SS	36													
			5	SS	41													2 4 62 32
200.6	Silty SAND and GRAVEL (TILL)		6	SS	100/0.1													
4.5	Very dense Grey Wet		7	SS	50/0.2													
199.1	GNEISS (BEDROCK)		1	RC	REC 100%													RQD = 100%
6.0	Bedrock cored from 6.0 m to 8.0 m depth. For coring details see Record of Drillhole N11.		2	RC	REC 100%													RQD = 100%
197.1	END OF BOREHOLE																	
8.0	Note: 1. Water level inside casing at 0.9 m above river surface (Elev. 206.0 m) upon completion of drilling.																	

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: N11

SHEET 1 OF 1

LOCATION: N 5515094.0 ;E 266140.7

DRILLING DATE: August 19 and 20, 2013

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D-25 BARGE

DRILLING CONTRACTOR: Walker

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRALLIC 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	Jun				k, cm/s	q
							FLUSH	FLUSH			FLUSH	FLUSH	FLUSH	FLUSH	FLUSH	FLUSH				FLUSH	FLUSH
6	NG	REFER TO PREVIOUS PAGE		199.1																	
6		GNEISS with pegmatite sills and inclusions Very strong Fine to very coarse grained Fresh Grey		6.0	1	GREY 100%															
7	NW				2	GREY 100%													UCS=110 MPa		
8		END OF DRILLHOLE		197.1																	
8				8.0																	
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					

SUD-RCK 11-1191-0008/DETAIL GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: N12

SHEET 1 OF 1

LOCATION: N 5515068.9 ;E 266170.4

DRILLING DATE: August 24 to 26, 2013

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D-25 BARGE

DRILLING CONTRACTOR: Walker

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA			HYDRALLIC CONDUCTIVITY k, cm/s	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	Jun
							FLUSH	FLUSH			FLUSH	FLUSH	FLUSH					FLUSH	FLUSH	FLUSH
		REFER TO PREVIOUS PAGE		198.9																
11	NW NO	PEGMATITE Medium strong Very coarse grained Slightly weathered Pink		10.4	1	GREY 100%	100	100	100							UCS=41 MPa				
		END OF DRILLHOLE		197.7																
12				11.6																
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

SUD-RCK 11-1191-0008/DETAIL GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N13	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515061.1; E 266189.1</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 13 and 19, 2013</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								
						20	40	60	80	100						
213.2	GROUND SURFACE															
0.0	Sand, trace to some gravel, some organics (FILL)		1	SS	WH											
212.6	Very loose Brown Moist		2	SS	9											2 14 59 25
0.6	Clayey silt to sandy silt, trace to some gravel (FILL)		3	SS	2											
	Very soft to stiff Brown to grey Moist to wet		4	SS	2											
	Peat pockets/seams noted in Samples 4 to 7.		5	SS	3											9 27 48 16
			6	SS	1											
			7	SS	5											
207.6	Sandy SILT, some clay, trace gravel (TILL)		8	SS	50/0.1											4 24 57 15
5.6	Very dense Grey Wet		9	SS	50/0.1											
205.0	END OF BOREHOLE															
8.2	Note: 1. Water level at a depth of 3.2 m below ground surface (Elev. 210.0m) upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

RECORD OF BOREHOLE No N14 1 OF 1 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515138.8; E 266091.0 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing COMPILED BY AC

DATUM GEODETIC DATE July 30 and August. 7, 2013 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	20	40	60	80					
											○ UNCONFINED	+ FIELD VANE				
											● QUICK TRIAXIAL	× REMOULDED				
											WATER CONTENT (%)					
											20	40	60			
212.1	GROUND SURFACE															
0.0	Peat, mixed with sand (FILL) Very soft Brown Moist		1	SS	3											
211.4																
0.7	Sand, some silt, trace clay (FILL) Loose to very dense Brown to grey Moist		2	SS	9											
			3	SS	17											
209.9																
2.2	SILT and SAND, some clay trace to some gravel (TILL) Very dense Brown to grey Moist to wet		4	SS	50											
			5	SS	51											
208.3																
3.8	SILT, trace sand, trace gravel Very dense Grey Wet		6	SS	112/0.2											
			7	SS	155											
206.0																
6.1	SILT and SAND, some clay some gravel (TILL) Very dense Grey Wet		8	SS	100/0.2											
			9	SS	126											
202.5																
			10	SS	137											
9.6	END OF BOREHOLE Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 209.2 m) upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT 11-1191-0008 **RECORD OF BOREHOLE No N15** 1 OF 2 **METRIC**
 G.W.P. 5307-04-00 LOCATION N 5515129.6; E 266101.5 ORIGINATED BY SA
 DIST HWY 11 BOREHOLE TYPE 108 mm Continuous Flight Hollow Stem Augers, NW Casing COMPILED BY AC
 DATUM GEODETIC DATE August 10, 2013 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	NUMBER	TYPE	"N" VALUES			20	40	60	80						100	20
211.3	GROUND SURFACE																
0.0	Sand and gravel, trace organics (FILL) Brown Moist	1	SS	6													
0.2	Sandy SILT to SILT and SAND, some clay, trace to some gravel (TILL) Very dense Brown turning grey below 1.5 m depth Moist to wet	2	SS	64										10	30	45	15
		3	SS	77													
		4	SS	68										12	16	54	18
		5	SS	92													
	75 mm cobble at 4.2 m depth.	6	SS	86/0.25													
		7	SS	120										6	29	49	16
		8	SS	129													
204.0																	
7.3	SILT, some clay, trace sand Very dense Grey Wet	9	SS	119													
		10	SS	81													
		11	SS	79										0	1	79	20
		12	SS	60													
		13	SS	51													

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 3007/14 DATA INPUT:

Continued Next Page

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



PROJECT 11-1191-0008 **RECORD OF BOREHOLE No N15** 2 OF 2 **METRIC**
 G.W.P. 5307-04-00 LOCATION N 5515129.6; E 266101.5 ORIGINATED BY SA
 DIST HWY 11 BOREHOLE TYPE 108 mm Continuous Flight Hollow Stem Augers, NW Casing COMPILED BY AC
 DATUM GEODETIC DATE August 10, 2013 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	20	40	60	80						100	20
195.5	SILT, some clay, trace sand Very dense Grey Wet		14	SS	58	196												
15.8	END OF BOREHOLE Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 208.4 m) on August 11, 2013 after leaving borehole open overnight.																	

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N16	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515068.8; E 266166.0</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>NW Casing, NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 27, 2013</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
208.1	GROUND SURFACE													
0.0	Sand to silty sand, trace gravel, trace asphalt, trace organics (FILL) Loose Brown Moist to wet		1	SS	5	▽	208							
206.9			2	SS	5		207							
206.6	BOULDER		-	RC	REC 92%		207							
1.5	SAND and GRAVEL, some silt Compact Brown Wet		3	SS	15		206							
205.9			4a				206							
205.5	SILT, clay Compact Brown to grey Wet		4b	SS	21		206							0 2 75 23
2.6							205							
	SILT and SAND, some clay, trace to some gravel (TILL) Very dense Grey Wet		5	SS	62		205							
			6	SS	104		204							5 30 48 17
			7	SS	110	203								
			8	SS	107/0.2	202							7 31 45 17	
						201								
200.0			9	SS	113	200								
8.1	END OF BOREHOLE													
	Note: 1. Water level inside casing at a depth of 0.8 m below ground surface (Elev. 207.3 m) upon completion of drilling.													

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N17	1 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515055.8; E 266184.5</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 12 and 13, 2013</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	20						40
213.9	GROUND SURFACE													
0.0	Sand, trace organics (FILL) Very loose Brown Moist		1	SS	2									
213.2														
0.7	Silt, some sand (FILL) Compact Brown to grey Moist		2	SS	14									
			3	SS	22									
211.7														
2.2	Clayey silt, some sand, trace gravel, trace organics (FILL) Soft Brown to grey Wet		4	SS	2									
			5	SS	4								3 15 55 27	
210.2														
3.7	Sandy silt, some clay, trace gravel (FILL) Very loose Grey Wet		6	SS	2									
			7	SS	2								4 28 56 12	
208.3														
5.6	Clayey silt, some sand, trace gravel, trace organics (FILL) Stiff Grey Wet		8	SS	9									
207.2														
6.7	Sandy SILT, some clay, trace gravel (TILL) Very dense Grey Wet		9	RC	REC 92%									
			10	SS	60									
			11	SS	70									
			12	SS	85								3 27 50 20	
			13	SS	100									
			14	SS	80									
199.6														
14.3														

SUD-MTO 001 11-1191-0008 DETAIL GP J GAL-MISS.GDT 3007/14 DATA INPUT:

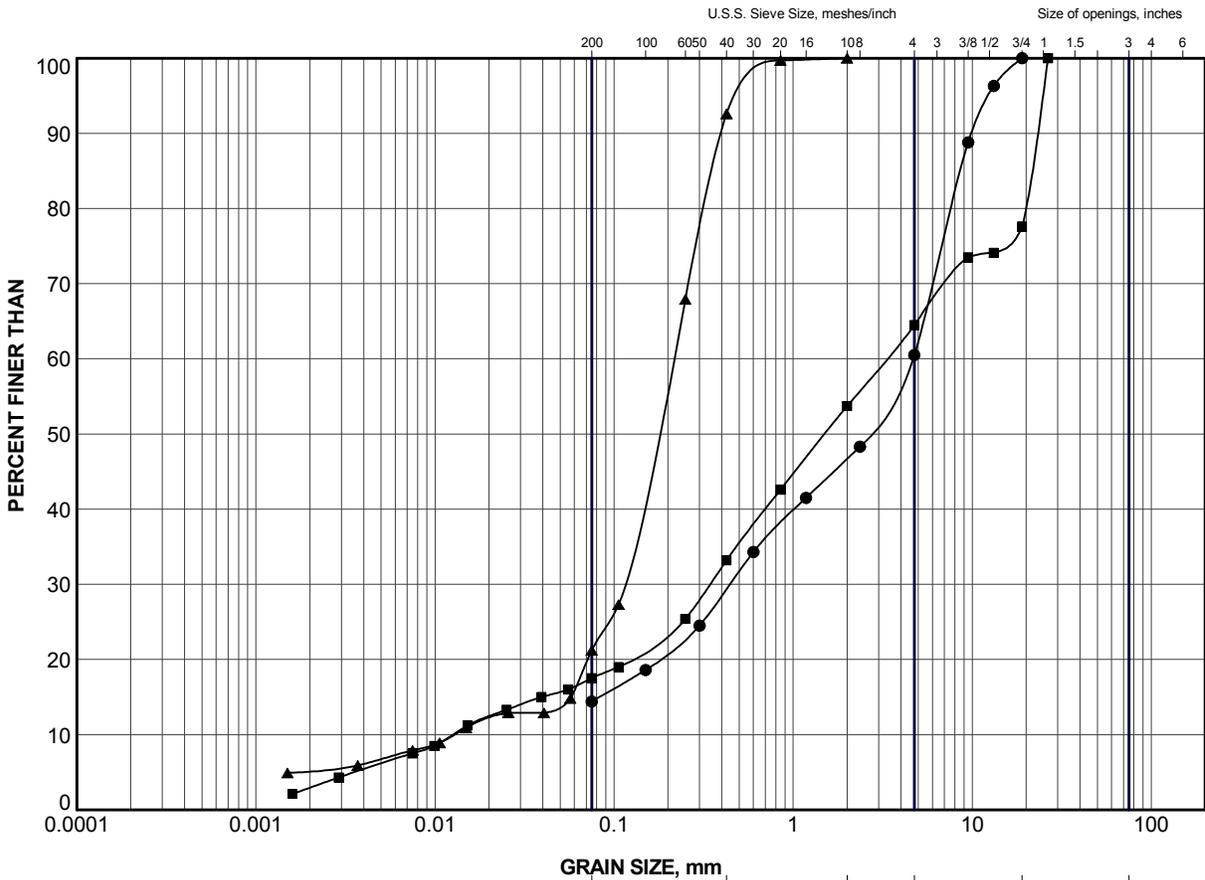
Continued Next Page

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No N17	2 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515055.8; E 266184.5</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>August 12 and 13, 2013</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			20	40	60	80	100					
	--- CONTINUED FROM PREVIOUS PAGE ---															
	END OF BOREHOLE Note: 1. Water level at a depth of 3.2 m below ground surface (Elev. 210.7 m) upon completion of drilling. 2. Water level at a depth of 3.1 m below ground surface (Elev. 210.8 m) in piezometer on August 27, 2013.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:



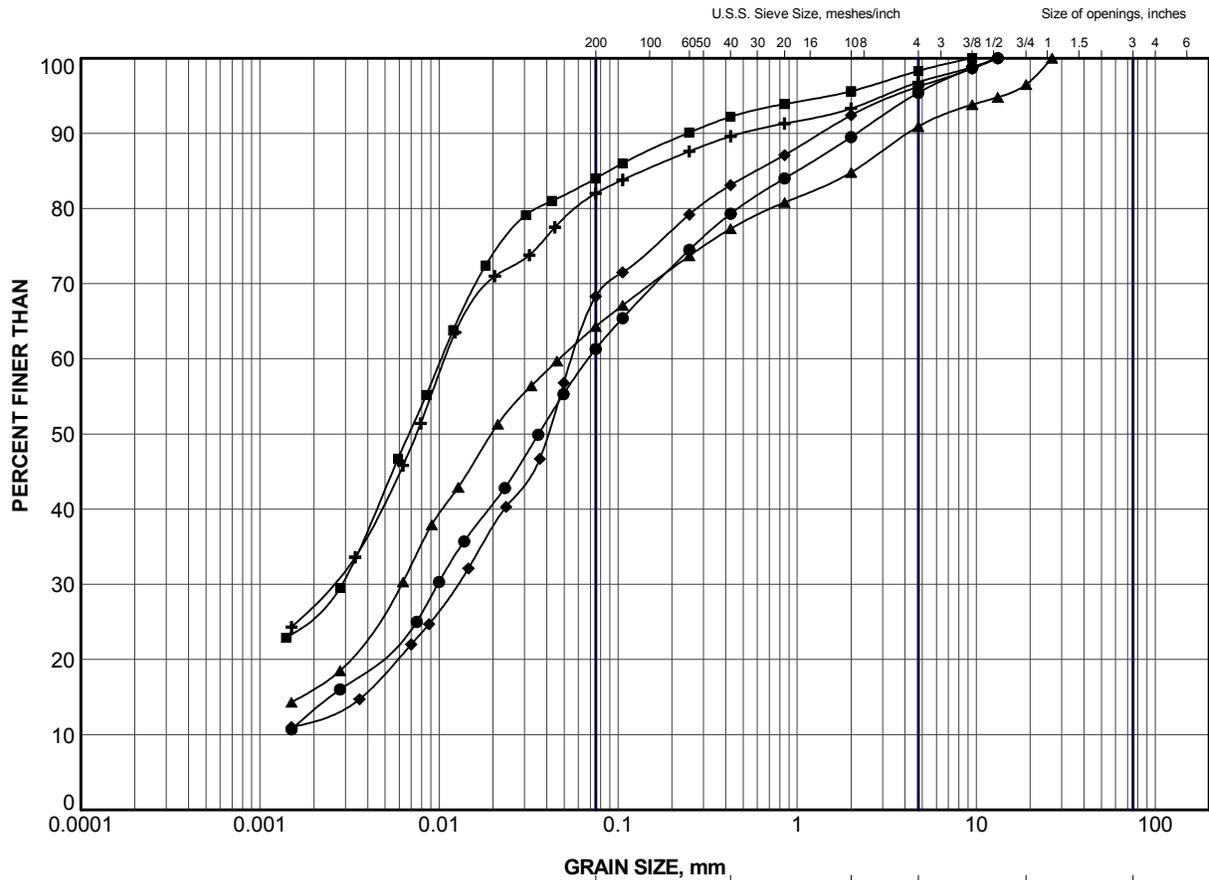
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N1	1b	211.5
■	N3	2	205.7
▲	N14	3	210.3

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE GRAIN SIZE DISTRIBUTION SAND to SAND AND GRAVEL (FILL)					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE #11-1191-0008 DETAIL.GPJ	
		DRAWN	JJL	Jan 2014	SCALE N/A
		CHECK	AB	Jan 2014	REV.
		APPR	JMAC	Jan 2014	
FIGURE A1					

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

LEGEND

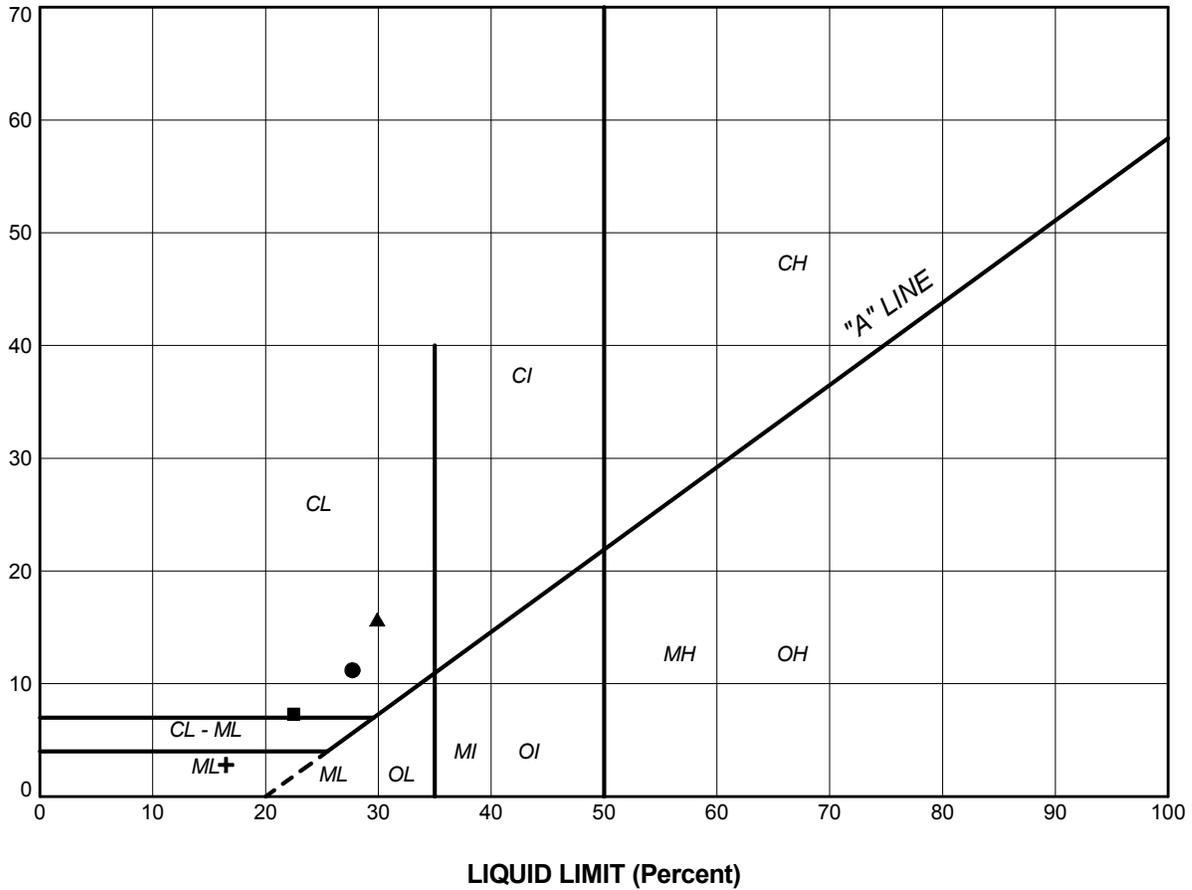
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N2	1b	208.4
■	N13	2	212.1
▲	N13	5	209.8
+	N17	5	210.5
◆	N17	7	209.0

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND to CLAYEY SILT (FILL)				
PROJECT No.		11-1191-0008		FILE # 11-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jan 2014	SCALE	N/A REV.
CHECK	AB	Jan 2014		
APPR	JMAC	Jan 2014	FIGURE A2	

Golder Associates
 SUDBURY, ONTARIO

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



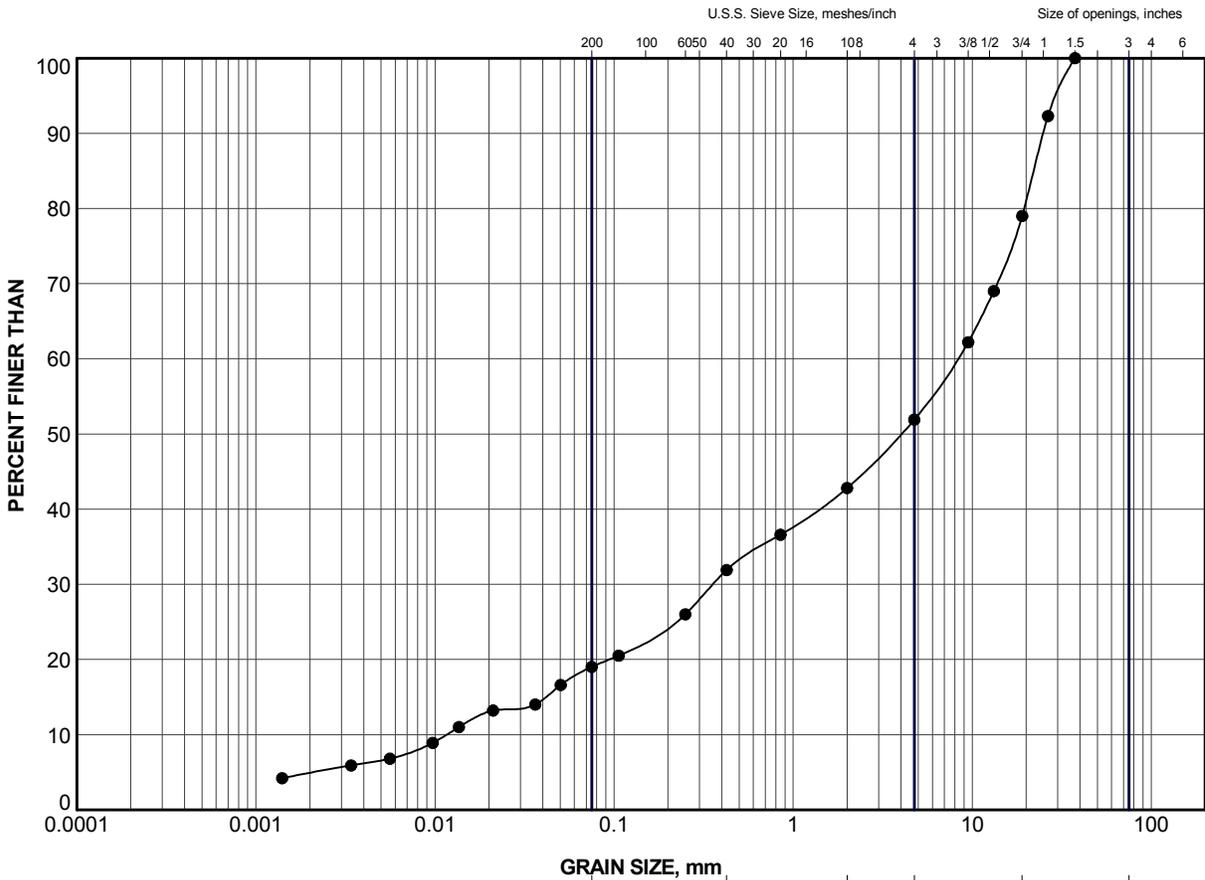
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	N13	2	27.7	16.5	11.2
■	N13	5	22.5	15.2	7.3
▲	N17	5	29.9	14.2	15.7
+	N17	7	16.5	13.7	2.8

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART SANDY SILT to CLAYEY SILT (FILL)					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN JJJ Jan 2014			SCALE N/A		REV.
CHECK AB Jan 2014			APPR JMAC Jan 2014			FIGURE A3				
 Golder Associates SUDBURY, ONTARIO										



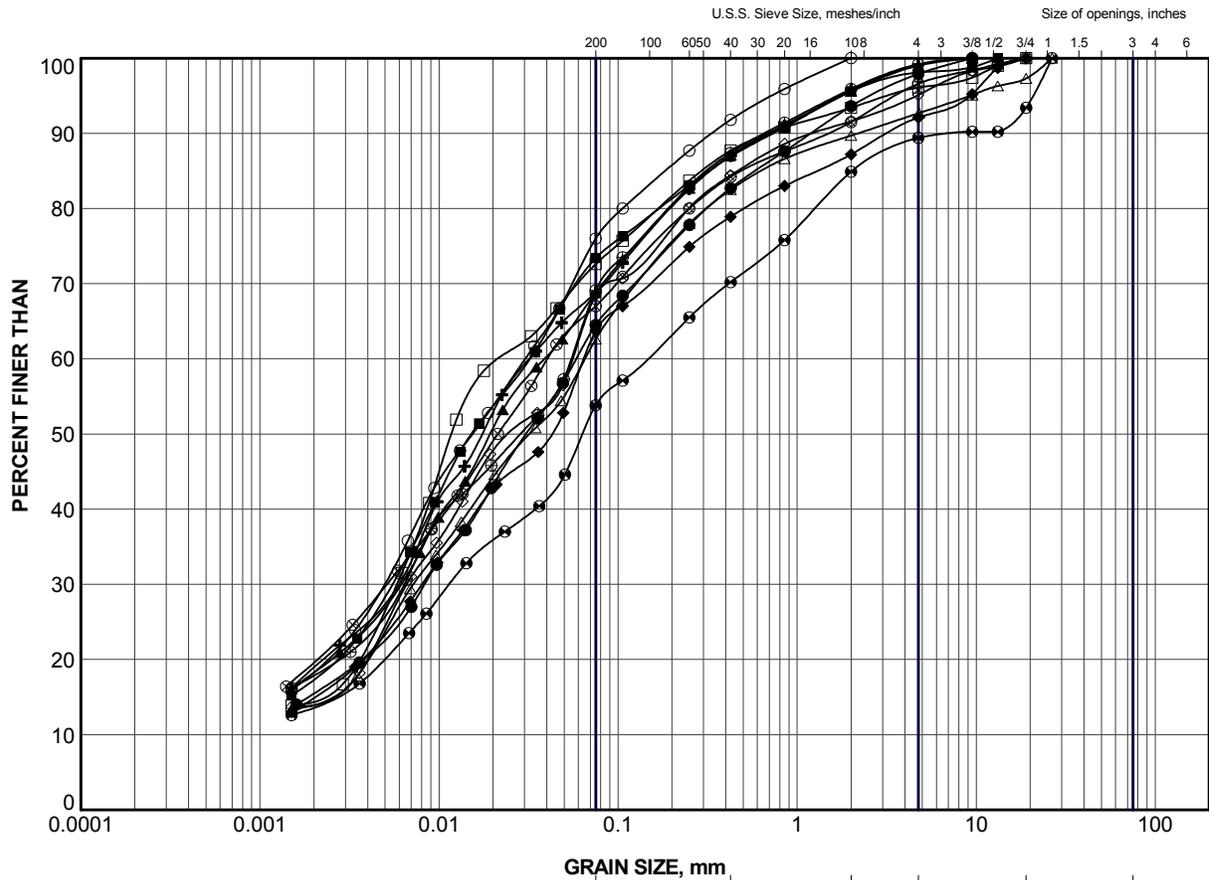
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N12	5	205.9

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE GRAIN SIZE DISTRIBUTION SAND and GRAVEL (UPPER DEPOSIT)					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE # 11-1191-0008 DETAIL.GPJ	
		DRAWN	JJL	Jan 2014	SCALE N/A
		CHECK	AB	Jan 2014	REV.
		APPR	JMAC	Jan 2014	
FIGURE A4					

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

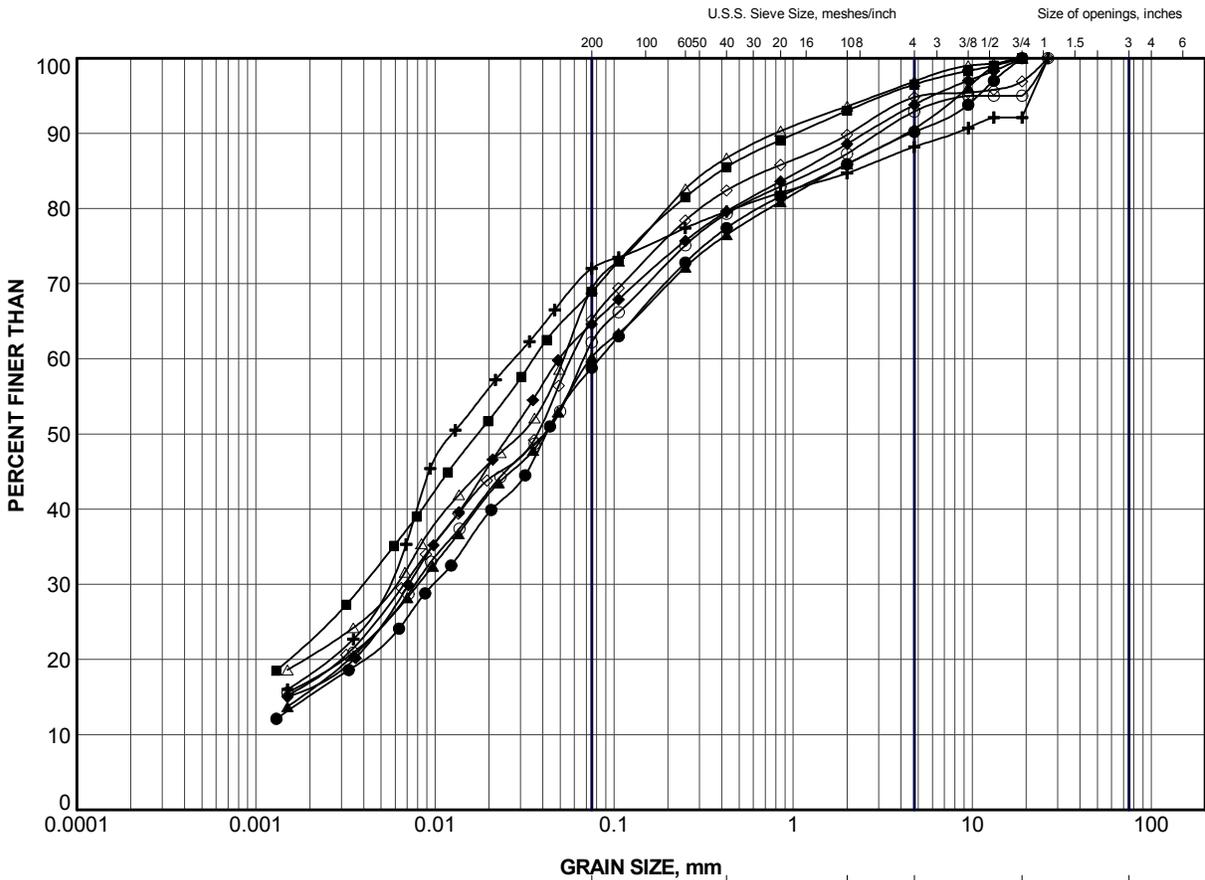
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N1	5	208.7
■	N1	9	204.0
▲	N3	5	203.4
+	N3	8	200.6
◆	N5	4	209.3
◇	N5	6	207.7
○	N6	3	209.3
△	N6	6	207.1
⊗	N12	7	204.5
⊕	N12	9	201.5
□	N13	8	207.0
⊙	N14	8	205.9

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND (TILL), UPPER DEPOSIT				
PROJECT No.		11-1191-0008		FILE No-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jul 2014	SCALE	N/A
CHECK	AB	Jul 2014	REV.	
APPR	JMAC	Jul 2014	FIGURE A5.1	



SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

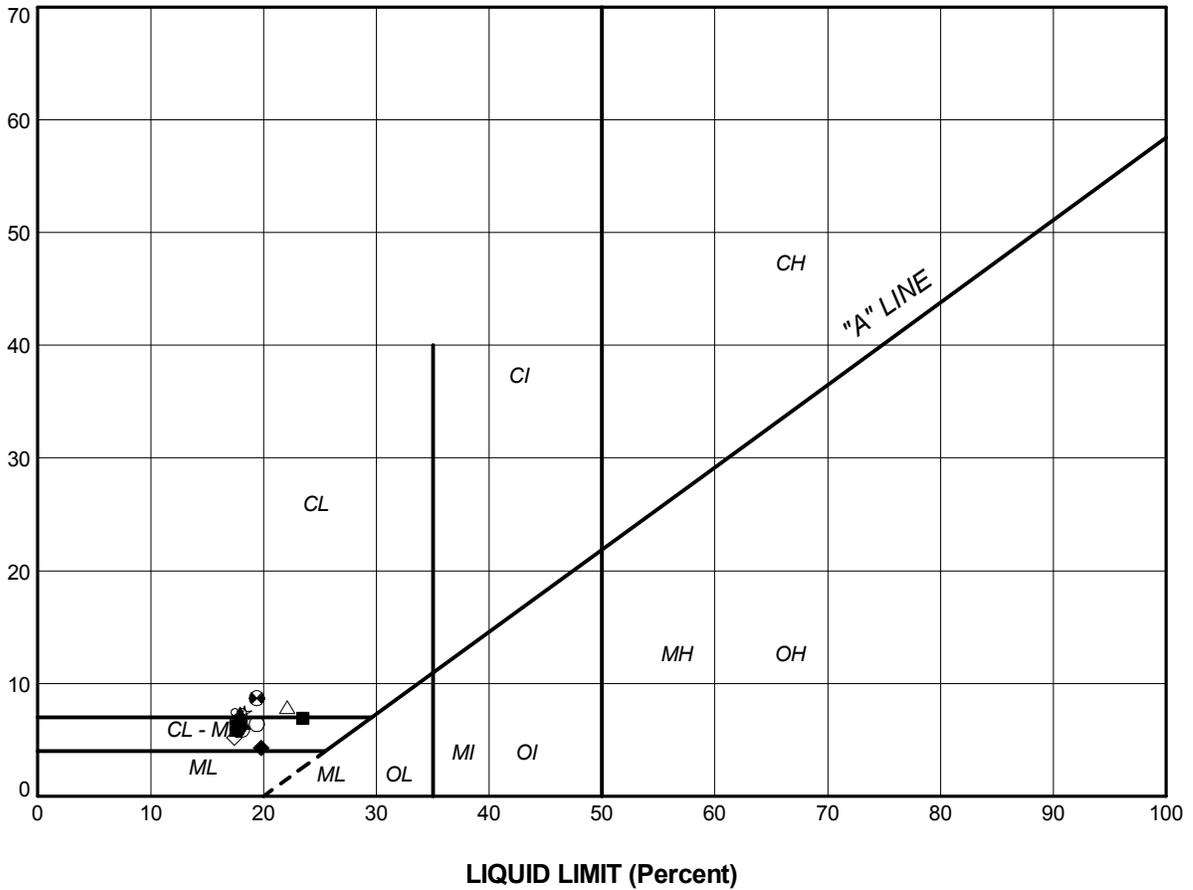
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N1	4	184.3
■	N1	7	175.1
▲	N15	2	210.2
+	N15	4	208.7
◆	N15	7	206.5
◇	N16	6	204.1
○	N16	8	201.8
△	N17	12	202.9

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND (TILL), UPPER DEPOSIT				
PROJECT No.		11-1191-0008		FILE No-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jul 2014	SCALE	N/A REV.
CHECK	AB	Jul 2014	FIGURE A5.2	
APPR	JMAC	Jul 2014		
Golder Associates <small>SUDBURY, ONTARIO</small>				

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

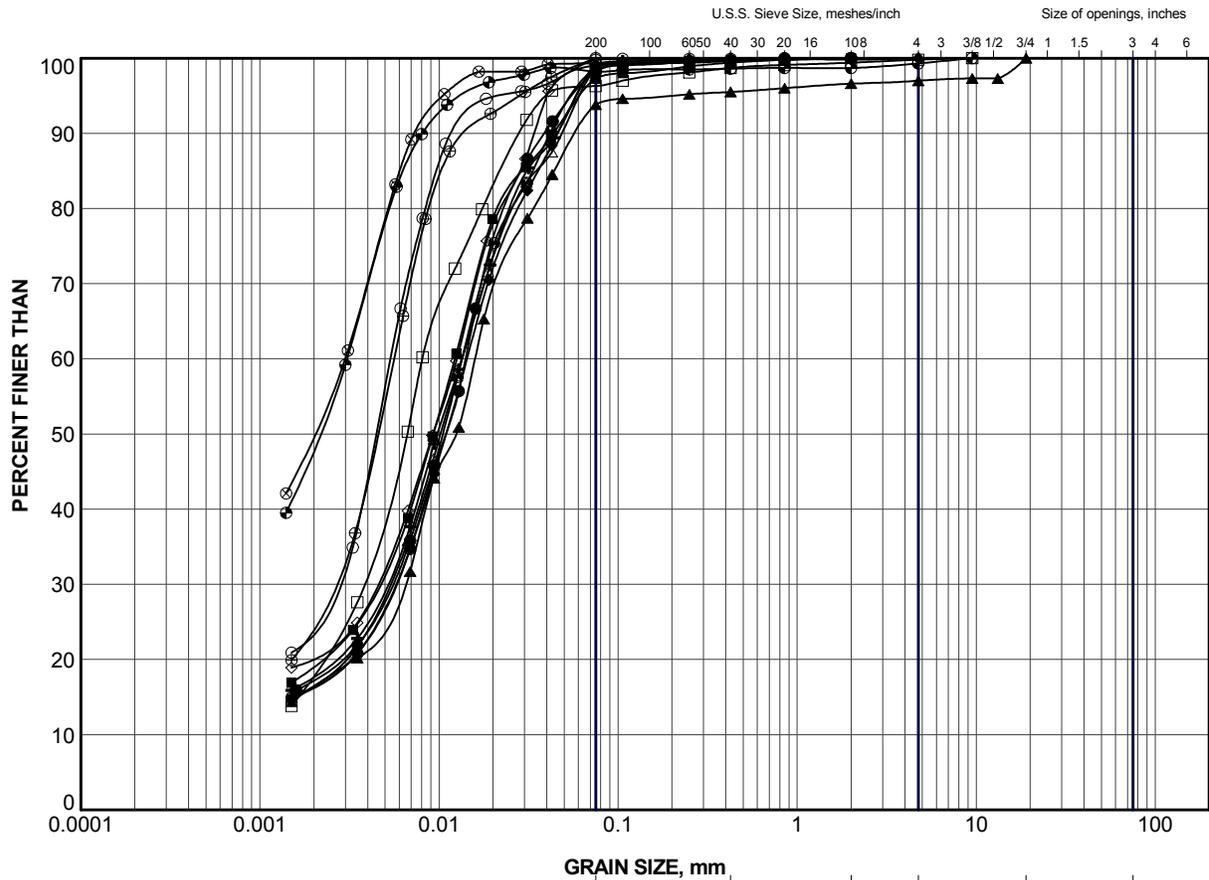
LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	N1	6	17.7	11.8	5.9
■	N1	10	23.5	16.6	6.9
▲	N12	7	17.9	10.6	7.3
+	N12	9	17.7	11.2	6.5
◆	N13	8	19.8	15.5	4.3
◇	N14	8	17.4	12.2	5.2
○	N15	2	19.4	13.0	6.4
△	N15	4	22.1	14.2	7.9
⊗	N15	7	17.9	11.6	6.3
⊕	N16	6	17.9	11.2	6.7
□	N16	8	17.7	11.3	6.4
⊙	N17	12	19.4	10.7	8.7
●	N5	4	18.1	12.2	5.9
☆	N5	6	18.3	10.9	7.4
⊗	N6	6	17.8	10.7	7.1

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE					PLASTICITY CHART SANDY SILT to SILT and SAND (TILL), UPPER DEPOSIT				
PROJECT No.		11-1191-0008		FILE No.		11-1191-0008 DETAIL.GPJ			
DRAWN	JJL	Jul 2014		SCALE	N/A		REV.		
CHECK	AB	Jul 2014		FIGURE A6					
APPR	JMAC	Jul 2014							



SUD-MTO PL (NEW) 25 GLDR_IDN.GDT



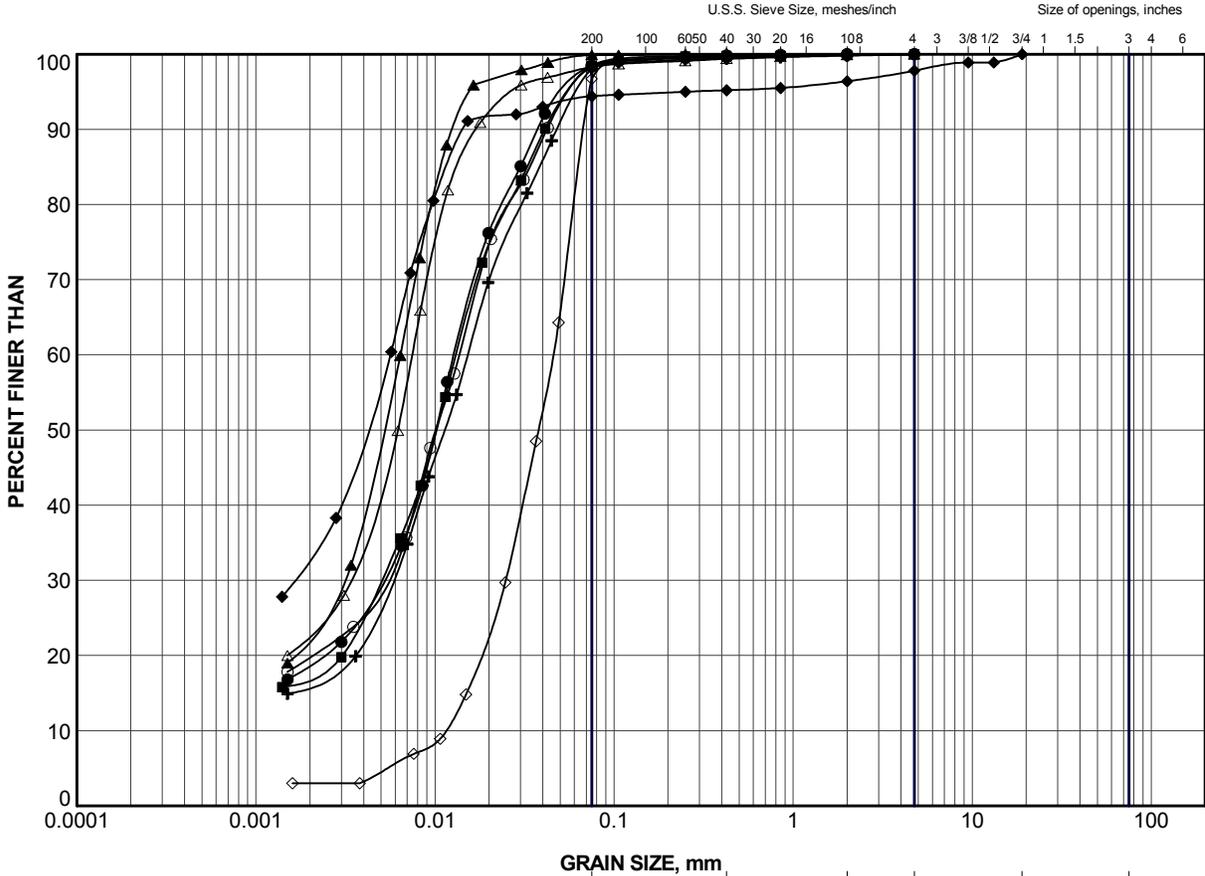
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N1	12	199.4
■	N6	10	201.8
▲	N6	13	197.2
+	N6	16	192.6
◆	N7	2	202.6
◇	N7	5	200.3
○	N7	7	198.8
△	N8	3	202.6
⊗	N8	5	201.1
⊕	N8	7	199.6
□	N8	9	197.3
⊙	N9	2	203.6
⊚	N9	6	200.5

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE					GRAIN SIZE DISTRIBUTION SILT				
PROJECT No.		11-1191-0008		FILE No.		1191-0008 DETAIL.GPJ			
DRAWN	JJL	Jul 2014	SCALE	N/A	REV.				
CHECK	AB	Jul 2014							
APPR	JMAC	Jul 2014	FIGURE A7.1						



SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

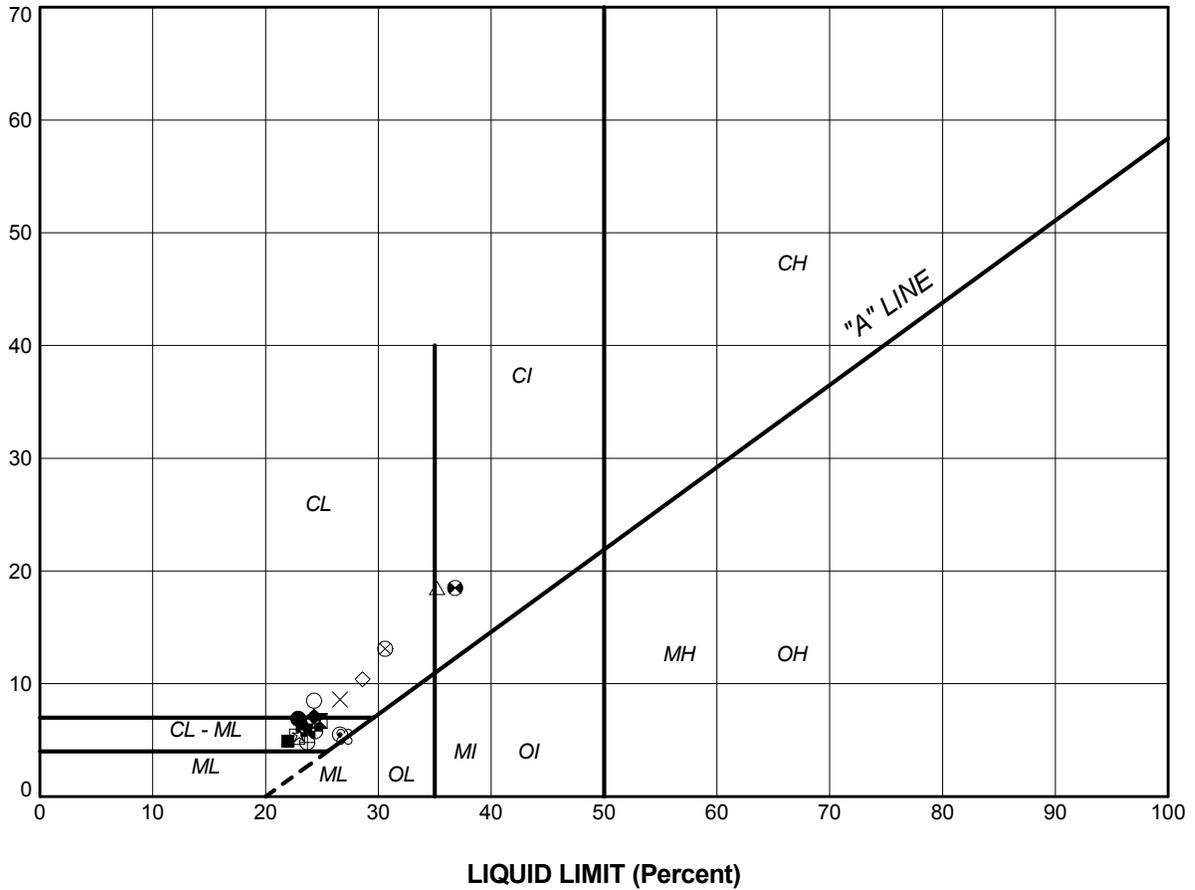
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N10	2	203.3
■	N10	5	201.0
▲	N10	8	198.7
+	N11	2	203.3
◆	N11	5	201.0
◇	N14	6	208.1
○	N15	11	200.3
△	N16	4a	205.7

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE						
TITLE GRAIN SIZE DISTRIBUTION SILT						
Golder Associates <small>SUDBURY, ONTARIO</small>		PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ		
		DRAWN	JJL	Jul 2014	SCALE N/A	REV.
		CHECK	AB	Jul 2014	FIGURE A7.2	
APPR	JMAC	Jul 2014				

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



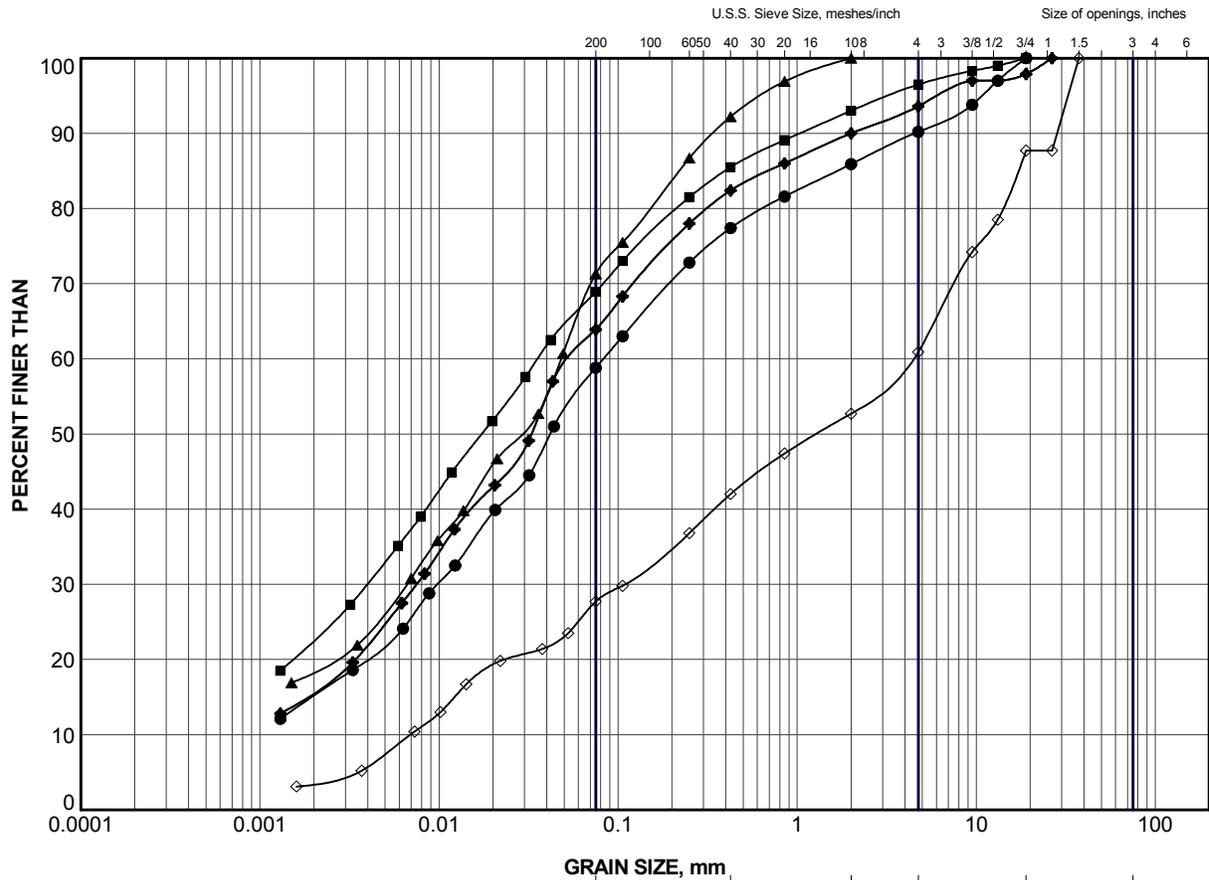
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	N6	10	22.9	16.0	6.9
■	N6	13	22.0	17.1	4.9
▲	N6	16	23.4	16.9	6.5
+	N7	2	23.5	17.2	6.3
◆	N7	5	24.3	17.2	7.1
◇	N7	7	28.6	18.2	10.4
○	N8	3	24.3	15.8	8.5
△	N8	5	35.2	16.7	18.5
⊗	N8	7	30.6	17.5	13.1
⊕	N8	9	23.7	18.9	4.8
□	N9	2	22.8	17.5	5.3
⊗	N9	6	36.8	18.3	18.5
⊕	N10	2	24.4	18.6	5.8
*	N10	5	23.0	17.5	5.5
⊗	N10	8	27.0	21.7	5.3
⊕	N11	2	24.8	18.1	6.7
⊕	N11	5	26.6	21.1	5.5
⊕	N15	11	23.4	17.4	6.0
×	N16	4a	26.6	18.0	8.6

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART SILT, SOME CLAY					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN JJJ Jul 2014			SCALE N/A		REV.
CHECK AB Jul 2014			APPR JMAC Jul 2014			FIGURE A8				
 Golder Associates SUDBURY, ONTARIO										



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

LEGEND

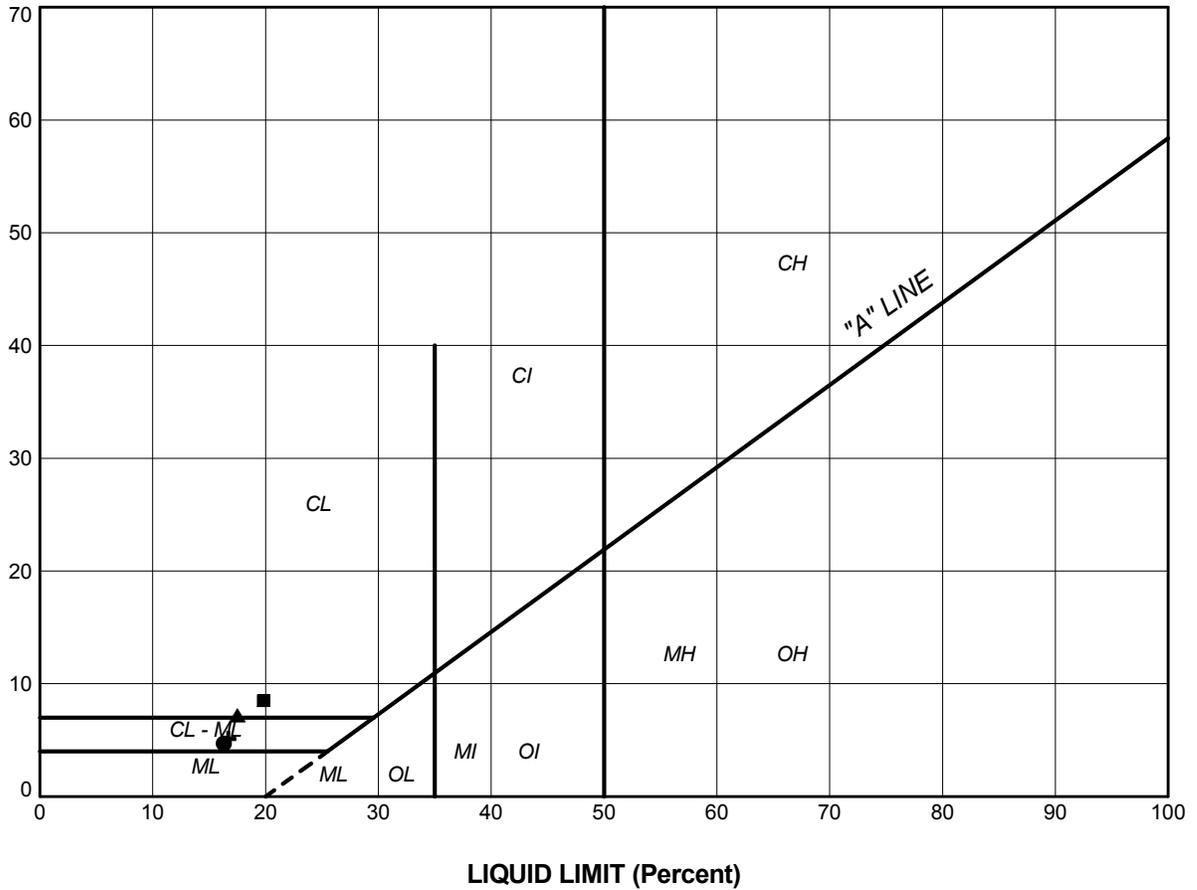
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	N1a	4	184.3
■	N1a	7	175.1
▲	N7	10	194.3
+	N8	2	203.4
◆	N8a	2	193.8
◇	N9	9b	197.3

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SANDY SILT to SILTY SAND and GRAVEL (TILL)				
PROJECT No.		11-1191-0008		FILE No-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jul 2014	SCALE	N/A
CHECK	AB	Jul 2014	REV.	
APPR	JMAC	Jul 2014	FIGURE A9	



SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	N1a	4	16.3	11.6	4.7
■	N1a	7	19.8	11.3	8.5
▲	N7	10	17.5	10.3	7.2
+	N8a	2	16.7	11.6	5.1

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART SILT and SAND (TILL)					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN			SCALE		REV.
DRAWN			JUL 2014		CHECK			N/A		
CHECK			AB		APPR			JMAC		JUL 2014
APPR			JMAC							FIGURE A10



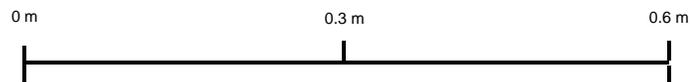
SUD-MTO PL (NEW) GLDR_LDN.GDT



Borehole N1a
Elevation 171.7 m to 168.6 m



Borehole N8a
Elevation 193.2 m to 190.1 m



PROJECT		HIGHWAY 11 NAGAGAMI RIVER BRIDGE	
TITLE		ROCK CORE PHOTOGRAPHS	
	PROJECT No.	11-1191-0008	FILE No. ----
	DESIGN	AC	NOV 2013
	CADD	--	
	CHECK	AB	NOV 2013
	REVIEW		
SCALE AS SHOWN			REV.
			FIGURE A11a



Borehole N9
Elevation 195.9 m to 192.7 m



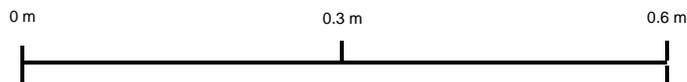
Borehole N10
Elevation 197.0 m to 194.1 m



Borehole N11
Elevation 199.1 m to 197.1 m



Borehole N12
Elevation 198.9 m to 197.7 m



PROJECT		HIGHWAY 11 NAGAGAMI RIVER BRIDGE	
TITLE		ROCK CORE PHOTOGRAPHS	
	PROJECT No.	11-1191-0008	FILE No. ----
	DESIGN	AC	NOV 2013
	CADD	--	
	CHECK	AB	NOV 2013
REVIEW			
			SCALE AS SHOWN REV.
			FIGURE A11b



APPENDIX B

Culvert Replacement – STA 20+585

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

CONT No. GWP No. 5307-04-00

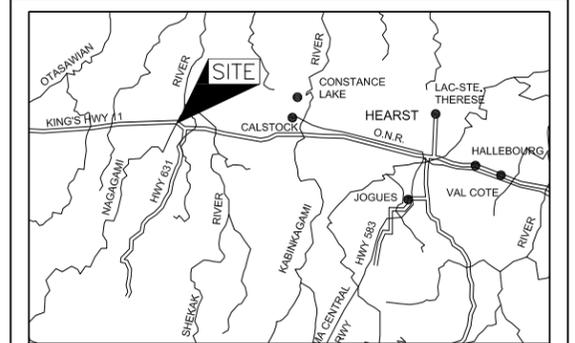


HIGHWAY 11
NAGAGAMI RIVER BRIDGE
CULVERT EXTENSION - STA 20+585
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

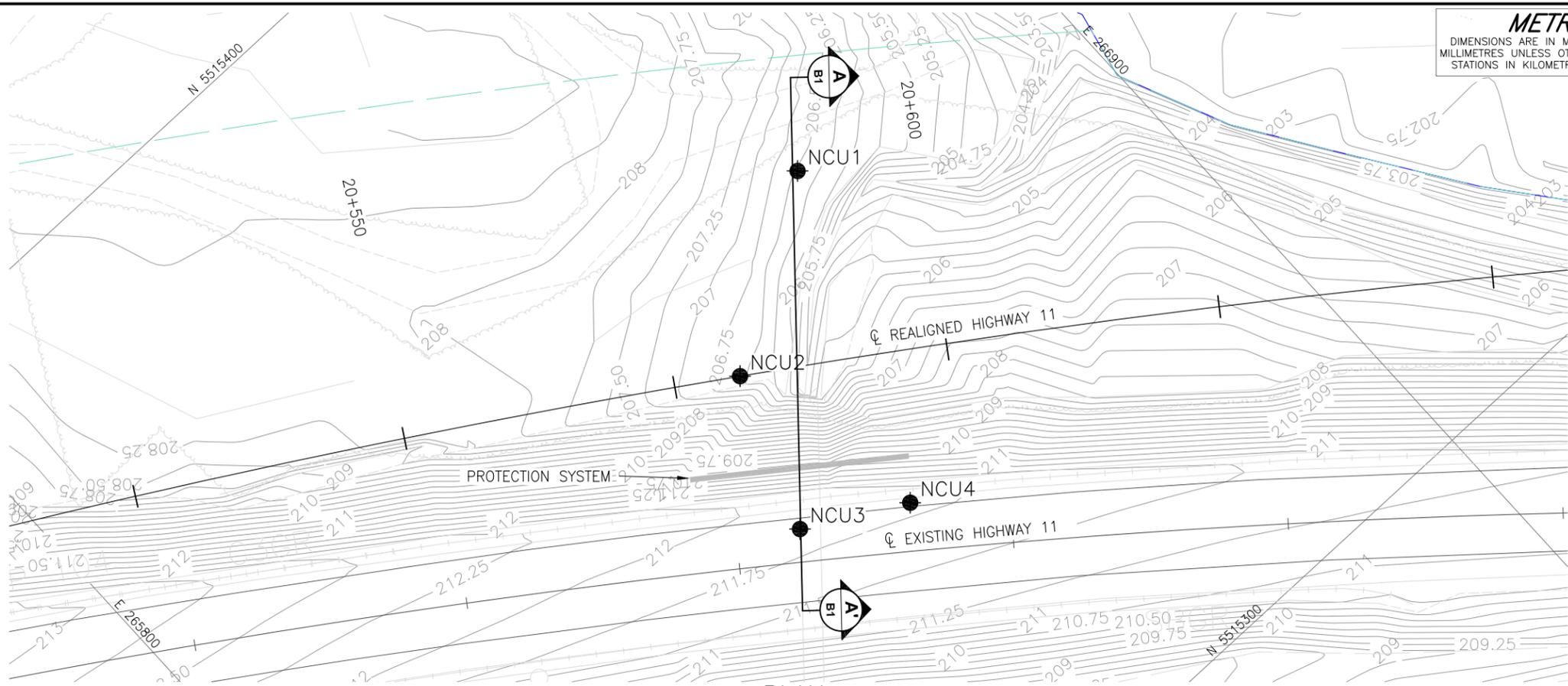


Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



KEY PLAN

SCALE 0 20 40 km



PLAN

SCALE 5 0 5 10 m

LEGEND

- Borehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
NCU1	206.4	5515358.2	265872.6
NCU2	206.2	5515348.0	265856.2
NCU3	211.8	5515334.1	265850.9
NCU4	211.9	5515329.1	265859.9

NOTES

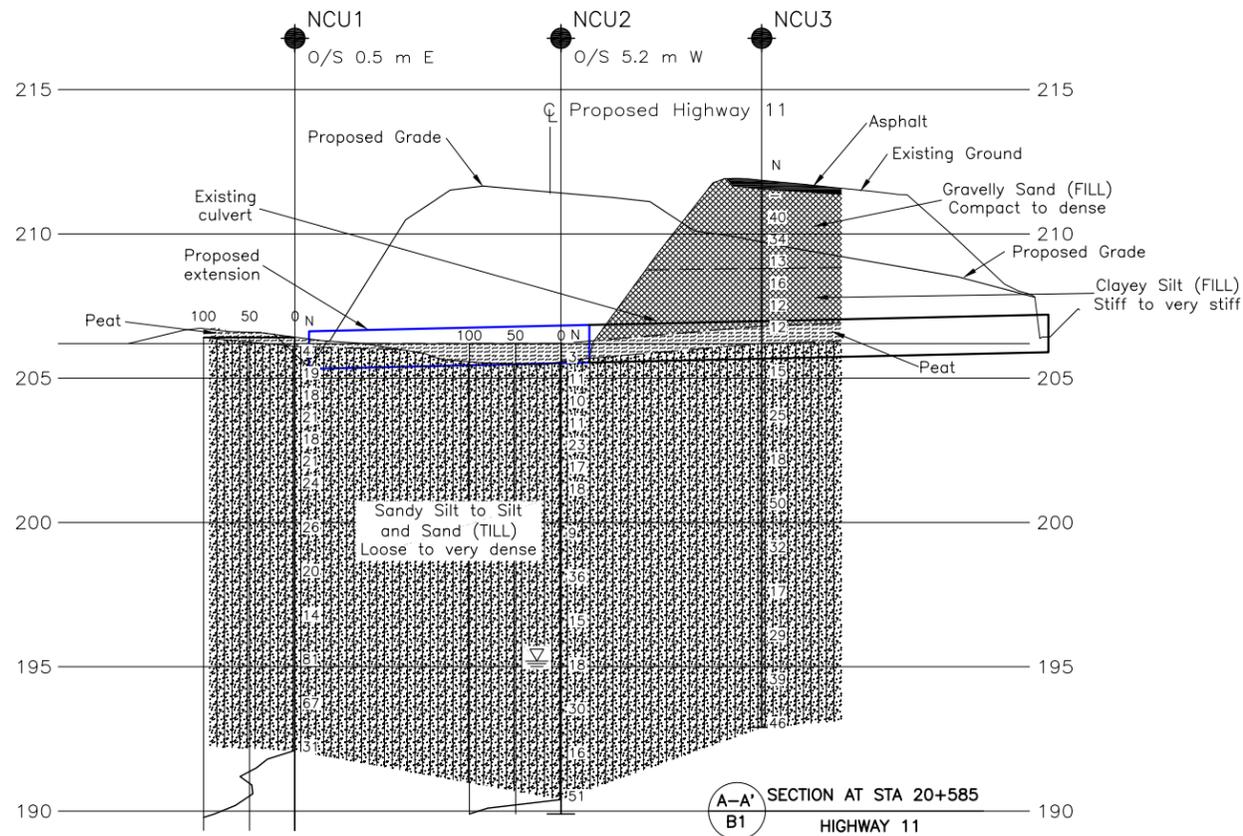
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

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REFERENCE

Base plans provided in digital format by LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagamí Base.dwg, received Sept 25, 2013. Culvert profile provided by LEA, drawing file no. x8960 Nago Prof.dwg, received Nov 26, 2013.



A-A' SECTION AT STA 20+585
HIGHWAY 11

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



NO.	DATE	BY	REVISION

Geocres No. 42F-28

HWY. 11	PROJECT NO. 11-1191-0008	DIST.
SUBM'D. AC	CHKD.	DATE: SEP 2014
DRAWN: TB	CHKD. AB	APPD. JMAC
		DWG. B1

RECORD OF BOREHOLE No NCU1 1 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515358.2; E 265872.6 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY AC

DATUM GEODETIC DATE July 20, 2013 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 (%)			
						20	40	60	80	100	20	40	60	GR	SA	SI	CL
206.4	GROUND SURFACE																
0.0	PEAT (Fibrous)																
206.1	Brown Moist		1	SS	4												
0.3	Sandy SILT to SILT and SAND, some clay, trace to some gravel (TILL) Compact to very dense Brown, grey below 1.5 m depth Moist to wet		2	SS	19									8	28	48	16
			3	SS	18												
			4	SS	21												
			5	SS	18												
			6	SS	21												
			7	SS	24												
			8	SS	26												
			9	SS	20												
			10	SS	14												
			11	SS	81									6	34	49	11
			12	SS	67												
			13	SS	31												
192.1	END OF BOREHOLE																
14.3	START OF DCPT																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

Continued Next Page

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



RECORD OF BOREHOLE No NCU1 2 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515358.2; E 265872.6 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY AC

DATUM GEODETIC DATE July 20, 2013 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			20	40	60	80	100						20
189.0	END OF BOREHOLE START OF DCPT					191											
17.4	END OF DCPT Note: 1. Borehole dry upon completion of drilling.					189											

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No NCU2	1 OF 2 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515348.0; E 265856.2</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 21, 2013</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									WATER CONTENT (%)		
						20	40	60	80	100		20	40	60	GR	SA	SI	CL	
206.2	GROUND SURFACE																		
0.0	PEAT (Fibrous), some sand Soft Brown Moist		1	SS	3														
205.6																			
0.6	SILT and SAND, some clay, trace to some gravel (TILL) Loose to compact Grey Moist to wet		2	SS	11														
			3	SS	10						ϕH				3	32	49	16	
			4	SS	11														
			5	SS	23														
			6	SS	17						ϕH				4	35	48	13	
			7	SS	18														
			8	SS	9														
			9	SS	36						○H				9	33	48	10	
			10	SS	15														
			11	SS	18														
			12	SS	30						○H				10	37	40	13	
			13	SS	16														

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

Continued Next Page

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



RECORD OF BOREHOLE No NCU2 2 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515348.0; E 265856.2 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY AC

DATUM GEODETIC DATE July 21, 2013 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	20	40	60	80						100
190.4	END OF BOREHOLE		14	SS	51	191											
15.8	END OF BOREHOLE																
189.9	START OF DCPT						190										
16.3	END OF DCPT																
	Note: 1. Water level at a depth of 11.0 m below ground surface (Elev. 195.2 m) upon completion of drilling.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

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



RECORD OF BOREHOLE No NCU3 2 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515334.1; E 265850.9 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY AC

DATUM GEODETIC DATE July 18, 2013 CHECKED BY AB

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					W _p	W			W _L	
						20 40 60 80 100	○ UNCONFINED	+ FIELD VANE										
						20 40 60 80 100	● QUICK TRIAXIAL	× REMOULDED										
192.9	18.9	--- CONTINUED FROM PREVIOUS PAGE ---																
		Sandy SILT to SILT and SAND, some clay, trace to some gravel (TILL) Compact to very dense Grey Moist to wet	14	SS	29	196												
			15	SS	39	195												
			16	SS	46	193												
		END OF BOREHOLE Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

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



RECORD OF BOREHOLE No NCU4 2 OF 2 **METRIC**

PROJECT 11-1191-0008

G.W.P. 5307-04-00 LOCATION N 5515329.1; E 265859.9 ORIGINATED BY EHS

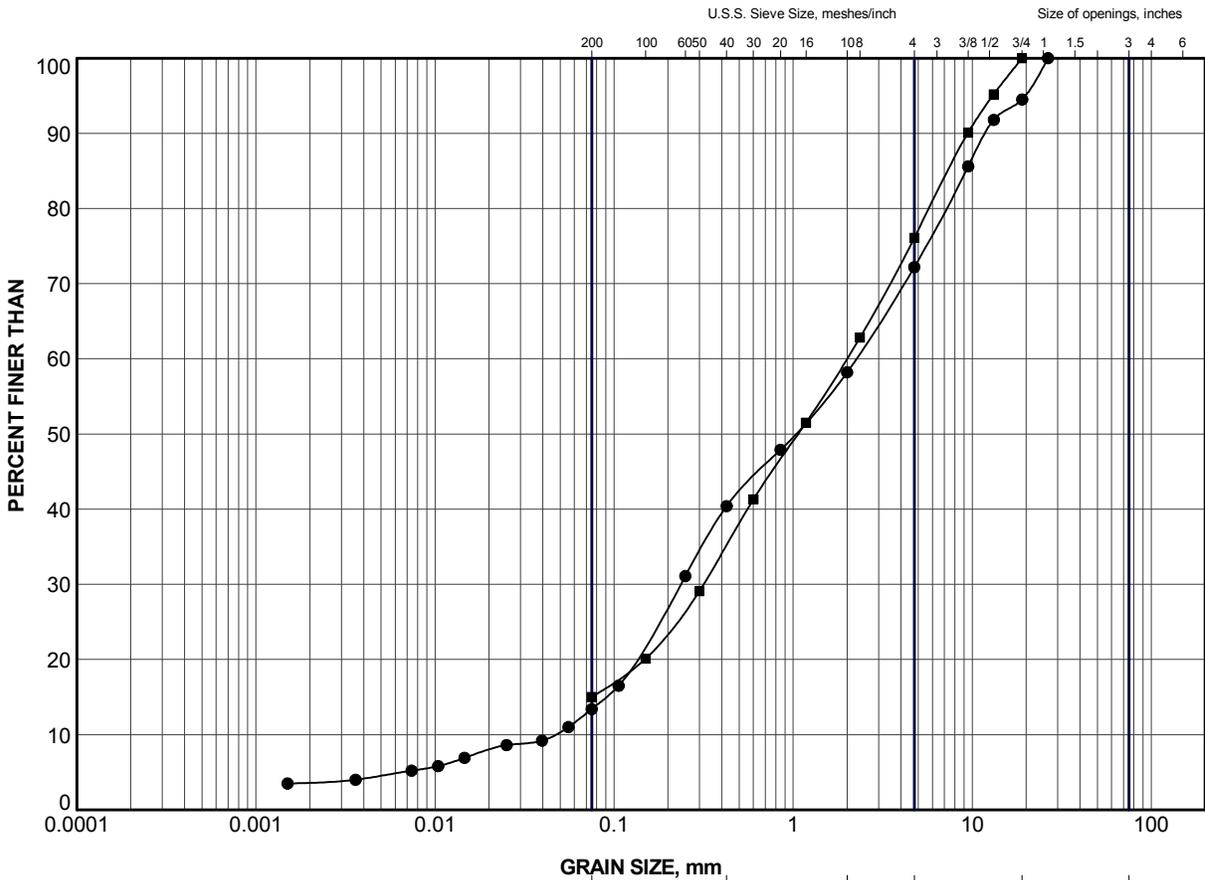
DIST HWY 11 BOREHOLE TYPE NW Casing and Wash Boring COMPILED BY AC

DATUM GEODETIC DATE April 3 and 7, 2014 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	20	40	60	80	100	W _p	W			W _L	20	40	60
196.1	15.8	END OF BOREHOLE	13	SS	77															
		Note: 1. Borehole dry upon completion of drilling.																		

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 24/04/14 DATA INPUT:

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



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

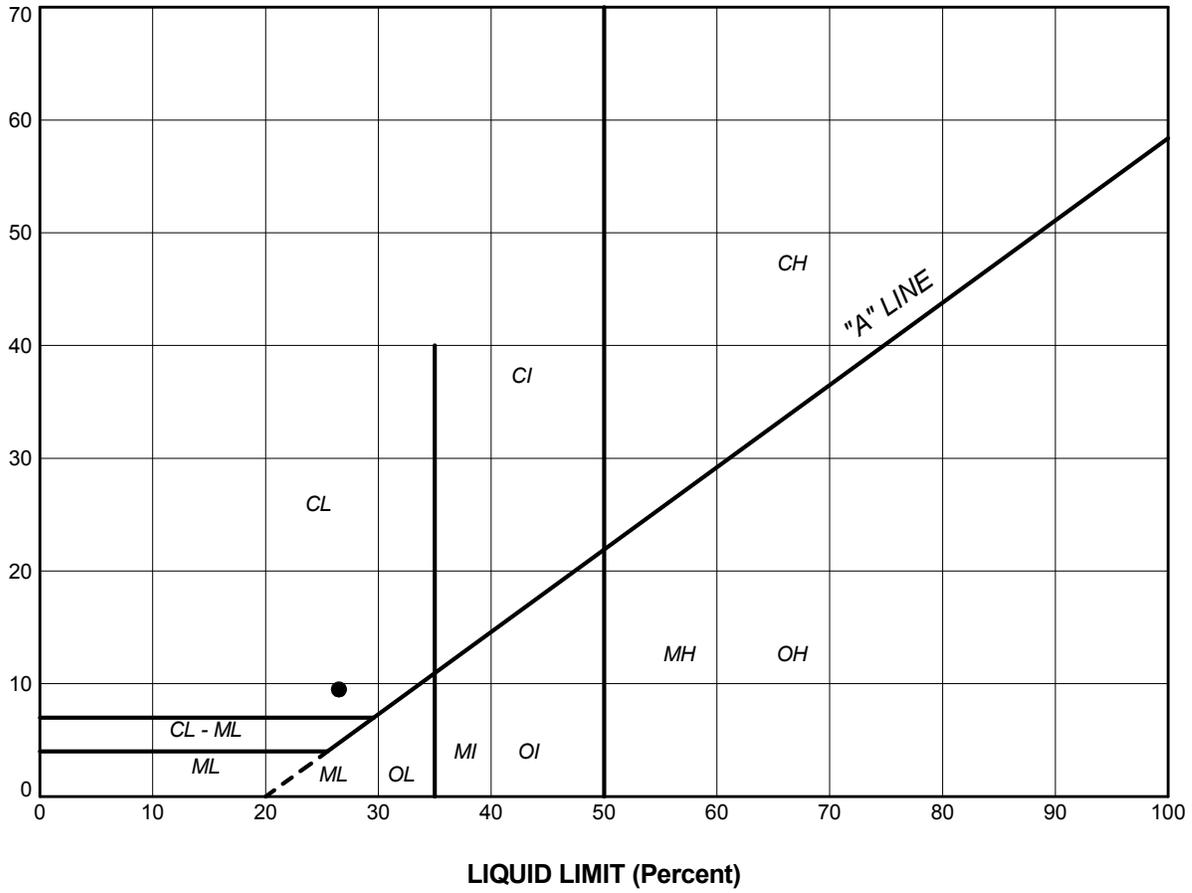
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NCU3	3	210.0
■	NCU4	2	210.1

PROJECT	HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+585				
TITLE	GRAIN SIZE DISTRIBUTION GRAVELLY SAND (FILL)				
 Golder Associates SUDBURY, ONTARIO	PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ		
	DRAWN	TB	Apr 2014	SCALE	N/A
	CHECK	AB	Apr 2014	REV.	
APPR	JMAC	Apr 2014	FIGURE B1		

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



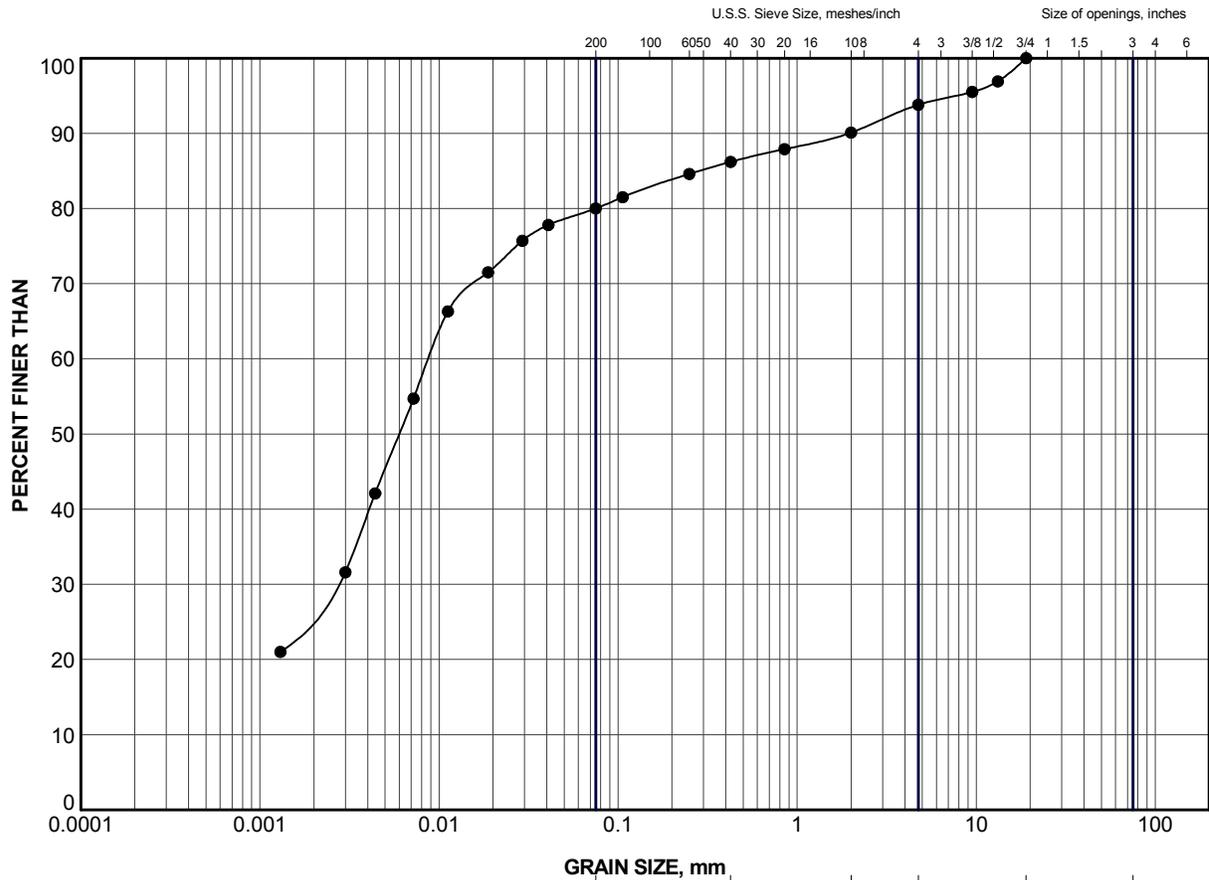
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NCU4	4	26.5	17.0	9.5

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+585									
TITLE										PLASTICITY CHART CLAYEY SILT (FILL)				
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ			DRAWN TB		Sep 2014		SCALE N/A		REV.		
CHECK AB		Sep 2014		APPR JMAC		Sep 2014		FIGURE B2						
 Golder Associates SUDBURY, ONTARIO														



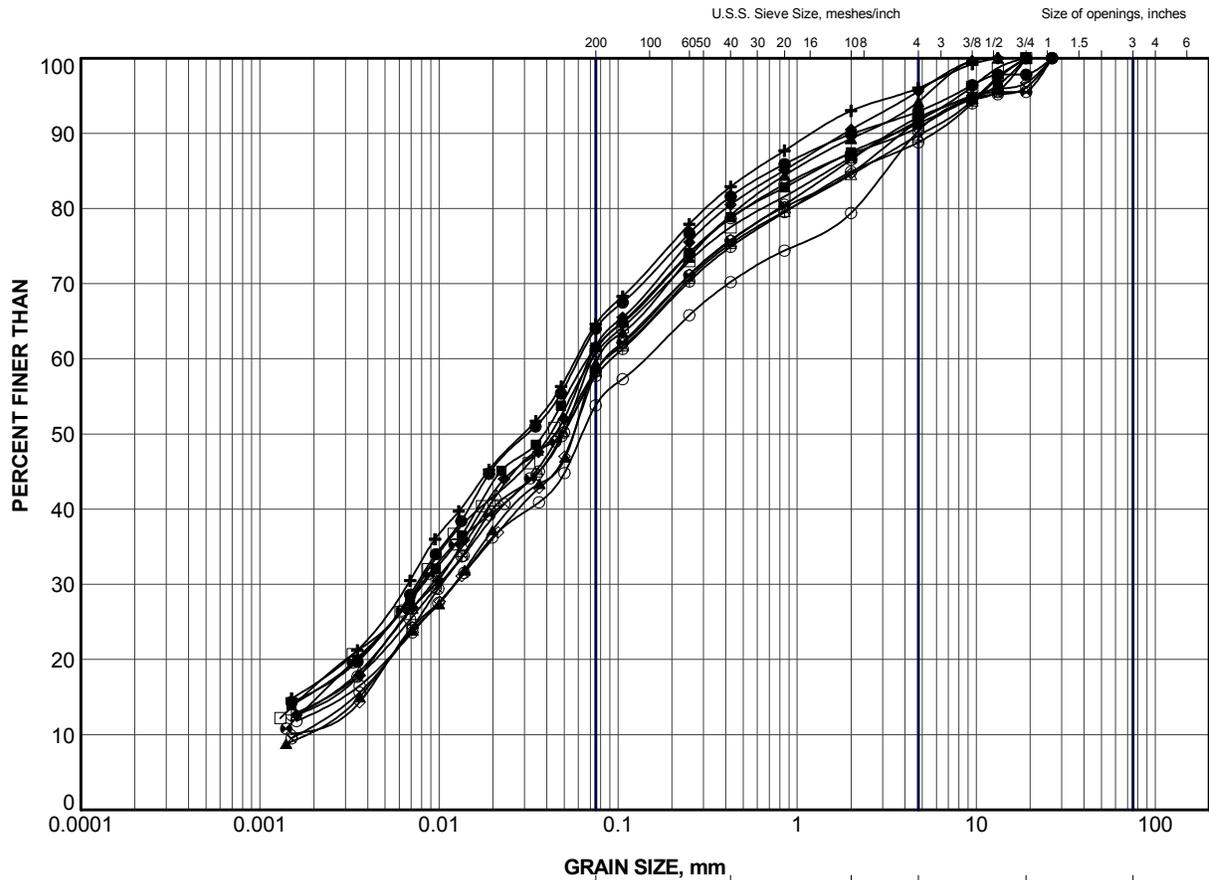
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NCU4	4	208.6

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+585							
TITLE GRAIN SIZE DISTRIBUTION CLAYEY SILT (FILL)							
Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ			
		DRAWN	TB	Apr 2014	SCALE	N/A	REV.
		CHECK	AB	Apr 2014	FIGURE B3		
APPR	JMAC	Apr 2014					

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

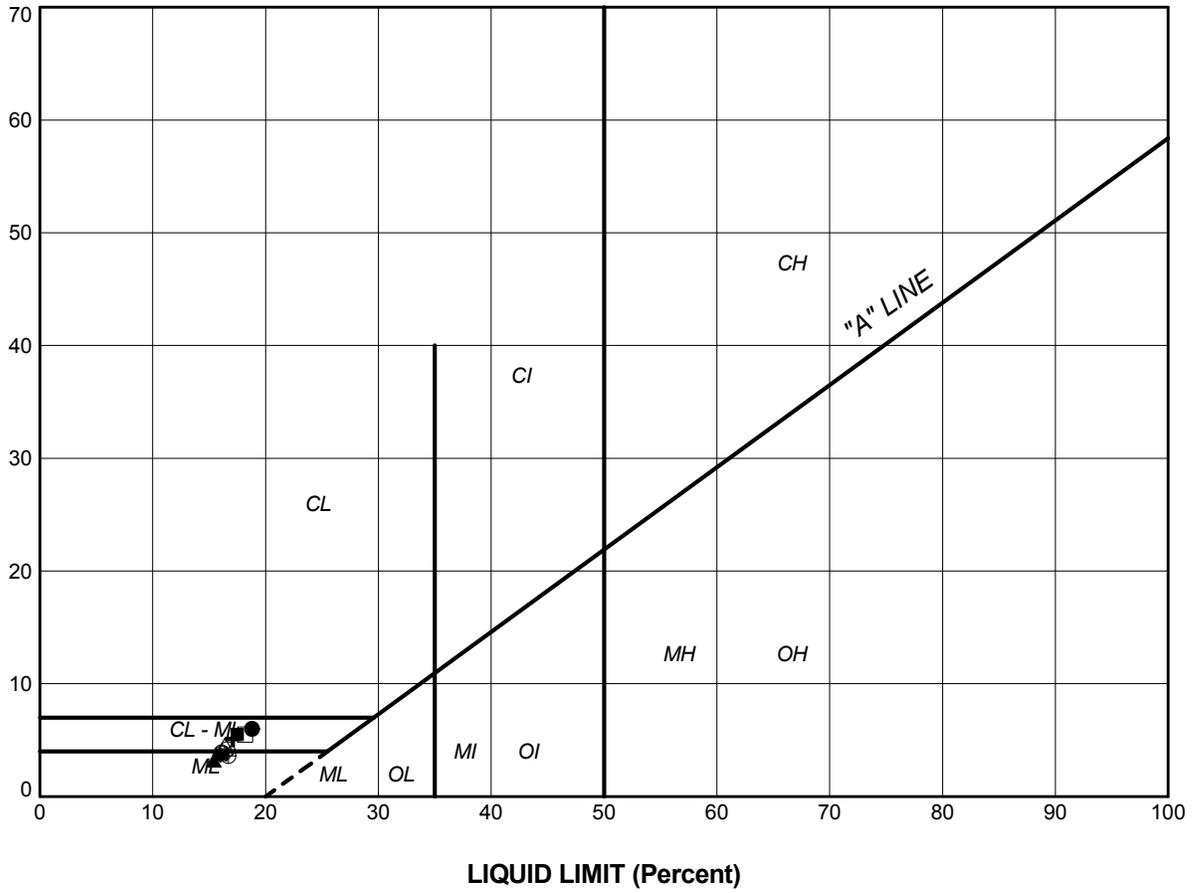
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NCU1	2	205.3
■	NCU1	6	202.3
▲	NCU1	11	195.4
+	NCU2	3	204.4
◆	NCU2	6	202.1
◇	NCU2	9	198.3
○	NCU2	12	193.7
△	NCU3	9	203.9
⊗	NCU3	11	200.8
⊕	NCU3	13	197.8
□	NCU4	7	205.5
⊙	NCU4	10	200.9

PROJECT					
HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+585					
TITLE					
GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND (TILL)					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE #11-1191-0008 DETAIL.GPJ	
		DRAWN	TB	Apr 2014	SCALE N/A
		CHECK	AB	Apr 2014	REV.
		APPR	JMAC	Apr 2014	
FIGURE B4					

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NCU1	2	18.8	12.8	6.0
■	NCU1	6	17.5	12.0	5.5
▲	NCU1	11	15.4	12.2	3.2
+	NCU2	3	17.1	12.0	5.1
◆	NCU2	6	16.0	12.3	3.7
◇	NCU2	9	16.5	12.7	3.8
○	NCU2	12	16.1	12.2	3.9
△	NCU3	9	16.4	11.8	4.6
⊗	NCU3	11	16.6	12.4	4.2
⊕	NCU3	13	16.7	13.1	3.6
□	NCU4	7	18.2	12.7	5.5
⊙	NCU4	10	16.1	12.3	3.8

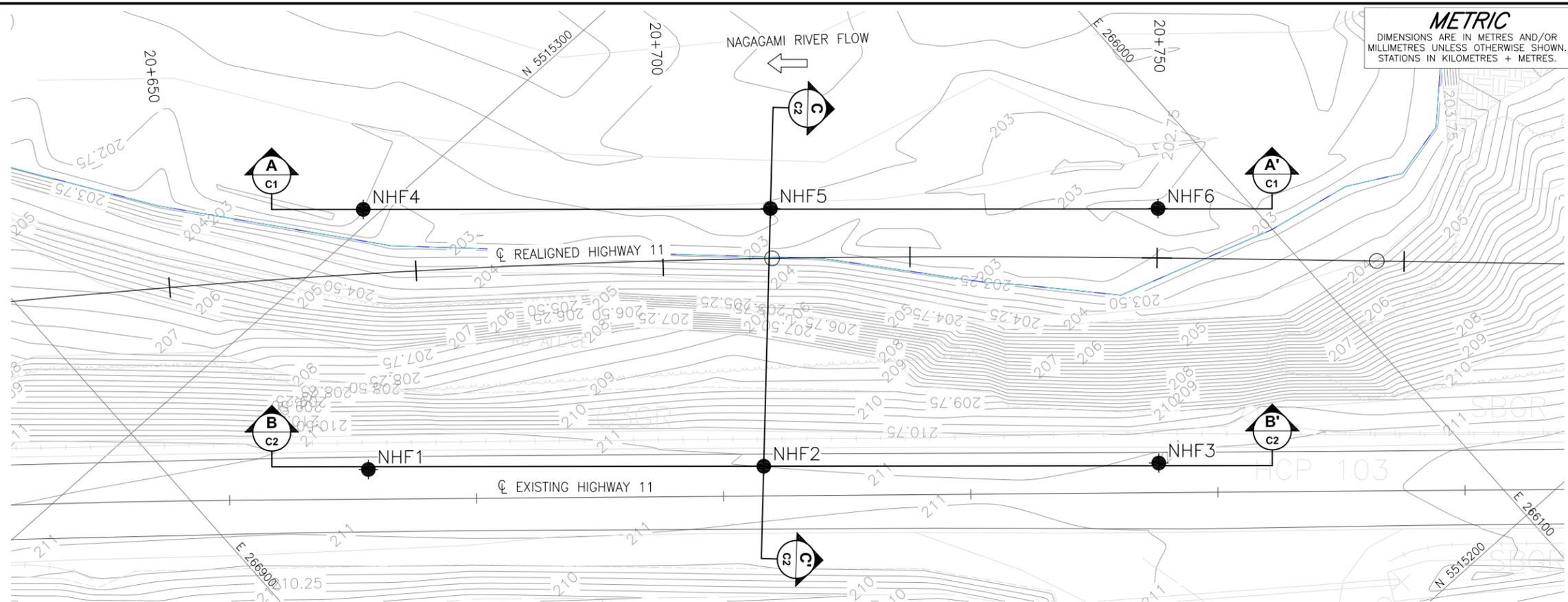
PROJECT		HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+585		
TITLE		PLASTICITY CHART SANDY SILT to SILT and SAND (TILL)		
PROJECT No.	11-1191-0008	FILE No. 11-1191-0008 DETAIL.GPJ		
DRAWN	TB	Apr 2014	SCALE	N/A
CHECK	AB	Apr 2014	REV.	
APPR	JMAC	Apr 2014	FIGURE B5	



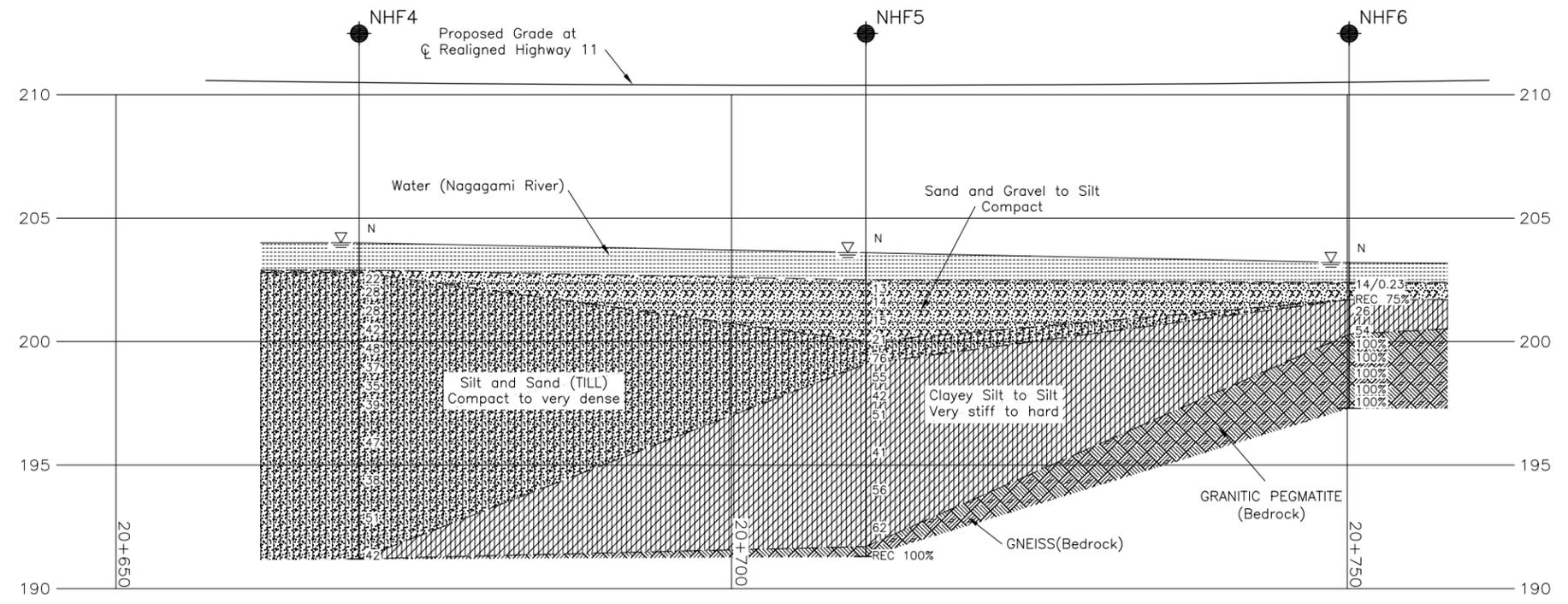


APPENDIX C

High Fill – STA 20+650 to 20+775



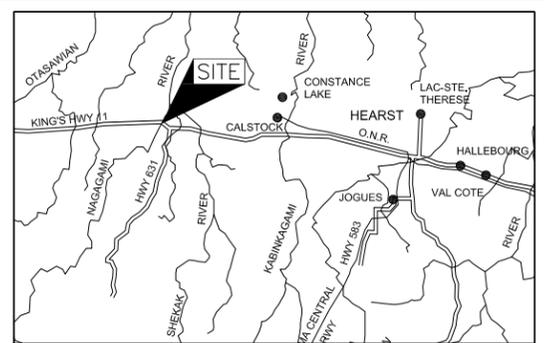
PLAN
SCALE
5 0 5 10 m



CONT No. GWP No. 5307-04-00
HIGHWAY 11
NAGAGAMI RIVER BRIDGE
HIGH FILL - STA 20+650 TO 20+775
BOREHOLE LOCATIONS AND SOIL STRATA



Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



LEGEND

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

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
NHF1	211.2	5515281.3	265915.5
NHF2	211.0	5515255.0	265945.6
NHF3	211.0	5515228.7	265975.7
NHF4	204.0	5515301.3	265932.6
NHF5	203.6	5515274.0	265963.4
NHF6	203.2	5515247.9	265992.7

NOTES

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

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REFERENCE

Base plans provided in digital format by LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.



NO.	DATE	BY	REVISION

Geocres No. 42F-28

HWY. 11	PROJECT NO. 11-1191-0008	DIST.
SUBM'D. AC	CHKD.	DATE: SEP 2014
DRAWN: TB	CHKD. AB	APPD. JMAC
		DWG. C1

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

CONT No. GWP No. 5307-04-00



HIGHWAY 11
NAGAGAMI RIVER BRIDGE
HIGH FILL - STA 20+650 TO 20+775
SOIL STRATA

SHEET



Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA

LEGEND

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

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
NHF1	211.2	5515281.3	265915.5
NHF2	211.0	5515255.0	265945.6
NHF3	211.0	5515228.7	265975.7
NHF4	204.0	5515301.3	265932.6
NHF5	203.6	5515274.0	265963.4
NHF6	203.2	5515247.9	265992.7

NOTES

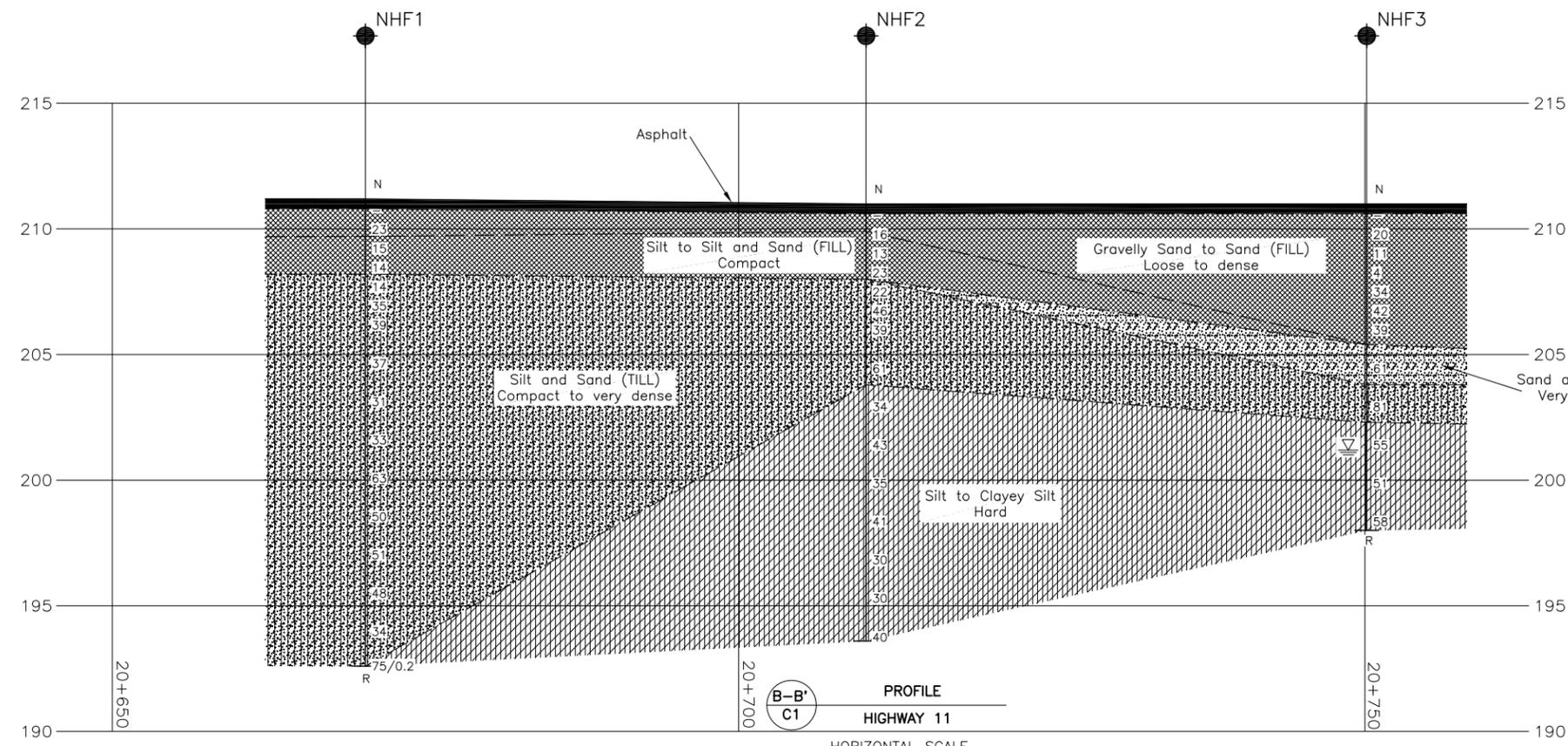
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013.





RECORD OF BOREHOLE No NHF1 2 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515281.3; E 265915.5 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Steam Augers, NW Casing, Wash Boring COMPILED BY AC

DATUM GEODETIC DATE July 22 and 23, 2013 CHECKED BY AB

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					W _p	W			W _L		
	--- CONTINUED FROM PREVIOUS PAGE ---					20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	WATER CONTENT (%)								
						20 40 60 80 100					20 40 60								
192.6	SILT and SAND, some clay, trace to some gravel (TILL) Compact to very dense Grey Moist to wet		14	SS	48												10 31 46 13		
195																			
194			15	SS	34														
193																			
18.6	END OF BOREHOLE SPLIT-SPOON REFUSAL Note: 1. Water level not recorded upon completion of drilling.		16	SS	75/0.2														

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 16/01/14 DATA INPUT:

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

RECORD OF BOREHOLE No NHF2 1 OF 2 **METRIC**

PROJECT 11-1191-0008 G.W.P. 5307-04-00 LOCATION N 5515255.0; E 265945.6 ORIGINATED BY SA

DIST HWY 11 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY AC

DATUM GEODETIC DATE July 23 and 24, 2013 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 (%)		
						20	40	60	80	100	20	40	60		GR	SA	SI	CL	
211.0	GROUND SURFACE																		
0.0	ASPHALT (400 mm)		1a	AS	-														
210.6			1b																
0.4	Gravelly sand, some silt (FILL) Compact Brown Moist		2	SS	16														
209.9			3	SS	13														
1.1	Silt and sand, some gravel, some clay (FILL) Compact Brown Moist		4	SS	23														
208.0			5	SS	22														
3.0	SILT and SAND, some clay, trace to some gravel (TILL) Compact to very dense Brown to grey Moist to wet		6	SS	46														
			7	SS	39														
207			8	SS	61														
206			9	SS	34														
205			10	SS	43														
204			11	SS	35														
203.8	SILT to CLAYEY SILT, trace sand, trace gravel Hard Grey Wet		12	SS	41														
7.2			13	SS	30														
203																			
202																			
201																			
200																			
199																			
198																			
197																			

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

Continued Next Page

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No NHF3	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515228.7; E 265975.7</u>	ORIGINATED BY <u>SA</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 29, 2013</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									WATER CONTENT (%)		
						20	40	60	80	100									
211.0	GROUND SURFACE																		
0.0	ASPHALT (400 mm)		1a	AS	-														
210.6			1b																
0.4	Gravelly sand to sand and gravel, trace to some silt (FILL) Loose to dense Brown Moist		2	SS	20														
			3	SS	11														
			4	SS	4														
			5	SS	34														
			6	SS	42														
			7	SS	39														
205.4																			
5.6	SAND and GRAVEL, some silt Very dense Grey Wet		8	SS	61														
203.8																			
7.2	Sandy SILT, some clay, trace to some gravel (TILL) Very dense Grey Moist to wet		9	SS	81														
202.3																			
8.7	CLAYEY SILT, trace sand Hard Brown Wet		10	SS	55														
	Augers grinding between 10.4 m and 10.8 m depth.		11	SS	51														
			12	SS	58														
198.0																			
13.0	END OF BOREHOLE AUGER REFUSAL																		
	Note: 1. Water level at a depth of 9.8 m below ground surface (Elev. 201.2 m) upon completion of drilling.																		

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

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

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No NHF4	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515301.3; E 265932.6</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 28 and 29, 2013</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									WATER CONTENT (%)		
						20	40	60	80	100						GR	SA	SI	CL
204.0	WATER SURFACE																		
0.0	WATER																		
202.9																			
1.2	SAND and GRAVEL Grey Wet		1	SS	22														
	SILT and SAND, some clay, trace to some gravel (TILL) Compact to very dense Grey Wet		2	SS	28														
			3	SS	28								ϕH			8	33	46	13
			4	SS	42														
			5	SS	48								○						
			6	SS	37														
			7	SS	35														
			8	SS	39								ϕH			3	32	49	16
			9	SS	47														
			10	SS	38														
			11	SS	51														
			12	SS	42								○H			22	36	32	10
191.2	END OF BOREHOLE																		
12.8	Note: 1. Water level inside casing at water surface (Elev. 204.0 m) upon completion of drilling.																		

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No NHF5	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515274.0; E 265963.4</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing and NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 27 and 28, 2013</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									WATER CONTENT (%)		
						20	40	60	80	100									
203.6	WATER SURFACE																		
0.0	WATER																		
202.5																			
1.1	SAND and GRAVEL, trace to some silt, trace clay Compact Brown Wet		1	SS	13														
			2	SS	14														
			3	SS	15												38	50	10 2
			4	SS	21														
200.0																			
3.6	SILT and SAND, some clay, trace to some gravel (TILL) Very dense Grey Moist		5	SS	76												6	35	47 12
199.1																			
4.5	CLAYEY SILT, trace to some sand, trace gravel Hard Brown to grey Moist to wet		6	SS	55														
			7	SS	42												0	4	74 22
			8	SS	51														
			9	SS	41														
			10	SS	56														
			11	SS	62												1	1	77 21
191.7	GNEISS (BEDROCK)		-	RC	REC 100%														
191.3	END OF BOREHOLE																		
12.3	Note: 1. Water level inside casing at water surface (Elev. 203.6 m) upon completion of drilling.																		

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No NHF6	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515247.9; E 265992.7</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing and NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>July 25 to 27, 2013</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			20	40	60	80	100						20	40	60
203.2	WATER SURFACE																			
0.0	WATER																			
202.4	SAND and GRAVEL Compact Brown Wet	[Strat Plot]	1	SS	14/0.2															
201.7			-	RC	REC 75%															
1.5	CLAYEY SILT, trace sand Very stiff to hard Brown Wet	[Strat Plot]	2	SS	26													0 1 66 33		
200.3			3	SS	54															
2.9	GRANITIC PEGMATITE (BEDROCK) Bedrock cored from 2.9 m to 5.9 m depth. For coring details see Record of Drillhole NHF6.	[Strat Plot]	1	RC	REC 100%													RQD = 100%		
			2	RC	REC 100%														RQD = 100%	
			3	RC	REC 100%															RQD = 100%
			4	RC	REC 100%															RQD = 100%
			5	RC	REC 100%															RQD = 100%
197.3	END OF BOREHOLE																			
5.9	Note: 1. Water level inside casing at water surface (Elev. 203.2 m) upon completion of drilling.																			

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: NHF6

SHEET 1 OF 1

LOCATION: N 5515247.9 ; E 265992.7

DRILLING DATE: July 25 to 27, 2013

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 BOMB

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	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/EL. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Ur	Ja	Ln				k, cm/s	10 ⁰	10 ¹	10 ²
								80	80			0	0	0	0	0	0				0	0	0	0
		REFER TO PREVIOUS PAGE		200.3																				
3	NW	GRANITIC PEGMATITE Sound Very coarse grained Grey/Pink		2.9	1		GREY 100%																	
					2		GREY 100%																	
4	NQ				3		GREY 100%																	
5					4		GREY 100%																	
					5		GREY 100%																	
6		END OF DRILLHOLE		197.3																				
				5.9																				
7																								
8																								
9																								
10																								
11																								
12																								

SUD-RCK 11-1191-0008 DETAIL GPJ GAL-MISS GDT 08/01/14 DATA INPUT:

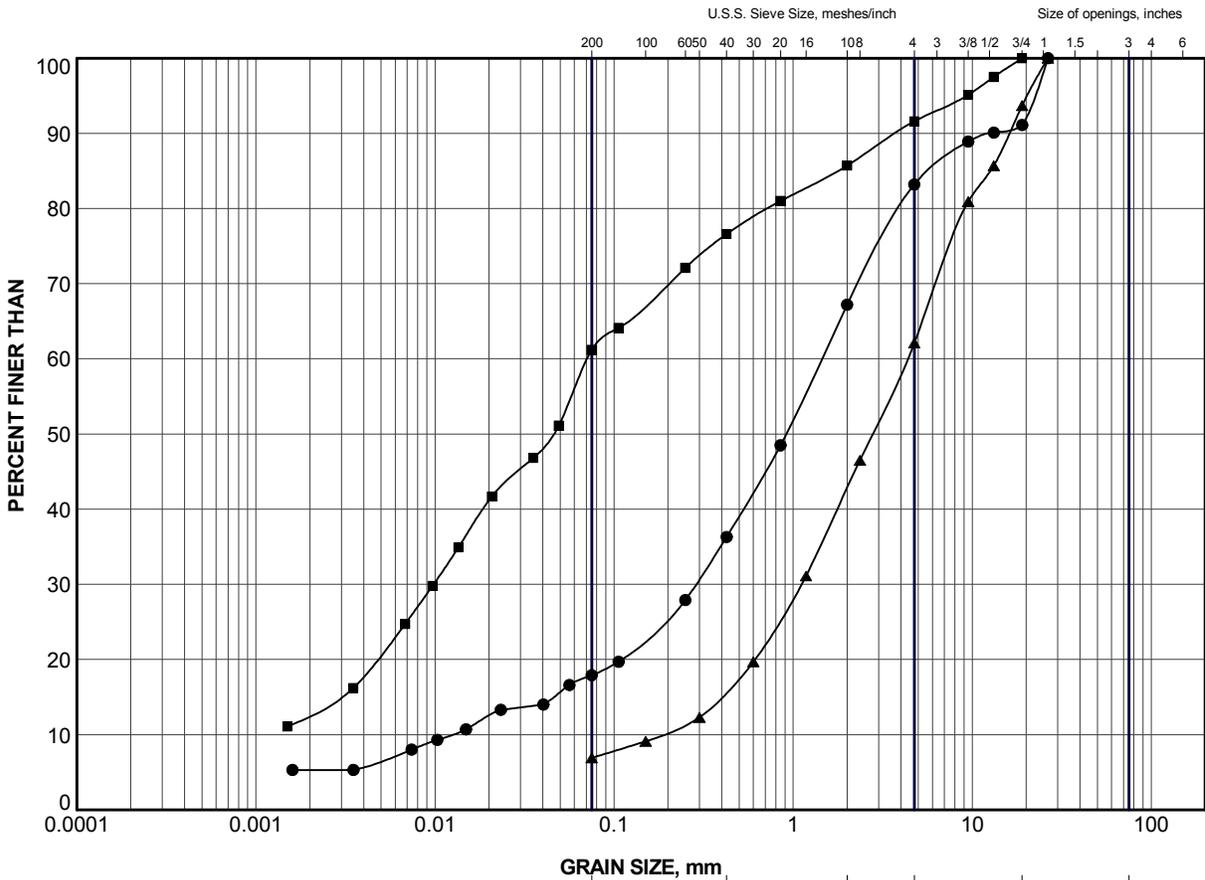
DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB



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

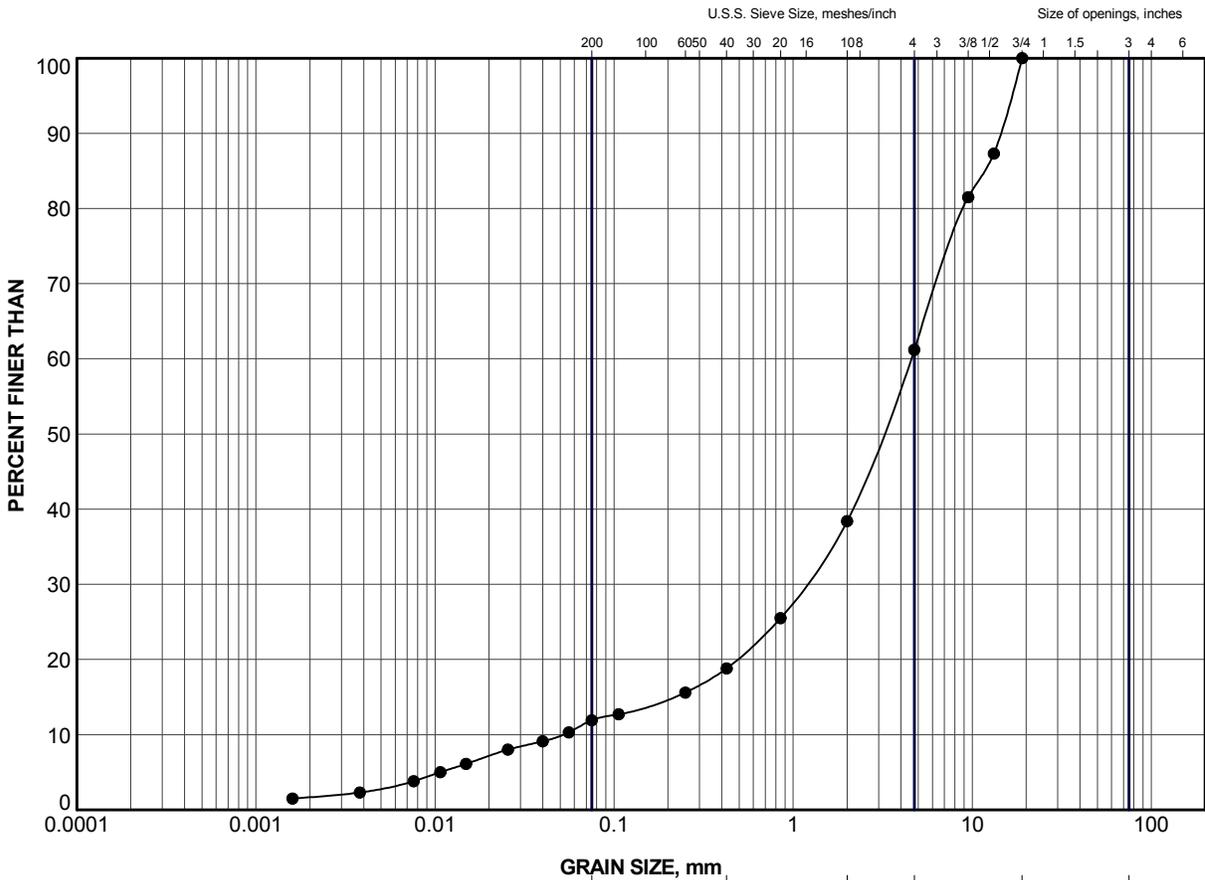
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NHF1	1	210.8
■	NHF2	3	209.2
▲	NHF3	6	206.9

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SILT and SAND to SAND and GRAVEL (FILL)				
PROJECT No.		11-1191-0008		FILE #11-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jan 2014	SCALE	N/A REV.
CHECK	AB	Jan 2014		
APPR	JMAC	Jan 2014	FIGURE C1	



SUD-MTO GSD (NEW) GLDR_LDN.GDT



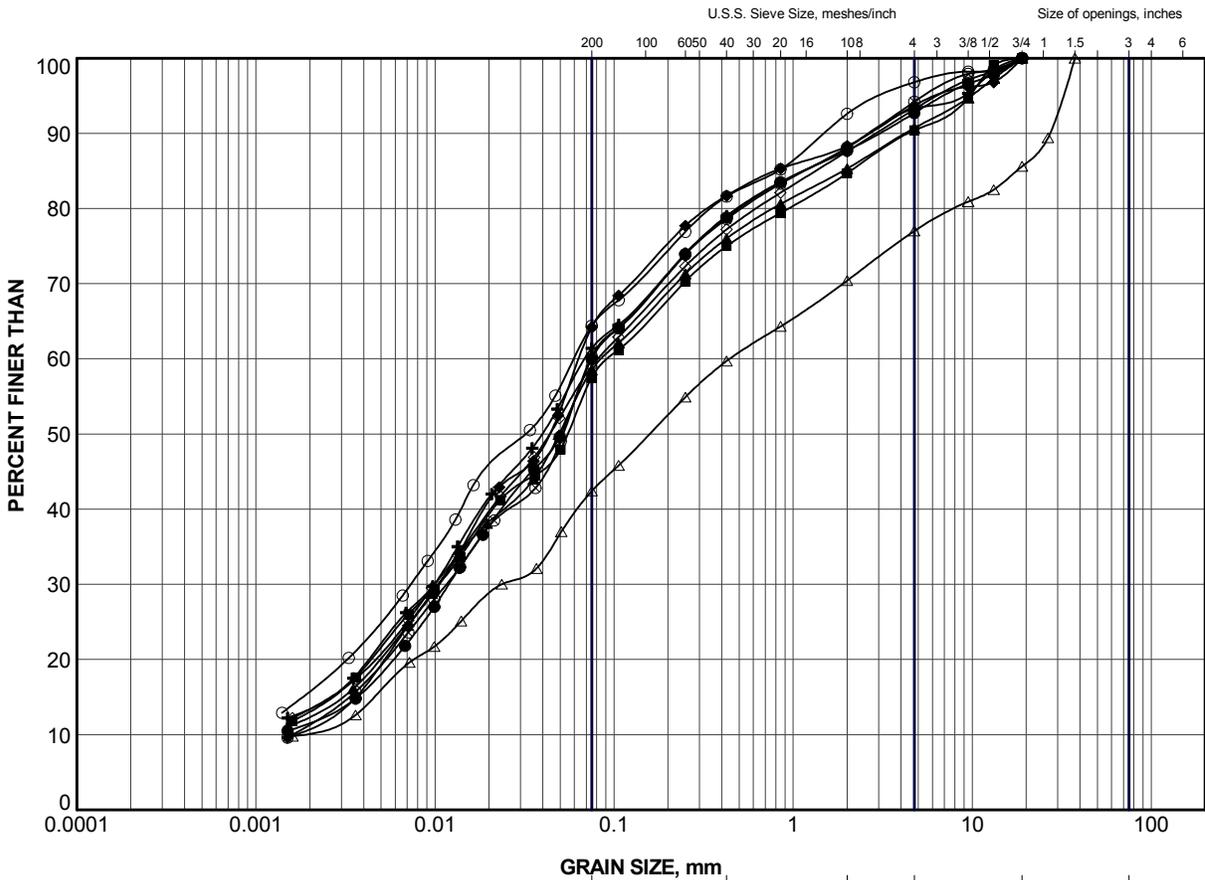
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NHF5	3	201.0

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE							
TITLE GRAIN SIZE DISTRIBUTION SAND and GRAVEL							
 Golder Associates SUDBURY, ONTARIO		PROJECT No.	11-1191-0008	FILE No-1191-0008 DETAIL.GPJ			
		DRAWN	JJL	Jan 2014	SCALE	N/A	REV.
		CHECK	AB	Jan 2014	FIGURE C2		
		APPR	JMAC	Jan 2014			

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

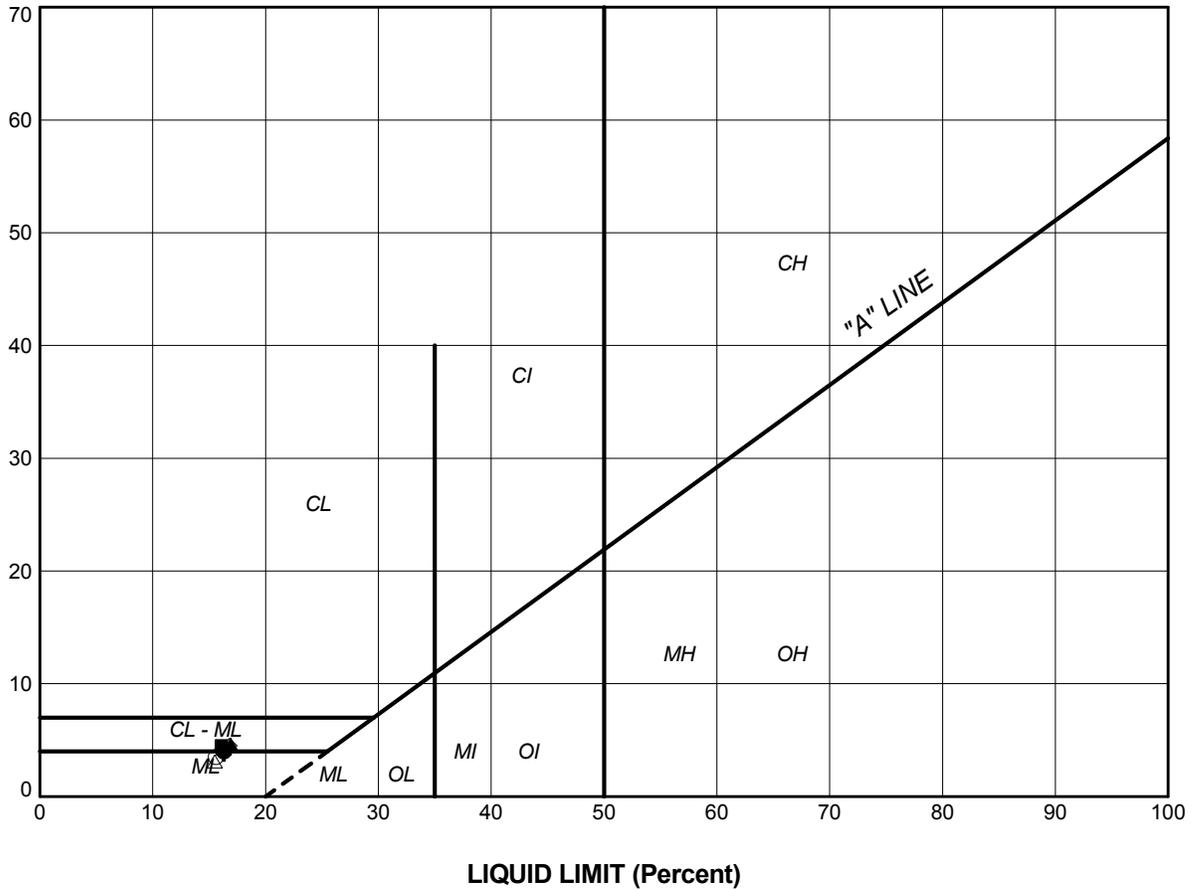
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NHF1	5	207.9
■	NHF1	10	201.8
▲	NHF1	14	195.7
+	NHF2	8	204.6
◆	NHF3	9	203.1
◇	NHF4	3	201.4
○	NHF4	8	197.6
△	NHF4	12	191.5
⊗	NHF5	5	199.5

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND (TILL)				
PROJECT No. 11-1191-0008		FILE No-1191-0008 DETAIL.GPJ		
DRAWN	J.J.L.	Jan 2014	SCALE	N/A
CHECK	A.B.	Jan 2014	REV.	
APPR	J.M.A.C.	Jan 2014	FIGURE C3	



PLASTICITY INDEX (Percent)



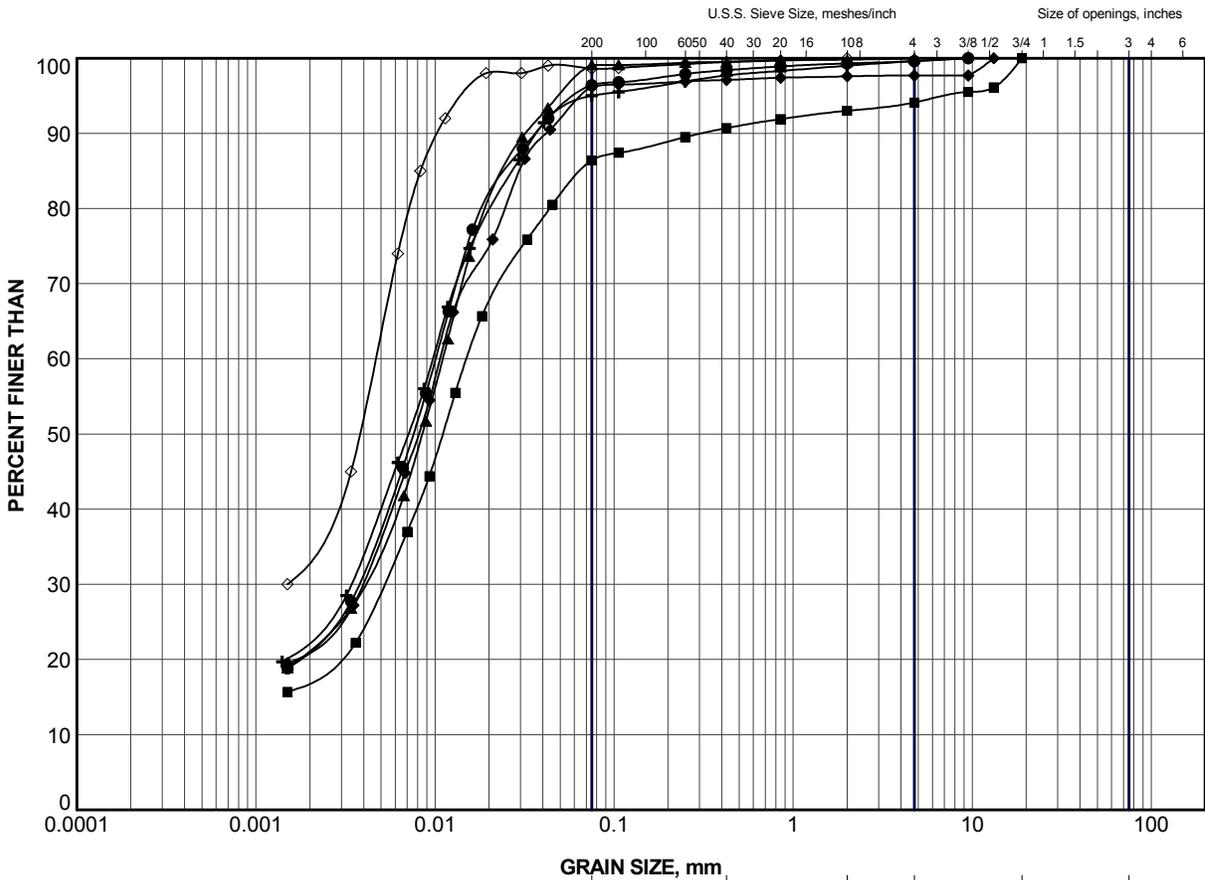
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NHF1	10	16.3	12.3	4.0
■	NHF1	14	16.1	11.6	4.5
▲	NHF2	8	16.9	12.3	4.6
+	NHF3	9	16.3	12.5	3.8
◆	NHF4	3	16.1	12.0	4.1
◇	NHF4	8	16.8	12.3	4.5
○	NHF4	12	15.6	12.1	3.5
△	NHF5	5	15.5	12.4	3.1

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE					PLASTICITY CHART SANDY SILT to SILT and SAND (TILL)				
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN J.J.L. Jan 2014			SCALE N/A	REV.
CHECK AB Jan 2014			APPR J.M.A.C. Jan 2014			FIGURE C4			
 Golder Associates SUDBURY, ONTARIO									



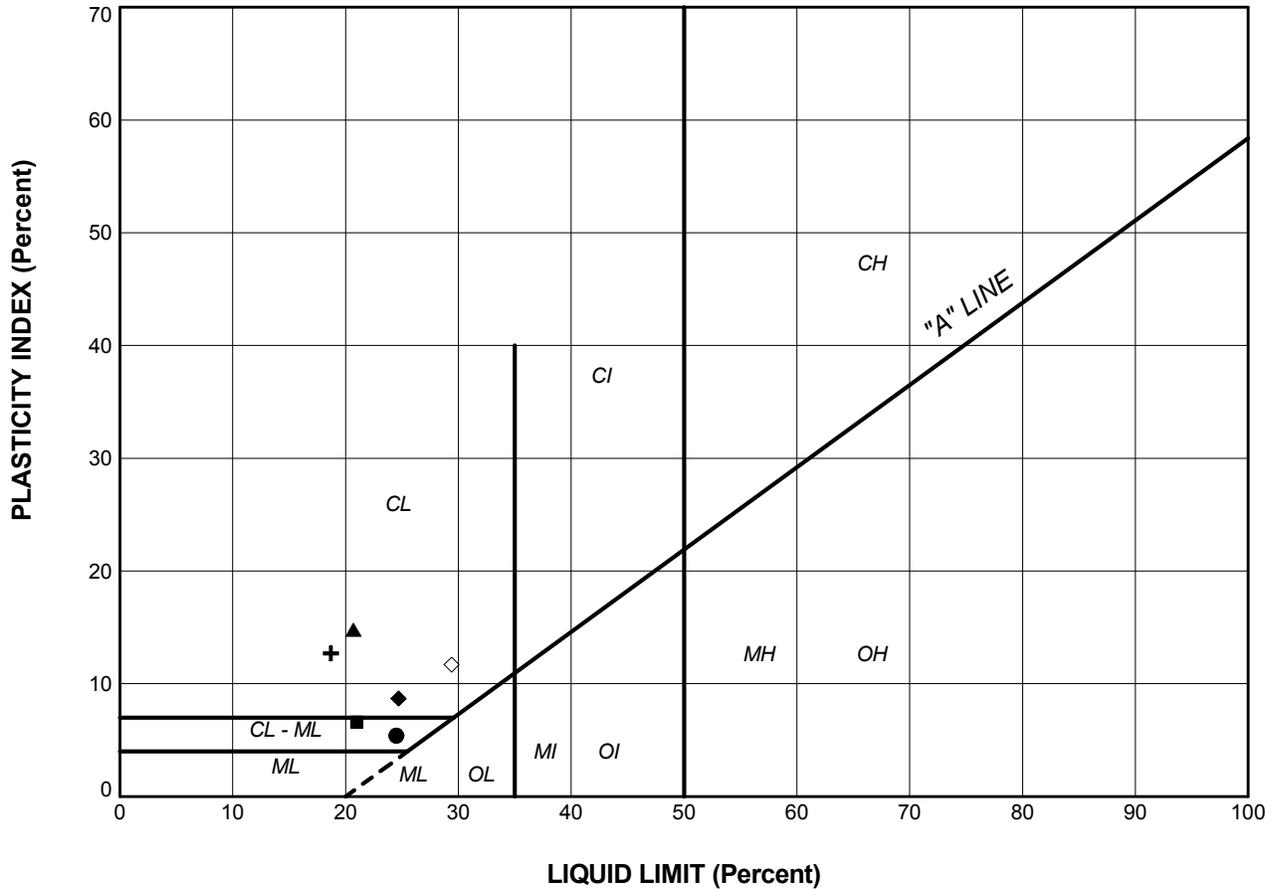
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NHF2	11	200.0
■	NHF2	14	195.5
▲	NHF3	11	200.0
+	NHF5	7	198.0
◆	NHF5	11	192.6
◇	NHF6	2	201.4

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE GRAIN SIZE DISTRIBUTION SILT to CLAYEY SILT					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ	
		DRAWN	JJL	Jan 2014	SCALE N/A
		CHECK	AB	Jan 2014	REV.
		APPR	JMAC	Jan 2014	
FIGURE C5					

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

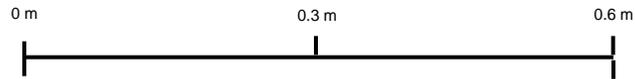
LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NHF2	11	24.5	19.1	5.4
■	NHF2	14	21.0	14.4	6.6
▲	NHF3	11	20.7	5.9	14.8
+	NHF5	7	18.7	6.0	12.7
◆	NHF5	11	24.7	16.0	8.7
◇	NHF6	2	29.4	17.7	11.7

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART SILT to CLAYEY SILT					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN JJJ Jan 2014			SCALE N/A		REV.
CHECK AB Jan 2014			APPR JMAC Jan 2014			FIGURE C6				
 Golder Associates SUDBURY, ONTARIO										



Borehole NHF6
Elevation 200.3 m to 197.3 m



PROJECT		HIGHWAY 11 NAGAGAMI RIVER BRIDGE	
TITLE		ROCK CORE PHOTOGRAPH	
	PROJECT No.	11-1191-0008	FILE No. ----
	DESIGN	AC NOV 2013	SCALE AS SHOWN REV.
	CADD	--	
	CHECK	AB NOV 2013	
	REVIEW		
			FIGURE C7



APPENDIX D

Deep Cut – STA 21+050 to 21+150

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

CONT No.
 GWP No. 5307-04-00

HIGHWAY 11
 NAGAGAMI RIVER BRIDGE
 DEEP CUT - STA 21+050 TO 21+150
 SOIL STRATA

SHEET



Golder Associates Ltd.
 SUDBURY, ONTARIO, CANADA

LEGEND

- Borehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
NDC1	225.1	5515039.2	266237.4
NDC2	224.8	5515000.3	266274.5

NOTES

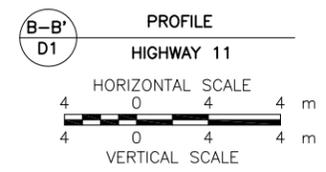
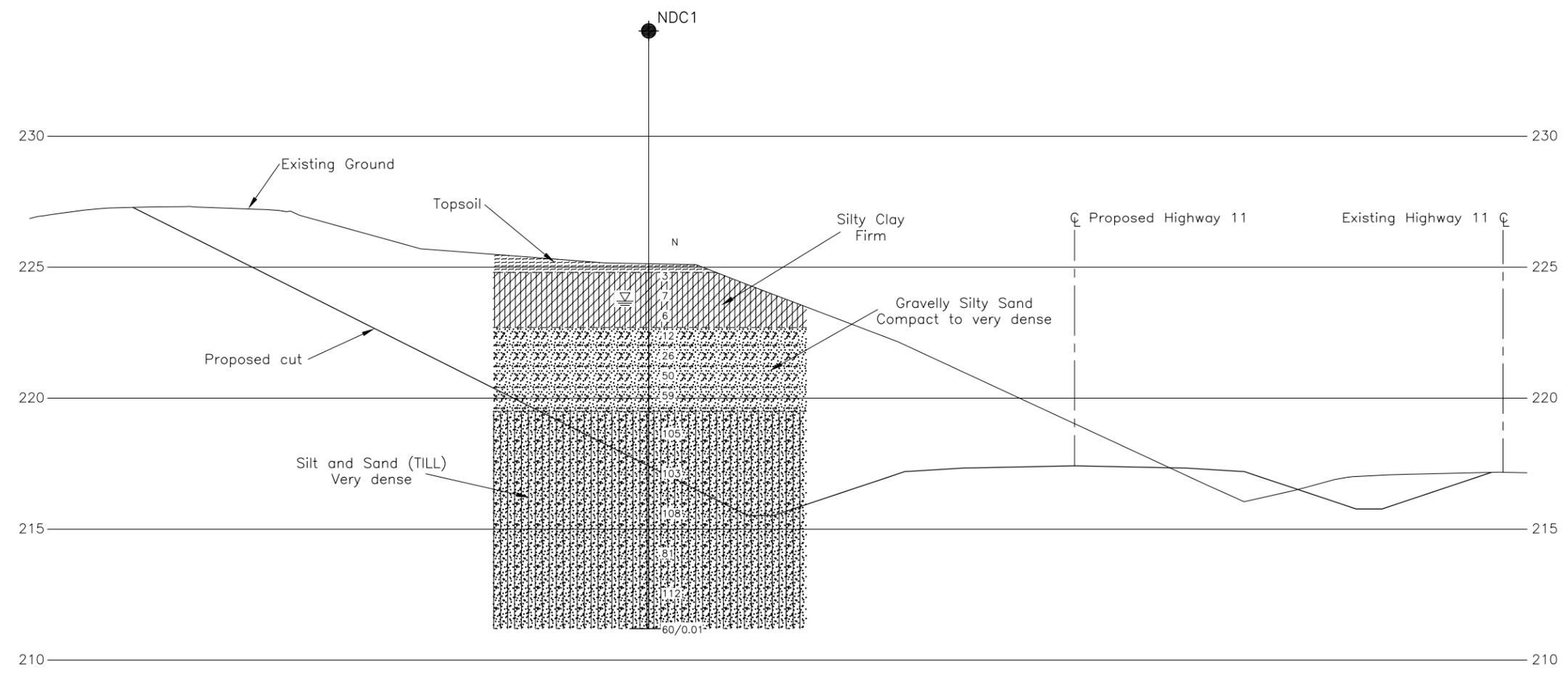
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 LEA, drawing file nos. 8960-Nag-S01.dwg received on May 28, 2013 and x8960 Nagagami Base.dwg, received Sept 25, 2013. Profile provided by LEA, drawing file no. x8960 Naga Prof.dwg, received Feb 5, 2014.



NO.	DATE	BY	REVISION
Geocres No. 42F-28			
HWY. 11	PROJECT NO. 11-1191-0008		DIST.
SUBM'D. AC	CHKD.	DATE: SEP 2014	SITE:
DRAWN: TB	CHKD. AB	APPD. JMAC	DWG. D2



RECORD OF BOREHOLE No NDC1 2 OF 2 **METRIC**

PROJECT 11-1191-0008

G.W.P. 5307-04-00 LOCATION N 5515039.2; E 266237.4 ORIGINATED BY EHS

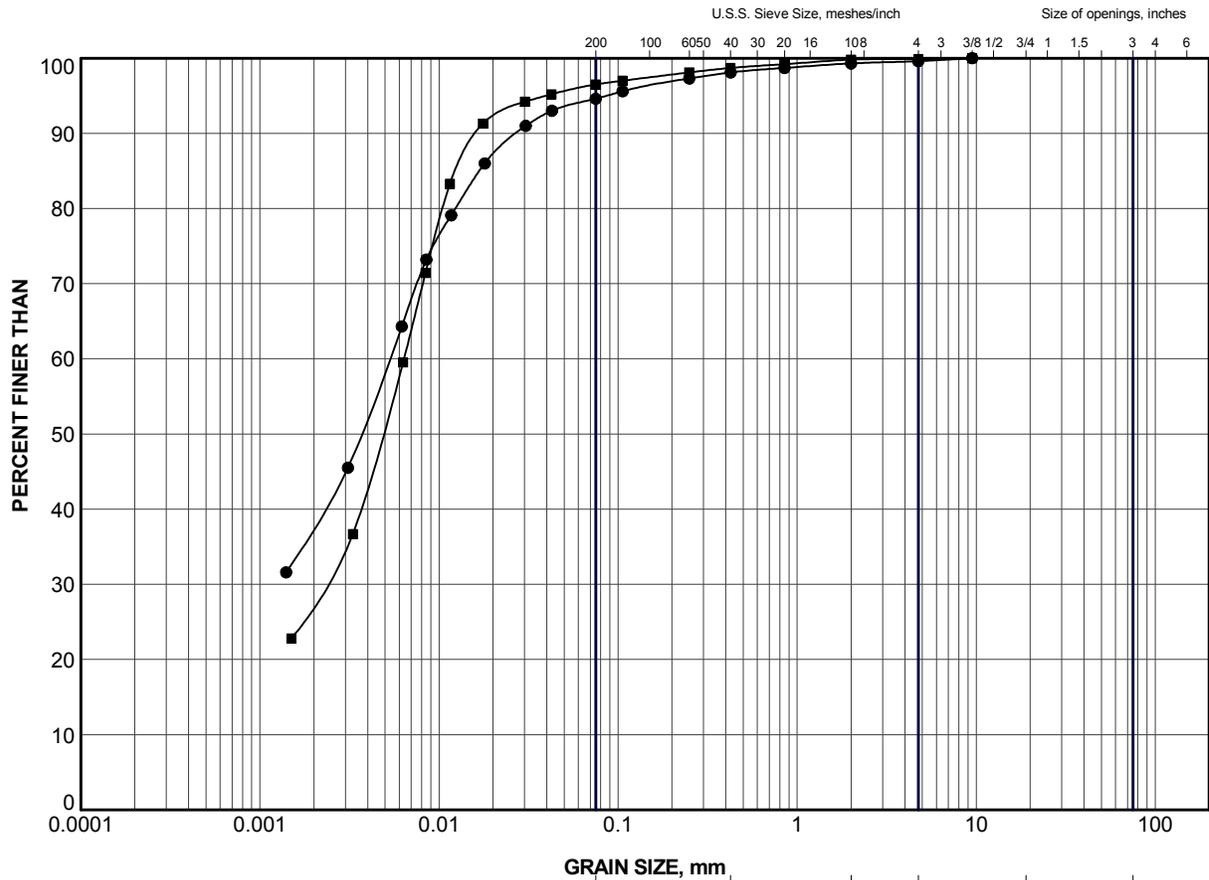
DIST HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AC

DATUM GEODETIC DATE August 22, 2013 CHECKED BY AB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	-- CONTINUED FROM PREVIOUS PAGE --															
	END OF BOREHOLE SPLIT SPOON REFUSAL Note: 1. Water level at a depth of 1.4 m below ground surface (Elev. 223.7 m) upon completion of drilling.															

SUD-MTO 001 11-1191-0008 DETAIL.GPJ CAL-MISS.GDT 08/01/14 DATA INPUT:

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



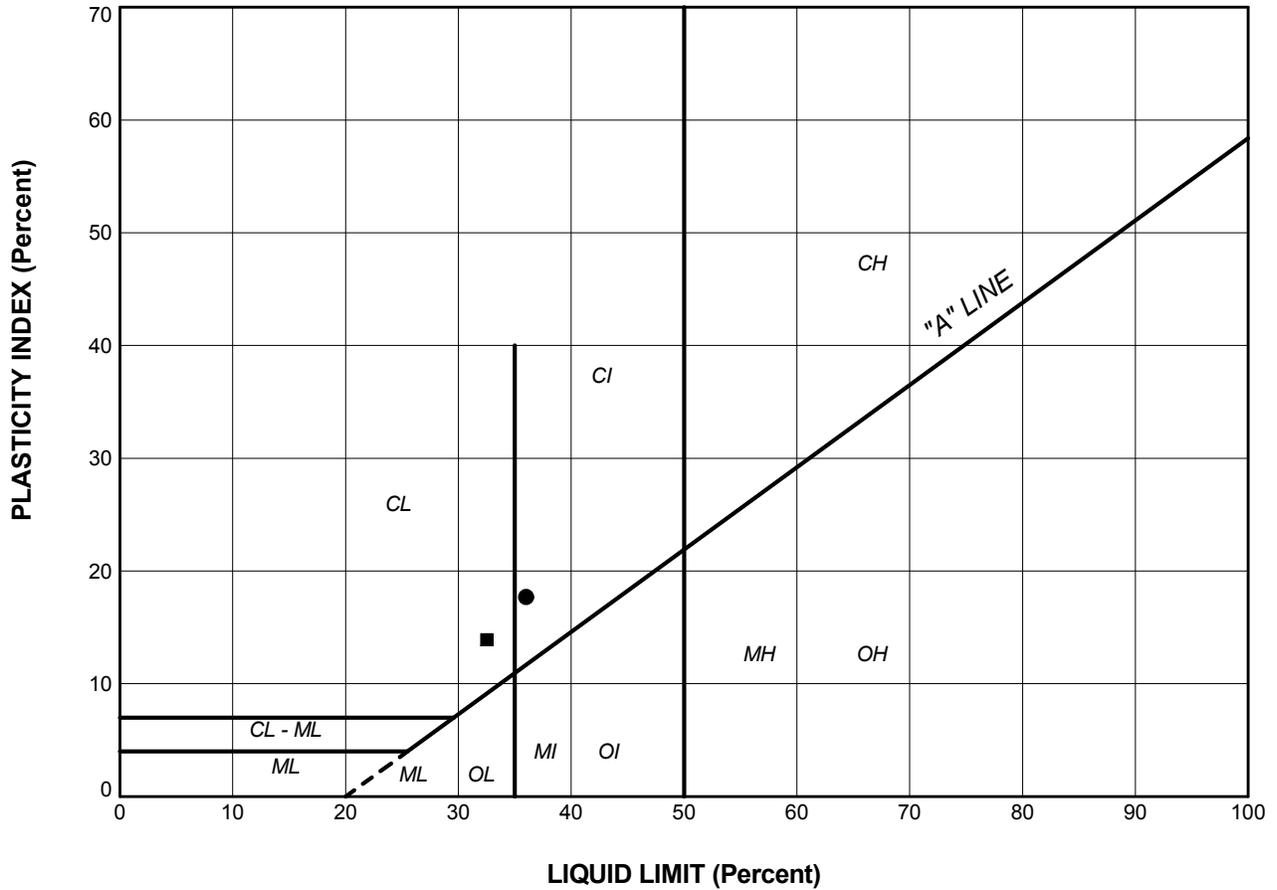
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NDC1	2	224.0
■	NDC2	2	223.7

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE GRAIN SIZE DISTRIBUTION CLAYEY SILT to SILTY CLAY					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ	
		DRAWN	JJL	Jan 2014	SCALE N/A
		CHECK	AB	Jan 2014	REV.
		APPR	JMAC	Jan 2014	FIGURE D1

SUD-MTO GSD (NEW) GLDR_LDN.GDT



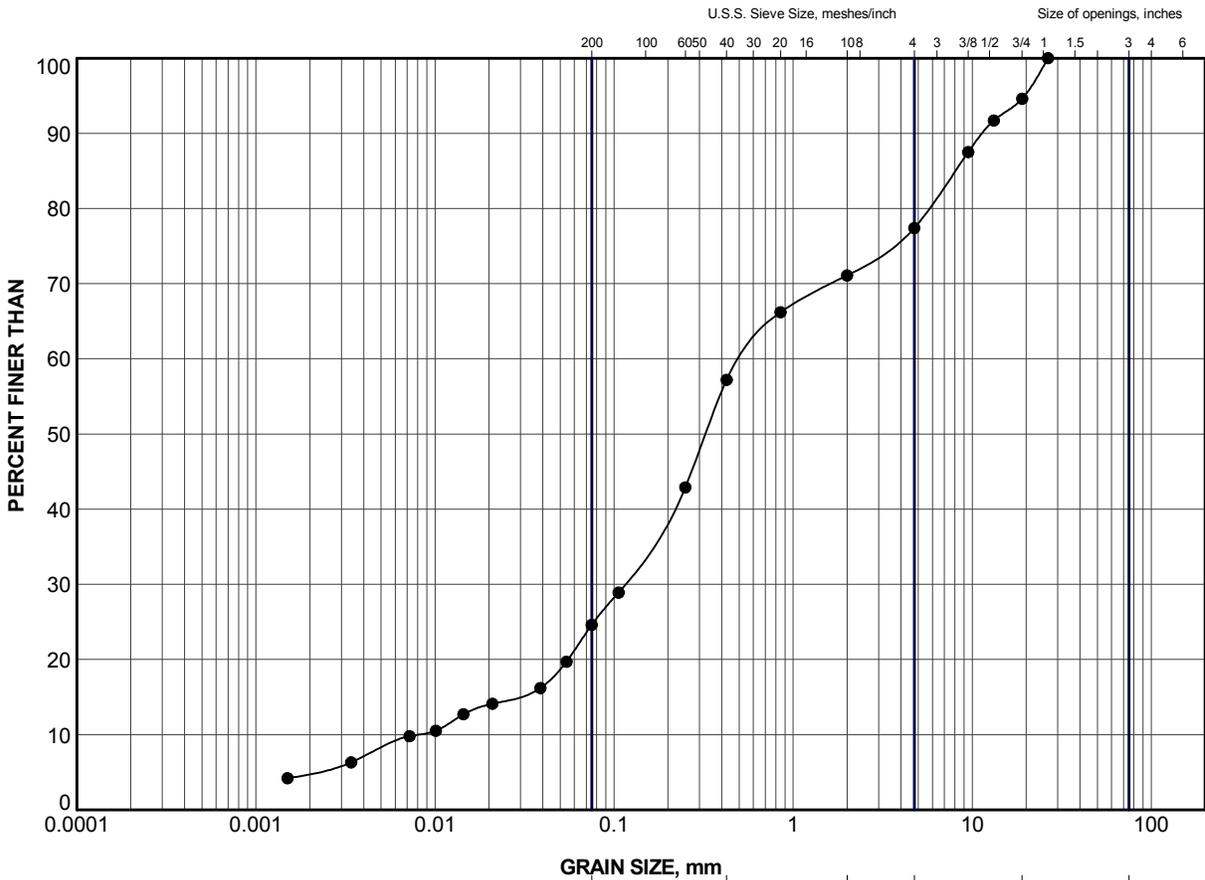
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NDC1	2	36.0	18.3	17.7
■	NDC2	2	32.5	18.6	13.9

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART CLAYEY SILT to SILTY CLAY					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN J.J.L. Jan 2014			SCALE N/A		REV.
CHECK AB Jan 2014			APPR JMAC Jan 2014			FIGURE D2				
 Golder Associates SUDBURY, ONTARIO										



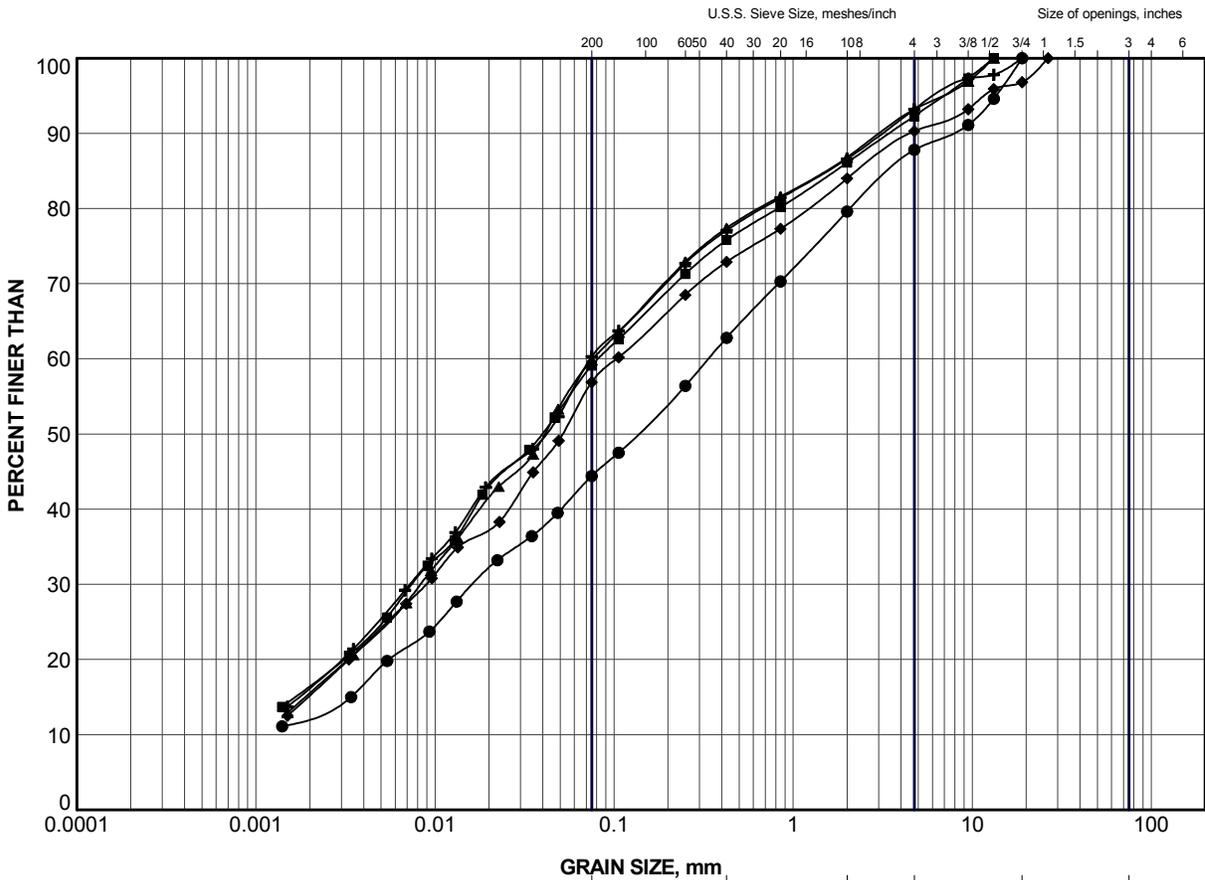
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NDC1	6	221.0

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE				
TITLE GRAIN SIZE DISTRIBUTION GRAVELLY SILTY SAND				
PROJECT No.		11-1191-0008		FILE #11-1191-0008 DETAIL.GPJ
DRAWN	JJL	Jan 2014	SCALE	N/A REV.
CHECK	AB	Jan 2014		
APPR	JMAC	Jan 2014	FIGURE D3	





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

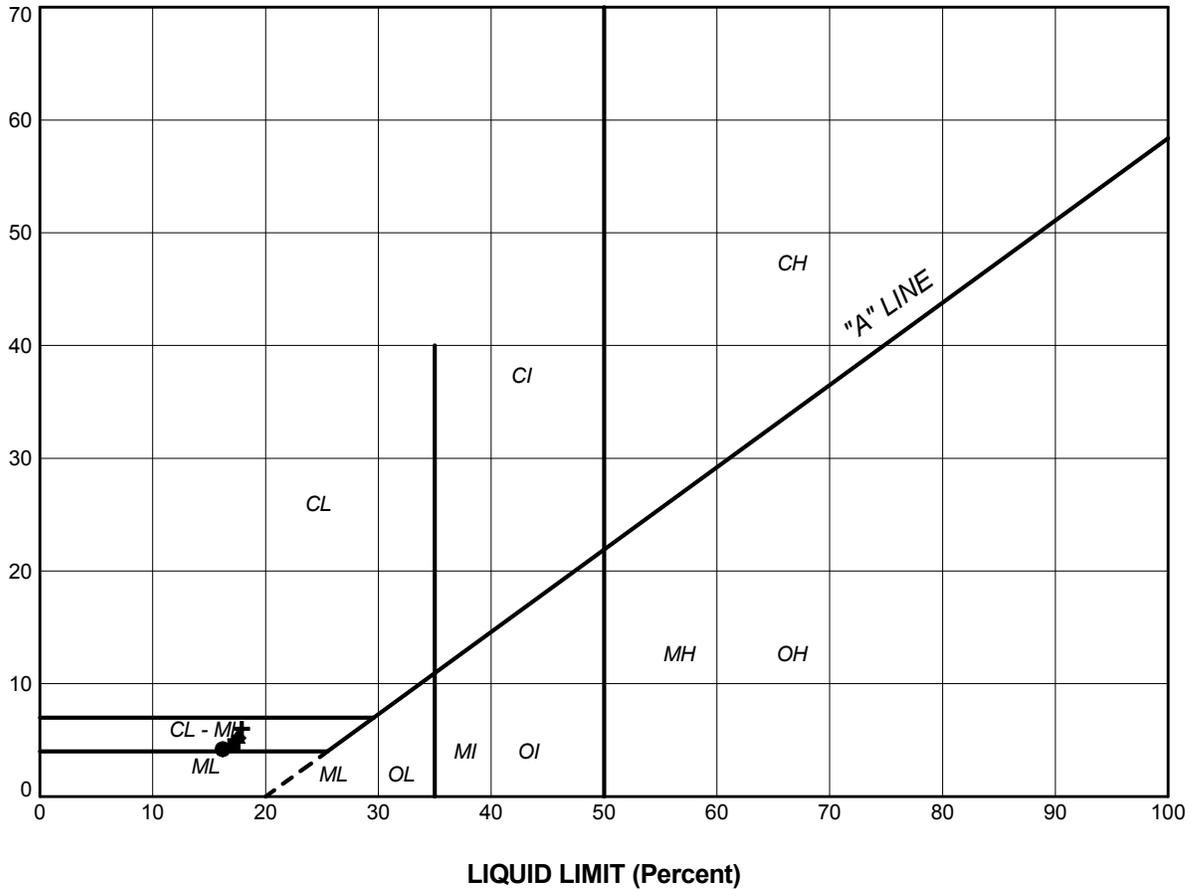
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NDC1	8	218.8
■	NDC1	12	212.7
▲	NDC2	6	220.8
+	NDC2	9	217.0
◆	NDC2	11	213.9

PROJECT HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE GRAIN SIZE DISTRIBUTION SILT and SAND (TILL)					
 Golder Associates SUDBURY, ONTARIO		PROJECT No. 11-1191-0008		FILE No. 1191-0008 DETAIL.GPJ	
		DRAWN	JJL	Jan 2014	SCALE N/A
		CHECK	AB	Jan 2014	REV.
		APPR	JMAC	Jan 2014	FIGURE D4

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NDC1	8	16.2	12.0	4.2
■	NDC1	12	17.2	12.6	4.6
▲	NDC2	6	17.5	12.2	5.3
+	NDC2	9	17.9	11.9	6.0
◆	NDC2	11	17.6	12.4	5.2

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE					
TITLE					PLASTICITY CHART SILT and SAND (TILL)					
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN			SCALE		REV.
DRAWN			JLL		Jan 2014		N/A			
CHECK			AB		Jan 2014					
APPR			JMAC		Jan 2014					
 Golder Associates SUDBURY, ONTARIO					FIGURE D5					



APPENDIX E

Culvert Extension – STA 20+070

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No 1	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515505.1; E 265379.6</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>HW Casing, NW Casing and NQ Coring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>April 3, 2014</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
233.2	GROUND SURFACE																
0.0 232.9	ASPHALT						233										
0.3	Sand and gravel to gravelly sand, trace silt (FILL) Brown Frozen																
232.4																	
0.9	STYROFOAM (75 mm) Gravelly sand to sand, trace to some silt (FILL) Compact Brown Moist		1	SS	23		232										
			2	SS	24												
230.8							231										
2.4	CLAYEY SILT, trace sand Stiff Brown Moist		3	SS	7												1 10 54 35
229.8							230										
3.4	SILT and SAND, trace to some clay, trace gravel (TILL) Very dense Brown to grey at 4.7 m depth. Moist		4	SS	74/0.1												
			5	SS	112/0.2		229										
							228										
							227										2 37 48 13
226.5			6	SS	50/0.1												
6.7	END OF BOREHOLE Note: 1. Borehole dry upon completion of drilling.																

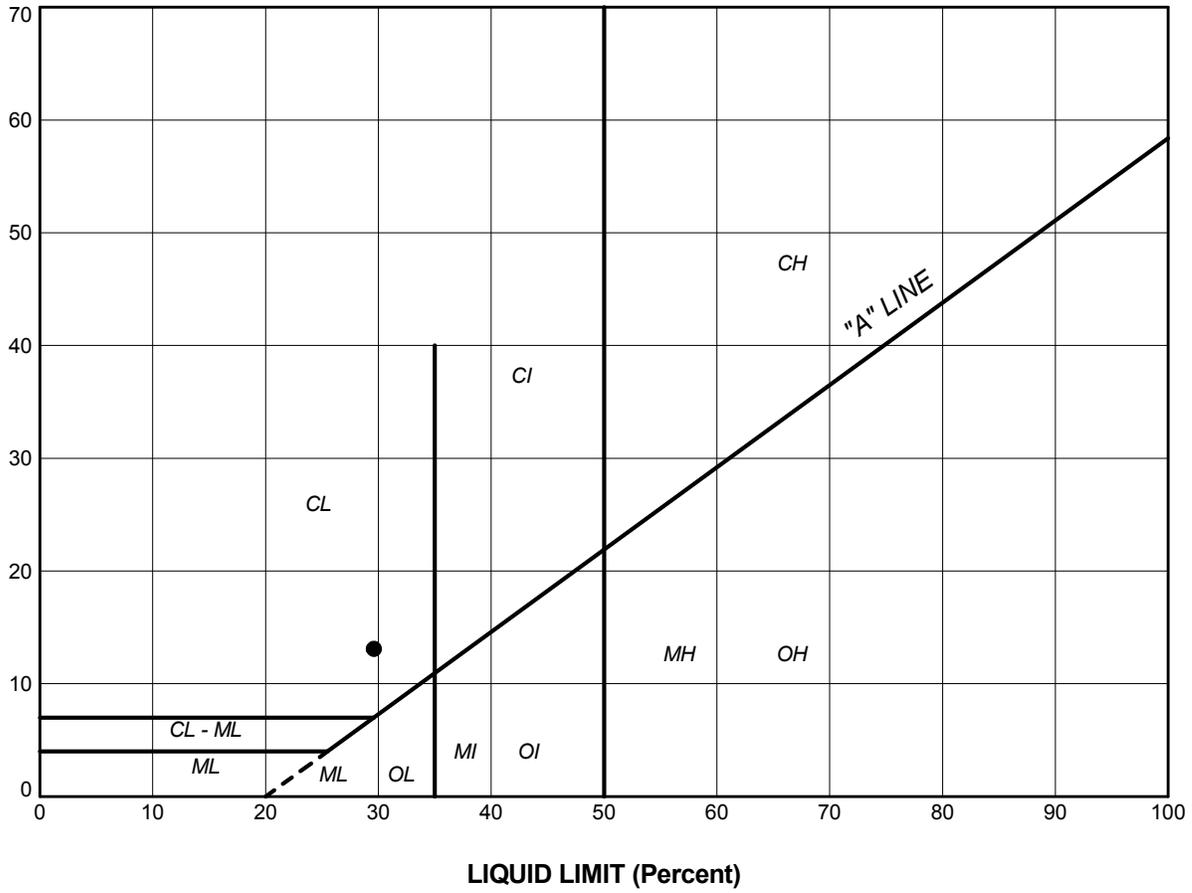
SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 10/09/14 DATA INPUT:

PROJECT <u>11-1191-0008</u>	RECORD OF BOREHOLE No 2	1 OF 1 METRIC
G.W.P. <u>5307-04-00</u>	LOCATION <u>N 5515513.4; E 265379.2</u>	ORIGINATED BY <u>EHS</u>
DIST <u> </u> HWY <u>11</u>	BOREHOLE TYPE <u>NW Casing and Wash Boring</u>	COMPILED BY <u>AC</u>
DATUM <u>GEODETIC</u>	DATE <u>April 7, 2014</u>	CHECKED BY <u>AB</u>

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
230.7	GROUND SURFACE																
0.0	Sand, to some gravel, trace organics (FILL) Grey Wet		1	SS	6												
0.2	Sandy SILT to SILT and SAND, trace to some gravel, trace clay (TILL) Loose to very dense Grey Moist		2	SS	64		230										10 25 52 13
			3	SS	45		229										
			4	SS	70/0.05		228										
			5	SS	80/0.05		227										3 35 47 15
			6	SS	40/0.02		226										
225.9			7	SS	50/0.1		226										
4.8	END OF BOREHOLE Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 11-1191-0008 DETAIL.GPJ GAL-MISS.GDT 30/07/14 DATA INPUT:

PLASTICITY INDEX (Percent)



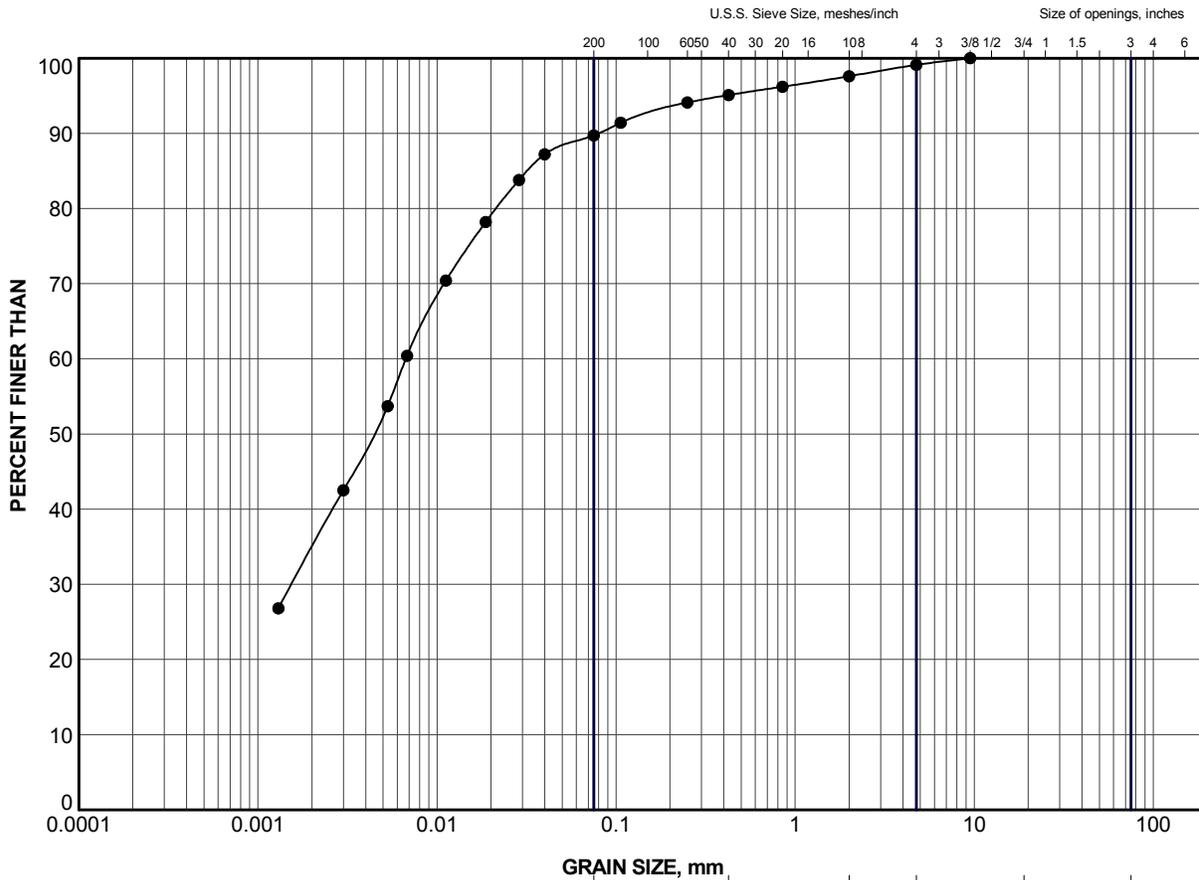
SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	1	3	29.6	16.5	13.1

PROJECT					HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+070				
TITLE					PLASTICITY CHART CLAYEY SILT				
PROJECT No. 11-1191-0008			FILE No. 11-1191-0008 DETAIL.GPJ		DRAWN TB Apr 2014			SCALE N/A REV.	
CHECK AB Apr 2014			APPR JMAC Apr 2014		FIGURE E1				
 Golder Associates SUDBURY, ONTARIO									

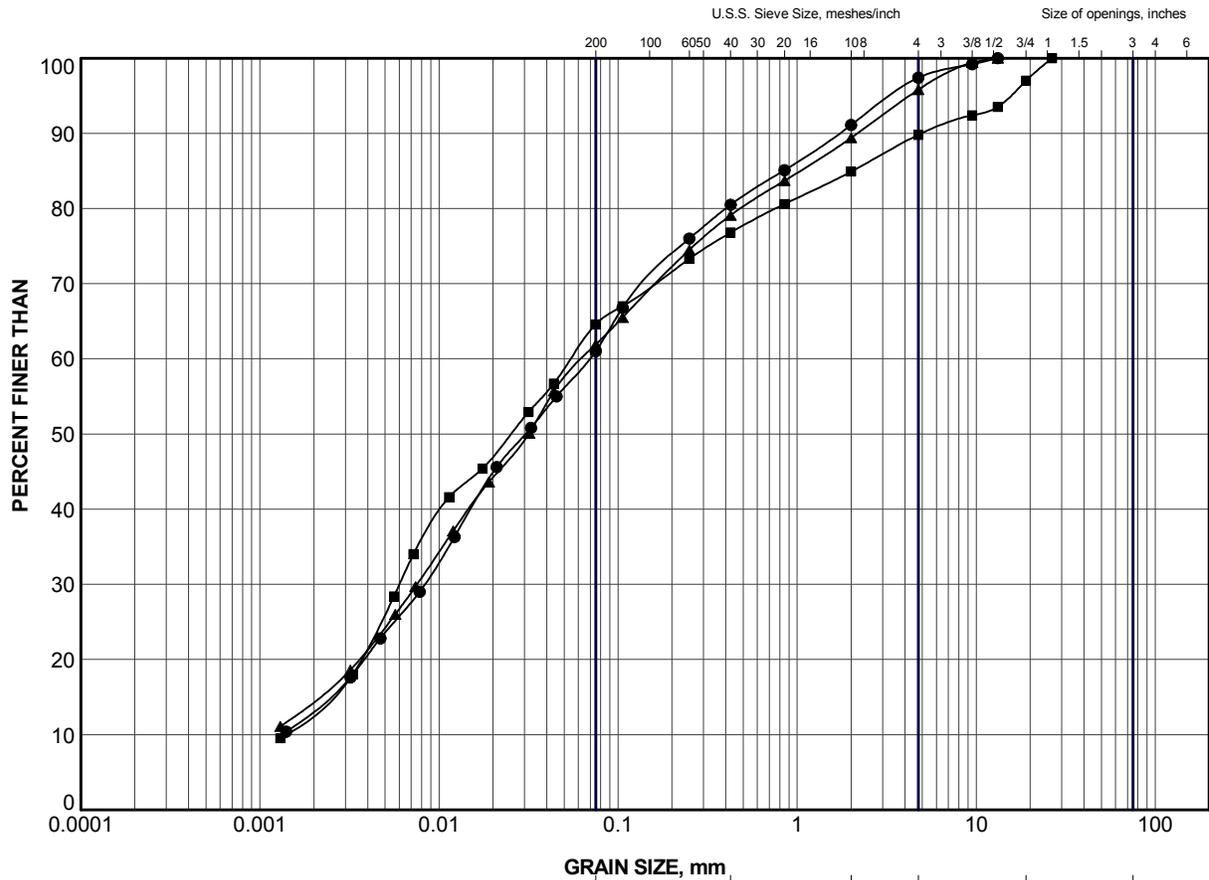


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	3	230.6

PROJECT	HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+070				
TITLE	GRAIN SIZE DISTRIBUTION CLAYEY SILT				
 Golder Associates SUDBURY, ONTARIO	PROJECT No.	11-1191-0008	FILE No.	1191-0008 DETAIL.GPJ	
	DRAWN	TB	Apr 2014	SCALE	N/A
	CHECK	AB	Apr 2014	REV.	
	APPR	JMAC	Apr 2014	FIGURE E2	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

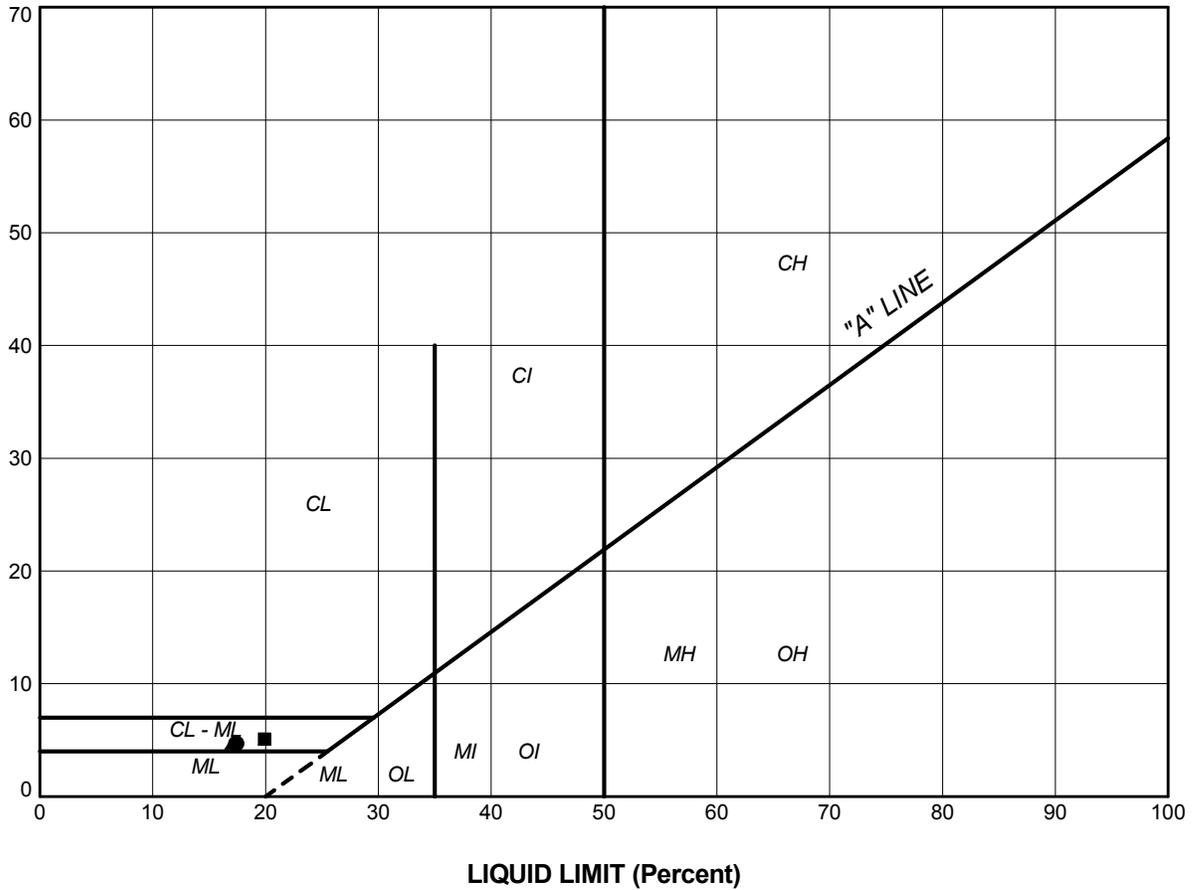
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	6	226.9
■	2	2	229.7
▲	2	5	227.5

PROJECT	HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+070					
TITLE	GRAIN SIZE DISTRIBUTION SANDY SILT to SILT and SAND (TILL)					
 Golder Associates <small>SUDBURY, ONTARIO</small>	PROJECT No. 11-1191-0008		FILE #11-1191-0008 DETAIL.GPJ			
	DRAWN	JJL	Jul 2014	SCALE	N/A	REV.
	CHECK	AB	Jul 2014			
	APPR	JMAC	Jul 2014	FIGURE E3		

SUD-MTO GSD (NEW) GLDR_LDN.GDT

PLASTICITY INDEX (Percent)



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	1	6	17.4	12.7	4.7
■	2	2	19.9	14.8	5.1
▲	2	5	17.1	12.3	4.8

PROJECT		HIGHWAY 11 NAGAGAMI RIVER BRIDGE CULVERT EXTENSION - STA 20+070		
TITLE		PLASTICITY CHART SANDY SILT to SILT and SAND (TILL)		
PROJECT No.		11-1191-0008	FILE No. 11-1191-0008 DETAIL.GPJ	
DRAWN	JJL	Jul 2014	SCALE	N/A
CHECK	AB	Jul 2014	REV.	
APPR	JMAC	Jul 2014	FIGURE E4	



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