



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

**Victoria Creek Culvert Replacement, Highway 672,
Township of Arnold, Northeast of Kirkland Lake, Ontario**

Agreement No. 5015-E-0007

Assignment No. 7

GWP 5027-17-00

Geocres No. 32D-22

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December 18, 2017

Ontario Ministry of Transportation

Northeastern Region Geotechnical Section

Foundation Investigation Report

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Table of Contents

1	FOUNDATION INVESTIGATION REPORT	1
1.1	Introduction	1
1.2	Site Description and Geological Setting	1
1.2.1	Site Description.....	1
1.2.2	Geological Setting.....	2
1.3	Investigation Procedures	2
1.3.1	Site Investigation and Field Testing.....	2
1.3.2	Previous Investigation	4
1.3.3	Laboratory Testing.....	4
1.4	Subsurface Conditions	4
1.4.1	Proposed Culvert Replacement Location	5
1.4.2	Temporary Modular Bridge Location	10
1.5	Groundwater Conditions.....	11
2	CLOSURE	13
3	LIMITATIONS AND USE OF REPORT	14

Appendices

Site Photographs	A
Drawings.....	B
Borehole Logs.....	C
Laboratory Data	D
Rock Core Photographs	E
Golder's Technical Memorandum.....	F

1 FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This report presents the results of a geotechnical investigation completed by **exp** Services Inc. for replacement of Victoria Creek Culvert on Highway 672, in Township of Arnold, northeast of Kirkland Lake, Ontario. The work was undertaken under Agreement No. 5015-E-0007, Assignment No. 7. The terms of reference (TOR) were as presented in Ministry of Transportation Ontario (MTO) email dated May 23, 2017.

The purpose of the investigation is to determine the subsurface conditions along the existing culvert alignment to permit detailed design for its replacement including cofferdams, as well as at the location of a proposed Temporary Modular Bridge (TMB) which will serve as a detour during the culvert replacement. The site specific geotechnical investigation consisted of a field investigation including visual inspections, drilling at land and in water, soil sampling, and laboratory testing.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The existing Victoria Creek culvert is located on Highway 672, at approximately Sta. 10+150 in the Township of Arnold, northeast of Kirkland Lake Ontario. Highway 672 is a two lane roadway, with a speed limit of 80 km/h and is about 6 m wide from edge of pavement with sand and gravel shoulders. The roadway embankment above the creek bed is about 5.5 m high with side slopes of about 1.7H:1V. Highway 672 runs in a generally north-south direction, and Victoria Creek flows from a west to east direction.

As reported by MTO, a washout has recently occurred at the project site and as a temporary and emergency measure, twin 2.4 m diameter temporary CSP pipes were installed and the embankment was restored by new earthfill. According to the field observation, the twin pipes were installed at about 8 m away from the existing pipe and at a much shallower depth with invert located at the obvert elevation of the existing pipe approximately, while the existing pipe remains in-place. The diameter of the existing CSP pipe is estimated to be approximately 2.4 m. A TMB which will serve as a detour during construction to allow traffic flow is proposed at the adjacent abandoned road located west of the existing Highway 672.

During the investigations, it was observed that earthfill used in the restored embankment in the vicinity of the existing culvert was predominantly sandy soils with some large rock and boulders at the bottom. The top of the road was unpaved having the elevation of about 313.4 m. Water seepages were noticed at the embankment toe at the outlet side, north and south of the existing culvert. Some submerged

wood logs were noticed at inlet side of the existing culvert. Bedrock outcrops were observed in the vicinity of the existing culvert. At the proposed location of the TMB, existing concrete abutments of the old bridge were found. The approaching abandon road was about one lane wide having shoulders grown in with vegetation. Its pavement was in rough shape having numerous cracks. At the inlet side, the creek water forms a body of water (i.e. pool) encompassed with the old road embankment at the west and Highway 672 embankment at the east side. At the outlet, a flowing stream was observed. In June 2017, the inlet of the existing culvert was completely submerged.

Selected photographs of the site and existing culvert are presented in Appendix A. The site plan and cross-section profiles for the proposed culvert and TMB alignments are shown on the drawing attached in Appendix B.

1.2.2 Geological Setting

According to the Ministry of Northern Development and Mines, Map 2555 (Quaternary Geology of Ontario, East-Central Sheet, 1991) the surface conditions in the vicinity of the project area consists of undifferentiated igneous and metamorphic rock exposed at surface to glaciolacustrine deposits which includes sand, gravelly sand and gravel. Glaciofluvial ice-contact deposits, which includes gravel, sand and minor till includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits and according to Map 2543 (Bedrock Geology of Ontario, East-Central Sheet, 1991), the bedrock geology of the site is of mafic to intermediate metavolcanics rocks of basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed in two phases, Phase I between June 13 and 16, 2017 and Phase II between July 5 and 13, 2017. Phase I field investigation consisted of drilling four (4) sampled boreholes (numbered BH-2, BH-3, BH-7 and BH-8) through road surface and Phase II field investigation consisted of drilling four (4) sampled off-road boreholes (numbered BH-1, BH-4, BH-5 and BH-6) in water using a barge. Among the boreholes drilled through the road surface, two boreholes (BH-2 and BH-3) were advanced at the location of existing culvert on Highway 672, while other two boreholes (BH-7 and BH-8) were advanced at the location of TMB on the detour route. Among the in-water boreholes, two boreholes (BH-1 and BH-5) were advanced on the outlet side and two boreholes (BH-4 and BH-6) were advanced on the inlet side of the existing culvert. The locations of boreholes are shown on Drawing 1 attached in Appendix B.

All culvert boreholes (BH-1, BH-2, BH-3, BH-4, BH-5 and BH-6) were strategically located along the existing culvert alignment to provide subsurface information for the replacement of existing culvert and construction of cofferdams. BH-2 and BH-3 were located on the south side of the existing culvert within NBL and SBL, respectively. BH-3 was intended to be drilled north of the existing culvert, however, since the inlet side of the culvert was submerged at the time of drilling of this land borehole it was difficult to estimate its proposed location relative to the culvert. BH-4 and BH-5 were located near the inlet and outlet of the existing culvert, respectively. BH-1 and BH-6 were located between the temporary

twin culverts and the existing culvert at the outlet and inlet side, respectively, assuming that cofferdams will be located there. Due to the presence of submerged wood logs near the inlet of existing culvert, BH-4 and BH-6 could not be drilled closer to the existing culvert, while BH-1 could not be drilled closer to the existing culvert due to the shallow water depth for a barge setup. BH-7 and BH-8 were strategically located at the proposed TMB to provide subsurface information along the TMB alignment. BH-7 was advanced on the approximate location of the north abutment, while BH-8 was advanced on the approximate south abutment location.

At the site location, Golder Associates Ltd. (Golder) also performed a preliminary foundation investigation, dated May 25, 2017, to support MTO on design of the culvert replacement. Golder's field investigation included advancing three rock probes (P1, P2 and P4) to depths ranging from 12.5 m to 17.4 m below the existing ground surface. The results of this preliminary foundation investigation were provided by MTO along with the TOR. The locations of probeholes performed by Golder are also shown on drawing in Appendix B.

Roadway boreholes drilled during Phase I of this fieldwork were advanced using a track mounted CME 55 drill rig equipped with hollow stem augers and standard soil sampling equipment, operated by a specialist drilling contractor, Marathon Drilling Co. Ltd. In-water boreholes in Phase II were advanced using a barge mounted Dierich D-25 drill rig with hollow stem augers and standard soil sampling equipment, operated by a specialist drilling contractor, Landcore Drilling Inc. Due to the difficulties to access inlet and outlet sides and high water level in the vicinity of culvert, the drill rig and the barge were lifted and placed in the water using a crane (90-ton link belt), as shown on the attached photos in Appendix A.

Roadway boreholes drilled at the existing culvert location (BH-2 and BH-3) were advanced to depths ranging between 14.5 m and 14.6 m below ground surface, while the boreholes drilled at the TMB location (BH-7 and BH-8) were advanced to depths ranging between 5.3 m to 6.8 m below ground surface. In-water boreholes (BH-1, BH-4, BH-5 and BH-6) were advanced to depths ranging between 9.7 m and 15.4 m below the water level in the creek at the time of investigation. Except BH-4, all the boreholes drilled at this site were cored approximately 3 m in to the bedrock. BH-4 was terminated at a desired depth of 15.4 m.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel. The ground surface elevations, including top of culvert and top of water at the location of existing culvert, were referenced to a geodetic benchmark (HCP 101) located on north-east side of the existing culvert; while the ground surface elevations at the location of proposed TMB location, were referenced to a geodetic benchmark (HCP 175) located on the south-west side of the proposed south abutment of TMB. The elevation of the BMs for HCP 101 and HCP 175 are 313.147 m and 311.228 m, respectively. The benchmarks locations are shown on Drawing 1 in Appendix B.

During the drilling of all boreholes, soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586) at intervals ranging from 0.75 m to 1.5 m in depth as shown on the attached borehole logs (Appendix C). The original field (uncorrected) SPT "N" values were recorded on the borehole logs as

recommended in the Canadian Foundation Engineering Manual (CFEM, pg. 40) and used to provide an assessment of in-situ relative density of non-cohesive soils. When a hard stratum was reached sampling of hard material was performed by diamond core drilling, using a 1.5 m long HQ/NQ double tube wireline core barrel.

Upon completion of the boreholes, ground water level measurements were carried out in boreholes in accordance with MTO guidelines. The recorded ground water levels after completion of drilling boreholes were presented in the borehole log sheets in Appendix C. The roadway boreholes were decommissioned by bentonite/cement mixtures in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the *Ontario Water Resources Act*).

The fieldwork was supervised by the **exp** geotechnical representative who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification.

All recovered soil samples were placed in labelled moisture-proof bags and returned to **exp**'s Sudbury laboratory for additional visual, textual and olfactory examination and selective testing.

1.3.2 Previous Investigation

The following previous/historical investigation report was provided by MTO:

- Technical Memorandum for Field Investigation for Highway 672 Centerline Culvert at Approximately STA 10+150, Township of Arnold; Assignment #10; Agreement # 5013-E-0012; Golder Associates Ltd.; May 25, 2017.

The technical memorandum and probehole logs prepared by Golder are attached in Appendix F of this report.

1.3.3 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content on all samples and particle size distribution for approximately 25% of the collected soil samples. All of the laboratory tests were carried out according to MTO and/or ASTM Standards as appropriate.

The laboratory test results are provided on the attached borehole log sheets in Appendix C. The results of the grain size analyses tests are presented graphically in Appendix D.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix C. Laboratory test results of grain size analyses are provided in Appendix D. The "Explanation of Terms Used in Report" preceding the borehole logs

in Appendix C forms an integral part of and should be read in conjunction with this report. Probehole logs prepared by Golder after their investigation are attached in Appendix F.

A borehole location plan and cross section subsurface profiles are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and cross section stratigraphic profiles are inferred from semi-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be regarded as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

1.4.1 Proposed Culvert Replacement Location

The general stratigraphy encountered within the investigated depths of Golder and current investigation are inline. In general, the subsurface conditions along the propose culvert replacement site consists of a layer of sand and gravel fill underlain by a layer of cobbles and boulders fill followed by native deposit of silty sand with gravel and bedrock. Organic silt with sand/sandy silt deposit overlying the bedrock was encountered at the inlet and outlet locations including the potential locations of cofferdams at those ends. A detailed description of the subsurface conditions encountered along the culvert and cofferdams locations is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by **exp**. Since, Golder conducted only probehole (no sampling and laboratory testing), the logs prepared by Golder are not considered here to describe subsurface conditions encountered at site.

1.4.1.1 Fill: Sand and Gravel

Sand and gravel fill was encountered at the surface of roadway BH-2 and BH-3. The fill layer extended to depths ranging between 3.1 m to 4.6 m below ground surface with elevations ranging between 310.7 m and 309.1 m. The explored thickness of this layer was between 3.1 m and 4.6 m.

The composition of this fill layer was generally sand and gravel with some cobbles, trace silt and clay. The material is brown in color, and moist. The SPT 'N' values obtained within this layer ranged from 9 to 38 blows per 0.3 m penetration, suggesting loose to dense material, but generally compact to dense in relative density.

Laboratory testing performed on selected samples consisted of eight (8) moisture content tests and three (3) grain size distribution tests. The test results are as follows:

Moisture Content:

- 1.8% to 11%

Grain Size Distribution:

- 26% to 54% gravel;
- 42% to 55% sand;
- 24% silt;

- 1% clay; and
- 4% to 5% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 1 in Appendix D.

1.4.1.2 Fill: Cobbles and Boulders

Cobbles and boulders fill was encountered below the sand and gravel fill layer of BH-2 and BH-3. The fill layer extended to depths ranging between 4.6 m and 6.1 m below ground surface with elevations ranging between 307.6 m and 309.1 m. The explored thickness of this layer was about 1.5 m.

The composition of this layer was generally cobbles and boulders with some sand and some gravel. The SPT 'N' values obtained within this layer were well above 100 blows per 0.3 m penetration.

Laboratory testing performed on selected samples consisted of two (2) moisture content tests. The test results are as follows:

Moisture Content:

- 2.4% to 8.8%

The results of the moisture tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 1 in Appendix D.

1.4.1.3 Sand and Gravel

A native sand and gravel layer was encountered below the water in BH-5. The sand and gravel layer extended to depth about 3.1 m below the water surface with elevation about 306.5 m. The explored thickness of this layer was about 2.0 m.

The composition of this layer was sand and gravel, some silt and occasional boulder. The material is brown to grey in color, and wet. The SPT 'N' values obtained within this layer ranged from weight hammer (WH) to 16 blows per 0.3 m penetration, suggesting very loose to very dense in relative density. One SPT 'N' value of 74 blows per 0.3 m penetration was also recorded within this layer, which could be influence of a boulder encountered.

Laboratory testing performed on selected samples consisted of two (2) moisture content tests. The test results are as follows:

Moisture Content:

- 5.2% to 6.9%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.1.4 Silty Sand/Sandy Silt

A native silty sand layer was encountered below the water in BH-1 and BH-4 and below organic silt with sand layer in BH-5 and BH-6. The silty sand/ sandy silt layer extended to depths ranging between 3.2 m and 7.2 m below the water surface with elevations ranging between 302.3 m and 306.3 m. The explored thickness of this layer was between 0.5 m and 4.4 m.

The composition of this layer was generally sand and silt, some gravel, trace to some clay and occasional boulder. The material is brown to grey in color, and wet. The SPT 'N' values obtained within this layer ranged from 2 to 32 blows per 0.3 m penetration, suggesting very loose to dense, but generally loose to compact in relative density.

Laboratory testing performed on selected samples consisted of eleven (11) moisture content and three (3) grain size distribution tests. The test results are as follows:

Moisture Content:

- 11.2% to 30%

Grain Size Distribution:

- 0% to 10% gravel;
- 31% to 73% sand;
- 27% to 51% silt;
- 0% to 10% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 2 in Appendix D.

1.4.1.5 Organic Silt with Sand/ Organic Sandy Silt

A native organic silt with sand/organic sandy silt layer was encountered below the silty sand layer in BH-1 and BH-4, below the sand and gravel layer in BH-5 and below the water in BH-6. The organic silt with sand/organic sandy silt layer extended to depths ranging between 4.6 m and 7.6 m below the water surface with elevations ranging between 302.2 m and 304.9 m. The explored thickness of this layer was between 1.5 m and 4.9 m.

The composition of this layer was silt and sand with organics and occasional wood. The material is dark brown in color, and wet. The SPT 'N' values obtained within this layer ranged from weight hammer (WH) to 32 blows per 0.3 m penetration, suggesting very loose in relative density.

Laboratory testing performed on selected samples consisted of ten (10) moisture content and two (2) grain size distribution tests. The test results are as follows:

Moisture Content:

- 40.4% to 112.8%

Grain Size Distribution:

- 0% gravel;
- 5% to 6% sand;
- 89% to 92% silt;
- 3% to 5% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 3 in Appendix D.

1.4.1.6 Silty Sand with Gravel/Silty Sand with Frequent Boulders

Native silty sand with gravel to silty sand with frequent boulders layer was encountered below the organic silty with sand layer in BH-1 and BH-4 and below the cobbles and boulders fill layer in BH-2 and BH-3. The silty sand with gravel/ silty sand with frequent boulders layer extended to depths ranging between 7.5 m and 11.6 m below the water surface in BH-1, and BH-4 with elevations ranging between 302.0 m and 298.2 m; and extended to depths ranging between 11.4 m and 11.6 below ground surface in BH-2 and BH-3 with elevations ranging between 302.3 m and 302.1 m. The explored thickness of this layer was between 2.6 m and 7.0 m.

The composition of this layer was generally silty sand and gravel with some cobbles and boulders and trace to some clay. The material is grey in color, and wet. The SPT 'N' values obtained within this layer ranged from 3 to 46 blows per 0.3 m penetration, suggesting very loose to dense, but generally very loose to compact in relative density. One SPT 'N' value of above 100 blow per 0.2 m penetration was also recorded within this layer, which could be influence of boulders encountered.

Laboratory testing performed on selected samples consisted of twelve (12) moisture content tests and five (5) grain size distribution tests. The test results are as follows:

Moisture Content:

- 0.8% to 33%

Grain Size Distribution:

- 1% to 23% gravel;
- 42% to 91% sand;
- 8% to 56% silt;
- 0% to 16% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 4 in Appendix D.

1.4.1.7 Cobbles and Boulders

Cobbles and boulders were encountered underlying the silty sand with frequent boulders layer in BH-4. The cobbles and boulders layer extended to depths about 15.4 m below the water surface with elevation about 294.4 m. The explored thickness of this layer was about 3.8 m. BH-4 was terminated within this layer.

The composition of this layer is mostly cobbles and boulders, some sand and some gravel. The SPT “N” value obtained within this layer was 50 blows per 127 mm penetration suggesting very dense compactness condition. The recovered cored sample obtained within this layer is about 150 mm.

Laboratory testing performed on one collected sample consisted of moisture content test and the test result is as follows:

Moisture Content:

- 0.8% to 33%

1.4.1.8 Bedrock

Bedrock was encountered underlying the silty sand with gravel/ silty sand with frequent boulders layer in all boreholes except in BH-4, which was terminated within the cobbles and boulders layer to its desired depth. The bedrock was encountered at depths ranging between about 6.6 m and 7.5 m below the water surface at the inlet and outlet, and about 11.4 m to 11.6 m below the existing road surface. The bedrock was confirmed by coring of 3.0 m to 3.2 m long rock cores. The elevation of the actual bedrock surface at proposed culvert replacement location ranges from 302.0 m to 303.2 m. Boreholes (BH-1, BH-2, BH-3, BH-5 and BH-6) were terminated within the bedrock level. The bedrock surface depth and elevation encountered at the drilled borehole locations are listed in Table 1.1. Photographs of rock cores are included in Appendix E.

Golder’s investigation with rock probeholes showed that the inferred bedrock surface could be approximately between Elev. 305.8 m and 300.8 m at the locations of drilling (Appendix F).

Table 1.1 Depth and elevation of bedrock surface

Borehole	Depth Below Ground Surface (m)	Elevation (m)	Comments
BH-1	7.5	302.0	Bedrock Cored
BH-2	11.4	302.3	Bedrock Cored
BH-3	11.6	302.1	Bedrock Cored
BH-5	7.2	302.3	Bedrock Cored
BH-6	6.6	303.2	Bedrock Cored

Based on the rock cores recovered, the bedrock consists of mafic metavolcanics rock. In general, the rock samples are described as dark grey, with white striations have a fine crystalline structure, slightly weathered, very strong. The Rock Quality Designation (RQD) measured on the rock core samples ranged from approximately 40% to 96.9%, indicating a rock mass of poor to excellent, but generally good to excellent quality.

1.4.2 Temporary Modular Bridge Location

In general, the subsurface conditions along the proposed temporary modular bridge site consist of a layer of sand and gravel fill underlain by bedrock. A detailed description of subsurface conditions encountered is discussed further in subsequent sections.

1.4.2.1 Fill: Sand and Gravel

Sand and gravel fill was encountered at the surface of BH-7 and BH-8 at the proposed TMB site. The fill layer extended to depth ranging between 2.3 m and 3.7 m below ground surface with elevations ranging between 307.7 m and 309.0 m. The explored thickness of this layer was between 2.3 m and 3.7 m.

The composition of this fill layer was generally sand and gravel with some silt, some cobbles, trace organics and trace wood. The material is brown in color, and moist. The SPT 'N' values within this layer ranged from 6 to 31 blows per 0.3 m penetration, suggesting loose to dense but generally compact in relative density.

Laboratory testing performed on selected samples consisted of eight (8) moisture content tests and two (2) grain size distribution tests. The test results are as follows:

Moisture Content:

- 4.1% to 26.7%

Grain Size Distribution:

- 43% to 53% gravel;
- 15% to 54% sand;
- 32% silt;
- 0% clay; and
- 3% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of the grain size distribution tests are also provided on Figure 5 in Appendix D.

1.4.2.2 Bedrock

Bedrock was encountered underlying the sand and gravel fill in all boreholes drilled at the TMB site location. The bedrock was encountered at depths ranging between about 2.3 m and 3.7 m below the ground surface. The bedrock was confirmed by coring of 3.0 m to 3.1 m long rock cores. The elevation of the actual bedrock surface ranges from 307.9 m to Elev. 309.2 m. All boreholes were terminated within the bedrock level. The bedrock surface depth and elevation encountered at the drilled borehole locations are listed in Table 1.2. Photographs of rock cores are included in Appendix E.

Table 1.2 Depth and elevation of bedrock surface

Borehole	Depth Below Ground Surface (m)	Elevation (m)	Comments
BH-7	3.7	307.9	Bedrock Cored
BH-8	2.3	309.2	Bedrock Cored

Based on the rock cores recovered, the bedrock consists of mafic metavolcanics rock. In general, the rock samples are described as dark grey, with white striations have a fine crystalline structure, slightly weathered, very strong. The Rock Quality Designation (RQD) measured on the rock core samples ranged from approximately 66.7% to 7.9%, indicating a rock mass of fair to excellent, but generally good to excellent quality.

1.5 Groundwater Conditions

Information regarding groundwater levels at the site was obtained by measuring water levels in open boreholes of land boreholes (BH-2, BH-3 and BH-8) after completion of drilling. The groundwater levels measured in the boreholes are shown on borehole logs. Water levels measured in open boreholes might not be stabilized due to a short-term observation and using of a wash boring technique to advance the boreholes. Since boreholes BH-1, BH-4, BH-5 and BH-6 were drilled in water, the water level in the pool/creek was measured as a relevant water level for these boreholes.

The groundwater levels measured in open boreholes upon completion of drilling were recorded at 4.1 m (BH-2) and 4.0 m (BH-3) below the ground surface corresponding to Elev. 309.6 m and 309.7 m, respectively at the proposed culvert replacement site location, and about 1.8 m below ground surface (Elev. 309.7 m) at the proposed TMB site location.

In June 2017, the inlet of the existing culvert was completely submerged and it was estimated that the water level was about Elev. 310.3 m. In July 2017, the water level at the inlet side was about Elev. 309.8 m. At the outlet, the water level of the flowing stream was measured approximately at elevation 309.5 m in June and July 2017.

Groundwater levels would be expected to reflect levels in the adjacent open water body/stream and to fluctuate seasonally. Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods as noted during this investigation.

2 CLOSURE

A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report has been prepared by Nimesh Tamrakar, M.Eng, EIT., and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Mr. Shane Tobias.

exp Services Inc.



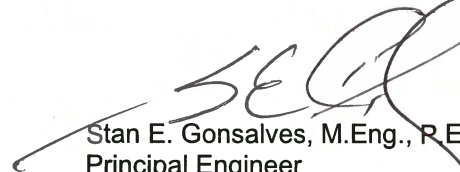
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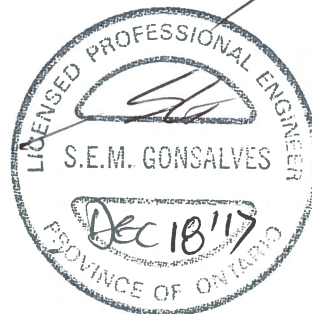
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3 LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or

inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.

USE OF REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of exp. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. exp is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

REPORT FORMAT

Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

Appendix A – Site Photographs



Photo 1. Hwy 672, looking north



Photo 2. Hwy 672, looking south



Photo 3. Looking east from the outlet of the culvert



Photo 4. Looking west from the inlet of the culvert



Photo 5. East (outlet) side of the embankment looking north



Photo 6. East (outlet) side of the embankment looking south

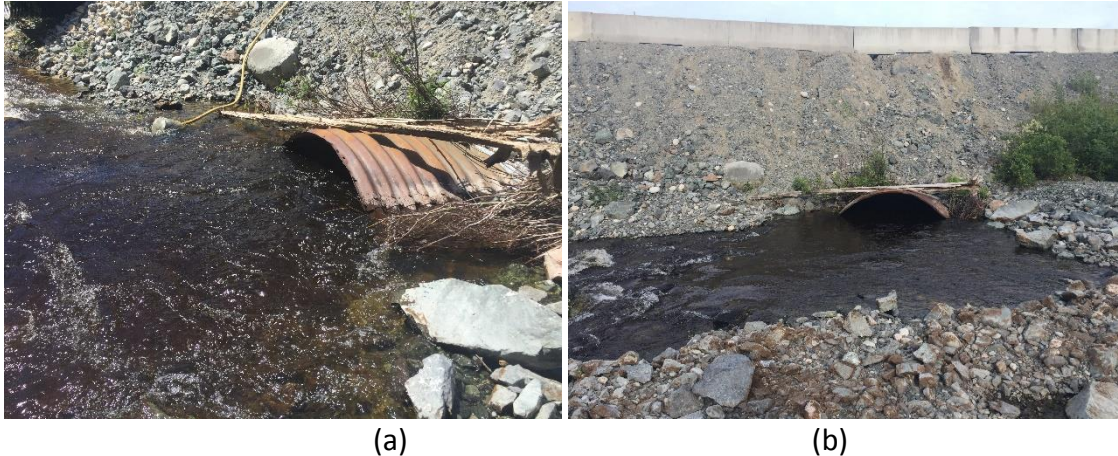


Photo 7. Water levels at outlet of existing culvert, (a) in June 2017 and (b) July 2017



Photo 8. West (inlet) side of the embankment looking north



Photo 9. West (inlet) side of the embankment looking south



Photo 10. Submerged inlet of existing culvert during Phase I investigation on June 2017



Photo 11. Temporary twin culvert, inlet side looking east



Photo 12. Water seepage through east(outlet) side of embankment north of existing culvert



Photo 13. Temporary modular bridge location looking south, note existing abutment



Photo 14. Crain lifting of barge and rig and placing them in water

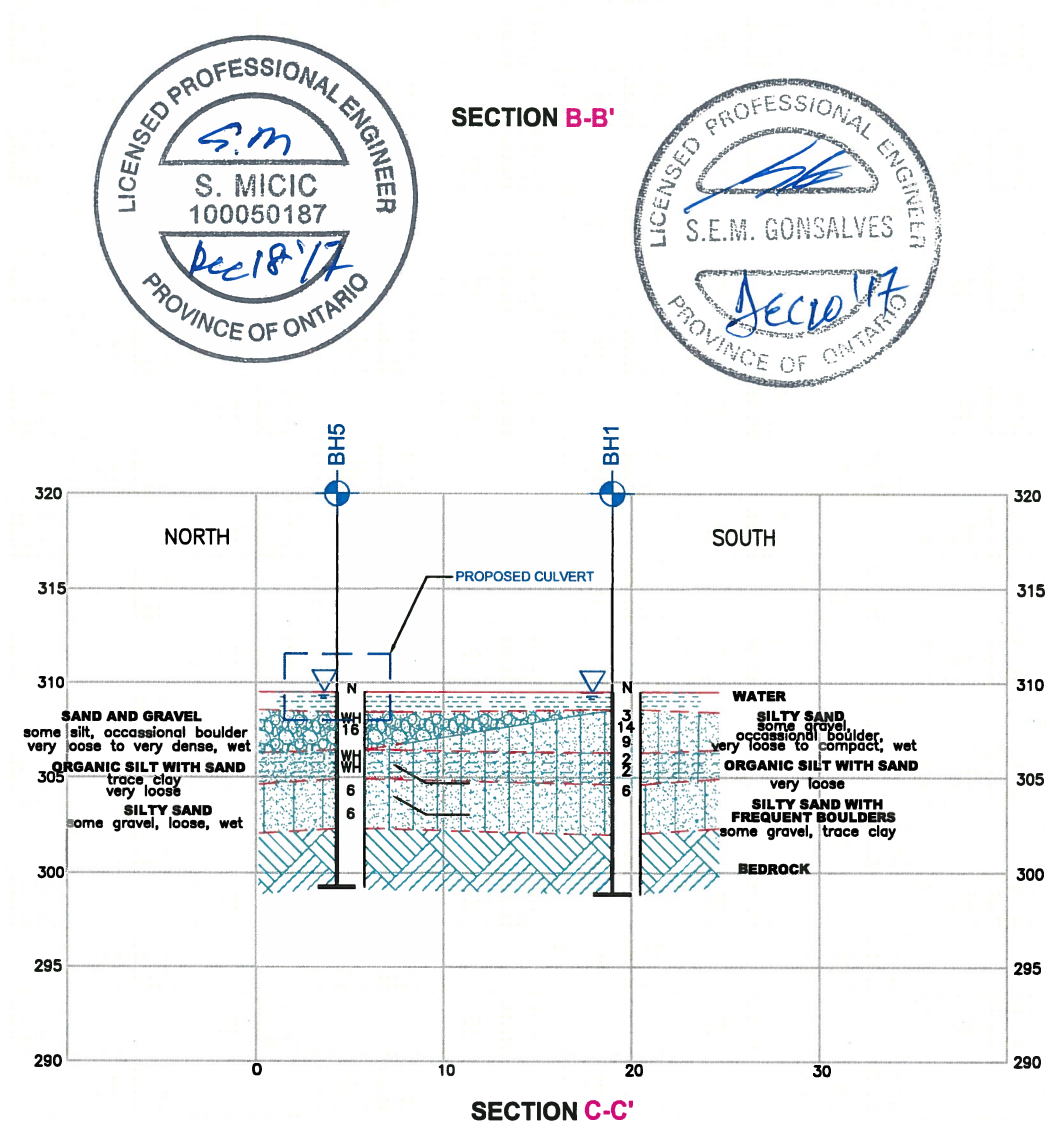
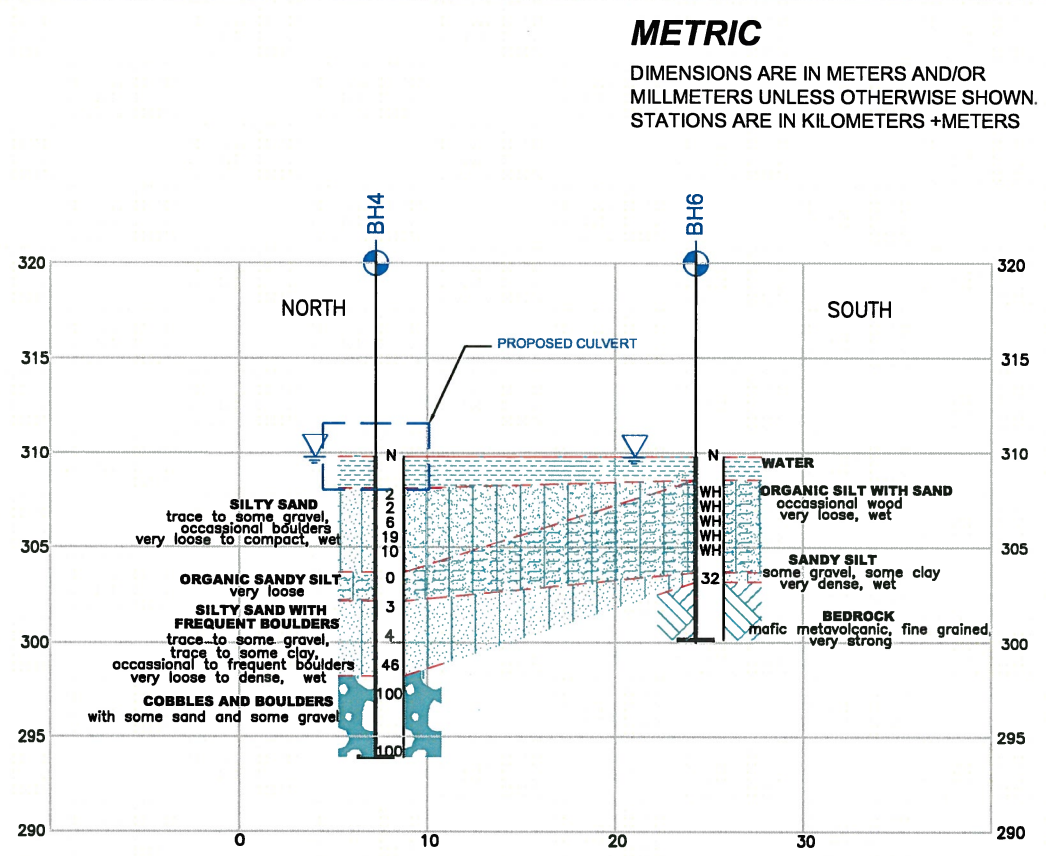
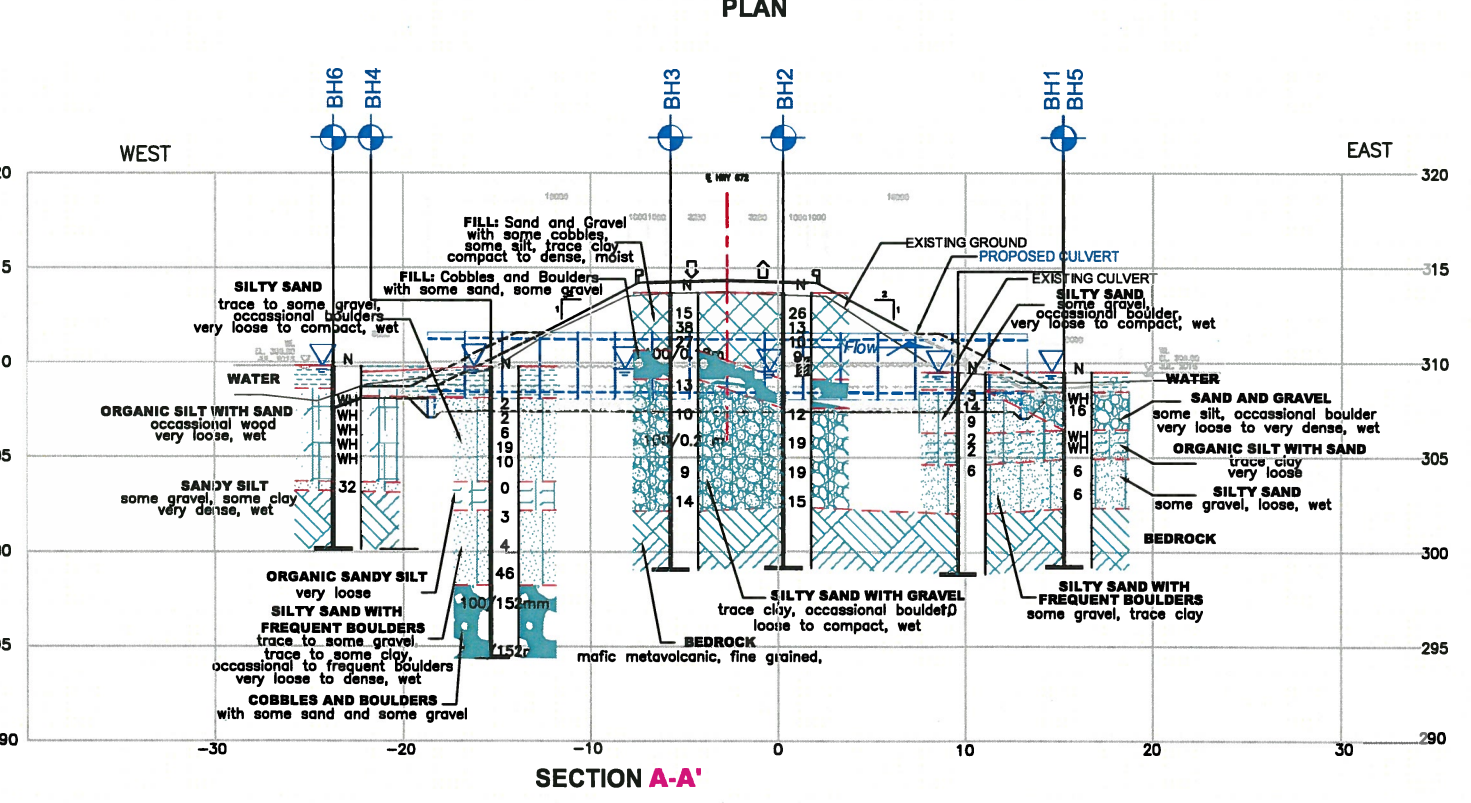
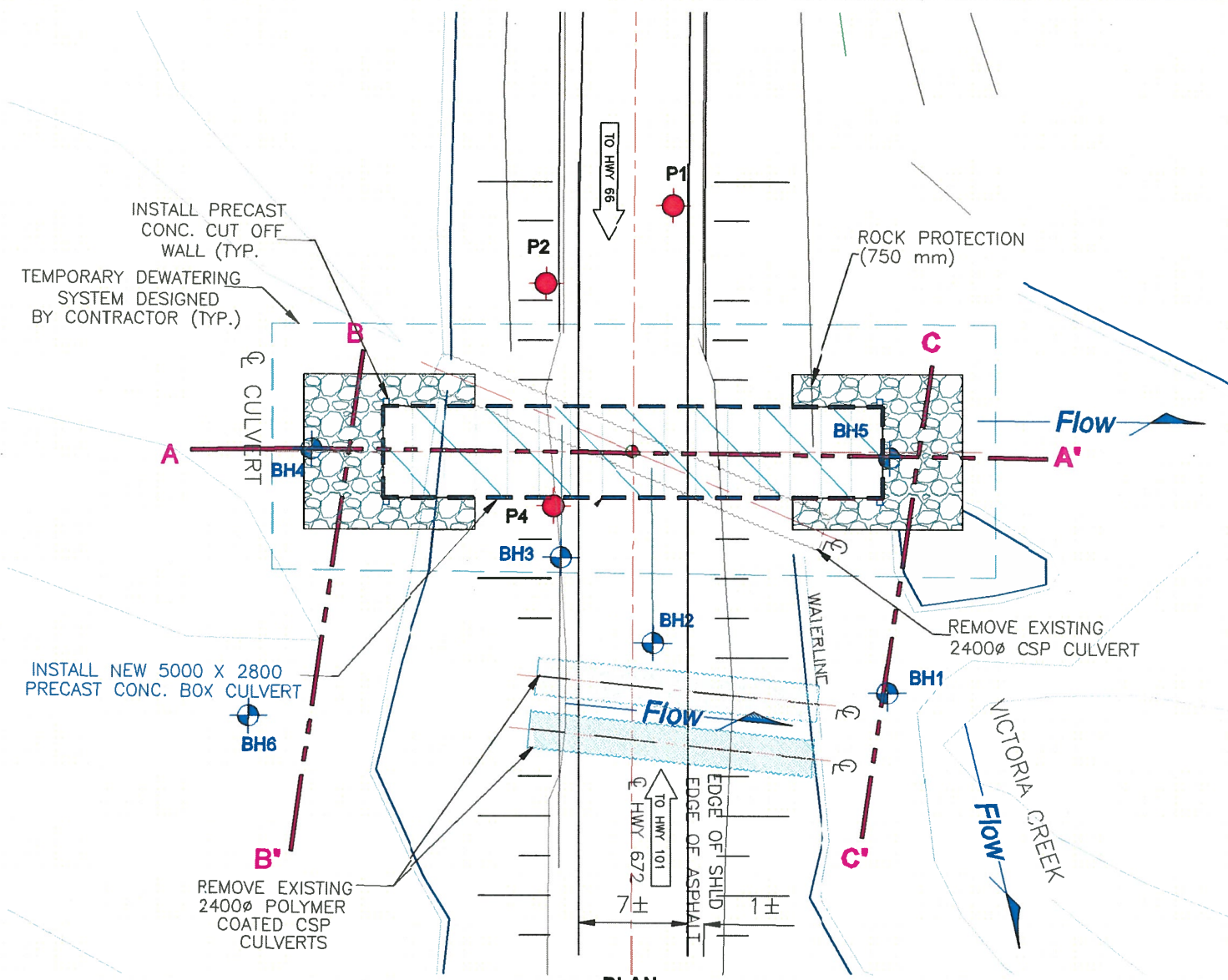


Photo 15. Borehole BH-1 drilling using a barge



Photo 16. Benchmark HCP (101)

Appendix B – Drawings



SECTION B-B'



SECTION C-C'

METRIC

DIMENSIONS ARE IN METERS AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETERS +METERS

Agreement No. 5015-E-0007
Assignment No. 7
GWP 5027-17-00



VICTORIA CREEK CULVERT REPLACEMENT
HWY 672
BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET

exp Services Inc.



- LEGEND**
- Boreholes Done in 2017 by exp
 - Probeholes Done in May 2017 by Golder
 - N Standard Penetration Test (Blows/0.3 m)
 - Water Level Upon Completion of Drilling
 - BM (HCP101)
 - BM (HCP175)

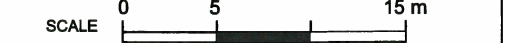
SOIL STRATA SYMBOLS

WATER	ORGANIC SILT WITH SAND/ ORGANIC SANDY SILT	FILL
SAND AND GRAVEL	COBBLES AND BOULDERS	SAND
SILTY SAND/ SANDY SILT	SILTY SAND WITH GRAVEL	BEDROCK

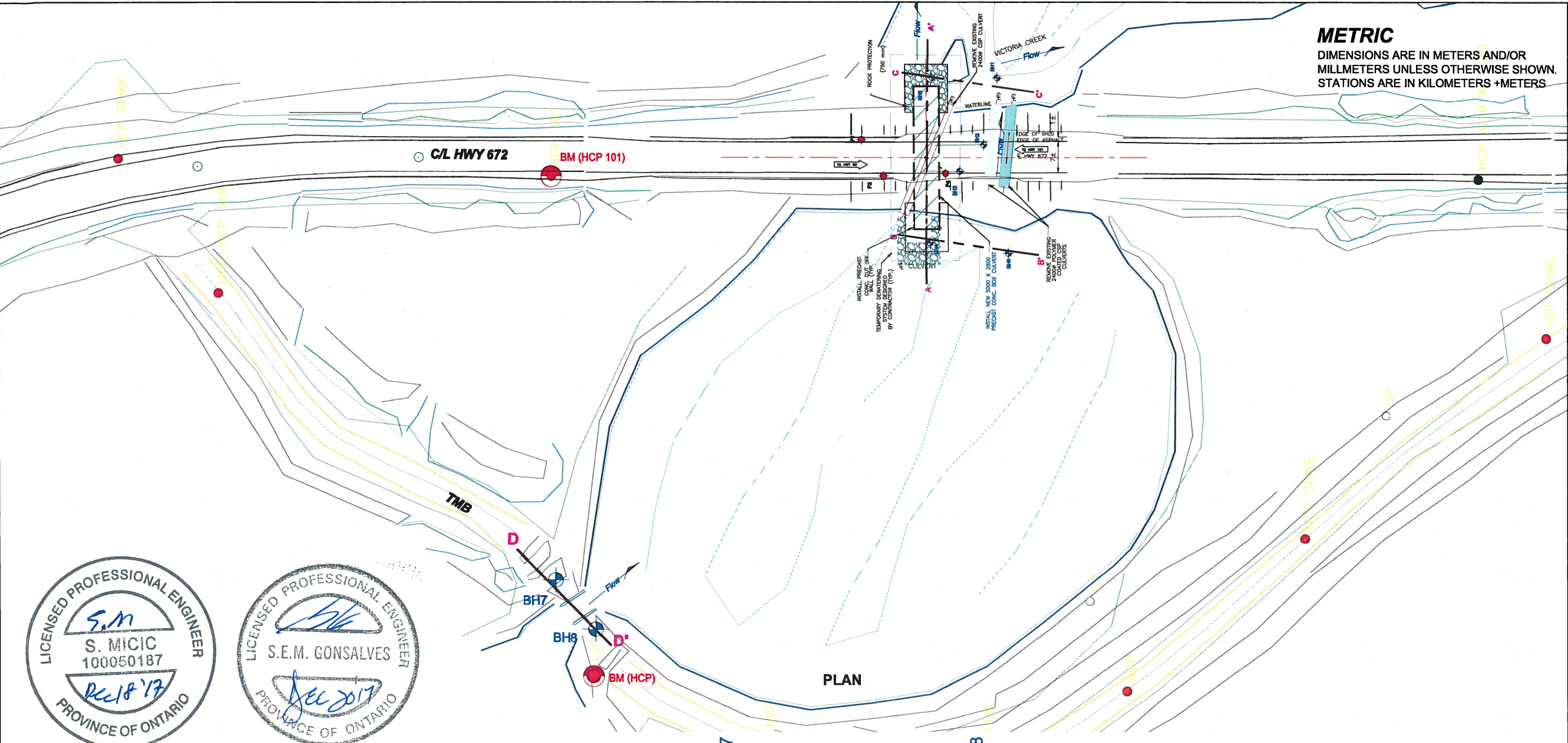
BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH1	309.5	5339886.1	389572.4
BH2	313.7	5339889.1	389557.4
BH3	313.7	5339894.5	389551.4
BH4	309.8	5339901.1	389535.4
BH5	309.5	5339916.1	389565.4
BH6	309.8	5339884.1	389533.4
BH7	311.6	5339985.2	389459.4
BH8	311.5	5339976.2	389448.4
P1	313.7	5339916.7	389558.4
P2	313.7	5339911.7	389550.3
P4	313.6	5339897.7	389550.9

NOTE
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 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 the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OHS Gen. Cond.



12/01/2017	SM	SUBMISSION FOR MTO REVIEW	
DATE	BY	DESCRIPTION	
		GEORES NO. 32D-22	
		PROJECT NO. ADM-00233185-H0	
SUBMD SM	CHECKED SM	DATE	Dec. 20, 17
DRAWN SH	CHECKED SG	APPROVED SG	DWG. 1



METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETERS + METERS

Agreement No. 5015-E-0007
Assignment No. 7
GWP 5027-17-00

VICTORIA CREEK CULVERT REPLACEMENT
HWY 672
BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET

exp

exp Services Inc.



LEGEND

- Boreholes Done in 2017 by exp
- Probeholes Done in May 2017 by Golder
- N Standard Penetration Test (Blows/0.3 m)
- Water Level Upon Completion of Drilling
- BM (HCP101)
- BM(HCP175)

SOIL STRATA SYMBOLS

WATER	ORGANIC SILT WITH SAND/ ORGANIC SANDY SILT	FILL
SAND AND GRAVEL	COBBLES AND BOULDERS	SAND
SILTY SAND/ SANDY SILT	SILTY SAND WITH GRAVEL	BEDROCK

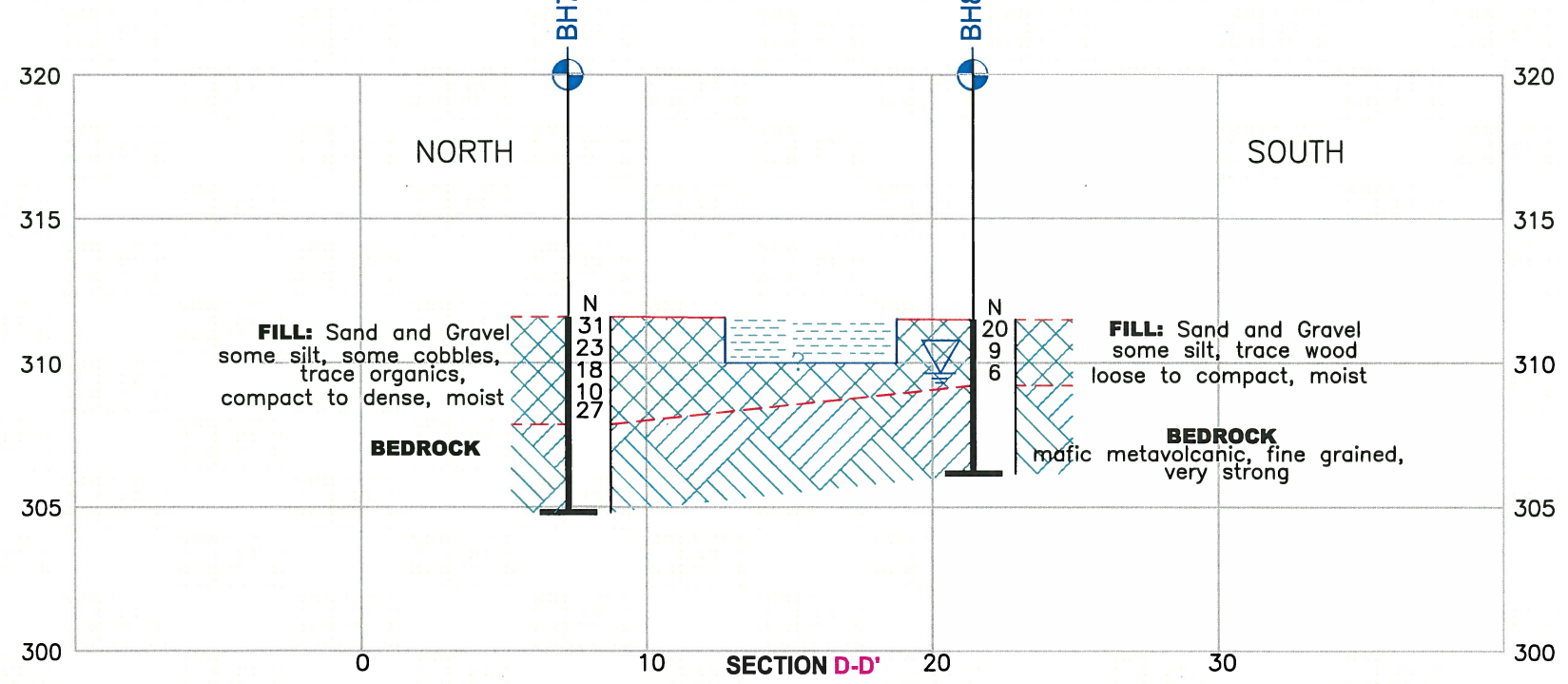
BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH1	309.5	5339886.1	389572.4
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BH4	309.8	5339901.1	389535.4
BH5	309.5	5339916.1	389565.4
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BH8	311.5	5339976.2	389448.4
P1	313.7	5339916.7	389558.4
P2	313.7	5339911.7	389550.3
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12/01/2017	SM	SUBMISSION FOR MTO REVIEW	
DATE	BY	DESCRIPTION	
		GEOCRES NO. 32D-22	
		PROJECT NO. ADM-00233185-H0	
SUBMD SM	CHECKED SM	DATE	Dec. 20, 17
DRAWN SH	CHECKED SG	APPROVED SG	DWG. 2



Appendix C – Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.

ISSMFE SOIL CLASSIFICATION											
CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	200	
EQUIVALENT GRAIN DIAMETER IN MILLIMETRES											
CLAY (PLASTIC) TO				FINE		MEDIUM		CRS.	FINE	COARSE	
SILT (NONPLASTIC)				SAND				GRAVEL			
UNIFIED SOIL CLASSIFICATION											

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Note 16 in ASTM D2488-09a:

Table a: Percent or Proportion of Soil, Pp

	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	$5 \leq Pp \leq 10\%$
Little	$15 \leq Pp \leq 25\%$
Some	$30 \leq Pp \leq 45\%$
Mostly	$50 \leq Pp \leq 100\%$

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	$N < 5$
Loose	$5 \leq N < 10$
Compact	$10 \leq N < 30$
Dense	$30 \leq N < 50$
Very Dense	$50 \leq N$

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

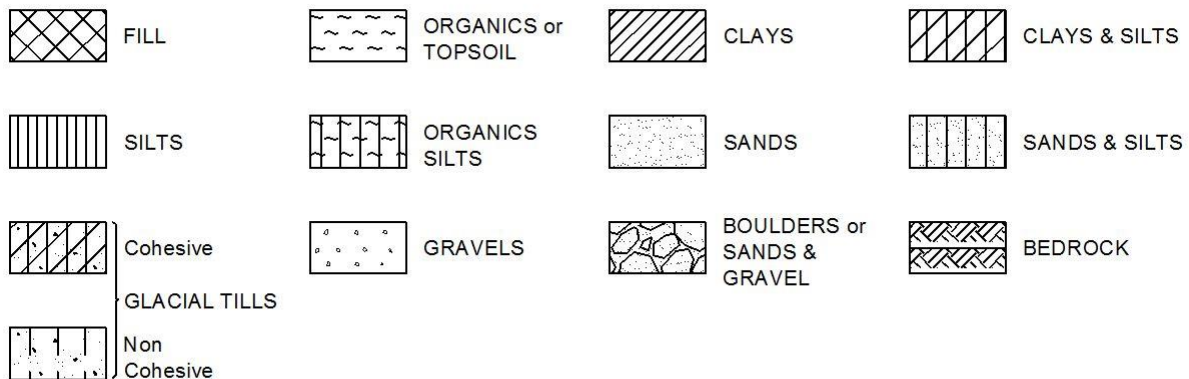
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m ² /s	Coefficient of consolidation
H	m	Drainage path
T_v	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_p	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	—°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	—°	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m ³	Density of solid particles
γ_s	kN/m ³	Unit weight of solid particles
ρ_w	kg/m ³	Density of water
γ_w	kN/m ³	Unit weight of water
ρ	kg/m ³	Density of soil
γ	kN/m ³	Unit weight of soil
ρ_d	kg/m ³	Density of dry soil
γ_d	kN/m ³	Unit weight of dry soil
ρ_{sat}	kg/m ³	Density of saturated soil
γ_{sat}	kN/m ³	Unit weight of saturated soil
ρ'	kg/m ³	Density of submerged soil
γ'	kN/m ³	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_p	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_p$
I_C	%	Consistency index = $(W_L - W)/I_p$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m ³ /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m ³	Seepage force

Brampton, Ontario

RECORD OF BOREHOLE No BH-1

1 OF 1

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339886.1, E389572.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT
 DATUM Geodetic DATE 2017.07.13 - 2017.07.13 LATITUDE 48.192133 LONGITUDE -79.859664 CHECKED BY SM

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										
								○ UNCONFINED	+	FIELD VANE								
309.5	Water Surface						● QUICK TRIAXIAL	×	LAB VANE	WATER CONTENT (%)								
0.0	WATER	△					20	40	60	80	100	20	40	60	GR SA SI CL			
		△																
		△																
308.6		△																
0.9	SILTY SAND: some gravel, occasional boulder, brown, wet, very loose to compact		1	SS	3							○						
			2	SS	14							○						
			3	SS	9							○						
306.3																		
3.2	ORGANIC SILT WITH SAND dark brown to grey, very loose		4	SS	2									○				
			5	SS	2								○		0 6 89 5			
304.6																		
4.9	SILTY SAND WITH FREQUENT BOULDERS: some gravel, trace clay, grey, wet, loose		6	SS	6							○			3 52 40 5			
	- becoming frequent boulders below 6.2 m																	
302.0																		
7.5	BEDROCK: mafic metavolcanic, fine grained, very strong, dark grey NQ Coring		7	NQ														
	Length (m) RQD(%) Run1 1.52 81.7% Run2 1.67 96.9%																	
			8	NQ														
298.8																		
10.7	End of borehole at 10.67 m depth.																	
	Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Borehole drilled through water using barge																	

ONTARIO MTO ASSIGNMENT#7, NER_GRP ONTARIO MTO.GDT 8/4/17

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

Brampton, Ontario

RECORD OF BOREHOLE No BH-2

1 OF 2

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339889.1, E389557.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE CME-75/NW Casing/HQ COMPILED BY NT
 DATUM Geodetic DATE 2017.06.13 - 2017.06.14 LATITUDE 48.19216 LONGITUDE -79.85986 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20					40	60	80				
313.7	Ground Surface																						
0.0	FILL: SAND AND GRAVEL with some cobbles, some silt, trace clay brown, moist, compact -suspect cobbles, no recovery		1	AS			313								○					40 55 (5)			
			2	SS	26											○						No sample recovery	
			3	SS	13																		
			4	SS	10											○							
			5	SS	9												○					26 49 24 1	
309.1	FILL: COBBLES AND BOULDERS with some sand, some gravel		6	SS	100/ 0.05 m		309									○							
4.6																							
								308															
307.6	SILTY SAND WITH GRAVEL: grey, wet, compact		7	SS	12			307									○				1 91 8 0		
6.1																						Very less sample recovery	
			8	SS	19		306										○						
								305														Very less sample recovery	
			9	SS	19		304											○					
								303															No sample recovery
			10	SS	15																		
302.3							302																
11.4			11	HQ																			

Continued Next Page

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

ONTARIO MTO ASSIGNMENT#7, NER_GRP ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

2 OF 2

METRIC

W.P.	5027-17-00	LOCATION	Hwy 672, Dobie, MTM ON12 N5339889.1, E389557.4			ORIGINATED BY	ST
DIST	Tamiskaming	HWY	672	TEST PIT TYPE	CME-75/NW Casing/HQ	COMPILED BY	NT
DATUM	Geodetic	DATE	2017.06.13 - 2017.06.14	LATITUDE	48.19216	LONGITUDE	-79.85986
						CHECKED BY	SM

[illegible]

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

ONTARIO MTO ASSIGNMENT#7, NER.GPJ ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

RECORD OF BOREHOLE No BH-3

1 OF 2

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339894.5, E389551.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE CME-75/NW Casing/HQ COMPILED BY NT
 DATUM Geodetic DATE 2017.06.14 - 2017.06.15 LATITUDE 48.19219 LONGITUDE -79.859945 CHECKED BY SM

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 (%)		
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE									
313.7 0.0	Ground Surface FILL: SAND AND GRAVEL with some cobbles, some silt, trace clay brown, moist, compact to dense		1	AS			313									54 42 (4)			
			2	SS	15														
			3	SS	38			312											
			4	SS	27			311											
310.7 3.1	FILL: COBBLES AND BOULDERS with some sand, some gravel			5	SS		100/ 0.18m		310										
309.1 4.6	SILTY SAND WITH GRAVEL: trace clay, occasional boulder, grey, wet, loose to compact		6	SS	13			309										23 50 27 0	
								308											
				7	SS		10		307										
				8	SS		100/ 0.2 m		306										
								305											
				9	SS	9		304											
								303											
				10	SS	14													
302.1 11.6	Spoon refusal, encountered boulder between 8 m to 8.4 m		11	HQ			302									19 42 36 3			

Continued Next Page

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

ONTARIO MTO ASSIGNMENT#7, NER_GPJ ONTARIO MTO.GDT 8/4/17

METRIC

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

Brampton, Ontario

RECORD OF BOREHOLE No BH-4

1 OF 2

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339901.1, E389535.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT
 DATUM Geodetic DATE 2017.07.05 - 2017.07.05 LATITUDE 48.192273 LONGITUDE -79.860158 CHECKED BY SM

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													
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)									
309.8 0.0	Water Surface WATER	△				▽	20	40	60	80	100	20	40	60	kN/m ³	GR	SA	SI	CL		
		△																			
		△																			
		△																			
		△																			
		△																			
308.1 1.7	SILTY SAND : trace to some gravel, occasional boulders grey, wet, very loose to compact	△																			
			1	SS	2								○								
			2	SS	2								○					0	73	27	0
			3	SS	6								○								
			4	SS	19								○								
			5	SS	10								○								
303.7 6.1	ORGANIC SANDY SILT dark brown , very loose		6	SS	0									○							
302.2 7.6	SILTY SAND WITH FREQUENT BOULDERS : trace to some gravel, trace to some clay, occasional to frequent boulders, grey, wet, very loose to dense -becoming occasional boulders		7	SS	3								○					0	28	56	16
			8	SS	4								○								
	-becoming occasional to frequent boulders																				
			9	SS	46								○								
298.2 11.6		○																			
		○																			

Continued Next Page

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

ONTARIO MTO ASSIGNMENT#7, NER_GRP ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

RECORD OF BOREHOLE No BH-4										2 OF 2		METRIC					
W.P. 5027-17-00			LOCATION Hwy 672, Dobie, MTM ON12 N5339901.1, E389535.4					ORIGINATED BY ST									
DIST Tamiskaming HWY 672			TEST PIT TYPE Continuous Flight Hollow Stem Augers					COMPILED BY NT									
DATUM Geodetic			DATE 2017.07.05 - 2017.07.05		LATITUDE 48.192273		LONGITUDE -79.860158		CHECKED BY SM								
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					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								20	40	60	80	100	20	40	60	kN/m ³	GR SA SI CL
	COBBLES AND BOULDERS: with some sand and some gravel NQ Coring Length (m) RQD(%) Run1 1.52 81.7% Run2 1.67 96.9% (continued)		10	SS	100/152 mm		297										No sample recovery
								296									
								295									
294.4 15.4	End of borehole at 15.4 m depth. Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Borehole drilled through water using barge		11	SS	100/152 mm												No sample recovery

ONTARIO MTO ASSIGNMENT#7, NER_GPJ ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

RECORD OF BOREHOLE No BH-5

1 OF 1

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339916.1, E389565.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT
 DATUM Geodetic DATE 2017.07.11 - 2017.07.12 LATITUDE 48.192403 LONGITUDE -79.859752 CHECKED BY SM

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 (%)			GR
309.5 0.0	Water Surface WATER	△ △ △ △						20	40	60	80	100								
308.4 1.1	SAND AND GRAVEL: some silt, occasional boulder, brown to grey, wet, very loose to very dense		1	SS	WH		309													
			2	SS	16		308													
			3	SS	74		307													
306.5 3.1	-boulder encountered ORGANIC SILT WITH SAND trace clay, dark brown, very loose		4	SS	WH		306										90.8	0	5	92 3
			5	SS	WH		305													
304.9 4.6	SILTY SAND : some gravel, brown, wet, loose		6	SS	6		304													
			7	SS	6		303											10	49	41 0
302.3 7.2	BEDROCK: mafic metavolcanic, fine grained, very strong, dark grey NQ Coring		8	NQ			302													
	Length (m) RQD(%) Run1 1.52 70% Run2 1.57 90.3%						301													
			9	NQ			300													
299.2 10.3	End of borehole at 10.29 m depth. Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Borehole drilled through water using barge																			

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

ONTARIO MTO ASSIGNMENT#7, NER_GRP ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

RECORD OF BOREHOLE No BH-6

1 OF 1

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339884.1, E389533.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT
 DATUM Geodetic DATE 2017.07.06 - 2017.07.06 LATITUDE 48.19212 LONGITUDE -79.860188 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P	W	W _L		WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE												
309.8 0.0	Water Surface WATER	△ △ △ △ △						20	40	60	80	100									
308.6 1.2	ORGANIC SILT WITH SAND occasional wood, dark brown, wet, very loose																				
			1	SS	WH																
			2	SS	WH																
			3	SS	WH																
			4	SS	WH																
			5	SS	WH																
303.7 6.1	SANDY SILT : some gravel, some clay, grey, wet, very dense		6	SS	32																
303.2 6.6	BEDROCK : mafic metavolcanic, fine grained, very strong, dark grey NQ Coring Length (m) RQD(%) Run1 1.52 83.3% Run2 1.52 91.7%		7	NQ																	
		8	NQ																		
300.2 9.7		End of borehole at 9.65 m depth. Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Borehole drilled through water using barge																			

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

ONTARIO MTO ASSIGNMENT#7, NER_GPJ ONTARIO MTO.GDT 8/4/17



Brampton, Ontario

RECORD OF BOREHOLE No BH-7

1 OF 1

METRIC

W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339985.16, E389459.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE CME-75/NW Casing/HQ COMPILED BY NT
 DATUM Geodetic DATE 2017.06.15 - 2017.06.15 LATITUDE 48.193038 LONGITUDE -79.861164 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE											
311.6	Ground Surface						● QUICK TRIAXIAL	× LAB VANE												
0.0	FILL: SAND AND GRAVEL some silt, some cobbles, trace organics, brown, moist, compact to dense		1	SS	31															
			2	SS	23															
			3	SS	18															
			4	SS	10															
			5	SS	27															
307.9																				
3.7	BEDROCK: mafic metavolcanic, fine grained, very strong, dark grey HQ Coring		6	HQ																
	Length (m) RQD(%) Run1 0.61 66.7% Run2 1.22 85.4% Run3 1.22 97.9%																			
			7	HQ																
			8	HQ																
304.8																				
6.8	End of borehole at 6.78 m depth.																			
	Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level was not measured in open hole upon completion of borehole																			

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

ONTARIO MTO ASSIGNMENT#7, NER_GRP ONTARIO MTO.GDT 8/4/17

Brampton, Ontario

RECORD OF BOREHOLE No BH-8

1 OF 1

METRIC

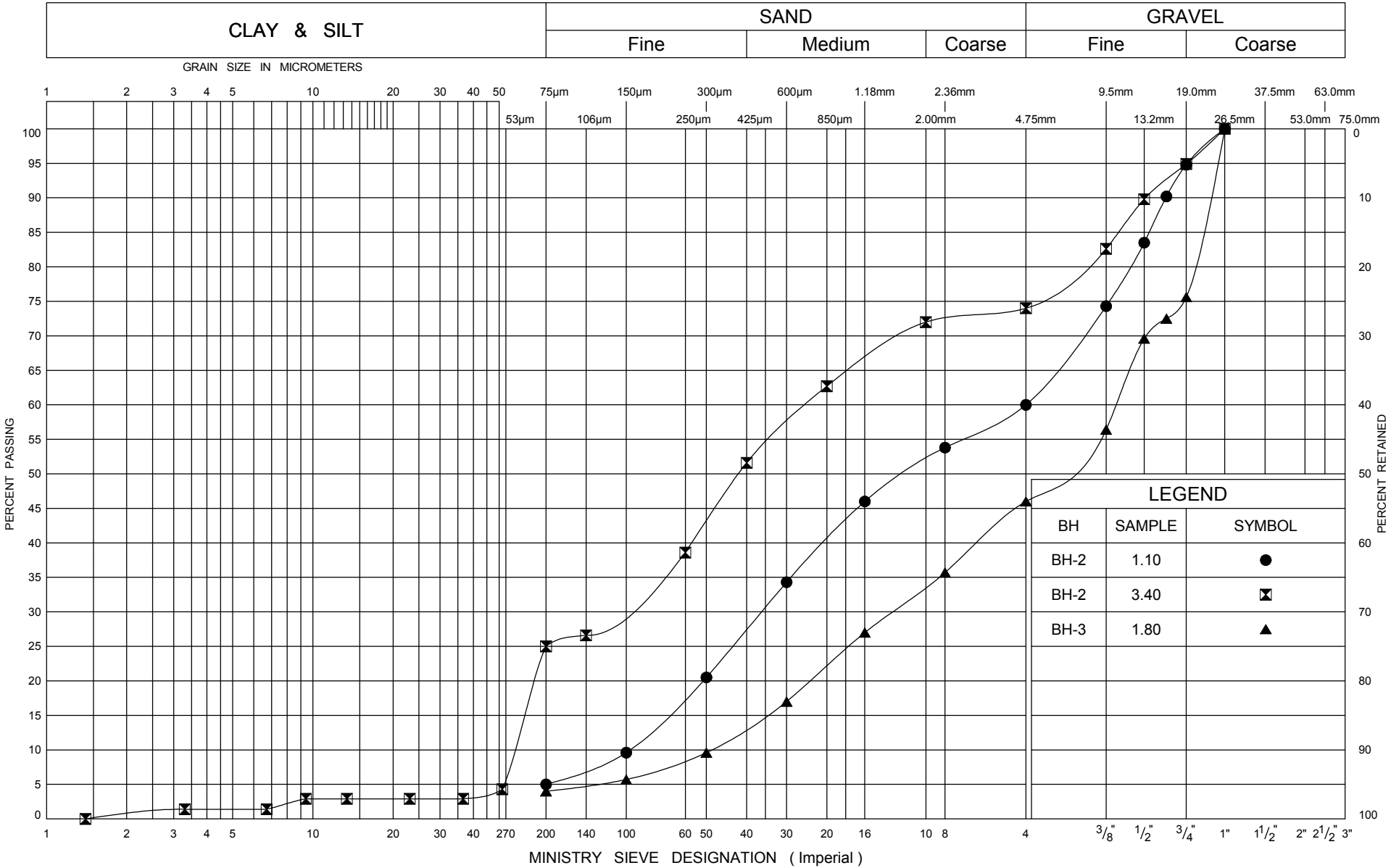
W.P. 5027-17-00 LOCATION Hwy 672, Dobie, MTM ON12 N5339976.15, E389448.4 ORIGINATED BY ST
 DIST Tamiskaming HWY 672 TEST PIT TYPE CME-75/NW Casing/HQ COMPILED BY NT
 DATUM Geodetic DATE 2017.06.13 - 2017.06.13 LATITUDE 48.19296 LONGITUDE -79.861314 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE														
311.5	Ground Surface																						
0.0	FILL: SAND AND GRAVEL some silt, trace wood, brown, moist, loose to compact		1	SS	20								○										
			2	SS	9								○										
			3	SS	6								○										
309.2																							
2.3	BEDROCK: mafic metavolcanic, fine grained, very strong, dark grey HQ Coring																						
	Length (m) RQD(%)		6	HQ																			
	Run1 1.27 94%																						
	Run2 0.91 94.4%																						
	Run3 0.86 88.2%																						
			7	HQ																			
			8	HQ																			
306.2																							
5.3	End of borehole at 5.33 m depth. Groundwater level was measured at 1.83 m Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level was measured in open hole upon completion of borehole																						

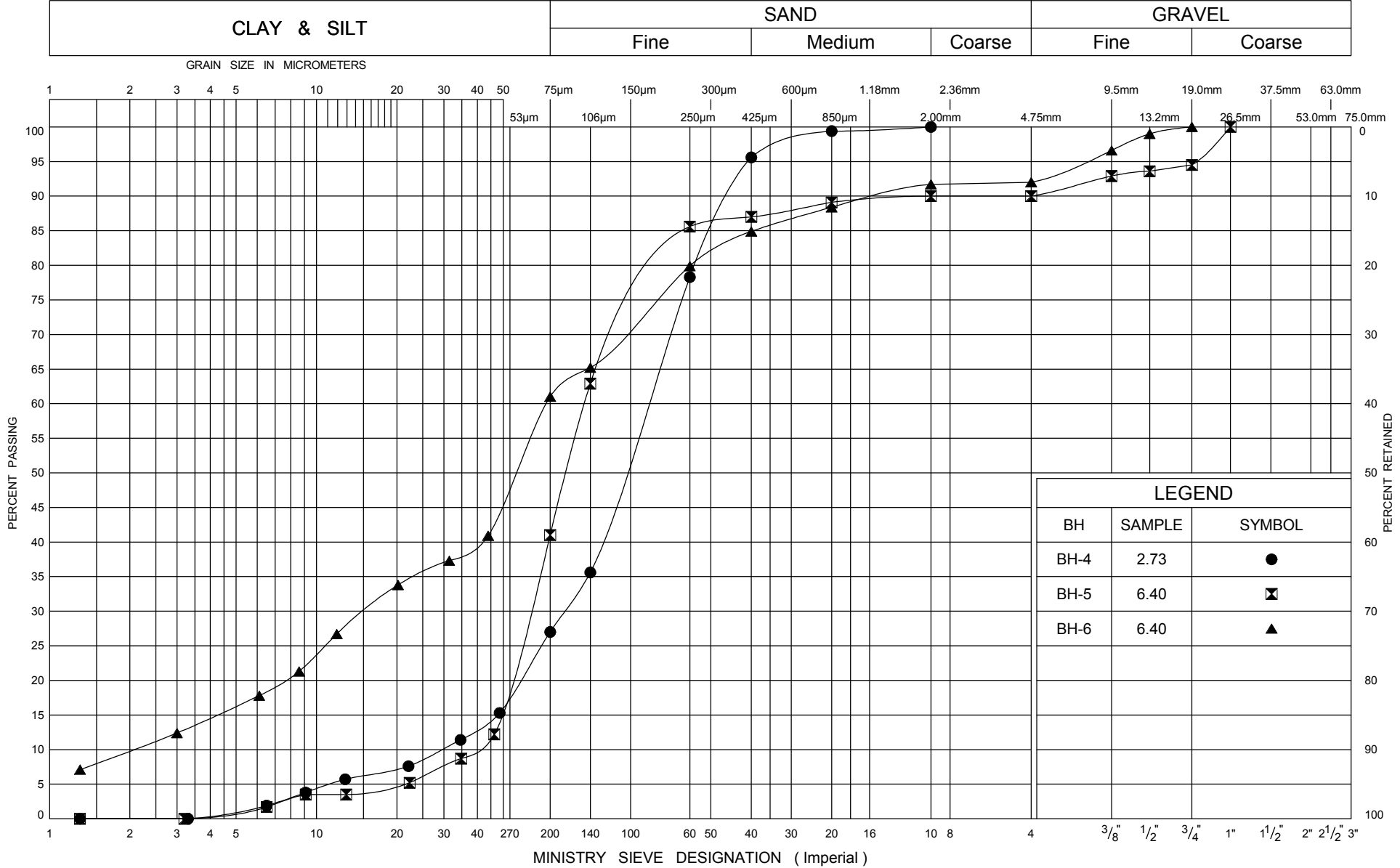
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Appendix D – Laboratory Data

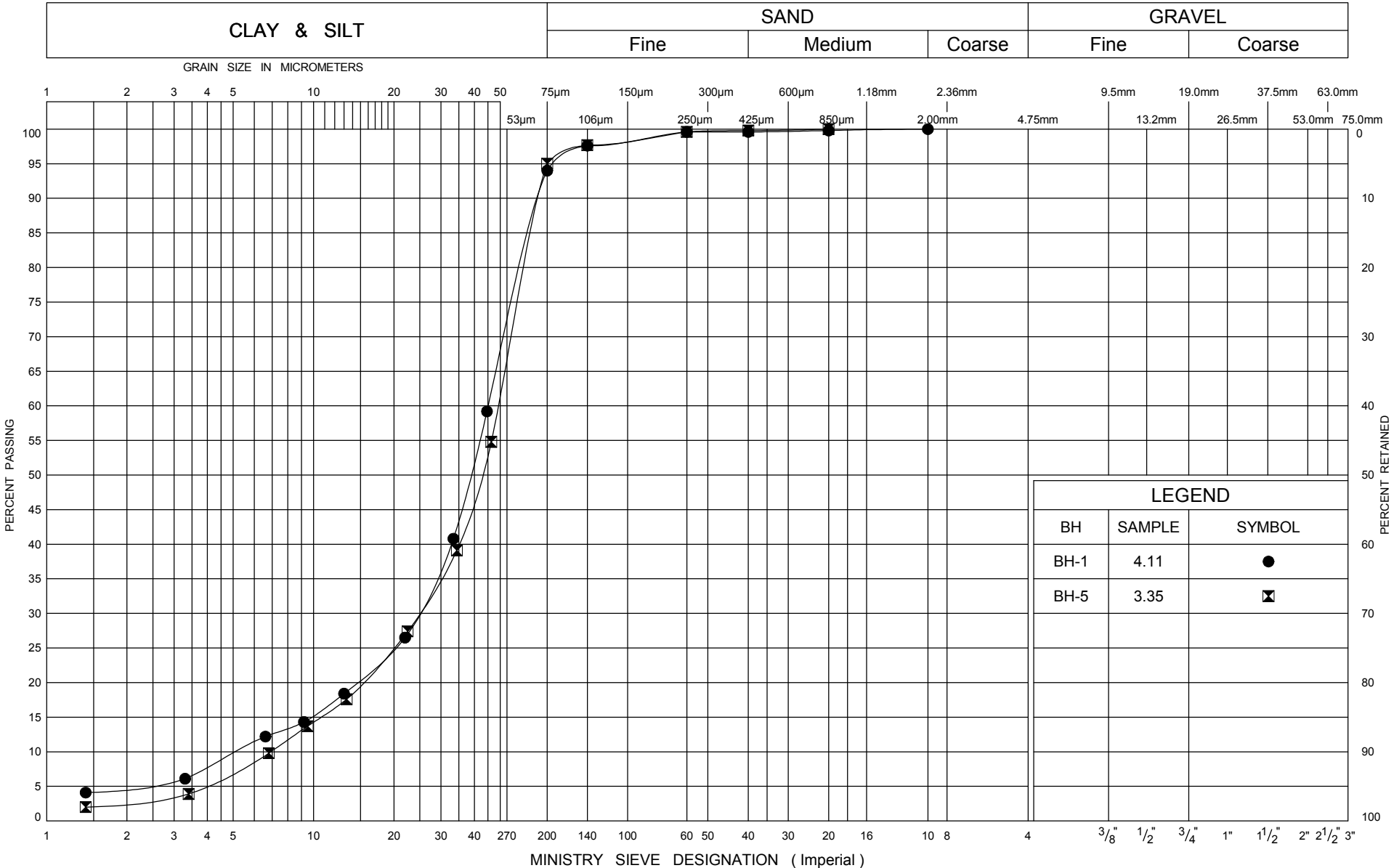
UNIFIED SOIL CLASSIFICATION SYSTEM



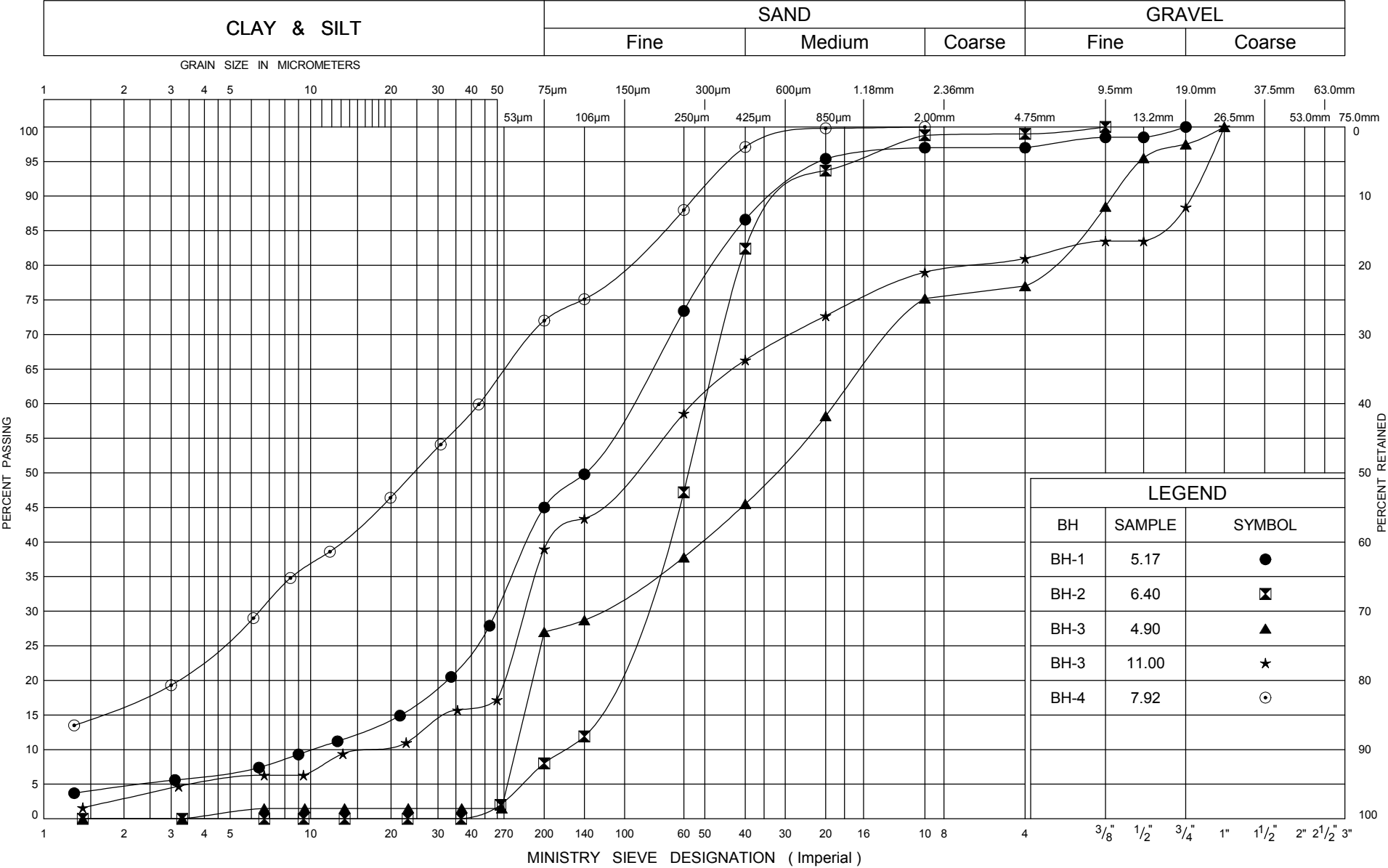
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

FIG No 4

W P5027-17-00

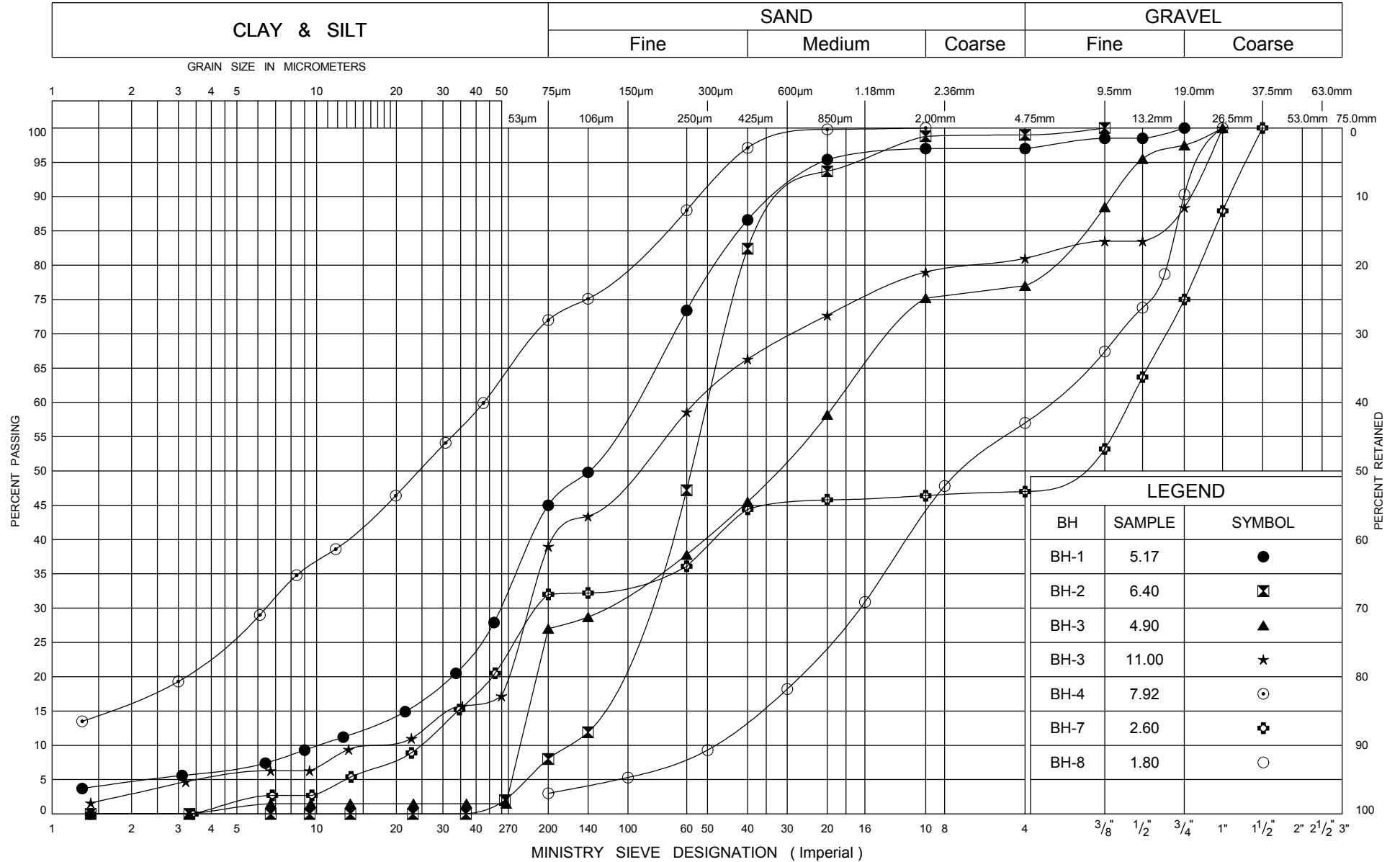
5015-E-0007, Assignment 7



Ministry of
Transportation

Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

FIG No 5

W P 5027-17-00

5015-E-0007, Assignment 7

Appendix E – Rock Core Photographs

Project NO: ADM 0002331875-H0
BH NO: 1
Run NO: 1 & 2
Sample Depth: 7.5 m to 10.7 m
Elevation: 302.0 m to 298.8 m
Date: July 13, 2017



Photo 1. Bedrock Core Sample for BH1 from Elevation 302.0 m to 298.8 m

Project NO: ADM 0002331875-H0
BH NO: 2
Run NO: 1,2 & 3
Sample Depth: 11.4 m to 14.5
Elevation: 302.3 m to 299.2 m
Date: June 14, 2017



Photo 2. Bedrock Core Sample for BH2 from Elevation 302.3 m to 299.2 m

Project NO: ADM 0002331875-H0
BH NO: 3
Run NO: 1,2 & 3
Sample Depth: 11.6 m to 14.6 m
Elevation: 302.1 m to 299.8 m
Date: June 15, 2017

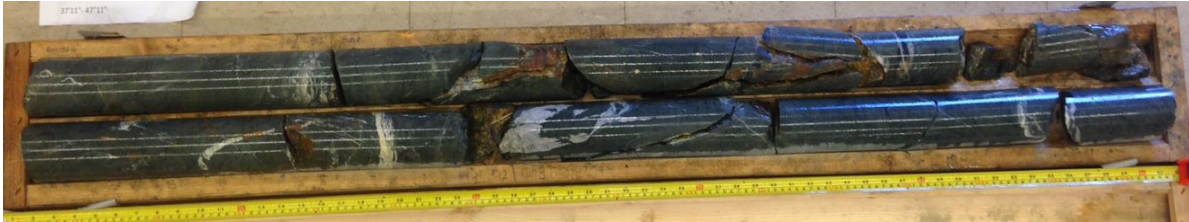


Photo 3. Bedrock Core Sample for BH3 from Elevation 302.1 m to 299.8 m

Project NO: ADM 0002331875-H0
BH NO: 5
Run NO: 1&2
Sample Depth: 7.2 m to 10.3 m
Elevation: 302.3 m to 299.2 m
Date: July 12, 2017



Photo 4. Bedrock Core Sample for BH5 from Elevation 302.3 m to 299.2 m

Project NO: ADM 0002331875-H0
BH NO: 6
Run NO: 1&2
Sample Depth: 6.6 m to 9.7 m
Elevation: 303.2 m to 300.2 m
Date: July 6, 2017



Photo 5. Bedrock Core Sample for BH6 from Elevation 303.2 m to 300.2 m

Project NO: ADM 0002331875-H0
BH NO: 7
Run NO: 1,2 &3
Sample Depth: 3.7 m to 6.8 m
Elevation: 307.9 m to 304.8 m
Date: June 15, 2017



Photo 6. Bedrock Core Sample for BH7 from Elevation 307.9 m to 304.8 m

Project NO: ADM 0002331875-H0
BH NO: 8
Run NO: 1,2 &3
Sample Depth: 2.3 m to 5.3 m
Elevation: 309.2 m to 306.2 m
Date: June 13, 2017



Photo 7. Bedrock Core Sample for BH8 from Elevation 309.2 m to 306.2 m

Appendix F – Golder's Technical Memorandum

DATE May 25, 2017**PROJECT No.** 1541608-10**TO** J.P. Perron, P.Eng.
Ministry of Transportation Geotechnical Section**FROM** John Hagan, P.Eng.
Andrew Balasundaram, P.Eng**EMAIL** John_Hagan@golder.com
Andrew_Balasundaram@golder.com**PAVEMENT ENGINEERING RETAINER - AGREEMENT NUMBER 5015-E-0012
ASSIGNMENT NO. 10 - FIELD INVESTIGATION FOR HIGHWAY 672
CENTRELINE CULVERT AT APPROXIMATELY STA 10+150,
ARNOLD TOWNSHIP, ONTARIO**

Golder Associates Ltd. (Golder) is pleased to provide this Technical Memorandum summarizing the results of the field investigation completed for the replacement of the existing centreline culvert located along Highway 672, at approximately Sta. 10+150 in the Township of Arnold, northeast of Kirkland Lake Ontario. We understand that the highway has previously washed out and that the MTO requires factual geotechnical information to support the design of the replacement culvert.

The field investigation completed on May 16, 2017 consisted of advancing three rock probes (P1, P2 and P4) to depths ranging from 12.5 m to 17.4 m below existing ground surface and 4.5 m to 4.6 m into inferred bedrock. The probeholes were advanced with a Junjin JD-800E Air-track using a 75 mm diameter drill bit. The approximate probehole locations are shown on the attached pedological sketch. The high rate of water flowing through the embankment resulted in drill sediments downstream, and it was also difficult to effectively manage drill cuttings using airtrack drilling methods. These issues were discussed with MTO and the decision made not to advance Probehole P3.

The as-drilled probehole locations were referenced in the field to the highway centreline and existing culvert, and converted into northing/easting coordinates on the plan drawing. The ground surface elevations were surveyed to HCP 101 as provided by MTO (ExplodedVictoriaCreekDTM.dwg). The MTM NAD83 Zone 10 northing and easting coordinates, the ground surface elevations referenced to Geodetic datum, and the probehole depths at each location are presented on the attached Record of Probehole sheets.

The inferred stratigraphy presented on the Record of Probehole sheets and shown on the stratigraphic profile on Drawing 1 is based on visual observations of drill cuttings, progress/advancement of the drill string through the subsurface materials encountered in the probehole, and audible observations of the drill string head striking the drill rods. Given the composition of the embankment fill materials, it was not possible to identify the approximate transition from embankment material to native soils (if present), present above the inferred bedrock surface.

We trust this Technical Memo meets MTO's approval. Please do not hesitate to contact the undersigned with any questions or concerns.

Yours very truly,

GOLDER ASSOCIATES LTD.



John Hagan, P.Eng.
Geotechnical Engineer



Andrew Balasundaram, P.Eng.
Pavement Engineering Project Manager

Attachments: Pedological Sketch
Record of Probeholes P1, P2 and P4

AC/JBH/ACB/us

w:\active\2015\3 proj\1541608 mto_5015-e-0012_ner retainer (east)\assignment 10\reporting\draft\1541608 (10000) tm assignment 10 - culvert hwy 672 - 2017\05\25.docx

PEDOLOGICAL SKETCH

10+250

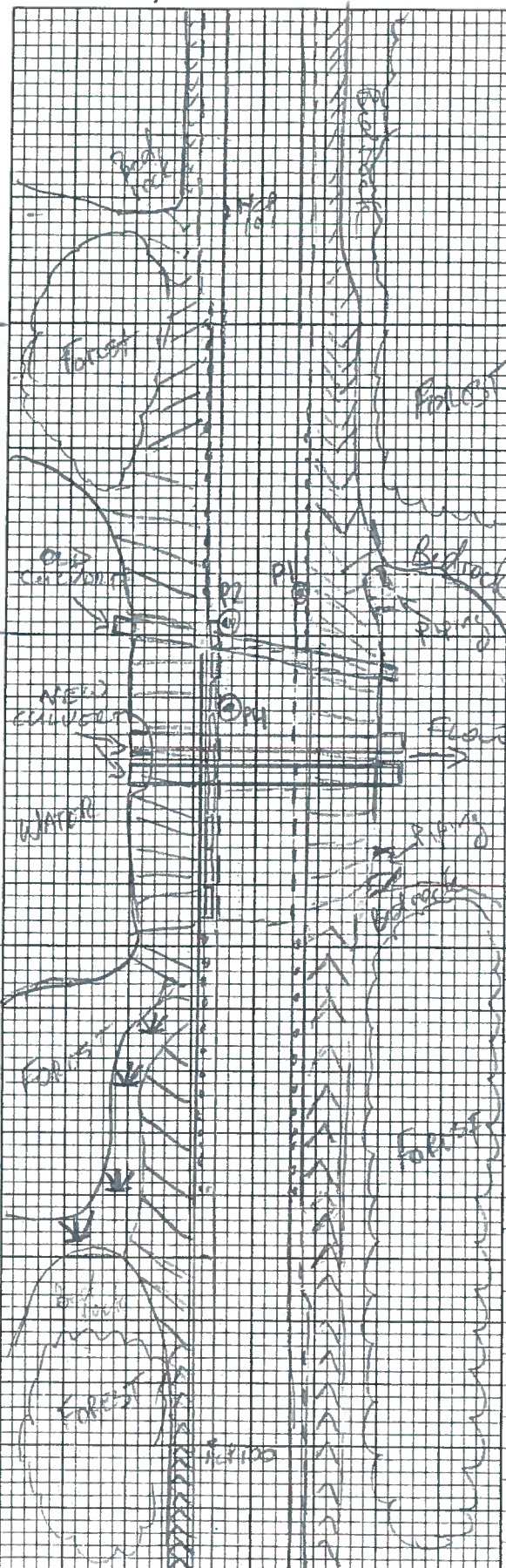
10+200

10+150

10+100

10+050

10+000



↑
NORTH

- Exposed bedrock on all four sides of creek crossing

- Water Flowing West to East

... culvert ...

(a deep po) under ...

... d

RECORD OF PROBEHOLES P1, P2 AND P4

PROJECT 1541608

RECORD OF PROBEHOLE No P1

1 OF 2 **METRIC**

LOCATION N 5339916.7; E 389558.4

ORIGINATED BY MR

DIST HWY 672

BOREHOLE TYPE 75 mm Diameter Airtrack Probehole

COMPILED BY AC

DATUM GEODETIC

DATE May 16, 2017

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
								● QUICK TRIAXIAL	×	REMOULDED						
313.7 0.0	GROUND SURFACE Inferred Embankment FILL						20	40	60	80	100	20	40	60		
	Boulder between 3.0 m and 3.5 m depth. <															

SUD-MTO 001 1542608 ASSIGNMENT 10.GPJ GAL-MISS GDT 23/05/17 DATA INPUT:

Continued Next Page

+ 3, x 3.

Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

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

SUD-MTO 001 1542608 ASSIGNMENT 10.GPJ GAL-MISS.GDT 23/05/17 DATA INPUT:

PROJECT <u>1541608</u>			RECORD OF PROBEHOLE No P2				2 OF 2 METRIC	
LOCATION <u>N 5339911.7; E 389550.3</u>			ORIGINATED BY <u>MR</u>					
DIST <u>HWY 672</u>			BOREHOLE TYPE <u>75 mm Diameter Airtrack Probehole</u>				COMPILED BY <u>AC</u>	
DATUM <u>GEODETIC</u>			DATE <u>May 16, 2017</u>				CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60			
	— CONTINUED FROM PREVIOUS PAGE —																
	Inferred BEDROCK																
			5	Probe	-												
297.9			6	Probe	-												
15.8	END OF PROBEHOLE																

SUD-MTO 001 1542608 ASSIGNMENT 10.GPJ GAL-MISS.GDT 23/05/17 DATA INPUT:

PROJECT 1541608

RECORD OF PROBEHOLE No P4

1 OF 2 **METRIC**

LOCATION N 5339897.7; E 389550.9

ORIGINATED BY MR

DIST HWY 672

BOREHOLE TYPE 75 mm Diameter Airtrack Probehole

COMPILED BY AC

DATUM GEODETIC

DATE May 16, 2017

CHECKED BY

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 (%)				
								○ UNCONFINED + FIELD VANE								○				
								● QUICK TRIAXIAL × REMOULDED												
313.6	GROUND SURFACE						20	40	60	80	100	20	40	60	GR SA SI CL					
0.0	Inferred Embankment FILL																			
			1	Probe	-		313													
							312													
							311													
							310													
	Cobble between 0.6 m and 0.8 m depth.		2	Probe	-		309													
							308													
							307													
			3	Probe	-		306													
							305													
							304													
	Boulder between 9.1 m and 9.4 m depth.						303													
			4	Probe	-		302													
	Boulder between 10.1 m and 10.7 m depth.																			

Continued Next Page

+ 3, x 3

Numbers refer to
Sensitivity

○ 3%

STRAIN AT FAILURE

PROJECT 1541608

RECORD OF PROBEHOLE No P4

2 OF 2 **METRIC**

LOCATION N 5339897.7; E 389550.9

ORIGINATED BY MR

DIST HWY 672

BOREHOLE TYPE 75 mm Diameter Airtrack Probehole

COMPILED BY AC

DATUM GEODETIC

DATE May 16, 2017

CHECKED BY

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 —																
300.8	Inferred Gravel (FILL)						301										
12.8	Inferred BEDROCK		5	Probe	-		300										
							299										
							298										
			6	Probe	-		297										
296.2																	
17.4	END OF PROBEHOLE																

SUD-MTO 001 1542608 ASSIGNMENT 10.GPJ GAL-MISS GDT 23/05/17 DATA INPUT:

+ 3, × 3. Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE