REPORT

October 31, 2013

FOUNDATION INVESTIGATION REPORT

REPLACEMENT OF VALENTINE RIVER BRIDGE - SITE NO. 39W-010
HIGHWAY 11, TOWNSHIP OF STODDART, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5150-05-00

Submitted to:
LEA Consulting Ltd.
625 Cochrane Drive, Suite 900
Markham, Ontario
L3R 9R9

GEOCRES NO.: 42G-48

Report Number: 11-1191-0008-5
Distribution:

1 PDF Copy - Ministry of Transportation, Ontario, North Bay, ON (Northeastern Region)
1 PDF Copy - Ministry of Transportation, Ontario, Downsview, ON (Foundations Section)
1 Copy - LEA Consulting Ltd., Markham, ON
1 PDF Copy - Golder Associates Ltd., Sudbury, ON

Golder Associates

Table of Contents

PART A

FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF VALENTINE RIVER BRIDGE
HIGHWAY 11, SITE NO. 39W-010
TOWNSHIP OF STODDART, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5150-05-00

October 31, 2013
Report No. 11-1191-0008-5

Golder Associates

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 Valentine River Bridge (Site No. 39W-010), located on Highway 11 west of Hearst in the Township of Stoddart, Ontario.

The purpose of this investigation is to establish the subsurface conditions at the location of the proposed replacement structure, including the associated approach embankments, by borehole drilling, rock coring, in situ testing and laboratory testing on selected soil and rock core samples. The location of the investigation area is shown in plan on Drawing 1.

2.0 SITE DESCRIPTION

The Valentine River Bridge site is situated in the Township of Stoddart on Highway 11, approximately 22 km west of the west junction of Highway 11 and Highway 583 in Hearst, Ontario. The surrounding land is generally flat but slopes down towards the riverbanks along the east and west sides of the river. The riverbanks adjacent to the existing bridge area are vegetated with grass and small shrubs, with moderate tree-covered terrain beyond the highway right-of-way limits. The river flows in a northerly direction and is about 35 m wide at the existing bridge location.

The existing structure is a two-lane, thirteen-span, timber bridge with a stressed laminated timber sub-struction with an asphalt surfaced deck and was constructed in 1956. The structure is founded on timber crib abutments and the abutments and piers are supported on timber piles founded at unknown depths. The existing ground surface along the existing structure alignment is about Elevation 239.5 m. The existing embankment front slopes are formed at approximately 1.1 horizontal to 1 vertical (1.1H:1V) and the east and west side slopes adjacent to the abutments are currently at about 1H:1V. The existing approach embankment side slopes are generally flatter than about 2H:1V. There are no visible signs of approach embankment instability or settlement.

The water level shown on the General Arrangement (GA) drawing is Elevation 235.3 m (from November 2011). The water level measured in Valentine River during the field investigations, which took place in October 2012 and July 2013 varied between Elevation 235.3 m and Elevation 234.9 m, respectively. The high water level is reported to be at Elevation 236.1 m. The existing highway embankment grade is approximately 3.7 m above the surrounding ground surface adjacent to the river.

3.0 INVESTIGATION PROCEDURES

The fieldwork for this subsurface investigation was carried out between October 16 to 18, 2012, and June 6 to July 6, 2013, at which time twelve boreholes (Boreholes VS1 to VS12) were advanced using a CME 55 track-mounted drill rig supplied and operated by Landcore Drilling Inc. of Sudbury, Ontario. Boreholes VS1, VS3 and VS4 were advanced at the west abutment, Boreholes VS2, VS5 and VS6 were advanced at the east abutment, VS7 to VS10 were advanced north of the proposed alignment for potential roadway protection, and VS11 and VS12 were advanced at the west and east approaches, respectively. The locations of the boreholes are shown on Drawing 1.

The boreholes were advanced using 108 mm inner diameter hollow-stem augers, as well as NW casing and NQ size core barrel where coring through boulders/bedrock was required. Soil samples were obtained at intervals of depth of about 0.75 m to 1.5 m, using a 50 mm outer diameter split-spoon sampler operated by an automatic hammer on the drill rig, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Field vane shear tests were carried out in cohesive soils for determination of undrained shear strengths (ASTM D2573, Field Vane Strength Sear Test) using MTO Standard 'N' size vanes.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and a standpipe piezometer was installed in Borehole VS2 to permit monitoring of the groundwater level. The piezometer consists of a 50 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 partially backfilled with bentonite pellets to create a seal then backfilled to near surface with cuttings from the boreholes and bentonite. A seal of bentonite was placed to ground surface. The piezometer installation details and water level readings are indicated on the Record of Borehole sheets contained in Appendix A. The open boreholes were backfilled upon completion of drilling and the piezometer was decommissioned in accordance with Ontario Regulation 903 Wells (as amended).

The fieldwork was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, directed the drilling and sampling and logged the boreholes. The soil 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. In addition, uniaxial compressive strength (UCS) testing was carried out on specimens of the recovered bedrock core. The results of the laboratory testing are shown on the Record of Borehole and Drillhole sheets in Appendix A and on the figures contained in Appendix B.

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, 2006)[1]. The degree of weathering of the bedrock samples (i.e., fresh to completely 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 (ISRM[2]) 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 results of the analytical testing are summarized in Table B1 in Appendix B.

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. The borehole locations (referenced to the MTM NAD83 co-ordinate system), ground surface elevations (referenced to Geodetic datum), and borehole depths are shown on Drawings 1 and 2, presented on the Record of Borehole sheets in Appendix A 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.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
VS1	5511323.7	307587.9	236.6	13.1
VS2	5511309.6	307639.2	235.8	12.0
VS3	5511324.2	307585.9	236.5	19.4
VS4	5511313.5	307577.2	236.5	16.1
VS5	5511316.1	307635.4	235.8	12.6
VS6	5511304.7	307630.5	236.1	14.2
VS7	5511330.2	307581.7	237.6	10.3
VS8	5511326.6	307593.6	237.4	14.0
VS9	5511321.6	307635.1	235.5	10.8
VS10	5511316.9	307654.3	239.4	15.5
VS11	5511330.7	307561.2	237.0	10.7
VS12	5511305.0	307657.3	236.5	10.5

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on NOEGTS[3] Mapping, the subsoils in the vicinity of the Valentine 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

For the detailed subsurface investigation, twelve boreholes were advanced in the vicinity of Valentine River Bridge. The borehole locations, ground surface elevations and interpreted stratigraphic conditions at the site are shown on Drawings 1 and 2. The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole sheets, contained in Appendix A. The results of geotechnical laboratory testing are presented in Appendix B. The results of the in situ field tests (i.e., SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record

[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.

of Borehole sheets, and on the interpreted stratigraphic profile on Drawings 1 and 2, are inferred from non-continuous sampling and observation of drilling progress and soil cutting 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.

In summary, the subsoil conditions encountered at the site consist of fill and/or peat/organic clay/topsoil, underlain by deposits of soft to firm clayey silt to silty clay, firm clayey silt to silt, very loose to compact sandy silt to sand and silt, and hard sandy clayey silt to clayey silt with sand till. A more detailed description of the soil deposits encountered in these boreholes is provided in Sections 4.2.1 to 4.2.7.

4.2.1 Fill

Fill consisting of sand to gravelly sand and/or clayey silt to clay, was encountered from ground surface in Boreholes VS7 and VS8 and underlying a 180 mm thick layer of asphalt in Borehole VS10. The total thickness of the fill ranges from 1.1 m to 3.0 m, and was encountered between Elevation 239.2 m and 237.4 m.

The granular fill consists of moist, brown gravelly sand to sand containing trace to some silt. The SPT 'N'-values measured within the granular fill portion of the deposit range from 4 blows to 10 blows per 0.3 m of penetration indicating a loose relative density.

The clayey silt to clay fill was moist, brown containing trace to some sand. The SPT 'N'-values measured within the clayey silt to clay fill range from 7 blows to 12 blows per 0.3 m of penetration suggesting a firm to stiff consistency.

The results of grain size distribution testing completed on one selected sample of the sand fill is shown on Figure B1 in Appendix B.

Atterberg limits testing carried out on two samples of the clayey silt to clay fill gave liquid limits of about 33 per cent and 51 per cent, plastic limits of about 18 per cent and 20 per cent and plasticity indices of about15 per cent to 31 per cent. The results of the Atterberg limits tests are shown in the Plasticity chart on Figure B2 in Appendix B, and indicate the fill material to be clayey silt of low plasticity to clay of high plasticity.

The natural moisture content measured on one sample of the granular fill is about 4 per cent. The natural moisture content measured on two samples of the clayey silt to clay fill is about 19 per cent and 24 per cent.

4.2.2 Peat/Organic Clay/Topsoil

A deposit containing black, fibrous to amorphous peat or topsoil was encountered from ground surface or underlying the fill deposit in all Boreholes except VS8. The top of this organic layer was encountered between Elevation 237.0 m and 235.5 m, and the thickness of the deposit ranges between 0.2 m and 2.2 m. In Borehole VS9, the amorphous peat transitioned to organic clay at a depth of 0.7 m below ground surface (Elevation 234.8 m).

The SPT 'N'-values measured within the organic deposit range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

Atterberg limits testing carried out on one sample of the organic clay gave a liquid limit of about 59 per cent, a plastic limit of about 31 percent and a plasticity index of about 28 per cent. The result of the Atterberg limits test is shown in the plasticity chart on Figure B3 in Appendix B and is below the A-line.

The organic content measured on one sample of the organic clay is about 4 per cent.

The natural moisture content measured on one sample of the organic clay is about 38 per cent.

4.2.3 Clayey Silt to Silty Clay

A deposit of brown to grey clayey silt to silty clay was encountered below the peat/organic clay/topsoil in all Boreholes except VS9. The surface of this deposit was encountered between Elevation 236.5 m and 235.2 m and the thickness of the deposit ranges from 0.8 m to 3.5 m.

The SPT 'N'-values measured within the clayey silt to silty clay deposit range from 0 blows (weight of hammer) to 10 blows per 0.3 m of penetration. In situ field vane tests carried out in this deposit measured undrained shear strengths ranging from 24 kPa to 45 kPa and calculated sensitivities ranging from 1 to 4. The in situ vane test results, together with the SPT 'N'-values, suggest that the clayey silt to silty clay deposit generally has a soft to firm consistency.

The results of grain size distribution tests completed on three samples of the clayey silt to silty clay are shown on Figure B4.

Atterberg limits testing carried out on twelve samples of the clayey silt to silty clay deposit yielded liquid limits ranging from about 27 per cent to 41 per cent, plastic limits ranging from about 14 per cent to 20 per cent and plasticity indices ranging from about 9 per cent to 23 per cent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure B5 and indicate that the deposit is classified as a clayey silt of low plasticity to silty clay of intermediate plasticity.

The natural moisture content measured on fifteen samples of the clayey silt to silty clay deposit ranges from about 19 per cent to 31 per cent.

4.2.4 Clayey Silt to Silt

A deposit of clayey silt to silt, trace to some sand, trace to some gravel, was encountered underlying the clayey silt to silty clay deposit in Boreholes VS1 to VS3, VS5 to VS8, VS10 and VS12 and underlying the organic clay in Borehole VS9. The surface of the clayey silt to silt deposit was encountered between Elevation 235.2 m and 232.1 m and the thickness of the deposit ranges from 0.7 m to 3.2 m.

The SPT 'N'-values measured within the clayey silt to silt deposit range from 1 blow to 9 blows per 0.3 m of penetration. In situ field vane tests carried out in this deposit measured undrained shear strengths ranging from 43 kPa to 48 kPa and calculated sensitivities ranging from 3 to 5. The in situ vane test results, together with the SPT 'N'-values, suggest that the clayey silt to silt deposit generally has a soft to firm consistency.

The results of grain size distribution testing completed on nine selected samples of the clayey silt to silt deposit are shown on Figure B6.

Atterberg limits testing carried out on ten samples of the clayey silt to silt deposit yielded liquid limits ranging from about 17 per cent to 23 per cent, plastic limits ranging from about 12 per cent and 17 per cent and plasticity indices ranging from about 4 per cent to 10 per cent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure B7 and indicate that the deposit consists of clayey silt of low plasticity to silt of slight plasticity.

The natural moisture content measured on ten samples of the clayey silt to silt deposit ranges from about 11 per cent and 31 per cent.

4.2.5 Sandy Silt to Sand and Silt

A deposit of grey sandy silt to sand and silt was encountered underlying the cohesive deposits in all of the boreholes. The surface of this deposit was encountered between Elevation 234.6 m and 230.2 m and the thickness of the deposit ranges from 2.7 m to 5.7 m.

SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 26 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The results of grain size distribution testing completed on nine samples of the sandy silt to sand and silt deposit are shown on Figure B8.

The natural moisture content measured on ten samples of the sandy silt to silty sand deposit ranges from about 13 per cent to 23 per cent.

4.2.6 Sandy Clayey Silt to Clayey Silt with Sand (Till)

A deposit of grey sandy clayey silt to clayey silt with sand till containing trace to some gravel was encountered below the sandy silt to sand and silt deposit in all of the boreholes. The surface of this deposit was encountered between Elevation 230.4 m and 226.8 m and the thickness of the deposit ranges from 1.6 m and 7.4 m where the deposit was fully penetrated. Boreholes VS1, VS2 and VS5 to VS12 were terminated within this deposit.

Difficult auger and/or casing advancement was noted throughout this deposit and coring techniques were required to advance some boreholes at various depths throughout this deposit, resulting in sample recoveries ranging from 0 per cent to 100 per cent. A granite boulder, 1.0 m thick, was encountered at a depth of 12.1 m below ground surface (Elevation 224.5 m) in Borehole VS1, and cored through. In Borehole VS8, a 0.4 m thick granite boulder was encountered and cored through at a depth of 9.7 m below ground surface (Elevation 227.7 m).

The measured SPT 'N'-values within the till deposit range from 36 blows to greater than 289 blows per 0.3 m of penetration with several split spoons that did not penetrate the full 0.3 m. The SPT 'N'-values together with the requirement for coring through boulders in the deposit indicate that the till deposit has a hard consistency.

The results of grain size distribution testing completed on eleven samples of the till deposit are shown on Figure B9.

Atterberg limits testing carried out on six samples of the sandy clayey silt to clayey silt with sand deposit yielded liquid limits ranging from about 13 per cent to 18 per cent, plastic limits ranging from about 6 per cent and

13 per cent and plasticity indices ranging from about 4 per cent to 9 per cent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure B10 and indicate that the fines portion of the till deposit consists of clayey silt of low plasticity to silt of slight plasticity.

The natural moisture content measured on eleven samples of the till deposit ranges from about 8 per cent to 11 per cent.

4.2.7 Bedrock

The bedrock surface was encountered in Boreholes VS3 and VS4 at depths of 16.1 m and 12.9 m below ground surface (Elevation 220.4 m and 223.6 m), and was cored for a length of 3.3 m and 3.2 m, respectively. The retrieved bedrock is described as fine grained, slightly to moderately weathered grey gneiss. Photographs of the retrieved bedrock core samples are shown on Figure B10.

The Total Core Recovery (TCR) in both Boreholes is 100 per cent. The Rock Quality Designation (RQD) measured ranges from about 77 per cent to 100 per cent, indicating a rock mass of good to excellent quality (CFEM, 2006).

Laboratory UCS testing was carried out on two core samples of the bedrock. The UCS values are presented on the Record of Drillhole sheets in Appendix A and summarized below and indicate that the bedrock is strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa) (ISRM, 1985).

Borehole	Elevation (m)	UCS (MPa)
VS3	219.0	75
VS4	223.2	126

4.2.8 Groundwater Conditions

Groundwater levels were measured in the open boreholes during and upon completion of drilling and a piezometer was installed in Borehole VS2, sealed within the sand and silt deposit, to monitor the groundwater level. The measured groundwater levels in the open boreholes and piezometer are presented below.

Borehole	Installation	Time and/or Date	Groundwater Depth (m)	Groundwater Elevation (m)
VS1	Open Borehole	October 17, 2012	1.4	235.2
VS2	Open Borehole	October 18, 2012	1.1	234.7
	Piezometer	December 6, 2012	0.4	235.4
	Piezometer	July 5, 2013	0.9	234.9
VS3	Open Borehole	June 8, 2013	-0.6[1]	237.1
VS4	Open Borehole	June 10, 2013	5.0	231.5
VS5	Open Borehole	July 4, 2013	1.1	234.7
VS6	Open Borehole	June 6, 2013	1.3	234.8

Borehole	Installation	Time and/or Date	Groundwater Depth (m)	Groundwater Elevation (m)
VS7	Open Borehole	June 7, 2013	1.8	235.8
VS8	Open Borehole	June 17, 2013	2.4	235.0
VS9	Open Borehole	June 27, 2013	6.1	229.4
VS10	Open Borehole	June 26, 2013	4.9	234.5
VS11	Open Borehole	June 6, 2013	2.9	234.1
VS12	Open Borehole	June 27, 2013	8.8	227.7

Note:
1. Water level above ground surface upon completion of drilling.

Groundwater levels 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 and river water levels in the area are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt. The water level in Valentine River was measured at Elevation 235.3 m on October 2012 and at Elevation 234.9 m in July 2013, which is near that of the groundwater level measured in the piezometer.

5.0 CLOSURE

The field drilling program was supervised by Mr. Indulis Dumpis and Mr. Ed Savard. This report was prepared by Mr. Adam Core, E.I.T. and by Mr. Evan Childerhose, P.Eng. The technical aspects were reviewed by Ms. Sarah Coyne, P.Eng., Associate. Messrs. Fintan Heffernan, P.Eng., and Jorge Costa, P.Eng., Principal, Designated MTO Foundations Contacts, conducted an independent quality control review of this report.

Report Signature Page

GOLDER ASSOCIATES LTD.

Evan Childerhose, P.Eng.
Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
S.E.M. COYNE
90471921
10/31/13
PROVINCE OF ONTARIO

Sarah E.M. Coyne, P.Eng.
Senior Geotechnical Engineer, Associate

LICENSED PROFESSIONAL ENGINEER
M. A. COSTA
10/31/13
PROVINCE OF ONTARIO

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

AC/EC/SEMC/FJH/JMAC//kp

http://capws.golder.com/sites/capws2/p111910008mtosixbridgesnearhearst/reports/reports/5valentine river/2c final detail report/11-1191-0008-5 rpt 13oct31 final fidr valentine river.docx

MINISTRY OF TRANSPORTATION, ONTARIO

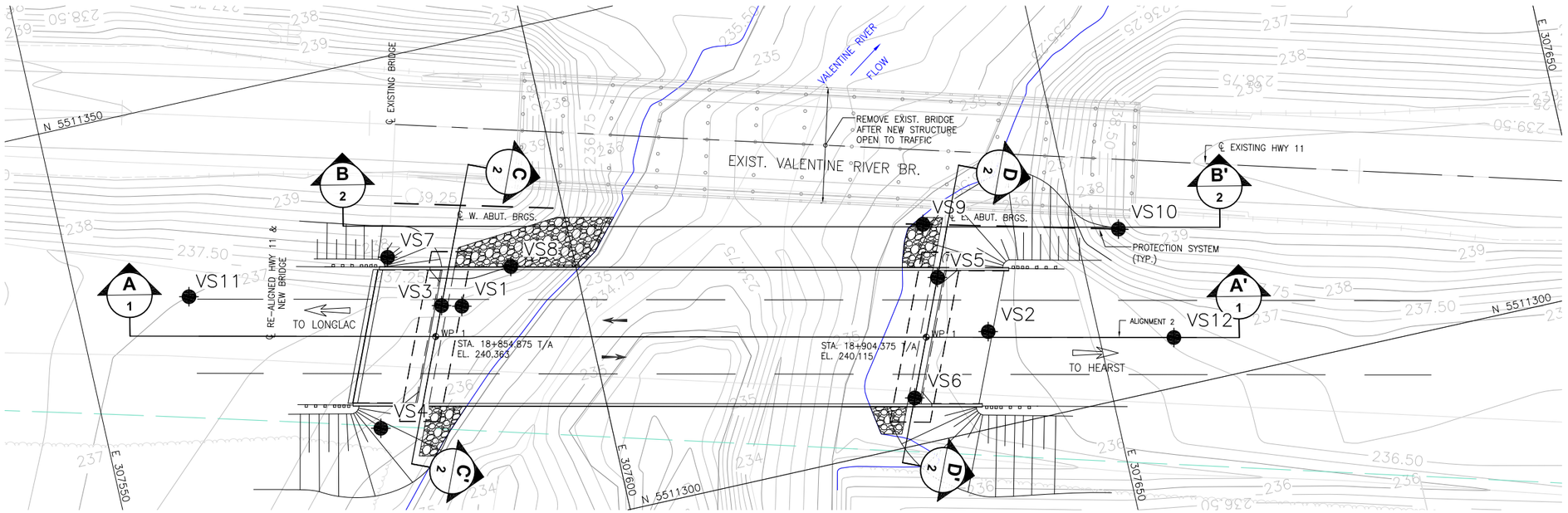
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5150-05-00

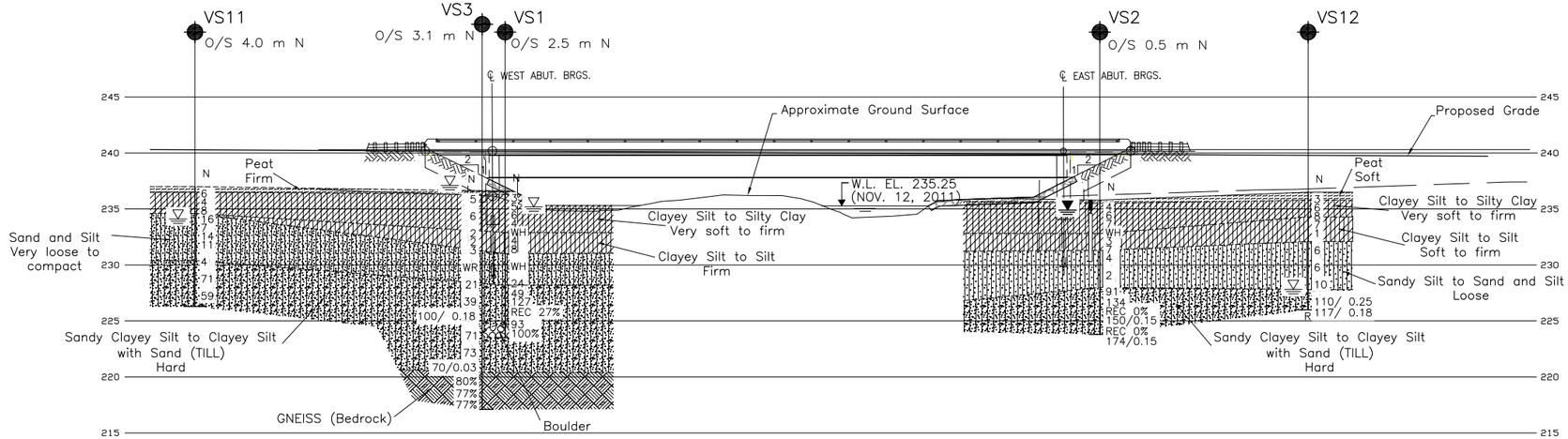
SHEET

HIGHWAY 11
VALENTINE RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA

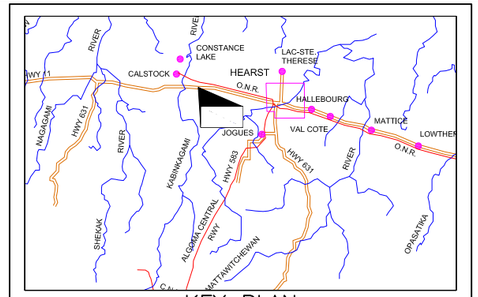


PLAN
SCALE
5 0 5 10 m



A-A'
1
CENTERLINE PROFILE
HIGHWAY 11

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



KEY PLAN
SCALE
20 0 20 km

LEGEND

●	Borehole
▮	Seal
▯	Piezometer
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
REC	Recovery
100%	Rock Quality Designation (RQD)
▽	WL upon completion of drilling
▼	WL in piezometer, measured on July 5, 2013
R	Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
VS1	236.6	5511323.7	307587.9
VS2	235.8	5511309.6	307639.2
VS3	236.5	5511324.2	307585.9
VS4	236.5	5511313.5	307577.2
VS5	235.8	5511316.1	307635.4
VS6	236.1	5511304.7	307630.5
VS7	237.6	5511330.2	307581.7
VS8	237.4	5511326.6	307593.6
VS9	235.5	5511321.6	307635.1
VS10	239.4	5511316.9	307654.3
VS11	237.0	5511330.7	307561.2
VS12	236.5	5511305.0	307657.3

REFERENCE
Base plans provided in digital format by LEA Consulting Ltd., drawing file no. 8960-VAL-S01(Ehx-40).dwg, received May. 30, 2013 and Inroads-X-Sections.dwg, received August 21, 2013.

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.

LICENSED PROFESSIONAL ENGINEER S.E.M. COYNE 90471921 OCT 31, 2013 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA OCT 31, 2013 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 42G-48

HWY. 11	PROJECT NO. 11-1191-0008		DIST.
SUBM'D. EC	CHKD.	DATE: OCT 2013	SITE: 39W-010
DRAWN: TB	CHKD. SEMC	APPD. JMAC	DWG. 1

PLOT DATE: October 31, 2013
FILENAME: \\golder.gds\GA\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0008 @ Bridges Hearst\3- Evelyn and Valentine\Detail_Valentine\\11191I0008A001 Va.Det.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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

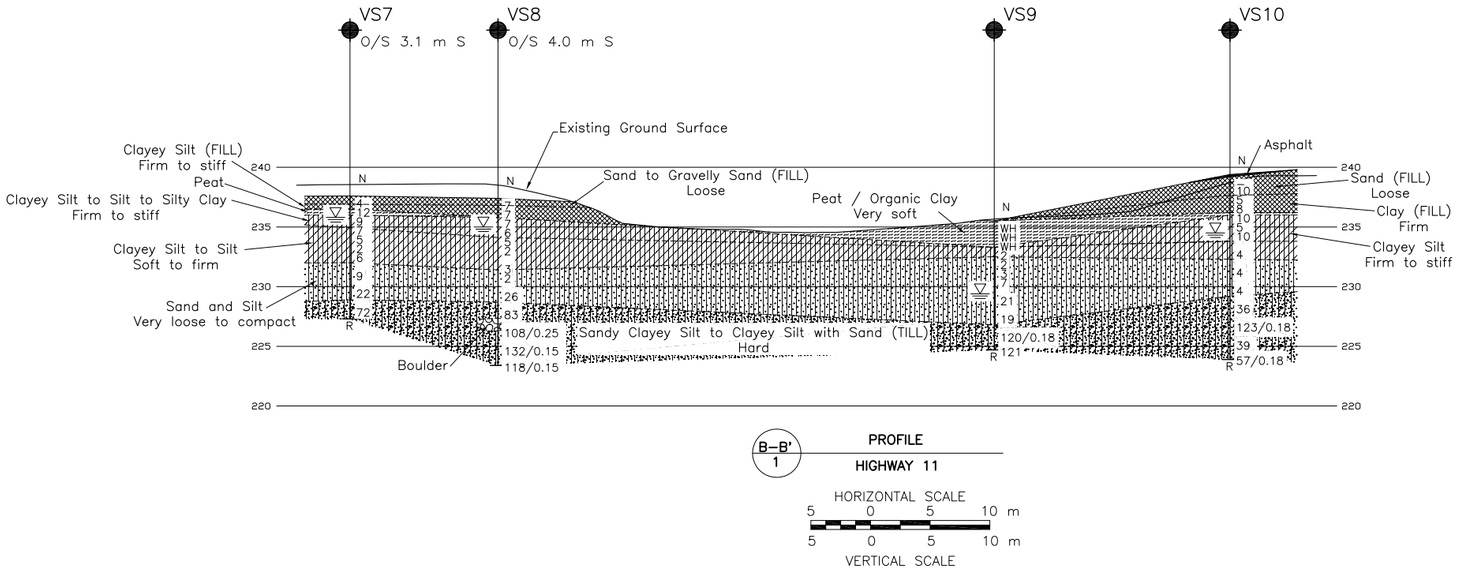
CONT No.
WP No. 5150-05-00

HIGHWAY 11
VALENTINE RIVER BRIDGE

SHEET

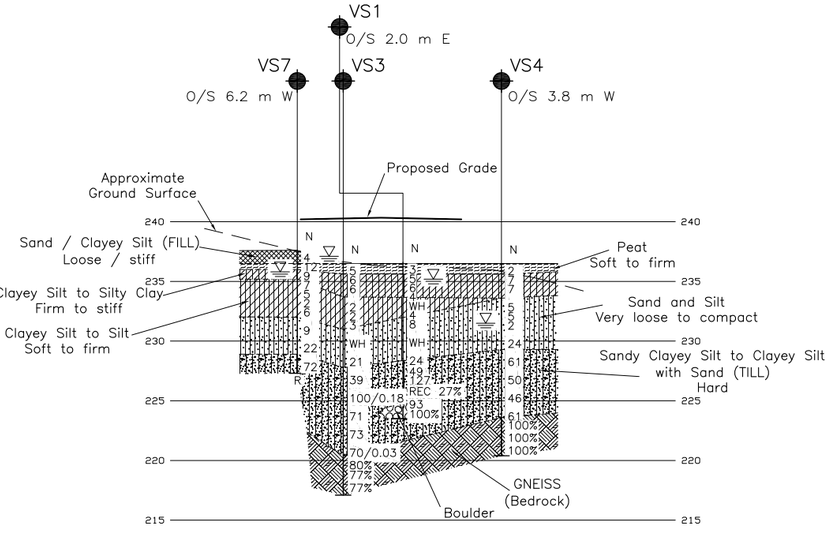
SOIL STRATA

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



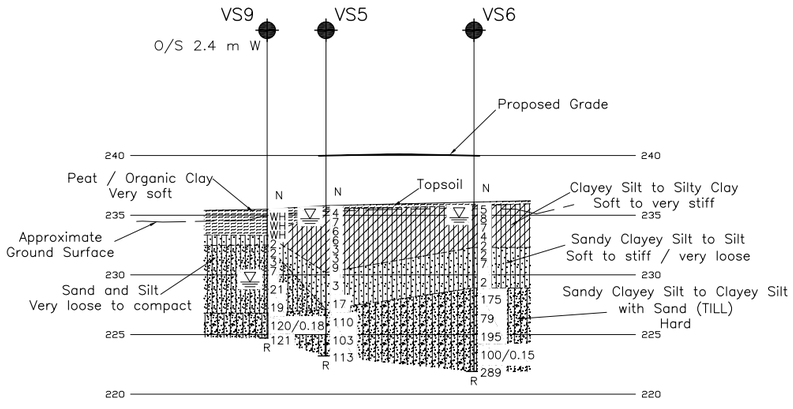
B-B' / 1 — PROFILE
HIGHWAY 11

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



C-C' / 1 — WEST ABUTMENT SECTION
HIGHWAY 11

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



D-D' / 1 — EAST ABUTMENT SECTION
HIGHWAY 11

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

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
R	Auger Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
VS1	236.6	5511323.7	307587.9
VS3	236.5	5511324.2	307585.9
VS4	236.5	5511313.5	307577.2
VS5	235.8	5511316.1	307635.4
VS6	236.1	5511304.7	307630.5
VS7	237.6	5511330.2	307581.7
VS8	237.4	5511326.6	307593.6
VS9	235.5	5511321.6	307635.1
VS10	239.4	5511316.9	307654.3

NOTES

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

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

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

REFERENCE

Base plans provided in digital format by LEA Consulting Ltd., drawing file no. 8960-VAL-S01(Ehx-40).dwg, received May. 30, 2013 and Inroads-X-Sections.dwg, received August 21, 2013.

LICENSED PROFESSIONAL ENGINEER
S.E.M. COYNE
90471921
OCT 31, 2013
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.M.A.COSTA
OCT 31, 2013
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 42G-48

HWY. 11		PROJECT NO. 11-1191-0008	DIST.
SUBM'D. EC	CHKD.	DATE: OCT 2013	SITE: 39W-010
DRAWN: TB	CHKD. SEMC	APPD. JMAC	DWG. 2

PLOT DATE: October 31, 2013
FILENAME: \\golder.gds\GAL\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0008 6 Bridges Hearst\3- Evelyn and Valentine\Detail_Valentine\11119100SBA001 Va.Det.dwg

APPENDIX A

Record of Boreholes (VS1 to VS12)
Record of Drillholes (VS3 and VS4)

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan\phi'$

2 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, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils

Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} 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
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

Golder Associates

RECORD OF BOREHOLE No VS1

1 OF 1 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511323.7; E 307587.9 | ORIGINATED BY ID

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | COMPILED BY EC

DATUM Geodetic | DATE October 16 and 17, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
236.6	GROUND SURFACE							
0.0 / 236.3	PEAT (Fibrous) Black Moist	1	SS	3				
0.3	CLAYEY SILT to SILTY CLAY, trace to some sand Very soft to firm Brown to grey Wet	2	SS	5				
		3	SS	6				
		4	SS	4				
232.9		5	SS	WH	0	9	59	32
3.7	CLAYEY SILT to SILT, some gravel, some sand Firm Grey Wet	6	SS	4				
231.0		7	SS	8	17	13	61	9
5.6	SAND and SILT, trace gravel Very loose to compact Grey Wet	8	SS	WH				
228.2		9	SS	24				
8.4	SAND and SILT, some gravel, trace clay (TILL) Dense to very dense Grey Moist to wet	10	SS	49				
		11	SS	127	13	45	37	5
	Spoon refusal (hammer bouncing) and auger refusal at 9.6 m depth. Coring between 9.7 m and 11.3 m depth.	1	REC	REC 27%				
		12	SS	93				
	A 1.0 m thick granite boulder was encountered at a 12.1 m depth.	2	REC	REC 100%				
223.5								
13.1	END OF BOREHOLE							

Note:

1. Water level at a depth of 1.4 m below ground surface (Elev. 235.2 m) upon completion of drilling.

SOIL PROFILE | STRAT PLOT | SAMPLES | GROUND WATER CONDITIONS | ELEVATION SCALE

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

$+^3, \times^3$: Numbers refer to Sensitivity

$\bigcirc^{3\%}$ STRAIN AT FAILURE

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS2

1 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511309.6; E 307639.2 | ORIGINATED BY ID

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | COMPILED BY EC

DATUM Geodetic | DATE October 17 and 18, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.8	GROUND SURFACE										
0.0 / 235.5	PEAT (Fibrous) Black Moist		1	SS	4						
0.3	CLAYEY SILT Very soft to firm Brown to grey Moist to wet		2	SS	6		235		○		
	Trace organics to 2.1 m depth.		3	SS	7		234		○		
232.8			4	SS	WH		233				
3.0	CLAYEY SILT to SILT, some sand, trace gravel Soft to firm Grey Wet		5	SS	3				○		5 19 60 16
231.3			6	SS	7		232				
4.5	SAND and SILT, trace gravel, trace clay Very loose Grey Wet		7	SS	4		231				
			8	SS	2		230		○		3 63 31 3
228.0							229				
7.8	CLAYEY Sandy SILT to SILT, trace to some gravel (TILL) Very dense Grey Moist to wet		9	SS	91		228				
	Auger refusal at 8.8 m depth. Coring between 9.2 m and 10.4 m depth. Coring between 10.7 m and 11.9 m depth.		10	SS	134		227		○		8 27 51 14
			1	SC	REC 0%		226				
			11	SS	150/0.1						
			2	SC	REC 0%		225				
223.8			12	SS	174/0.1		224				
12.0	END OF BOREHOLE										

Continued Next Page

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

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS2

2 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511309.6; E 307639.2 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | DATE October 17 and 18, 2012

ORIGINATED BY ID | COMPILED BY EC | CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Note: 1. Water level at a depth of 1.1 m below ground surface (Elev. 234.7 m) upon completion of drilling. 2. Water level in piezometer at a depth of 1.0 m below ground surface (Elev. 234.3 m) on October 18, 2012. 3. Water level in piezometer at a depth of 0.4 m below ground surface (Elev. 235.4 m) on December 6, 2012. 4. Water level in piezometer at a depth of 0.9 m below ground surface (Elev. 234.9 m) on July 5, 2013.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No VS3

1 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511324.2; E 307585.9 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | DATE June 7 and 8, 2013

ORIGINATED BY EHS | COMPILED BY EC | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
236.5	GROUND SURFACE							
0.0	PEAT (Fibrous) Firm Black Moist	1	SS	5				
235.6								
0.9	SILTY CLAY, trace sand Firm Brown Wet	2	SS	6				
		3	SS	6				
233.7								
2.8	CLAYEY SILT to SILT, some sand Soft Grey Wet	4	SS	2	0	16	62	22
		5	SS	2				
		6	SS	3				
231.0								
5.5	SAND and SILT Very loose to compact Brown Wet Between 0.3 m and 2.1 m of heave encountered below 6.1 m depth.	7	SS	WR				
		8	SS	21				
227.8								
8.7	CLAYEY Sandy SILT to SILT, trace to some gravel (TILL) Dense to very dense Grey Moist to wet	9	SS	39	11	31	48	10
		10	SS	100/0.18				
	Spoon refusal (hammer bouncing) at 11.0 m depth.							
		11	SS	71				
		12	SS	73	13	24	46	17

ELEVATION SCALE: 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225, 224, 223, 222

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

+ 4

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD_MTO 003 1111911008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS3

2 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511324.2; E 307585.9 | ORIGINATED BY EHS

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | COMPILED BY EC

DATUM Geodetic | DATE June 7 and 8, 2013 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY Sandy SILT to SILT, trace to some gravel (TILL) Dense to very dense Grey Moist to wet		13	SS	70/0.03		221				
220.4											
16.1	GNEISS (BEDROCK) Bedrock cored from 16.1 m depth to 19.4 m depth. For coring details see Record of Drillhole VS-3.		1	RC	REC 100%		220				RQD = 80%
			2	RC	REC 100%		219				RQD = 77%
			3	RC	REC 100%		218				RQD = 77%
217.1											
19.4	END OF BOREHOLE Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 233.6 m) on the morning of June 8, 2013. 2. Water level at 0.6 m above ground surface (Elev. 237.1 m) upon completion of drilling.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: VS3

SHEET 1 OF 1

LOCATION: N 5511324.2 ;E 307585.9

DRILLING DATE: June 7 and 8, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME55

DRILLING CONTRACTOR: Landcore Drilling Ltd.

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		REFER TO PREVIOUS PAGE		220.4																
17	June 8, 2013 NQ Coring NW	GNEISS Strong Fine to coarse grained Slightly weathered Grey		16.1	1	GREY 100%							JNPLRo JNPLRo							
													JNPLRo							
					2	GREY 100%							JNFORo JNFORo JNFORo JNPLRo JNPLRo JNUNRo							UCS = 75 MPa
													JNIRRo							
18													JNSTRo JNFORo JNUNRo JNPLK							
					3	GREY 100%							JNPLRo JNIRRo JNIRRo JNIRRo JNIRRo JNIRRo							
19				217.1									JNIRRo							
		END OF DRILLHOLE		19.4																
20																				
21																				
22																				
23																				
24																				
25																				
26																				

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: EHS

CHECKED: SEMC

SUD-RCK 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS4

1 OF 2 **METRIC**

PROJECT 11-1191-0008
W.P. 5150-05-00
LOCATION N 5511313.5; E 307577.2
ORIGINATED BY EHS
DIST HWY 11
BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring
COMPILED BY EC
DATUM Geodetic
DATE June 9 and 10, 2013
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.5	GROUND SURFACE										
0.0	PEAT (Amorphous) Soft Black Moist		1	SS	2		236				
235.6											
0.9	CLAYEY SILT, trace sand, trace organics Firm Brown Wet		2	SS	7		235				
			3	SS	7						
233.6							234	+ 4			
2.9	SAND and SILT, trace gravel, trace to some clay Very loose to loose Grey Wet		4	SS	5		233				
			5	SS	5				○		4 33 56 7
			6	SS	2	▽	232				
			7	SS	24		231				
229.3							230				
7.2	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Dense to very dense Grey Moist		8	SS	61		229		○H		3 27 55 15
			9	SS	50		228				
			10	SS	46		227		○		3 28 56 13
			11	SS	61		226				
223.6							225				
12.9	GNEISS (BEDROCK) Bedrock cored from 12.9 m depth to 16.1 m depth. For coring details see Record of Drillhole VS4.		1	RC	REC 100%		224				RQD = 100%
			2	RC	REC 100%		223				RQD = 100%
							222				

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No VS4

2 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511313.5; E 307577.2 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | DATE June 9 and 10, 2013

ORIGINATED BY EHS | COMPILED BY EC | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---		2	RC				20 40 60 80 100	20 40 60		RQD = 100%
220.4			3	RC	REC 100%		221	20 40 60 80 100	20 40 60		RQD = 100%
16.1	END OF BOREHOLE Note: 1. Water level at a depth of 5.0 m below ground surface (Elev. 231.5 m) upon completion of drilling.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT: 11-1191-0008

RECORD OF DRILLHOLE: VS4

SHEET 1 OF 1

LOCATION: N 5511313.5 ;E 307577.2

DRILLING DATE: June 9 and 10, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME55

DRILLING CONTRACTOR: Landcore Drilling Ltd.

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		REFER TO PREVIOUS PAGE		223.6																
13	June 10, 2013 NQ Coring NW	GNEISS Very Strong Fine to coarse grained Slightly weathered Grey		12.9	1	GREY 100%							JNIRRo JNSTRo JNIRRo							UCS = 126 MPa
14													JNIRRo							
15					2	GREY 100%							JNFORo							
16				220.4	3	GREY 100%														
		END OF DRILLHOLE		16.1																
17																				
18																				
19																				
20																				
21																				
22																				

SUD-RCK 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: EHS

CHECKED: SEMC

Golder Associates

RECORD OF BOREHOLE No VS5

1 OF 1 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511316.1; E 307635.4 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | DATE July 4, 2013

ORIGINATED BY ID | COMPILED BY EC | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.8	GROUND SURFACE										
0.0 / 235.5	TOPSOIL		1A, 1B	SS	4		235				
0.3	CLAYEY SILT, trace sand Soft to firm Brown to grey Wet		2	SS	7	▽					
			3	SS	6		234				
			4	SS	6				○		0 3 80 17
232.1			5	SS	3		233				
3.7	Sandy CLAYEY SILT to SILT, trace to some gravel Soft to stiff Grey Wet		6	SS	3		232		⊢○		10 39 38 13
			7	SS	9		231				
230.2							230				
5.6	SAND and SILT, some gravel Very loose to compact Grey Wet		8	SS	3						
							229				
			9	SS	17		228				
227.1											
8.7	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Very dense Grey Moist		10	SS	110		227		○⊢		4 26 55 15
							226				
			11	SS	103		225				
							224				
223.2			12	SS	113						
12.6	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 1.1 m below ground surface (Elev. 234.7 m) upon completion of drilling.										

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

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS6

1 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511304.7; E 307630.5 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | DATE July 5 and 6, 2013

ORIGINATED BY ID | COMPILED BY EC | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
236.1	GROUND SURFACE							
0.0 / 235.8	TOPSOIL	1A, 1B	SS	5				
0.3	SILTY CLAY Soft to firm Brown to grey Moist to wet	2	SS	8				
		3	SS	7				
		4	SS	4				
		5	SS	2				
232.3								
3.8	SILT, some sand, trace to some clay, trace to some gravel Very loose Grey Wet	6	SS	2	6	22	61	11
231.6								
4.5	Sandy SILT, trace to some clay, trace to some gravel Very loose to loose Grey Wet	7	SS	7				
		8	SS	2				
228.9								
7.2	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Very dense Grey Moist	9	SS	175	3	30	55	12
	Between 0.9 m and 1.2 m of heave encountered below 7.6 m depth.							
	Spoon refusal (hammer bouncing) at 8.1 m depth.	10	SS	79				
		11	SS	195				
	Spoon refusal (hammer bouncing) at 11.1 m depth.	12	SS	100/ 0.15				
	Spoon refusal (hammer bouncing) at 12.5 m depth.							
221.9		13	SS	289				
14.2								

ELEVATION SCALE: 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225, 224, 223, 222

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GROUND WATER CONDITIONS

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No VS6

2 OF 2 **METRIC**

PROJECT 11-1191-0008
W.P. 5150-05-00
DIST HWY 11
DATUM Geodetic
LOCATION N 5511304.7; E 307630.5
BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers
DATE July 5 and 6, 2013
ORIGINATED BY ID
COMPILED BY EC
CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 1.3 m below ground surface (Elev. 234.8 m) upon completion of drilling. 2. Moved 1.0 m east of Borehole VS6 and turned N-vanes from 2.4 m depth to 3.8 m depth.										

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No VS7

1 OF 1 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511330.2; E 307581.7 | ORIGINATED BY EHS

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE June 7, 2013 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.6	GROUND SURFACE										
0.0 / 236.9	Sand, trace to some gravel (FILL) Loose Brown Moist		1	SS	4		237				
236.5 / 1.1	Clayey silt (FILL) Stiff Brown Moist		2A 2B	SS	12						
236.0 / 1.6	PEAT (Amorphous) Black Moist		3	SS	9	▽	236				
235.2 / 2.4	SILTY CLAY Stiff Brown Moist to wet		4	SS	7		235				
	CLAYEY SILT, some sand, trace gravel Soft to firm Brown to grey Wet		5	SS	5						
			6	SS	2		234		⊖		2 20 56 22
232.0			7	SS	6		233				
5.6	SAND and SILT, trace to some clay, trace gravel Loose to compact Grey Wet		8	SS	9		232		○		2 38 54 6
			9	SS	22		231				
228.9	Spoon refusal (hammer bouncing) at 8.1 m depth.						230				
8.7	CLAYEY Sandy SILT to SILT, some gravel (TILL) Very dense Grey Moist		10	SS	72		229				
	Augers grinding below 10.0 m depth.						228				
227.3											
10.3	END OF BOREHOLE AUGER REFUSAL										

Note:

1. Water level at a depth of 1.8 m below ground surface (Elev. 235.8 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS8

1 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511326.6; E 307593.6 | ORIGINATED BY EHS

DIST _____ HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | COMPILED BY EC

DATUM Geodetic | DATE June 10 and 17, 2013 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.4	GROUND SURFACE						237				
0.0	Gravelly sand, trace silt (FILL) Loose Brown Moist		1	SS	7						
236.5							236				
0.9	Clayey silt, trace to some sand, trace organics (FILL) Firm Grey Moist to wet		2	SS	7						
			3	SS	7						
235.2							235				
2.2	CLAYEY SILT Firm Brown to grey Wet		4	SS	6	▽					
			5	SS	5		234				
233.7											
3.7	CLAYEY SILT to SILT Firm Grey Brown		6	SS	2		233				
			7	SS	3		232				
231.4											
6.0	SAND and SILT, trace to some clay, trace gravel Very loose to compact Brown to grey Wet		8	SS	2		231				5 44 41 10
			9	SS	26		230				
228.7							229				
8.7	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Very dense Grey Wet A 0.4 m thick granite boulder was encountered at 9.7 m depth.		10	SS	83		228				5 25 56 14
			11	SS	108/ 0.25		227				
			12	SS	132/ 0.15		226				
							225				
223.4			13	SS	118/ 0.15		224				
14.0											

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No VS8

2 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST | HWY 11 | DATUM Geodetic

LOCATION N 5511326.6; E 307593.6 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring | DATE June 10 and 17, 2013

ORIGINATED BY EHS | COMPILED BY EC | CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE Note: 1. Water level at a depth of 2.4 m below ground surface (Elev. 235.0 m) on June 17 prior to resuming drilling completion below 9.1 m depth.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS9

1 OF 1 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511321.6; E 307635.1 | ORIGINATED BY EHS

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE June 27, 2013 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.5	GROUND SURFACE										
0.0 / 234.8	PEAT (Amorphous) Very soft Black Wet		1	SS	WH		235				
0.7 / 233.3	ORGANIC CLAY Very soft Black Wet		2	SS	WH					OC=4.1%	
			3	SS	WH		234				
2.2 / 232.5	CLAYEY SILT to SILT, some sand Soft Grey Wet		4	SS	2		233				0 13 66 21
3.0	SAND and SILT, trace to some clay, trace to some gravel Very loose to compact Grey Wet		5	SS	2		232				
			6	SS	3						4 31 57 8
			7	SS	7		231				
			8	SS	21	▽	230				
			9	SS	19		229				
226.8							228				11 50 33 6
8.7	CLAYEY Sandy SILT to SILT, trace to some gravel (TILL) Very dense Grey Wet Spoon refusal (hammer bouncing) at 9.3 m depth.		10	SS	120/0.18		227				
224.7			11	SS	121		226				
10.8	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 6.1 m below ground surface (Elev. 229.4 m) upon completion of drilling.						225				

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS10

1 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | LOCATION N 5511316.9; E 307654.3 | ORIGINATED BY EHS

DIST | HWY 11 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE June 25 and 26, 2013 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.4	GROUND SURFACE						239				
0.0	ASPHALT (180 mm)										
0.2	Sand, some gravel, trace to some silt (FILL) Loose Brown Moist		1	AS	-						
			2	SS	10		238		○		18 74 (8)
237.4			3	SS	5						
2.0	Clay, trace to some sand (FILL) Firm Brown Moist		4	SS	8		237				
236.2											
	PEAT (Fibrous) Black Moist		5	SS	10		236				
3.4	CLAYEY SILT, trace sand Firm to stiff Brown to grey Wet		6	SS	5						0 2 53 45
			7	SS	10	▽	235				
233.8											
5.6	CLAYEY SILT to SILT Firm Brown to grey Wet		8	SS	4		234				8 43 39 10
232.2											
7.2	SAND and SILT, trace to some clay, trace to some gravel Loose Brown to grey Wet		9	SS	4		233				
			10	SS	4		232				
229.2											
10.2	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Dense to very dense Grey Wet		11	SS	36		231		○		2 37 52 9
	Spoon refusal (hammer bouncing) at 12.4 m depth.		12	SS	123/0.18		230				
			13	SS	39		229				
							228				
							227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No VS10

2 OF 2 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511316.9; E 307654.3 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | DATE June 25 and 26, 2013

ORIGINATED BY EHS | COMPILED BY EC | CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
223.9			14	SS	57/ 0.20		224				
15.5	END OF BOREHOLE SPOON REFUSAL AND AUGER REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 4.9 m below ground surface (Elev. 234.5 m) upon completion of drilling.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No VS11

1 OF 1 **METRIC**

PROJECT 11-1191-0008
W.P. 5150-05-00
DIST ____ HWY 11
DATUM Geodetic
LOCATION N 5511330.7; E 307561.2
BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers
DATE June 6, 2013
ORIGINATED BY EHS
COMPILED BY EC
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.0	GROUND SURFACE										
0.0 / 236.5	PEAT (Amorphous) Firm Black Wet		1	SS	6		236				
0.5	CLAYEY SILT, trace to some sand Firm Brown Wet		2	SS	4						
234.6			3	SS	8		235				
2.4	SAND and SILT, trace to some clay, trace to some gravel Loose to compact Brown to grey Wet		4	SS	16	▽	234				
			5	SS	7						
			6	SS	14		233		○		9 39 46 6
			7	SS	11		232				
230.4			8A 8B	SS	4		231		○		0 35 64 4
6.6	CLAYEY Sandy SILT to SILT, trace gravel (TILL) Very dense Grey Wet		9	SS	71		230				
			10	SS	59		229		○		3 29 57 11
226.3			11	AS	-		228				
10.7	END OF BOREHOLE						227				

Note:

1. Water level at a depth of 2.9 m below ground surface (Elev. 234.1 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No VS12

1 OF 1 **METRIC**

PROJECT 11-1191-0008 | W.P. 5150-05-00 | DIST ____ HWY 11 | DATUM Geodetic

LOCATION N 5511305.0; E 307657.3 | BOREHOLE TYPE 108 mm ID Continuous Flight Hollow Stem Augers | DATE June 26 and 27, 2013

ORIGINATED BY EHS | COMPILED BY EC | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.5	GROUND SURFACE								
0.0	PEAT (Fibrous) Soft Black		1	SS	3		236		
235.8	Wet								
0.7	SILTY CLAY Firm Brown to grey Moist to wet		2	SS	6				
			3	SS	8		235		
234.3									
2.2	CLAYEY SILT to SILT, trace to some sand Firm Brown to grey Wet		4	SS	7		234		
			5	SS	1		233		0 6 65 29
232.1									
4.4	Sandy SILT to SAND and SILT, trace to some clay, trace gravel Loose Grey Wet		6	SS	6		232		
			7	SS	6		231		3 27 64 6
	Approximately 0.6 m of heave encontered at 7.6 m depth.		8	SS	10		230		
227.8							229		
8.7	CLAYEY Sandy SILT to SILT, some gravel (TILL) Very dense Grey Wet		9	SS	110/0.25	▽	228		
	Spoon refusal (hammer bouncing) at 9.6 m depth.						227		
226.0			10	SS	30/0.03		226		
10.5	END OF BOREHOLE SPOON AND AUGER REFUSAL (HAMMER BOUNCING)								
	Note: 1. Water level at a depth of 8.8 m below ground surface (Elev. 227.7 m) upon completion of drilling.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

+ 5

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

SUD_MTO 003 1111910008DET.GPJ GAL-MISS.GDT 23/10/13 DATA INPUT:

APPENDIX B

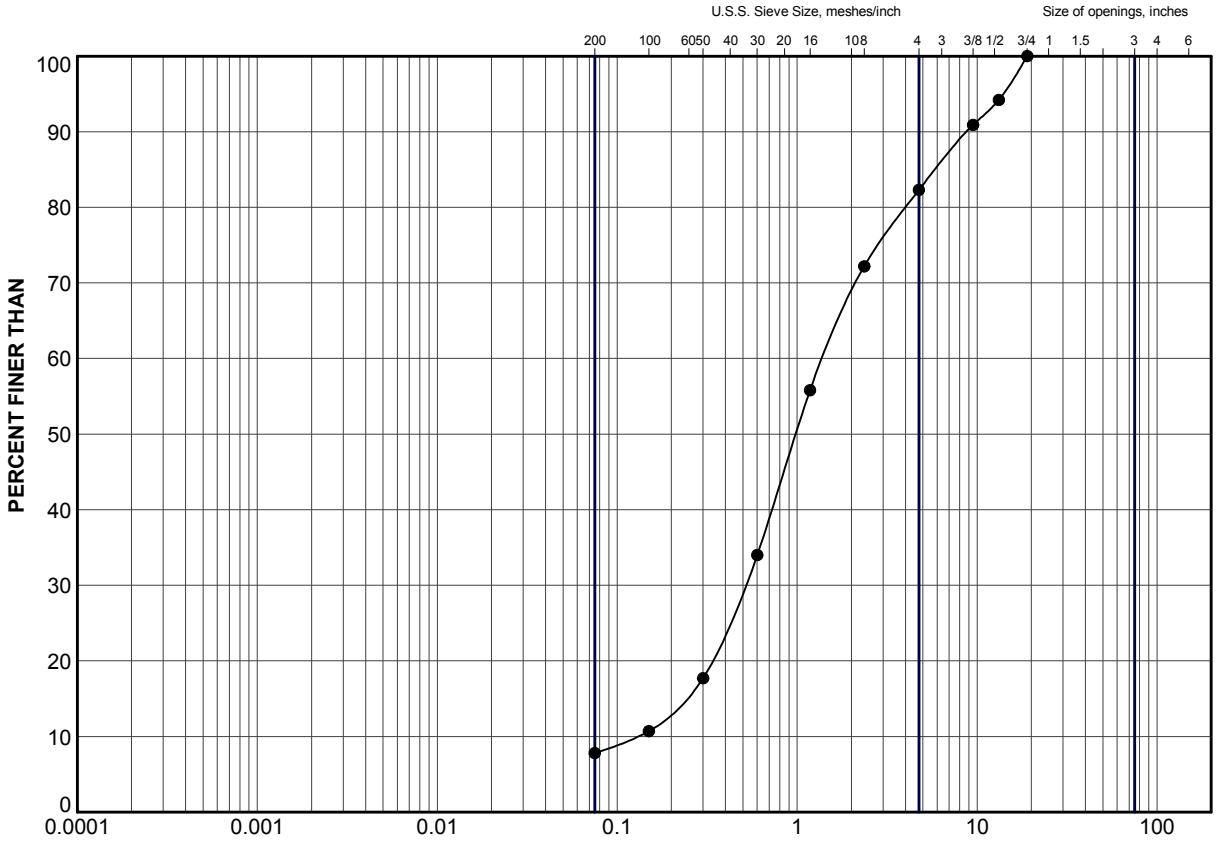
Laboratory Test Results

Table B1 - Summary of Analytical Testing of Creek Water

Parameter	Units	Result
Resistivity	ohm-cm	9,100
Conductivity	µmho/cm	110
pH	pH	7.15
Sulphate	mg/L	Not Detected
Chloride	mg/L	2

Prepared by: EC
Reviewed by: SFMC

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



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	VS10	2	238.3

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

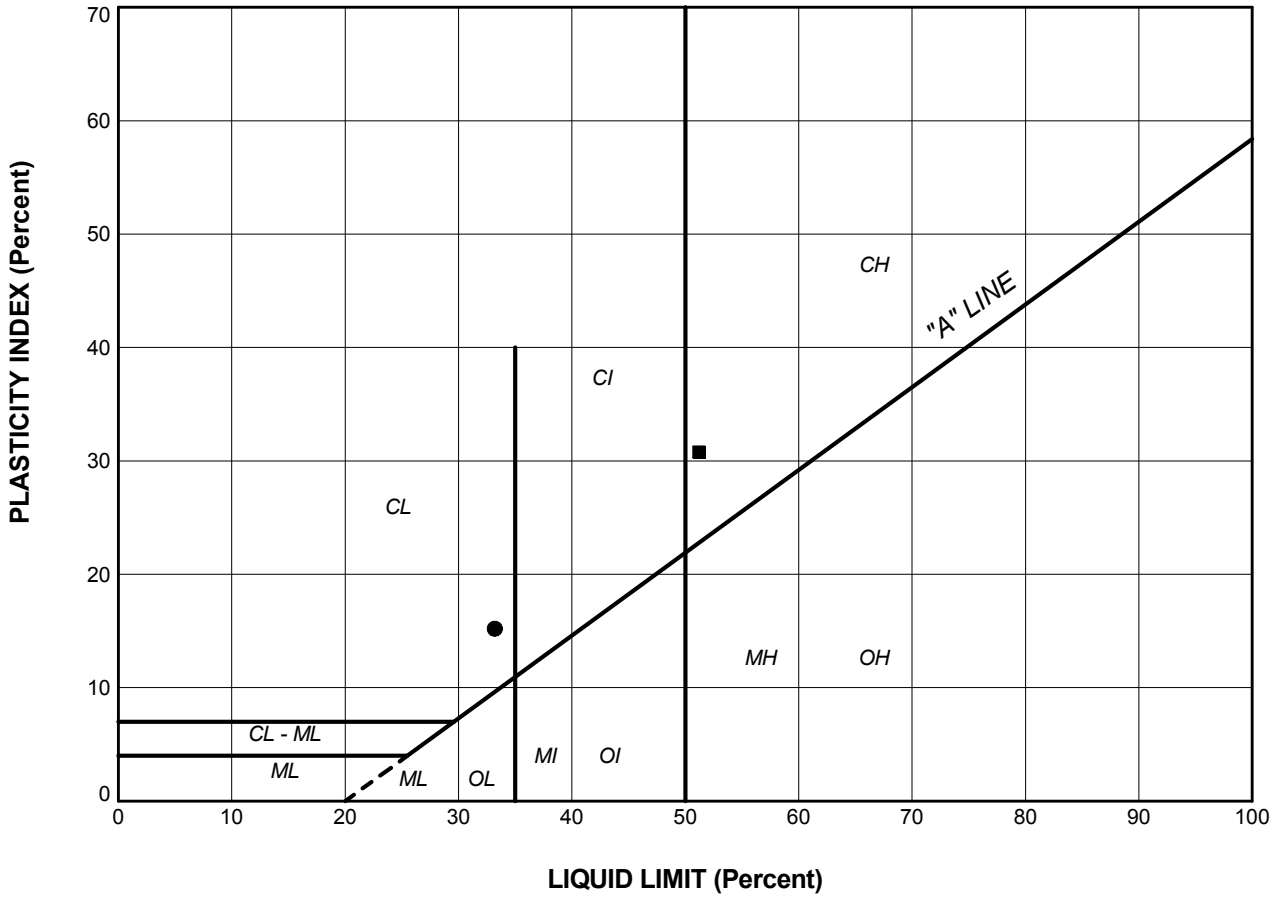
GRAIN SIZE DISTRIBUTION

SAND (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B1**	

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
●	VS8	2	33.2	18.0	15.2
■	VS10	4	51.2	20.4	30.8

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

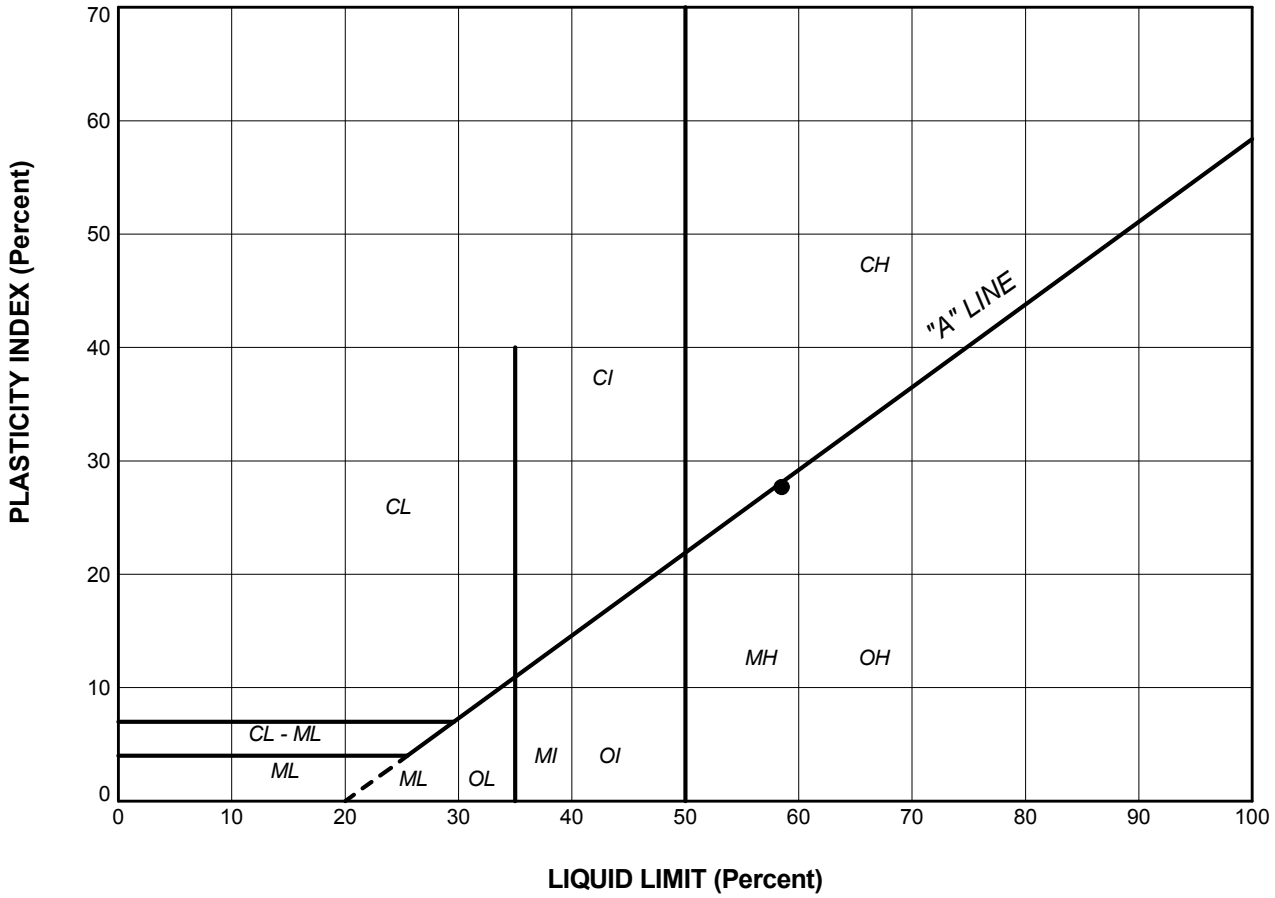
PLASTICITY CHART

CLAYEY SILT to CLAY (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B2**	

SUD-MTO PL (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
●	VS9	2	58.5	30.8	27.7

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

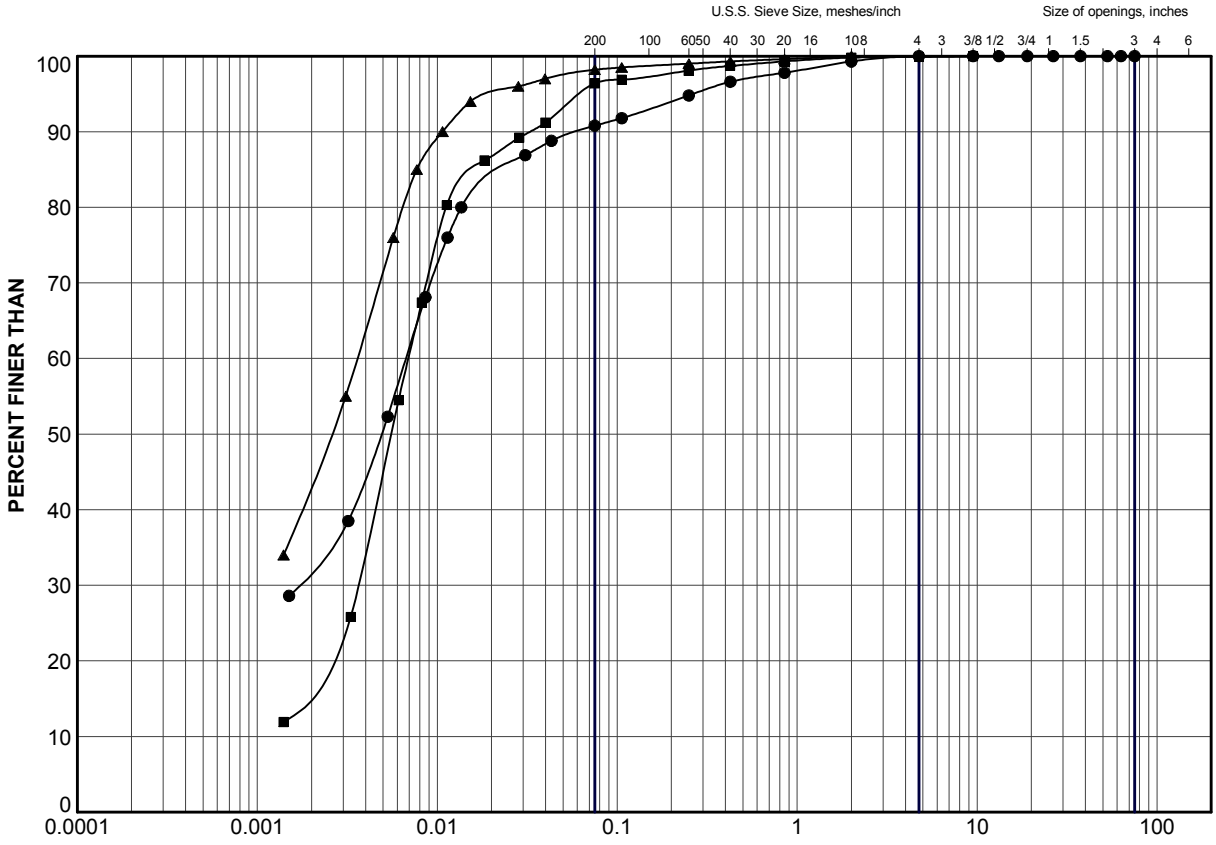
PLASTICITY CHART

ORGANIC CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ	
DRAWN	JJL	Oct 2013	SCALE	N/A	REV.
CHECK	SEMC	Oct 2013			
APPR	JMAC	Oct 2013	**FIGURE B3**		

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	VS1	5	233.2
■	VS5	4	233.2
▲	VS10	6	235.3

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

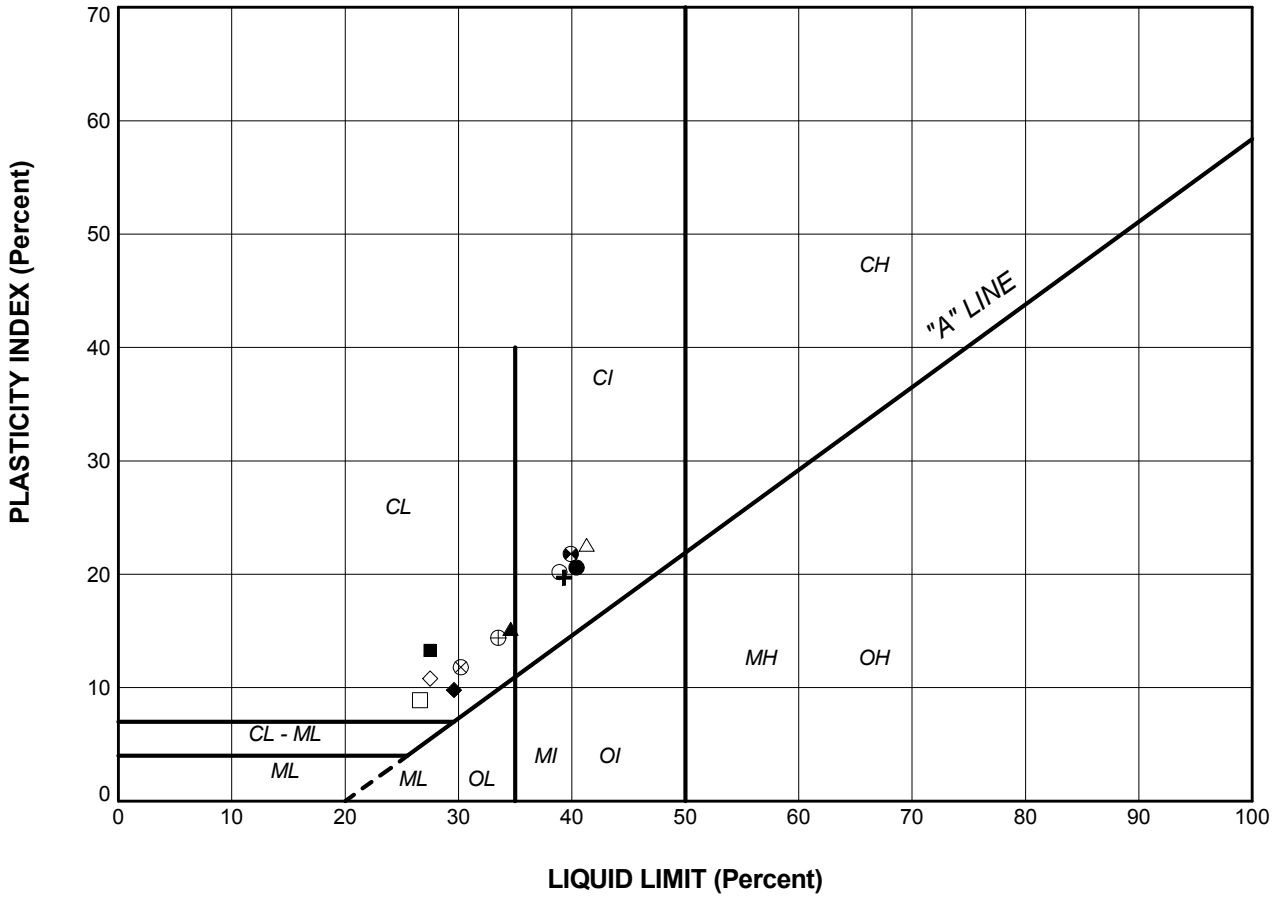
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B4**	

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
●	VS1	2	40.4	19.8	20.6
■	VS1	5	27.5	14.2	13.3
▲	VS2	3	34.6	19.4	15.2
✚	VS3	2	39.3	19.6	19.7
◆	VS4	3	29.6	19.8	9.8
◇	VS5	2	27.5	16.7	10.8
○	VS6	3	38.9	18.7	20.2
△	VS7	3	41.3	18.7	22.6
⊗	VS8	4	30.2	18.4	11.8
⊕	VS10	6	33.5	19.1	14.4
□	VS11	3	26.6	17.7	8.9
☢	VS12	2	39.9	18.1	21.8

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

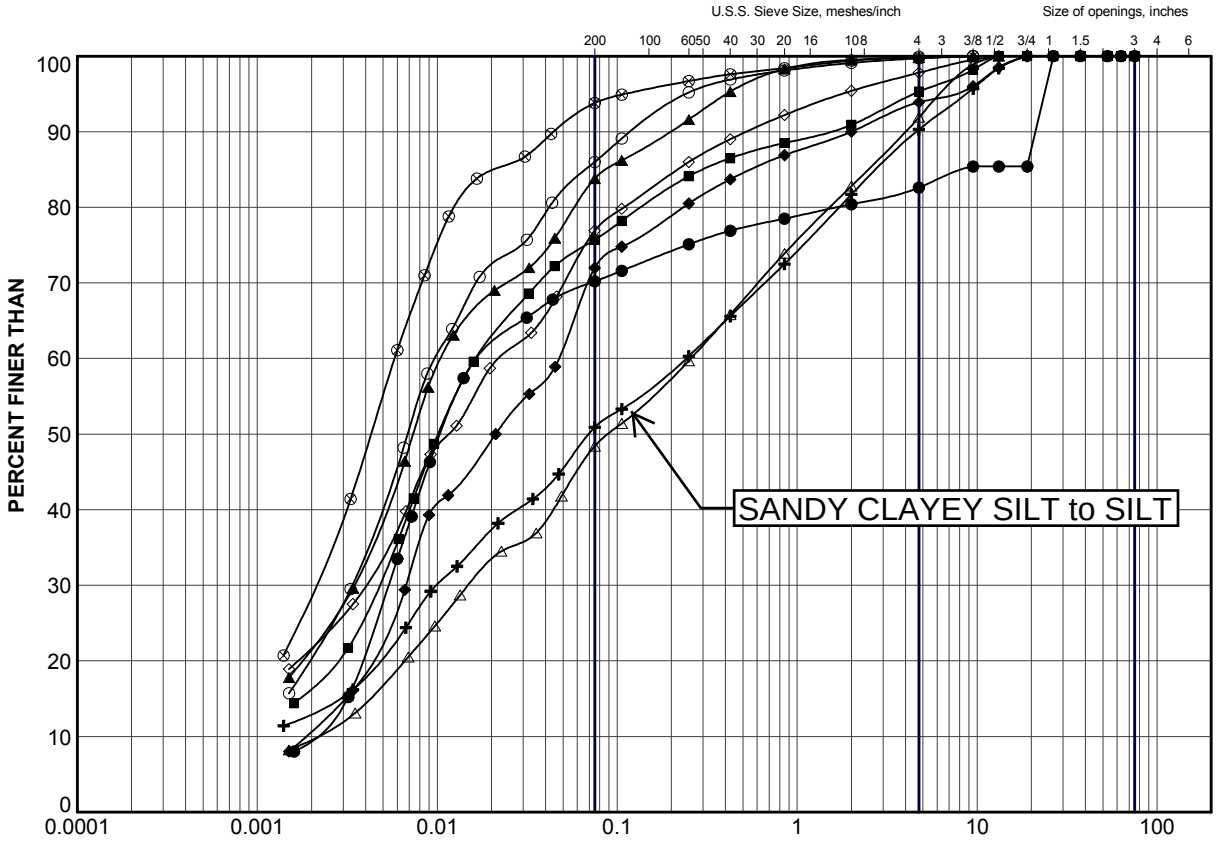
PLASTICITY CHART

CLAYEY SILT to SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE	N/A
CHECK	SEMC	Oct 2013	REV.	
APPR	JMAC	Oct 2013	**FIGURE B5**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	VS1	7	231.7
■	VS2	5	232.4
▲	VS3	4	233.1
✚	VS5	6	231.7
◆	VS6	6	232.0
◇	VS7	6	233.5
○	VS9	4	232.9
△	VS10	8	233.0
⊗	VS12	5	233.1

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

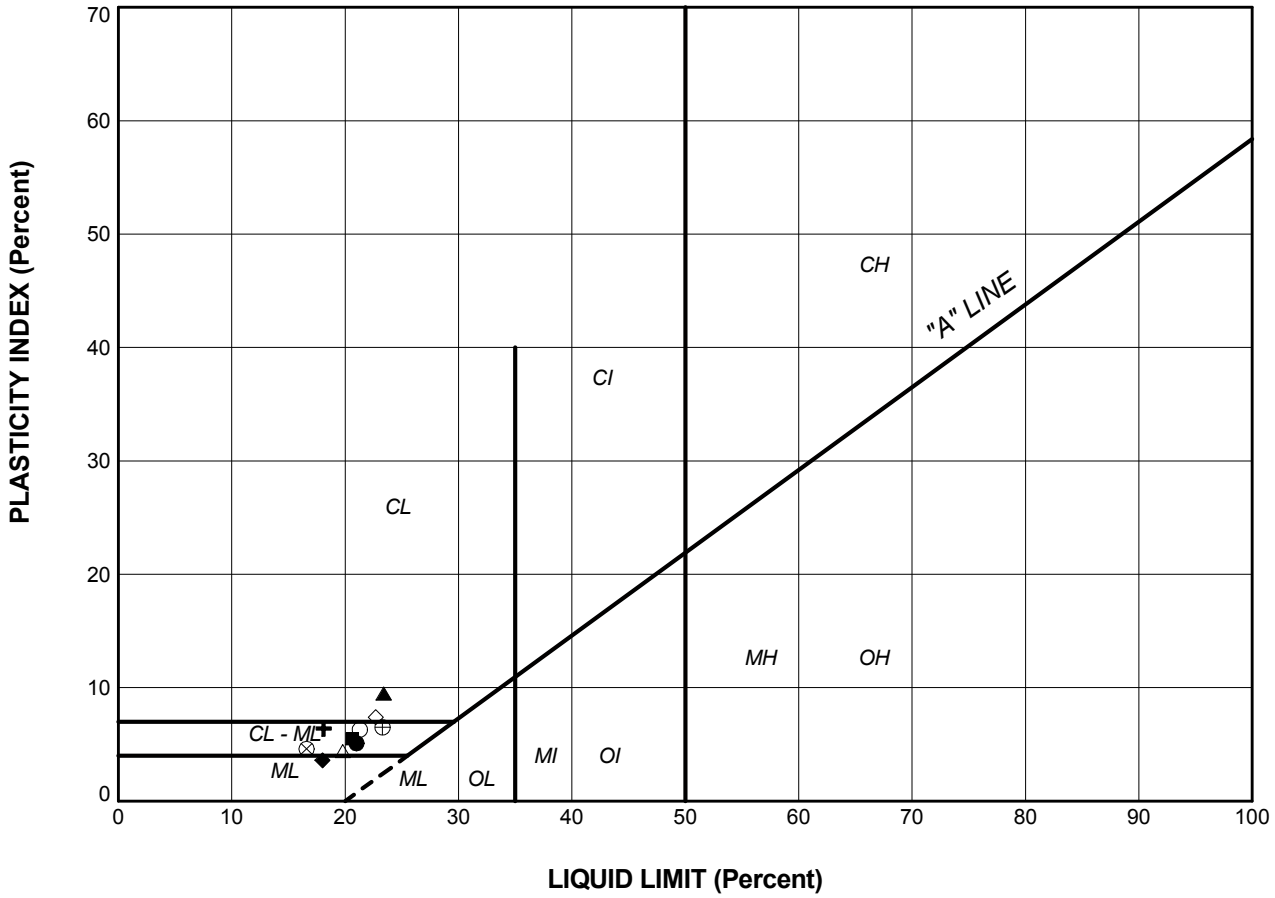
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B6**	

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
●	VS1	7	21.0	15.9	5.1
■	VS2	5	20.6	15.1	5.5
▲	VS3	4	23.4	13.9	9.5
+	VS5	6	18.1	11.7	6.4
◆	VS6	6	18.0	14.4	3.6
◇	VS7	6	22.7	15.3	7.4
○	VS8	6	21.3	15.0	6.3
△	VS9	4	19.8	15.4	4.4
⊗	VS10	8	16.6	12.0	4.6
⊕	VS12	5	23.3	16.8	6.5

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

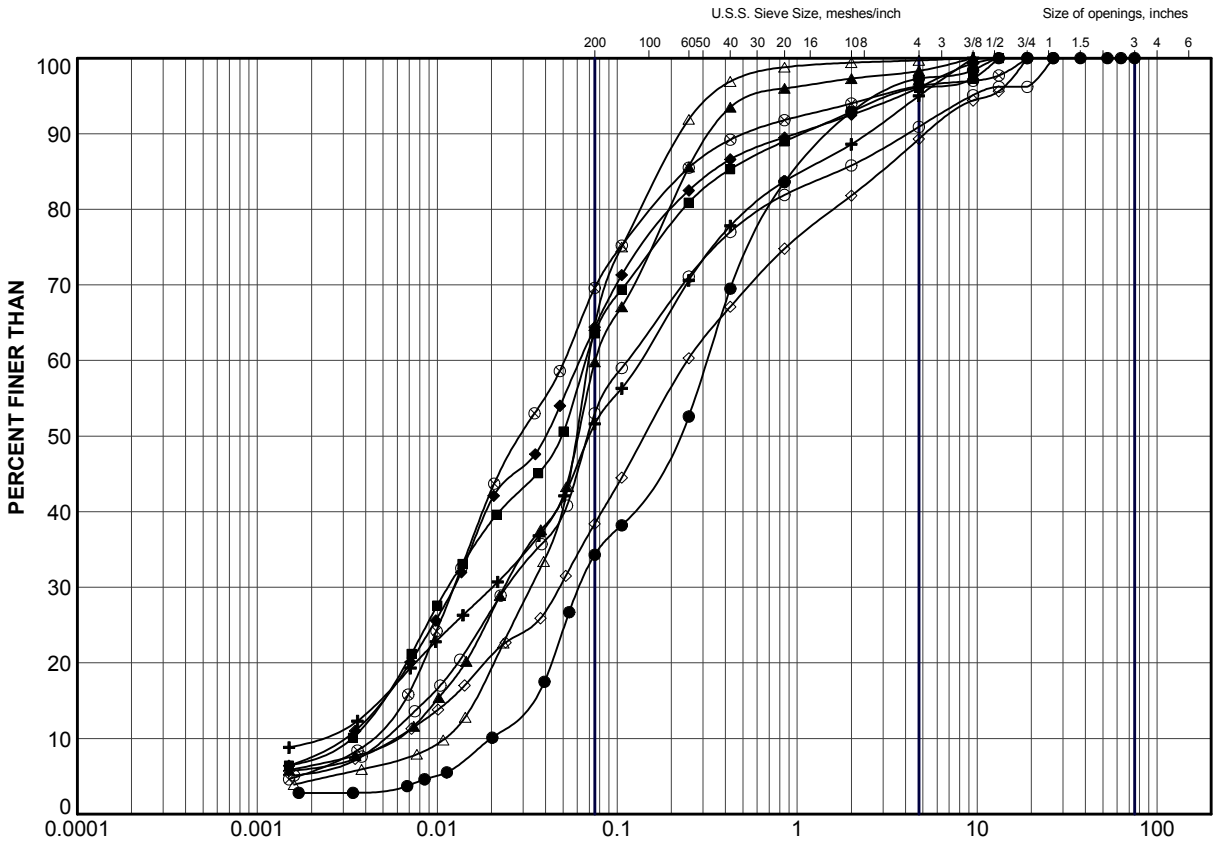
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ	
DRAWN	JJL	Oct 2013	SCALE	N/A	REV.
CHECK	SEMC	Oct 2013			
APPR	JMAC	Oct 2013	**FIGURE B7**		

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	VS2	8	229.4
■	VS4	5	232.4
▲	VS7	8	231.2
✚	VS8	8	231.0
◆	VS9	6	231.4
◇	VS9	9	227.6
○	VS11	6	232.9
△	VS11	8A	230.8
⊗	VS12	7	230.1

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

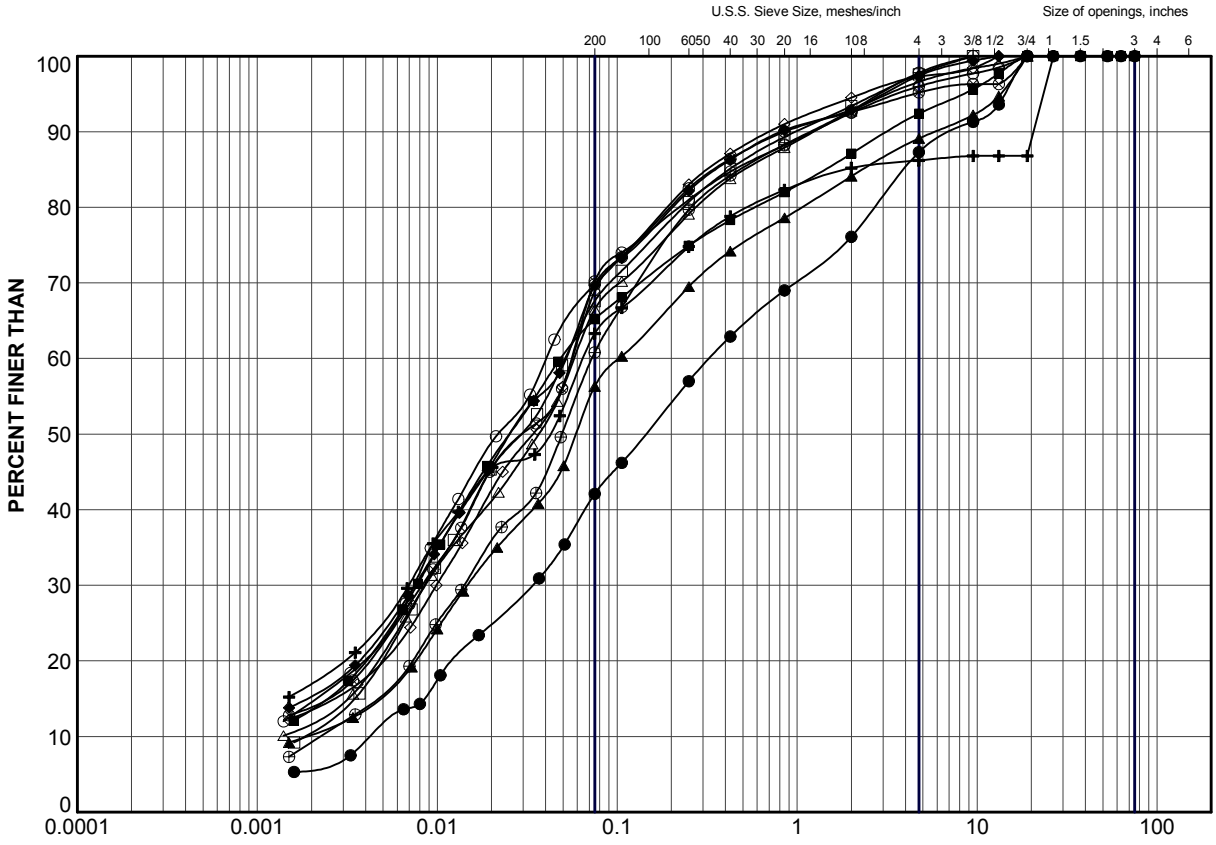
GRAIN SIZE DISTRIBUTION

SANDY SILT to SAND and SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B8**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	VS1	11	227.2
■	VS2	10	226.8
▲	VS3	9	227.1
✚	VS3	12	222.5
◆	VS4	8	228.6
◇	VS4	10B	225.4
○	VS5	10	226.4
△	VS6	9	228.3
⊗	VS8	10	228.0
⊕	VS10	11	228.4
□	VS11	10	227.6

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

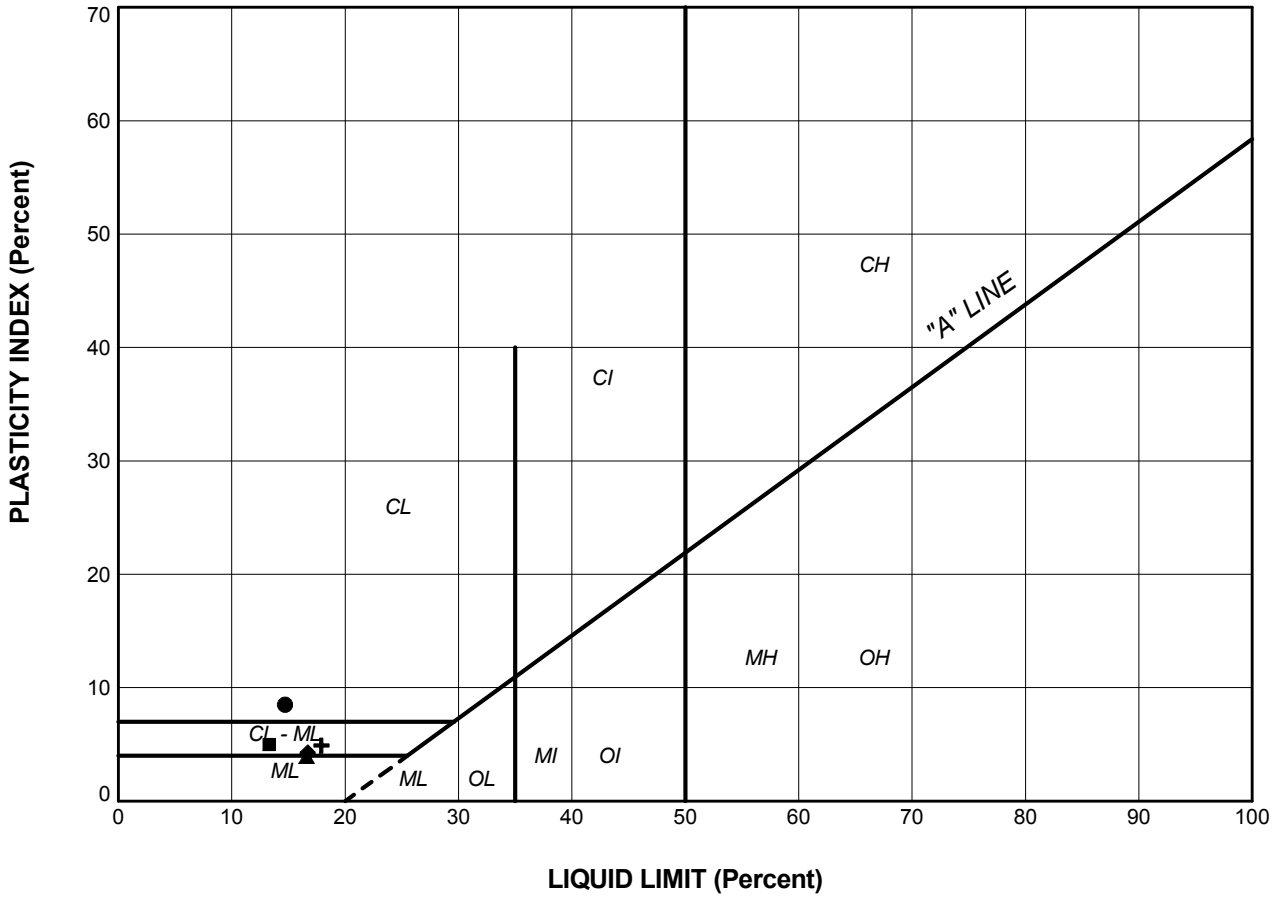
GRAIN SIZE DISTRIBUTION

CLAYEY SANDY SILT to SILT (TILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B9**	

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
●	VS2	10	14.7	6.2	8.5
■	VS3	12	13.3	8.3	5.0
▲	VS4	8	16.6	12.7	3.9
+	VS5	10	17.9	13.0	4.9
◆	VS6	9	16.7	12.4	4.3
◇	VS8	10	16.7	12.5	4.2

PROJECT

HIGHWAY 11
VALENTINE RIVER BRIDGE

TITLE

PLASTICITY CHART

CLAYEY SANDY SILT to SILT (TILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0008		FILE No.	1111910008DET.GPJ
DRAWN	JJL	Oct 2013	SCALE N/A	REV.
CHECK	SEMC	Oct 2013		
APPR	JMAC	Oct 2013	**FIGURE B10**	

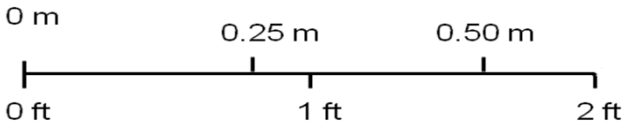
SUD-MTO PL (NEW) GLDR_LDN.GDT

Borehole VS3

Elevation 220.4 m to 217.1 m

Borehole VS4

Elevation 223.6 m to 220.4 m



PROJECT

HWY 11
Valentine River Bridge Site # 39W-010

TITLE

BEDROCK CORE PHOTOGRAPHS (VS3 and VS4)

Golder Associates

PROJECT No. 11-1191-0008			FILE No. ----	
DESIGN	EC	Aug 2013	SCALE AS SHOWN	REV.
CADD	--		**FIGURE B11**	
CHECK	SEMC	Aug 2013		
REVIEW				

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
1010 Lorne Street
Sudbury, Ontario, P3C 4R9
Canada
T: +1 (705) 524 6861

Golder Associates