



Updated Foundation Investigation Report

Highway 599 Trout Creek Culvert Replacement

Agreement No. 6019-E-0004

Assignment No. 8

GWP 6530-17-00

Geocres No. 52J-20

Latitude: 50.206730°; Longitude: -90.726231°

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*Ministry of Transportation Ontario
Northwestern Region Geotechnical Section*

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1 UPDATED FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This report presents the results of the geotechnical investigation completed by EXP Services Inc. for the replacement of the Trout Creek Culvert on Highway 599, in the Thunder Bay District. An initial investigation was conducted in the fall 2020¹ under Agreement No. 6019-E-0004, Assignment No. 1 and the follow-up, additional investigation was conducted in the fall 2021 under Agreement No. 6019-E-0004, Assignment No. 8. The terms of reference (TOR) for Assignment No. 1 were provided by the MTO via email, dated September 17, 2020 (i.e., initial investigation). For the follow-up investigation, following a meeting on November 5, 2021 involving the MTO and EXP, a TOR for Assignment No. 8 was sent via email on November 9, 2021.

The purpose of the initial investigation (i.e. Assignment No. 1) was to evaluate the subsurface condition along the existing/new culvert, to permit detailed design for the replacement of the Trout Creek non-structural culvert to a structural culvert and to provide construction staging recommendations. As per the TOR, the purposes of the follow-up investigation (i.e. Assignment No. 8) are to better establish the bedrock profile along the proposed culvert and to include recommendations for the foundation of the temporary modular bridge and any other geotechnical and hydrogeological concerns that are involved with the use of a temporary modular bridge for staging purposes of this project. The site specific geotechnical investigations consisted of field investigations including visual inspections, drilling, soil sampling, and laboratory testing.

This foundation investigation report discusses the findings of both the initial and follow-up investigations to produce one combined report. This 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 Trout Creek culvert is located on Highway 599 (Sta. 78+603; Latitude: 50.206730°; Longitude: -90.726231°), about 4.6 km south of Savant Lake CNR crossing within the District of Thunder Bay, Ontario. Although Highway 599 is generally a northbound-southbound highway it is oriented east-west at the site location, thus it will be described as oriented east-west in this project. At the site, Highway 599 is a two lane roadway, with a speed limit of 80 km/h (unless otherwise posted) and is about 7.2 m wide from edge of pavement to edge of pavement, with 1.5 m and 1.0 m gravel shoulders on north and south sides, respectively. The elevation of highway pavement centerline at Sta. 78+603 is about 416.6 m. Based on documents provided by MTO, the roadway embankment above the creek bed is approximately 4.5 m high with side slopes of approximately 1.1H:1V (outlet) to 1.3H:1V (inlet).

Based on the information in the TORs and AutoCAD drawing provided by MTO, the existing culvert is a 22.47 m long 1.5 m x 1.5 m wooden box culvert with two overflow CSP culverts on both sides. At the outlet side, the wooden box culvert was extended with a 2 m diameter CSP pipe, approximately 5.5 m in length (Photo 5 in Appendix A), while at the inlet side the culvert starts with a concrete headwall (Photo 1 in Appendix A). The existing culvert alignment has a skew angle of 14 degrees to the highway central line. Based on available information the obvert of the existing

¹ *Foundation Investigation Design Report "Highway 599 Trout Creek Culvert Replacement" prepared by EXP Services Inc., dated April 5, 2021. (Geocres No. 52J-19)*

culvert is located at approximate elevation of Elev. 413.8 m at the inlet side and Elev. 413.2 m at the outlet side. Since the top elevation of the roadway is approximately at Elev. 416.6 m, the fill cover above the culvert crown is approximately 3.4 m thick. The existing overflow west and east culverts are approximately 23.7 m long CSP pipes with a 1.22 m diameter. The obverts of the west and east CSPs were measured to be at an approximate Elev. 413.5 m and 413.7 m, respectively. Selected photographs of the site and existing culverts are presented in Appendix A. The site plan and cross-section profiles for the proposed culvert alignment are shown on the drawings attached in Appendix B.

The general site conditions were assessed during the site reconnaissance visit on October 8, 2020 as well as during the initial and follow-up field investigations on November 2-6, 2020 and November 23-28, 2021, respectively. Since Highway 599 runs in an east to west direction at this location, the creek flows north to south beneath the highway. Based on observations at the site, it appears that to the north of the culvert inlet, the Trout Creek flows through a rocky canyon (Photos 3, 7 & 9 in Appendix A), while on the other side of the culvert (outlet), the creek flows into a larger water body which is a part of Sturgeon Lake located south of Highway 599 (Photos 4 & 10 in Appendix A). Rapids and relatively steep gradient of rocky creek bed were observed north of the inlet (Photos 7 & 9 in Appendix A). However, a small pool of water was observed in front of the culvert inlet as it was partially blocked by branches and broken CSP pipes (Photo 1 in Appendix A). South of the outlet, the creek becomes calm upon entering the lake as shown on Photos 2, 4 and 10 in Appendix A. At the time of the 2020 investigation, the approximate top of water elevations at the inlet and outlet were about 412.7 m and 410.9 m, respectively. The water depth in the pool formed in front of the inlet was measured to be approximately 0.4 m to 0.75 m above the rocky bottom. The measured water depth in the creek beyond the culvert outlet was around 0.7 m. Based on observations at the site, riprap (rock fill) was present on the outlet and inlet sides of the existing culvert, to protect against scour or erosion (Photos 1 and 2 in Appendix A). The roadway elevation generally increases towards the west direction. The terrain at the site is covered by bushes and trees. Bedrock outcrops were observed in the vicinity on both sides of the roadway. Some surface erosion and instability of the existing embankment was observed at the inlet side.

1.2.2 Geological Setting

According to the Ministry of Northern Development and Mines, Map 2554 (Quaternary Geology of Ontario, West-Central Sheet, 1991) the surface conditions in the vicinity of the project area consists of bedrock, undifferentiated igneous and metamorphic rock, exposed at surface or rock covered by a discontinuous, thin layer of drift and according to Map 2542 (Bedrock Geology of Ontario, West-Central Sheet, 1991), the bedrock geology of the site is of foliated tonalite suite: tonalite to granodiorite – foliated to massive.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The initial and follow-up field investigations were performed between November 2 and 6, 2020 and between November 23 and 28, 2021, respectively.

The initial field program consisted of drilling three (3) sampled boreholes and nine (9) hand probe holes, numbered BH20-1 to BH20-3 and HP20-4 to HP20-11, respectively. The three (3) boreholes were located on the embankment to provide subsurface information for the culvert replacement and the temporary roadway protection system, while due to access restriction for the drill rig, nine (9) hand probe holes were drilled at the ends of the existing culvert (i.e. at toes of the embankment). BH20-1 to BH20-3 were advanced from the top of the embankment. HP20-4 to HP20-7 and HP20-6I were advanced at an accessible location near the inlet and HP20-8 to HP20-11 were advanced

at an accessible location near the outlet. BH20-1 was drilled about 3 m east of the edge of the east outflow CSP culvert, BH20-2 was drilled about 3.5 m west of the edge of the west outflow CSP culvert and BH20-3 was drilled about 22 m east of the main culvert centreline.

During the follow-up field program four (4) boreholes and one (1) test pit, numbered BH21-1 to BH21-4 and TP21-1, respectively, were advanced. The four (4) boreholes were advanced at the top of the embankment to provide subsurface information for the temporary modular bridge and any other geotechnical and hydrogeological concerns that are involved with the use of a temporary modular bridge for staging purposes of this project. Boreholes BH21-1 to BH21-4 were advanced near the shoulder of the northbound lane. The lone test pit was advanced about 7 m west of the existing culvert outlet and about 12 m from the edge of pavement (i.e., at the toe of the embankment). BH21-1 and BH21-4 were drilled about 22.4 m and 4.5 m west of the main culvert centreline, respectively, and BH21-2 and BH21-3 were drilled about 17.5 m and 4.5 m east of the main culvert centreline, respectively.

Table 1.1. Summary of boreholes completed by EXP

Borehole/Hand Probe/Test pit No.	Location	Coordinates (MTM NAD 83 Zone 15)		Ground Surface Elevation Elev. (m)	Borehole Depth (m)
		Northing	Easting		
November 2020					
BH20-1	Top of Roadway ~3 m east of the east outflow CSP culvert	5563540.7	252977.6	416.5	6.8
BH20-2	Top of Roadway ~3.5 m west of the west outflow CSP culvert	5563531.1	252968.2	416.5	10.4
BH20-3	Top of Roadway ~22 m east of the main culvert C/L	5563542.0	252994.7	416.1	3.9
HP20-4	~13 m west of culvert inlet	5563540.8	252950.6	414.2	0.8
HP20-5	Culvert inlet	5563545.4	252961.8	413.9	0.7
HP20-6	~8 m east of the culvert inlet	5563552.9	252974.1	413.8	0.8
HP20-6l	~13 m east of the culvert inlet	5563553.7	252978.1	413.9	0.5
HP20-7	~20 m east of the culvert inlet	5563556.5	252984.2	414.5	0.2
HP20-8	~20 m west of the culvert outlet	5563512.3	252962.4	411.9	0.3
HP20-9	~7 m west of the culvert outlet	5563518.9	252972.7	411.6	0.3
HP20-10	Culvert outlet	5563526.4	252986.0	413.1	0.5

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Borehole/Hand Probe/Test pit No.	Location	Coordinates (MTM NAD 83 Zone 15)		Ground Surface Elevation Elev. (m)	Borehole Depth (m)
		Northing	Easting		
HP20-11	~10 m east of the culvert outlet	5563529.1	252992.1	414.9	0.7
November 2021					
BH21-1	Top of roadway ~22.4 m west of the main culvert C/L	5563525.7	252953.9	416.9	12.3
BH21-2	Top of roadway ~17.5 m east of the main culvert C/L	5563540.2	252990.6	416.3	5.3
BH21-3	Top of roadway ~4.5 m east of the main culvert C/L	5563535.7	252978.4	416.4	7.4
BH21-4	Top of roadway ~4.5 m west of the main culvert C/L	5563532.0	252970.2	416.5	9.1
TP21-1	~7 m west of the culvert outlet	5563516.9	252973.6	411.6	3.5

Note:

(1) Attempted BH/split spoons with portable rig due to drill rig access issues. Could not penetrate rock fill at the surface.

The three (3) roadway boreholes drilled during the initial fieldwork were advanced using a rubber track mounted B54X drill rig equipped with solid stem augers, NQ core and standard soil sampling equipment, operated by a specialist drilling contractor, Maple Leaf Drilling Ltd., and all hand probe holes were advanced using a power hand auger with SSA. The roadway boreholes BH20-1, BH20-2 and BH20-3 were advanced to depths of about 6.8 m, 10.4 m and 3.9 m below ground surface, respectively. The off-road probe holes (HP20-4 to HP20-11 and HP20-6I) were advanced to a depth of between 0.2 m and 0.8 m.

During the follow-up investigation, BH21-1 was advanced using a rubber track mounted CME 55 drill rig with NW core. Due to drill rig issues, the remaining three (3) boreholes (BH21-2, BH21-3, BH21-4) were advanced using a rubber track mounted CME 750 drill rig with HW core. Both drill rigs were equipped with solid stem augers and standard soil sampling equipment, and were operated by RPM Drilling. The boreholes were advanced to depths ranging between 5.3 m and 12.3 m below ground surface. The off-road test pit was advanced to a refusal depth of about 3.5 m below ground surface using a track mounted Link-Belt 235 Excavator, operated by Perron Contracting.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by EXP personnel using a GPS (Garmin 60 CSX) and a basic level and survey rod, respectively, having an accuracy of ± 2 m in the horizontal directions and 0.1 m in the vertical direction. The relative distances between the location of boreholes and geographical and structural features on the site were also measured by a field measuring tape. The locations of boreholes, hand probe holes and test pit advanced during the investigations are shown on Drawing 1 in Appendix B. Note that the elevations for the boreholes and test pit advanced during the follow-up investigation are interpolated from the topographic survey provided by MTO.

For both drilling programs, 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.

Upon completion of the boreholes and test pit, groundwater level measurements were carried out in accordance with MTO guidelines. The recorded groundwater levels after completion of drilling boreholes and dug test pits were presented in the borehole / test pit log sheets in Appendix C. The 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*).

All fieldwork was supervised by an EXP geotechnical representative who directed the drilling, excavating and sampling operation, logged borehole / test pit 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 Thunder Bay laboratory for additional visual, textual, olfactory examination and selective testing.

1.3.2 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 soil samples, particle size distribution and Atterberg Limit testing for approximately 30% of the collected soil samples. Uniaxial compression tests were performed on selected rock cores from six (6) boreholes. In addition, soil chemical package tests were performed on three (3) soil samples. All laboratory tests were carried out according to MTO and/or ASTM Standards as appropriate.

The results of laboratory tests on soil and rock samples are provided on the attached borehole / test pit log sheets in Appendix C. The results of the grain size analyses and Atterberg Limits are presented graphically in Appendix D. The soil chemical test results are presented in Appendix F.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes and test pit advanced during the investigations are presented on the borehole and test pit log sheets in Appendix C. Laboratory test results of grain size analyses tests and Atterberg Limits are provided in Appendix D. The “Explanation of Terms Used in Report” preceding the borehole / test pit logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A borehole location plan and cross section subsurface profile are provided in the drawings attached 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.

In general, the subsoil condition at the roadway consisted of sand and gravel fill to rock fill below the asphalt treatment, followed by native gravelly to silty sand / sandy silt layers followed by silty sand with gravel / silt till underlain by bedrock (sloping bedrock is observed at this site, 2.1 m to 4.6 m below ground surface to the east of culvert centerline while 6.8 m to > 12.3 m below ground surface to the west of centerline). In addition, a peat with silt and sand layer was encountered beneath the fill material at BH21-4 and a native gravel layer was encountered beneath the native gravelly sand layer in BH21-1.

At the inlet and outlet sides, the subsurface conditions consist of native silty sand/sandy gravel layers below topsoil or peat underlain by a layer of native silty sand with gravel, cobbles and boulders and/or bedrock.

A detailed description of the subsurface conditions encountered is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by EXP.

1.4.1 Stratigraphy below Existing Embankment

1.4.1.1 Asphalt Treatment

Asphalt treatment, approximately 0.025 m (~1 inch) to 0.05 m (~2 inch) thick, was generally encountered at the surface of boreholes BH20-1 to BH20-3 and BH21-2 to BH21-4.

1.4.1.2 Fill: Sand and Gravel / Gravel

Sand and gravel fill was encountered below the surface treatment in boreholes advanced through the embankment, BH20-1 to BH20-3 and BH21-2 to BH21-4 as well as at the surface at BH21-1. The depths and elevations encountered at these borehole locations are listed in Table 1.2.

The fill layer extended to depths between 0.2 m to 4.6 m below ground surface with an elevation between Elev. 416.2 m to 412.0 m. The explored thickness of this layer ranged from 0.2 m to 4.6 m.

The composition of this fill material generally consisted of sand and gravel with occasional cobbles and/or boulders and trace to some silt and trace clay. The fill was generally grey to brown in color, and moist. Samples of the fill material were generally collected from the auger flights. The SPT "N" values obtained within this fill material recorded in the boreholes BH20-3, BH21-1, BH21-2 and BH21-4 ranged from 5 to 65 blows per 0.3 m and 50 blows per 0.1 m penetration (likely affected by cobbles/boulders), suggesting that this layer was loose to very dense in relative density.

Table 1.2. Summary of Fill: Sand and Gravel / Gravel

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
BH20-1	416.5	414.9	0	1.5
BH20-2	416.5	415.8	0	0.8
BH20-3	416.1	413.8	0	2.3
November 2021				
BH21-1	416.9	414.6	0	3.5
BH21-2	416.3	414.5	0	1.8
BH21-3	416.4	416.2	0	0.2
BH21-4	416.5	411.9	0	4.6

Notes:

1. Depths are relative to ground surface.

Laboratory testing performed on selected samples consisted of thirty-two (32) moisture content tests and seven (7) grain size distribution tests. The test results are as follows:

Moisture Content:

- 1.5% to 10.6%

Grain Size Distribution:

- 15% to 50% gravel;
- 42% to 59% sand; and
- 7% to 27% silt and clay

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

1.4.1.3 Fill: Gravelly Sand

Gravelly sand fill was encountered below the sand and gravel/gravel fill in boreholes advanced through the embankment, BH20-1, BH20-2, and BH21-3. The depths and elevations encountered at these borehole locations are listed in Table 1.3.

Table 1.3. Summary of Fill: Gravelly Sand

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
BH20-1	414.9	412.8	1.5	2.2
BH20-2	415.8	411.5	0.8	4.2
November 2021				
BH21-3	416.2	414.1	0.2	2.1

Notes:

1. Depths are relative to ground surface.

This fill layer extended to depths between 2.3 m to 5.0 m below ground surface with elevations between Elev. 414.1 m and 411.5 m. The explored thickness of this layer ranged from 2.1 m to 4.2 m.

The composition of this fill material generally consisted of sand and gravel with occasional boulders and trace to some silt and clay. The fill was generally brown in color, and moist. Samples of the fill material were generally collected from the auger flights, however, refusal was encountered in BH20-1 at about 4.4 m depth below ground surface within this layer. The SPT "N" values obtained at this depth within this fill material ranged from about 38 blows to 100 blows per 0.3 m penetration, suggesting that this layer dense to very dense relative density.

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

Moisture Content:

- 2.8% to 25.4%

Grain Size Distribution:

- 22% to 34% gravel;
- 56% to 65% sand;
- 10% to 15% silt and clay in BH20-1 and BH21-3;
- 10% silt in BH20-2; and
- 1% clay in BH20-2

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

1.4.1.4 Rock Fill

A layer of rock fill was encountered beneath the sand and gravel/gravel fill layer in borehole BH21-1 and gravelly sand fill layer in BH21-3. The depths and elevations encountered at these borehole locations are listed in Table 1.4.

Table 1.4. Summary of Rock Fill

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2021				
BH21-1	413.5	412.3	3.5	1.1
BH21-3	414.1	411.8	2.3	2.3

Notes:

1. Depths are relative to ground surface.

The rock fill layer extended to a depth of about 4.6 m below ground surface with elevations of Elev. 412.3 m and 411.8 m at BH21-1 and BH21-3, respectively. Rock coring techniques were generally conducted; however, one SPT was conducted, and the “N” value obtained at this depth was 16 blows per 0.3 m penetration, suggesting that this layer was compact in relative density. The explored thickness of the rock fill ranged from 1.1 m to 2.3 m.

1.4.1.5 Peat with Silt and Sand

Peat with silt and sand was encountered in borehole BH21-4, below the sand and gravel fill material. The depth and elevation encountered at the borehole location is listed in Table 1.5.

Table 1.5. Summary of Peat with Silt and Sand

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2021				
BH21-4	411.9	411.2	4.6	0.7

Note:

1. Depths are relative to ground surface.

The peat with silt and sand layer extended to a depth of about 5.3 m below ground surface with an elevation of about Elev. 411.2 m. The explored thickness of this layer was about 0.7 m.

The composition of this layer was peat, silt and sand with trace gravel. The material was dark brown in color, and moist to wet. The SPT “N” value obtained within this layer is about 44 blows per 0.3 m penetration, suggesting that this layer was dense in relative density.

Laboratory testing performed on a selected sample consisted of one (1) moisture content test. The test result is as follows:

Moisture Content:

- 38.8%

The result of the moisture content test performed by EXP is provided on the record of borehole sheets in Appendix C.

1.4.1.6 Silty Sand to Sandy Silt

Native silty sand to sandy silt was encountered in boreholes BH20-2 and BH21-2, below the sand and gravel fill and in BH21-1, below the rock fill. The depths and elevations encountered at these borehole locations are listed in Table 1.6.

Table 1.6. Summary of Silty Sand to Sandy Silt

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
BH20-2	411.5	410.4	5.0	1.1
November 2021				
BH21-1	412.3	411.6	4.6	0.7
BH21-2	414.5	414.2	1.8	0.3

Notes:

1. Depths are relative to ground surface.

The silty sand to sandy silt layer extended to depths ranging from 2.1 m to 6.1 m below ground surface with elevations between about Elev. 414.2 m and 410.4 m. The explored thickness of this layer ranged from 0.3 m to 1.1 m. BH20-2 and BH21-1 were cored due to auger refusal at a depth of 4.4 m and 3.5 m, respectively, and was switched back to drilling at a depth of 5.8 m and 4.6 m, respectively.

The composition of this layer was sand, silt and gravel with trace clay. The material was grey to light brown in color, and moist to wet. The SPT “N” values obtained within this layer was between 20 blows to 34 blows per 0.3 m and 50 blows per 0.05 m penetration (likely due to cobble/boulder), suggesting that this layer was compact to very dense in relative density.

Laboratory testing performed on a selected sample consisted of four (4) moisture content tests and three (3) grain size distribution tests. The test results are as follows:

Moisture Content:

- 9.3% to 16.5%

Grain Size Distribution:

- 4% to 23% gravel;
- 31% to 53% sand;
- 8% to 9% silt and clay in BH21-2;
- 36% to 57% silt in BH20-2 and BH21-1; and
- 8% to 9% clay in BH20-2 and BH21-1

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

1.4.1.7 Gravelly Sand

Native gravelly sand was encountered in BH21-1 below the native sandy silt layer. The depth and elevation encountered at this borehole location is listed in Table 1.7.

Table 1.7. Summary of Gravelly Sand

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2021				
BH21-1	411.6	406.1	5.3	5.5

Note:

1. Depths are relative to ground surface.

The gravelly sand layer extended to a depth of 10.8 m below ground surface with an elevation of about Elev. 406.1 m. The explored thickness of this layer was 5.5 m.

The composition of this layer was sand and gravel with trace to some silt and clay. The material was light brown in color, and wet. The SPT “N” values obtained within this layer was between about 35 to 71 blows per 0.3 m penetration, suggesting that this layer was dense to very dense in relative density.

Laboratory testing performed on a selected sample consisted of six (6) moisture content tests and four (4) grain size distribution tests. The test results are as follows:

Moisture Content:

- 6.8% to 13.9%

Grain Size Distribution:

- 25% to 44% gravel;
- 44% to 62% sand; and
- 11% to 18% silt and clay

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

1.4.1.8 Gravel

Native gravel was encountered in borehole BH21-1, below the gravelly sand layer. The depth and elevation encountered at this borehole location is listed in Table 1.8.

Table 1.8. Summary of Gravel

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2021				
BH21-1	406.1	404.6	10.8	1.5

Note:

1. Depths are relative to ground surface.

The gravel extended to depth of about 12.3 m below ground surface with elevation of about Elev. 404.6 m. The explored thickness of this layer was about 1.5 m.

The composition of this layer was gravel, with trace sand and trace silt. The material was reddish brown in color and wet. Rock coring techniques were generally conducted; however, one SPT (1) was conducted and the “N” value

obtained at this depth was 50 blows per 0.075 m penetration, suggesting that this layer was very dense in relative density.

Laboratory testing performed on a selected sample consisted of one (1) moisture content test. The test result is as follows:

Moisture Content:

- 7.2%

The result of the moisture content test performed by EXP is provided on the record of borehole sheets in Appendix C.

1.4.1.9 Till: Silty Sand with Gravel to Silt

Silty sand with gravel to silt till was encountered in borehole BH20-2, below the sandy silt layer, and in borehole BH21-4, below the peat with silt and sand layer. The depths and elevations encountered at these borehole locations are listed in Table 1.9.

Table 1.9. Summary of Silty Sand to Sandy Silt

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
BH20-2	410.4	409.6	6.1	0.9
November 2021				
BH21-4	411.2	409.7	5.3	1.5

Note:

1. Depths are relative to ground surface.

The till layer extended to depths ranging from 5.3 m to 6.1 m below ground surface with elevations between about Elev. 409.7 m and Elev. 409.6 m. The explored thickness of this layer ranged from 0.9 m to 1.5 m.

The composition of this layer was silt, sand, and gravel with occasional to some cobbles and boulders and trace clay. The material was grey in color and wet. The SPT “N” values within this layer ranged from 33 blows per 0.3 m to 50 blows per 0.125 m penetration, suggesting that this layer was dense to very dense in relative density. It is noted that rock coring techniques were initiated at BH21-4 at about 5.6 m and that a boulder was observed from 5.6 m to 6.3 m below ground surface. Below the boulder, a rock void within the silt till was observed to about 6.8 m below ground surface.

Laboratory testing performed on a selected sample consisted of three (3) moisture content tests and one (1) grain size distribution test. The test results are as follows:

Moisture Content:

- 2.5% to 15.1%

Grain Size Distribution:

- 21% gravel;
- 49% sand;
- 24% silt; and
- 6% clay.

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

1.4.1.10 Bedrock

The presence of bedrock was encountered at depths ranging from 2.1 m to 7.0 m below the existing ground surface. The bedrock was confirmed by coring about 1.6 m to 3.4 m in the stratum in boreholes BH20-1 to BH20-3 and BH21-2 to BH21-4. Bedrock was not encountered to a depth of 12.3 m below ground surface in BH21-1 (about 22 m west of culvert center line). It should be noted that sloping bedrock was observed at the site, decreasing in elevation from east to west, as shown in Table 1.10 and Drawing 1 in Appendix B. On the east side of the culvert center line, bedrock was encountered at 2.1 m to 3.7 m below ground surface, while bedrock was encountered at 6.8 m to 7.0 m below ground surface on the west side. In addition, the bedrock elevation is about 1 m higher on the north side of the embankment (Elev. 412.8 m) compared to the south side of the embankment (Elev. 411.8 m), as shown on Drawing 2 in Appendix B. The actual bedrock surface depth and elevation encountered at these borehole locations are listed below in Table 1.10. Photographs of rock cores are included in Appendix E.

Table 1.10. Depth and elevation of encountered bedrock surface

Borehole / Hand Probe / Test Pit No.	Location	Depth Below Ground Surface (m)	Elevation (m)	Uniaxial Compressive Strength – UCS (MPa)
BH20-1	East of culvert center line, north embankment	3.7	412.8	82
BH20-2	West of culvert center line, south embankment	7.0	409.6	83
BH20-3	East of culvert center line, south embankment	2.3	413.8	103 ¹ 95 ²
BH21-1	West of culvert center line, south embankment	>12.3	<404.6	N/A

BH21-2	East of culvert center line, south embankment	2.1	414.2	175
BH21-3	East of culvert center line, south embankment	4.6	411.8	91
BH21-4	West of culvert center line, south embankment	6.8	409.7	134

Notes:

1. UCS test at 2.8 m depth
2. UCS test at 3.5 m depth

Based on the bedrock NQ and HQ cores (~ core diameter 47 mm and 64 mm, respectively) recovered, the bedrock at the site consisted of meta-volcanic rock. In general, the rock samples are described as pink/white to grey/black and/or green in colour, fine to coarse grained, severely fractured to very sound. The Rock Quality Designation (RQD) measured on the core samples typically ranged from approximately 30% to 93%, indicating a rock mass of poor to excellent quality, mostly fair quality. The total core recovery (TCR) ranged from 99% to 100%. The top 0.5 m of the bedrock is estimated to be weathered.

The uniaxial compressive strength (UCS) was measured to be about 82 MPa to 175 MPa, indicating strong to very strong (R4 to R5) rock, primarily strong (R4) according to CFEM. However, our experience suggests that the rock in this area could be very strong to extremely strong (i.e. UCS in the range of 150 to 250 MPa). The laboratory uniaxial compression tests results are presented on the borehole records in Appendix C.

1.4.2 Stratigraphy at Inlet and Outlet

As previously indicated, due to steep side slopes of the embankment, access to the inlet and outlet of the Trout Creek Culvert was restricted and not accessible by a drill rig. Instead, during the initial investigation, hand probe holes, HP20-4 to HP20-7 and HP20-6I, were advanced at the inlet areas, and hand probe holes, HP20-8 to HP20-11, were advanced at the outlet areas. Furthermore, due to limited information at the outlet area, one test pit (TP21-1) was advanced at the outlet area using a tracked excavator during the follow-up investigation. The hand probes were drilled to refusal depths ranging between about 0.2 and 0.8 m below ground surface, and the test pit was advanced to a refusal depth of about 3.5 m. At the inlet and outlet sides, bedrock outcrop and rock fill were observed at the toe of embankment, suggesting very shallow bedrock or buried rock fill in the vicinity of inlet and outlet.

1.4.2.1 Topsoil

Topsoil, approximately 0.1 m to 0.6 m thick, was encountered at the surface of probe holes at inlet HP20-4 to HP20-7 and HP20-6I, at the surface of probe hole at outlet HP20-11, and at the surface of test pit TP21-1 (outlet area). Topsoil thicknesses may further vary beyond these locations. The depths and elevations encountered at these locations are listed in Table 1.11.

Table 1.11. Summary of Topsoil

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
HP20-4	414.2	414.1	0	0.1
HP20-5	413.9	413.3	0	0.6
HP20-6	413.8	413.7	0	0.1
HP20-6I	413.9	413.8	0	0.1
HP20-7	414.5	414.4	0	0.1
HP20-11	414.9	414.6	0	0.3
November 2021				
TP21-1	411.6	411.4	0	0.2

Note:

1. Depths are relative to ground surface.

The composition of this layer consisted of occasional boulders, occasional to some cobbles, trace gravel, some sand, some silt. The topsoil was brown to dark brown in color, moist to wet and loose.

Laboratory testing performed on selected samples consisted of nine (9) moisture content test. The test result is as follows:

Moisture Content:

- 22.1% to 129.4%

The results of the moisture content tests performed by EXP are provided on the record of borehole / test pit sheets in Appendix C.

1.4.2.2 Peat and Sand

A peat and sand layer, approximately 0.3 m to 1.0 m thick, was encountered at the surface of outlet probe holes, HP20-8 to HP20-10, and beneath the topsoil at TP21-1. Peat and sand thicknesses may further vary beyond the probe hole and test pit locations. Probe holes, HP20-8 and HP20-9 were terminated in this layer due to auger refusal. The depths and elevations encountered at these locations are listed in Table 1.12.

Table 1.12. Summary of Peat and Sand

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
HP20-8	411.9	411.6	0	0.3
HP20-9	411.6	411.3	0	0.3
HP20-10	413.1	412.8	0	0.3
November 2021				
TP21-1	411.4	410.4	0.2	1.0

Note:

1. Depths are relative to ground surface.

The composition of this layer generally consisted of peat, sand and silt, some cobbles and boulders, and some gravel. The peat and sand material was dark brown to black in color, wet and loose.

Laboratory testing performed on selected samples consisted of seven (7) moisture content tests and three (3) grain size distribution tests. The test results are as follows:

Moisture Content:

- 34.3% to 94.5%

Grain Size Distribution:

- 3% to 6% gravel;
- 54% to 57% sand;
- 37% to 43% silt and clay

The results of the moisture content and grain size distribution tests performed by EXP are provided on the record of borehole/test pit sheets in Appendix C. The results of the grain size distribution tests performed by EXP are also provided on Figure 6 in Appendix D.

1.4.2.3 Silt to Clayey Silt

Native silt to clayey silt was encountered underlying the peat and sand at test pit, TP21-1. The depth and elevation encountered at this location is listed in Table 1.13.

Table 1.13. Summary of Silt to Clayey Silt

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2021				
TP21-1	410.4	409.0	1.2	1.4

Note:

1. Depths are relative to ground surface.

The silt to clayey silt layer extended to a depth of about 2.6 m below ground surface (Elev. 409.0 m). The explored thickness of this layer was about 1.4 m.

The composition of this layer is silt, some clay to clayey soils, trace to some sand, and occasional cobbles. The material is light grey to grey in color, and wet.

Laboratory testing performed on selected samples consisted of four (4) moisture content tests, three (3) grain size distribution tests, and two (2) Atterberg limits tests. The test results are as follows:

Moisture Content:

- 13.2% to 22.4%

Grain Size Distribution:

- 0% to 1% gravel;
- 2% to 12% sand
- 77% to 82% silt; and
- 11% to 16% clay

Atterberg Limits:

- 19.6% to 23.3% liquid limit;
- 15.7% to 16.1% plastic limit; and
- 3.6% to 7.6% plasticity index

The results of the moisture content grain size distribution, and Atterberg limits tests performed by EXP are provided on the record of borehole/test pit sheets in Appendix C. The results of the grain size distribution tests performed by EXP are also provided on Figure 7 in Appendix D, and the Atterberg limits tests results are presented graphically on the Plasticity Chart on Figure 10, in Appendix D.

1.4.2.4 Silty Sand / Silty Sand with Gravel

Native silty sand / silty sand with gravel was encountered in probe holes HP20-4, HP20-6, HP20-6I, HP20-7 and HP20-11 below topsoil and in HP20-10 below peat and sand, as well as below the silt to clayey silt at test pit TP21-1. The depths and elevations encountered at these locations are listed in Table 1.14.

Table 1.14. Summary of Silty Sand / Silty Sand with Gravel

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
HP20-4	414.1	413.4	0.1	0.7
HP20-6	413.7	413.0	0.1	0.7
HP20-6I	413.8	413.4	0.1	0.4
HP20-7	414.4	414.3	0.1	0.1
HP20-10	412.8	412.6	0.3	0.2
HP20-11	414.6	414.2	0.3	0.4
November 2021				
TP21-1	409.0	408.1	2.6	0.9

Note:

1. Depths are relative to ground surface.

The silty sand/silty sand with gravel layer extended to depths ranging between 0.2 m to 3.5 m below ground surface with elevations ranging between Elev. 414.3 m to Elev. 408.1 m. The explored thickness of this layer was between 0.1 m to 0.9 m. Probe holes HP20-4, HP20-6, HP20-6I, HP20-7, HP20-10 and HP20-11 as well as test pit TP21-1 were terminated within this layer due to auger / excavator refusal.

The composition of this layer was sand, silt and gravel with occasional cobbles and boulders, trace to some peat and trace roots. The material is dark brown to brown in color, wet to moist, and loose to dense but mostly compact in in compactness condition.

Laboratory testing performed on a selected sample consisted of thirteen (13) moisture content tests and six (6) grain size distribution tests. The test results are as follows:

Moisture Content:

- 8.5% to 30.4%

Grain Size Distribution:

- 3% to 29% gravel;
- 48% to 79% sand; and
- 15% to 33% silt and clay

The results of the moisture content and grain size distribution tests performed by EXP are provided on the record of borehole / test pit sheets in Appendix C. The results of the grain size distribution tests performed by EXP are also provided on Figure 8 in Appendix D.

1.4.2.5 Sandy Gravel

Native sandy gravel was encountered in probe hole HP20-5 below the topsoil. The depth and elevation encountered at this location is listed in Table 1.15.

Table 1.15. Summary of Sandy Gravel

Borehole / Hand Probe / Test Pit No.	Elevation (m)		Layer Surface Depth ¹ (m)	Layer Thickness (m)
	Top	Bottom		
November 2020				
HP20-5	413.3	413.2	0.6	0.1

Notes:

1. Depths are relative to ground surface.

The sandy gravel layer extended to depth of about 0.6 m below ground surface with elevation of about Elev. 413.2 m. The explored thickness of this layer was 0.1 m. Probe hole BH20-5 was terminated within this layer.

The composition of this layer is sand and gravel with occasional cobbles and boulders and some silt. The material is light brown in color, moist and compact in compactness condition.

Laboratory testing performed on a selected sample consisted of one (1) moisture content tests and one (1) grain size distribution test. The test results are as follows:

Moisture Content:

- 18.7%

Grain Size Distribution:

- 45% gravel;
- 39% sand;
- 16% silt; and
- 0% clay

The results of the moisture content and grain size distribution tests performed by EXP are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution test performed by EXP are also provided on Figure 9 in Appendix D.

1.4.2.6 Refusal

Probe hole drilling refusal was encountered at depths ranging between 0.2 m and 0.8 m below the existing ground surface (Elev. 414.3 m to 411.3 m). At test pit, TP21-1, refusal was encountered at 3.5 m depth below the existing ground surface (Elev. 408.1 m); note that the nature of refusal (e.g., boulder or bedrock) could not be determined as groundwater was present within the test pit obstructing observations. The presence of bedrock and/or buried rock fill below the soils was suspected based on observed bedrock outcrops as well as boulders and cobbles sized rock pieces.

1.5 Groundwater and Surface Water Conditions

The groundwater levels in the boreholes were observed during and upon completion of their drilling. During EXP's investigation in November 2020, the groundwater levels in the inlet holes were dry. In the outlet holes, groundwater was observed to be at depths of about 0.2 m below ground surface, corresponding to Elev. 411.7 m and Elev. 411.4 m in HP20-8 and HP20-9 respectively while other holes were dry. In borehole BH20-1 drilled from the road, the groundwater was observed to be at depths of about 3.1 m below ground surface, corresponding to Elev. 413.4 m.

The measured elevations of the top of water at the inlet and outlet of the existing culvert and overflow culverts were Elev. 412.7 m and Elev. 410.9 m, respectively. As noted in Section 1.2.1, the water depth in the pool formed in front of the inlet was measured to be approximately 0.4 m to 0.75 m above the rocky bottom, while the measured water depth in the creek beyond the culvert outlet was around 0.7 m.

During EXP's follow-up investigation in November 2021, the groundwater level at the outlet location (TP21-1) was observed to be at a depth of about 0.6 m below ground surface, corresponding to Elev. 411.0 m. In boreholes, BH21-1, BH21-3 and BH21-4, which were drilled through the embankment, groundwater levels were measured the day following the borehole completion to allow for water levels to stabilize (note that water was introduced into the boreholes for rock coring purposes). The groundwater levels at BH21-1, BH21-3 and BH21-4 were all at about 4.4 m below ground surface, and at elevations ranging between about 412.0 m and 412.5 m. No groundwater measurement was obtained at BH21-2, as water levels were not representative before the borehole was backfilled (again water was introduced in the borehole for rock coring purposes). The groundwater levels encountered in the boreholes are shown on the borehole logs and is summarized below in Table 1.16.

Table 1.16. Groundwater levels encountered

Borehole / Hand Probe / Test Pit No.	Date Measured	Ground Surface Elevation (m)	Groundwater Depth ¹ /Elevation (m)
November 2020			
BH20-1	November 3, 2020	416.5	3.1/413.4
HP20-8	November 2, 2020	411.9	0.2/411.7
HP20-9	November 2, 2020	411.6	0.2/411.4
November 2021			
BH21-1	November 25, 2021	416.9	4.4/412.5
BH21-3	November 27, 2021	416.4	4.4/412.0
BH21-4	November 27, 2021	416.5	4.4/412.1
TP21-1	November 26, 2021	411.6	0.6/411.0

Note:

1. Depths are relative to ground surface.

Groundwater levels would be expected to reflect levels in the adjacent open water 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.

1.6 Chemical Analysis

Three soil samples were selected for chemical analyses and they were sent via courier, in a secure cooler under chain of custody, to Bureau Veritas Laboratories (formerly Maxam Analytics Inc.), a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix F, and are summarized in Table 1.17, below.

Table 1.17. Corrosivity chemical analysis

Sample Identification	pH (unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)
BH20-1 S7	7.66	23	<20	7,900	0.130
HP20-5 S4	4.76	<20	<20	34,000	0.029
HP20-11 S2	6.13	30	<20	13,000	0.080

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 and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

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 Report has been prepared by Ahileas Mitsopoulos, P.Eng., 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 Elwin Farkas.

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ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Ontario Water Resources Act:

R.R.O 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40

Ontario Occupational Health and Safety Act (OHSA):

Ontario Regulation 213/91 Construction Projects

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.

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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 utilized 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.

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ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Ontario Water Resources Act:

R.R.O 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40

Ontario Occupational Health and Safety Act (OHSA):

Ontario Regulation 213/91 Construction Projects

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 utilized 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



Photograph 1. Inlet side of the culvert, October 2020



Photograph 2. Outlet side of the culvert, October 2020



Photograph 3. Inlet side of the culvert (facing south), November 2020



Photograph 4. Outlet side of the culvert (facing south), November 2020



Photograph 5. Inside of the centreline culvert at outlet, October 2020



Photograph 6. Drilling borehole BH20-1 on the Highway 599 embankment (facing east), November 2020



Photograph 7. Drilling hand probe hole HP20-4, HP20-5, at the inlet side, November 2020



Photograph 8. Drilling hand probe hole HP20-6I, at the inlet side, November 2020



Photograph 9. Inlet side of culvert (facing north), November 2021



Photograph 10. Outlet side of culvert (facing south), November 2021



Photograph 11. View of north embankment (facing east), November 2021



Photograph 12. View of south embankment (facing east), November 2021. Test pit TP21-1 advanced on the south side of Highway 599 and west of culverts.

Appendix B – Drawings



KEY PLAN



LEGEND

- Borehole Location (2021)
- Borehole Location (2020)
- Test Pit Location (2021)
- ⊗ Bench Mark Location (Elev. 417.007m)
- N Standard Penetration Test (Blows/0.3 m)
- ▽ Groundwater level measured in open hole

SOIL STRATA SYMBOLS

- TOPSOIL
- FILL/ROCKFILL
- GRAVELLY SAND
- SILTY SAND
- SANDY SILT
- SILTY SAND WITH GRAVEL (TILL)
- SANDY GRAVEL
- PEAT
- GRAVEL
- SILT TO CLAYEY SILT
- BEDROCK

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-15)	
		NORTHING	EASTING
BH20-01	416.5	5563540.7	252977.6
BH20-02	416.5	5563531.1	252968.2
BH20-03	416.1	5563542.0	252994.7
HP20-04	414.2	5563540.8	252950.6
HP20-05	413.9	5563545.4	252961.8
HP20-06	413.8	5563552.9	252974.1
HP20-06i	413.9	5563553.7	252978.1
HP20-07	414.5	5563556.5	252984.2
HP20-08	411.9	5563512.3	252962.4
HP20-09	411.6	5563518.9	252972.7
HP20-10	413.1	5563526.4	252986.0
HP20-11	414.9	5563529.1	252992.1
BH21-1	416.9	5563524.6	252954.9
BH21-2	416.3	5563540.2	252990.6
BH21-3	416.4	5563535.7	252978.4
BH21-4	416.5	5563532.0	252970.2
TP21-1	411.6	5563516.9	252973.6

NOTES

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DATE	SM	BY	DESCRIPTION
			SUBMISSION FOR MTO REVIEW
			GEOCRETS NO. 52J-20
			PROJECT NO. ADM-00262199-H0
SUBM'D SH	CHECKED SM	DATE	APRIL 27, 2022
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 1

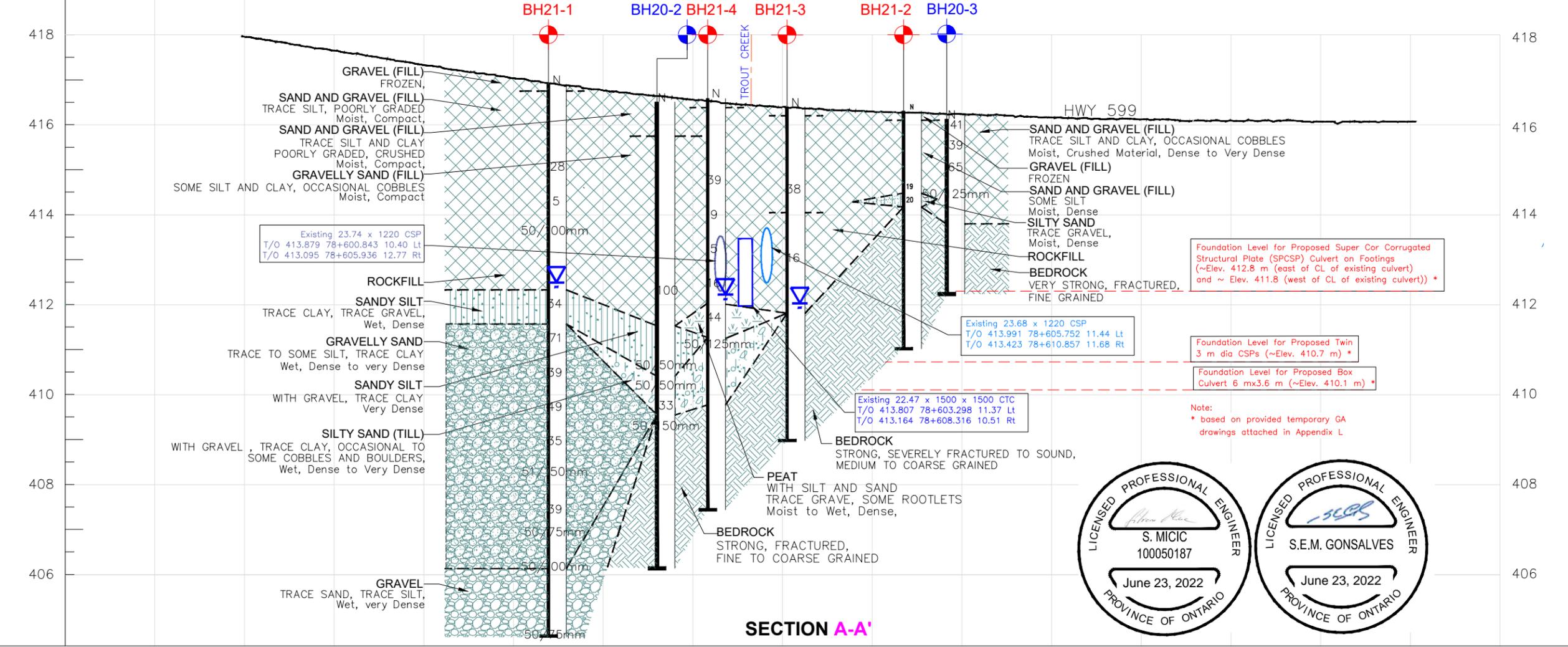
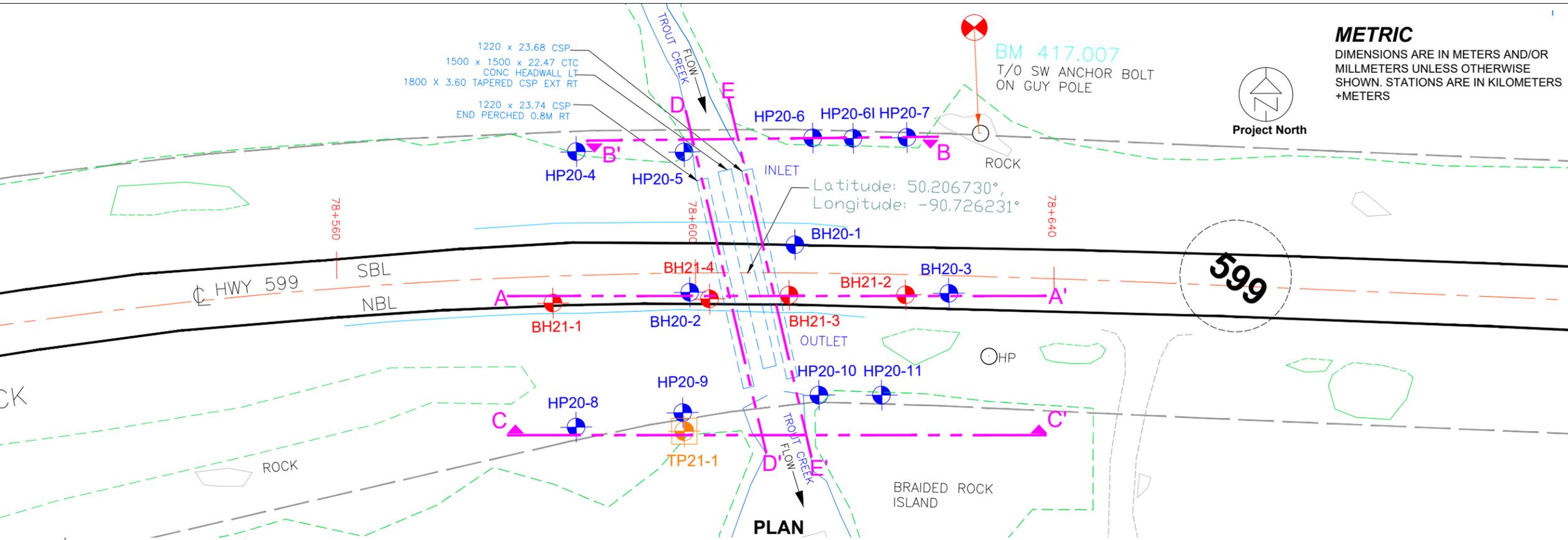
METRIC

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



BM 417.007
T/O SW ANCHOR BOLT ON GUY POLE

- 1220 x 23.68 CSP
- 1500 x 1500 x 22.47 CTC CONC HEADWALL LT
- 1800 x 3.60 TAPERED CSP EXT RT
- 1220 x 23.74 CSP
- END PERCHED 0.8M RT



Foundation Level for Proposed Super Cor Corrugated Structural Plate (SPCSP) Culvert on Footings (~Elev. 412.8 m (east of CL of existing culvert) and ~ Elev. 411.8 (west of CL of existing culvert)) *

Foundation Level for Proposed Twin 3 m dia CSPs (~Elev. 410.7 m) *

Foundation Level for Proposed Box Culvert 6 mx3.6 m (~Elev. 410.1 m) *

Note: * based on provided temporary GA drawings attached in Appendix L



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

Agreement No. 6019-E-0004/0005
 GWP No. 6530-17-00
 Assignment No. 8

Trout Creek Non-Structural Culvert to be Replaced with a Structural Culvert- Highway 599
 Northwestern Region, Thunder Bay, ON
 Latitude: 50.206730°, Longitude: -90.726231°

BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET 2

exp. **EXP Services Inc.**

KEY PLAN



LEGEND

- Borehole Location (2021)
- Borehole Location (2020)
- Test Pit Location (2021)
- Bench Mark Location (Elev. 417.007m)
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS

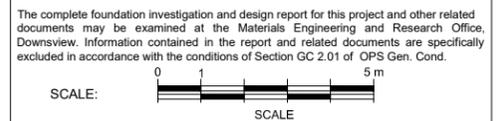
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	SANDY SILT		SANDY SILT		SILTY SAND WITH GRAVEL (TILL)
	SANDY GRAVEL		PEAT		GRAVEL
	SILT TO CLAYEY SILT		BEDROCK		

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BH20-02	416.5	5563531.1	252968.2
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BH21-4	416.5	5563532.0	252970.2
TP21-1	411.6	5563516.9	252973.6

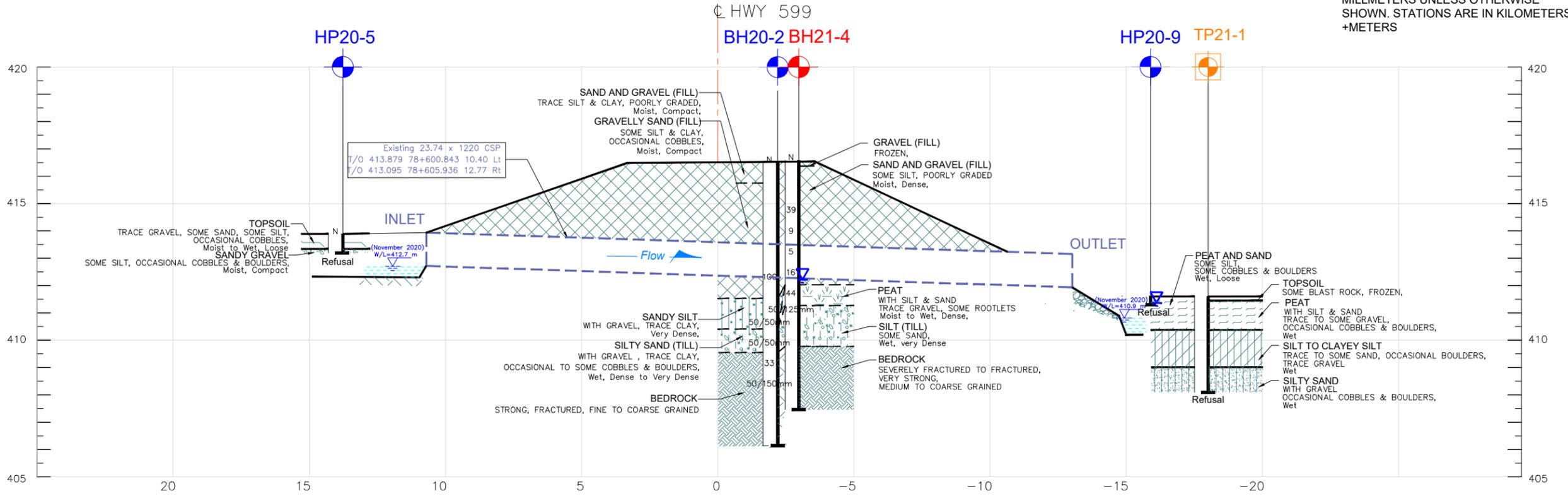
NOTES

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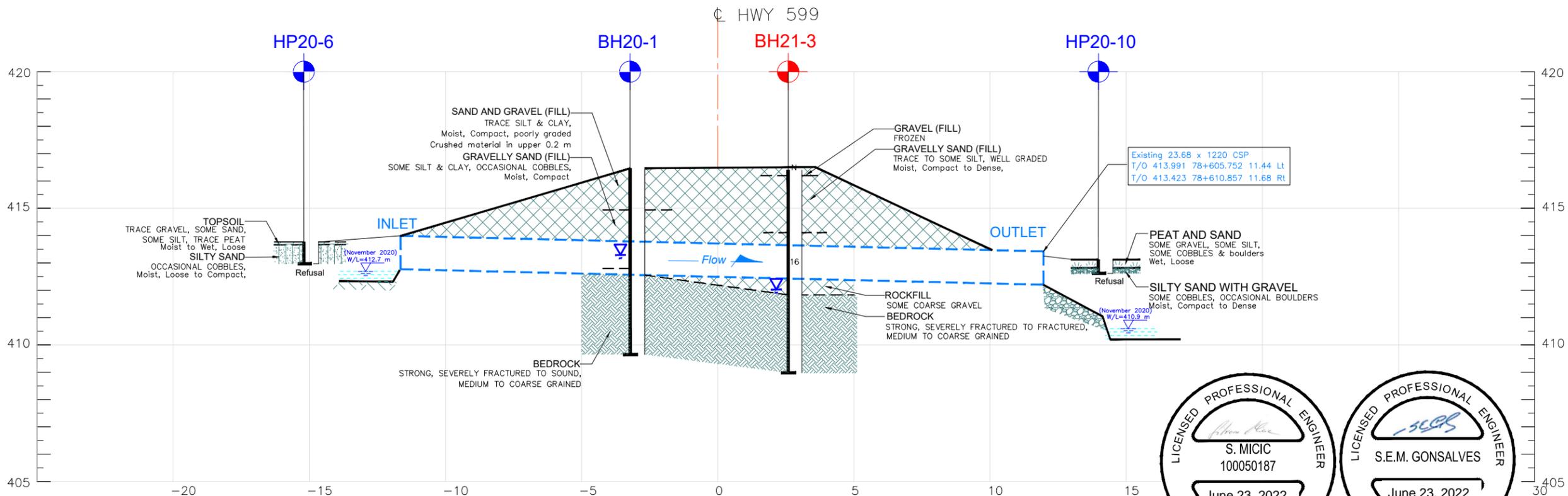
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	BY	DESCRIPTION	
		GEOCRETS NO.	52J-20
		PROJECT NO.	ADM-00262199-H0
SUBM'D SH	CHECKED SM	DATE	APRIL 27, 2022
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 2



SECTION D-D'



SECTION E-E'





METRIC
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 SHOWN. STATIONS ARE IN KILOMETERS
 +METERS

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 GWP No. 6530-17-00
 Assignment No. 8

Trout Creek Non-Structural Culvert to be Replaced with
 a Structural Culvert- Highway 599
 Northwestern Region, Thunder Bay, ON
 Latitude: 50.206730°, Longitude: -90.726231°

BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET 3

exp. EXP Services Inc.

KEY PLAN



LEGEND

- Borehole Location (2021)
- Borehole Location (2020)
- Test Pit Location (2021)
- Bench Mark Location (Elev. 417.007m)
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS

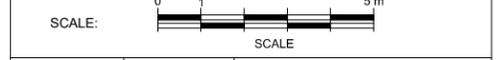


BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-15)	
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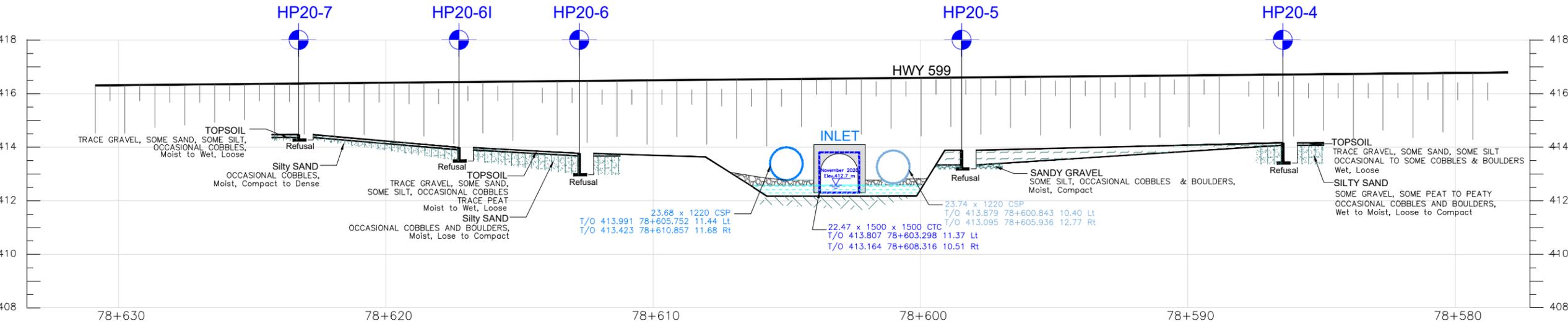
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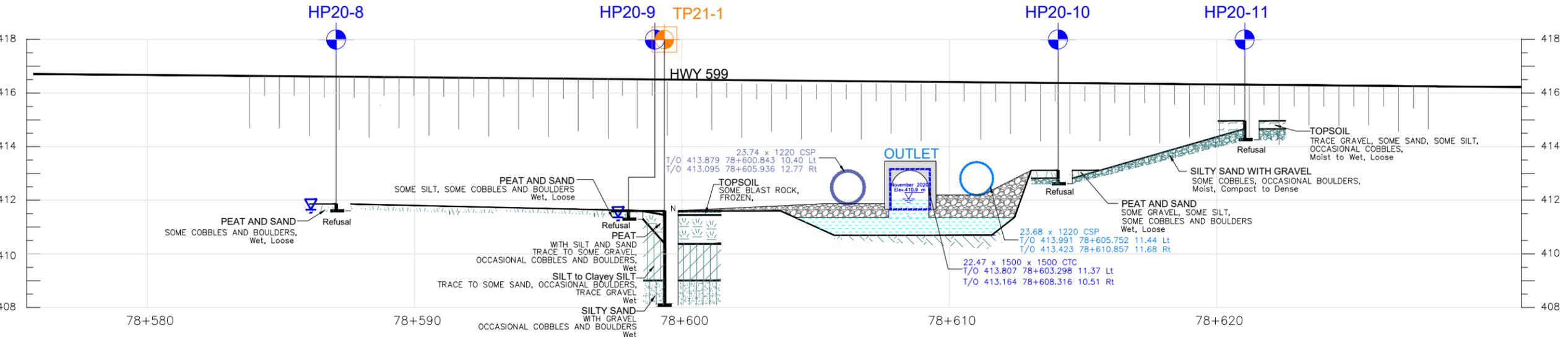
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DRAWN SH	CHECKED SM	APPROVED SG	DWG. 3



SECTION B-B'



SECTION C-C'

Appendix C –
Borehole and Test Pit 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.

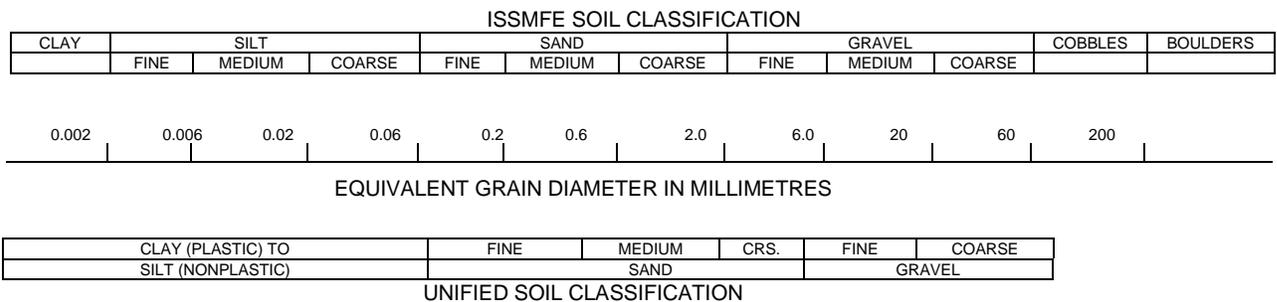
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

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.



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 Canadian Foundation Engineering Manual (CFEM):

Table a: Percent or Proportion of Soil

Term	Description	Criteria
“trace”	trace gravel, trace sand, etc.	1% - 10%
“some”	some gravel, some sand, etc.	10% - 20%
Adjective	gravelly, sandy, silty and clayey	20% - 35%
“and”	and gravel, and sand, etc.	>35%
Noun	gravel, sand, silt, clay	>35% and main fraction

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≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤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:

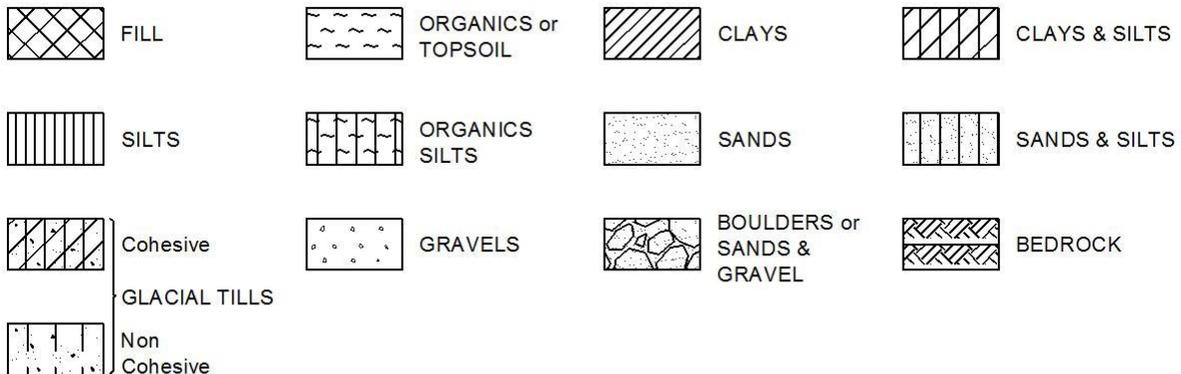
Table c: Consistency of Cohesive Soil

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 BH21-1

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~ 4.6 km South of Savant Lake CNR Crossing MTM ON-15 252954.9E 5563524.6N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE CME 55 Rubber Track / SSA / NW COMPILED BY KP
 DATUM Local DATE 2021.11.23 - 2021.11.24 LATITUDE 50.20661 LONGITUDE -90.72632 CHECKED BY AM/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	20	40	60	80						100	20	40
416.9	Gravel		S1	AS															
416.8	Gravel (FILL) - frozen, brown		S2	AS															
0.2	Sand and Gravel (FILL) - trace silt, brown, moist, compact, poorly graded		S3	AS															
			S4	AS															
			S5	AS															
			S6	SS	28														39 51 (10)
	becomes more silty below ~2.3 m depth		S7	SS	5														15 59 (27)
413.5	- refusal to SPT and auger at about 3.5 m depth, rock coring techniques initiated		S8	SS	50/100mm														
	ROCK FILL		S9	CORE															
412.3																			
411.6	Sandy SILT - trace clay, trace gravel, light brown, wet, dense		S10	SS	34													4 31 57 8	
5.3	Gravelly SAND - trace to some silt, trace clay, light brown, wet, dense to very dense		S11	SS	71													44 44 (12)	
			S12	SS	39														25 57 (18)
			S13	SS	49														
			S14	SS	35														27 62 (11)
			S15	SS	51/150mm														
	- some cobbles at about 9.1 m depth		S16	SS	39														32 52 (15)
			SS	50/75mm															no recovery
			SS	50/100mm															no recovery
406.1	GRAVEL - trace sand, trace silt, reddish brown, wet, very dense		S17	CORE															
404.6																			
12.3	End of Borehole - refusal		S18	SS	50/75mm														
	- groundwater was measured 4.4 m below ground surface																		

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT. 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No BH21-2

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~ 4.6 km South of Savant Lake CNR Crossing MTM ON-15 252990.6E 5563540.2N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE CME 750 Rubber Track / SSA / HW COMPILED BY KP
 DATUM Local DATE 2021.11.28 - 2021.11.28 LATITUDE 50.20675 LONGITUDE -90.72582 CHECKED BY AM/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	20	40	60	80						100	20	40	60
416.3	Asphalt 2" thick																			
416.0	GRAVEL (FILL) - frozen, grey Sand and Gravel (FILL) - some silt, brown, moist, dense		S1	AS																
0.2			S2	AS																
			S3	AS																
			S4A	SS	19															39 50 (11)
414.5	Silty SAND - trace gravel, light brown to grey, moist, dense - refusal to SPT and auger at about 2.1 m depth, rock coring techniques initiated BEDROCK - very strong, very sound, black/white to grey, medium to coarse grained - becoming severely fractured, green/white to grey, fine to coarse grained at about 3.1 m depth - becoming sound, black/white to greenish grey at about 4.6 m depth		S4B	SS	20														9 53 (38)	
1.8			S5	CORE																UCS test at 2.4 m depth = 175 MPa Recovery=100% RQD=93%
414.2			S6	CORE																
2.1			S7	CORE																Recovery=100% RQD=86%
411.0	End of Borehole - no groundwater measurements were recorded as the introduced water for rock coring purposes had not stabilized before backfilling																			
5.3																				

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

RECORD OF BOREHOLE No BH21-3

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~ 4.6 km South of Savant Lake CNR Crossing MTM ON-15 252978.4E 5563535.7N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE CME 750 Rubber Track / SSA / HW COMPILED BY KP
 DATUM Local DATE 2021.11.27 - 2021.11.27 LATITUDE 50.20671 LONGITUDE -90.72599 CHECKED BY AM/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						
416.4	Asphalt 2" thick															
416.0	Gravel (FILL) - frozen, grey Gravelly Sand (FILL) - trace to some silt, brown, moist, compact to dense, well graded		S1	AS												
0.2			S2	AS												
			S3	AS												
			S4	SS	38											
			S5	AS												
414.1	ROCK FILL - some coarse gravel in upper 3.1 m															
2.3				SS	16											
			S6	CORE												
411.8	BEDROCK - strong, severely fractured to fractured, black/white and grey to pink/white, medium to coarse grained															
4.6			S7	CORE												
			S8	CORE												
409.0	End of Borehole - groundwater was measured 4.4 m below ground surface															
7.4																

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

RECORD OF BOREHOLE No BH21-4

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~ 4.6 km South of Savant Lake CNR Crossing MTM ON-15 252970.2E 5563532N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE CME 750 Rubber Track / SSA / HW COMPILED BY KP
 DATUM Local DATE 2021.11.25 - 2021.11.26 LATITUDE 50.20668 LONGITUDE -90.72611 CHECKED BY AM/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								
416.5	Asphalt 2" thick															
416.0	Gravel (FILL) - frozen, grey		S1	AS												
0.2	Sand and Gravel (FILL) - some silt, brown, moist, dense, poorly graded		S2	AS												
			S3	AS												
			S4	AS												
			S5	SS	39											38 50 (12)
			S6	SS	9											
			S7	SS	5											
			S8	SS	16											40 47 (13)
411.9	PEAT with Silt and Sand - trace gravel, dark brown, moist to wet, dense, some rootlets		S9	SS	44											
411.2	SILT (TILL) - some sand, grey, wet, very dense, cobbles and boulders		S10	SS	50/125mm											
	- refusal to SPT and auger at about 5.6 m depth, rock coring techniques initiated		S11	CORE												
	- void/soil noted from about 6.3 m to 6.8 m depth		S12	CORE												
409.7	BEDROCK - very strong, severely fractured to fractured, black/white to greenish grey, some pink, medium to coarse grained		S13	CORE												Recovery=99% RQD=76% UCS test at 7.0 m depth = 134 MPa
6.8																Recovery=100% RQD=73%
407.4	End of Borehole															
9.1	- groundwater was measured 4.4 m below ground surface															

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No TP21-1

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~ 4.6 km South of Savant Lake CNR Crossing MTM ON-15 252973.6E 5563516.9N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Link-Belt 235 Track Excavator COMPILED BY KP
 DATUM Local DATE 2021.11.26 - 2021.11.26 LATITUDE 50.20654 LONGITUDE -90.72606 CHECKED BY AM/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 (%)
							20	40	60	80	100	20	40	60	129.4	GR SA SI CL	
411.6	Topsoil		S1	GRAB													
410.6	TOPSOIL - some blast rock, frozen, dark brown PEAT with Silt and Sand - trace to some gravel, occasional cobbles and boulders, dark brown, wet		S2	GRAB												5 51 (43)	
410.4			S3	GRAB													
410.4		SILT to Clayey SILT - trace to some sand, occasional boulders, light grey to grey, wet		S4	GRAB												0 12 77 11
409.0	- trace gravel at about 2.3 m depth		S5	GRAB													
			S6	GRAB													0 2 82 16
			S7	GRAB													1 3 82 14
408.1	Silty SAND with Gravel - occasional cobbles and boulders, dark brown, wet		S8	GRAB													
408.1	End of Test Pit - refusal - groundwater was measured 0.6 m below ground surface																

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No BH20-1

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252977.6E 5563540.7N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE B54X Rubber Track SSA / HQ COMPILED BY AM
 DATUM Local DATE 2020.11.03 - 2020.11.03 LATITUDE 50.20676 LONGITUDE -90.726 CHECKED BY DG/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 (%)			
						20	40	60	80	100	20	40	60		GR	SA	SI	CL		
416.5	Asphalt treatment 1" thick		S1	AS																
0.0	Sand and Gravel (FILL) trace silt and clay, grey, moist, compact, poorly graded, crushed material in upper 0.2 m - becoming brown, occasional cobbles at about 0.2 m depth		S2	AS																
			S3	AS																
414.9			S4	AS																
1.5			Gravelly Sand (FILL) some silt and clay, occasional cobbles, brown, moist, compact		S5	AS														
	S6	AS																		
412.8	S7	AS																		
3.7	BEDROCK strong, severely fractured to sound, white/pink to grey, medium to coarse grained		S8	CORE																
			S9	CORE																
409.7			S10	CORE																
6.8	End of Borehole - groundwater was measured 3.1 m below ground surface																			

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No BH20-2

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252968.2E 5563531.1N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE B54X Rubber Track SSA / HSA / HQ COMPILED BY AM
 DATUM Local DATE 2020.11.03 - 2020.11.06 LATITUDE 50.20667 LONGITUDE -90.72614 CHECKED BY DG/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	20	40	60	80						100	20	40
416.5	Asphalt treatment 1" thick																		
0.0	Sand and Gravel (FILL) trace silt and clay, grey, moist, compact, poorly graded, crushed material in upper 0.2 m Gravelly Sand (FILL) some silt and clay, occasional cobbles, brown, moist, compact - refusal to SPT and auger at about 4.4 m depth, rock coring techniques initiated		S1	AS															
415.8			S2	AS															
0.8			S3	AS															
			S4	AS															
			S5	AS															
			S6	AS															
			S7	SS	100														
411.5	Sandy SILT with Gravel trace clay, very dense, grey, wet		S8	CORE															
5.0			S9	SS	50/50mm														
410.4	Silty SAND with Gravel (TILL) trace clay, occasional to some cobbles and boulders, grey, wet, dense to very dense		S10	SS	50/50mm														
6.1			S11	SS	50/50mm														
409.6	BEDROCK strong, fractured, white and black, fine to coarse grained		S12	CORE	150mm														
7.0			S13	CORE															
			S14	CORE															
406.1	End of Borehole - no obtainable groundwater level due to caved borehole																		
10.4																			

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL GPJ ONTARIO MTO GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No BH20-3

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252994.7E 5563542.0N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE B54X Rubber Track SSA / HSA / HQ COMPILED BY AM
 DATUM Local DATE 2020.11.05 - 2020.11.06 LATITUDE 50.20677 LONGITUDE -90.72576 CHECKED BY DG/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	20	40	60		GR SA SI CL		
416.1	Asphalt treatment 1" thick																
0.0	Sand and Gravel (FILL) trace silt and clay, occasional cobbles, grey to brown, moist, crushed material, dense to very dense		S1A	SS	41												
			S1B	SS	39												
			S2	SS	65												
			S3	SS	50/ 125mm											44 42 (14)	
413.8	BEDROCK very strong, fractured, green to blue, fine grained																
2.3																	
412.2	- becoming strong, white and black, medium to coarse grained at about 3.2 m depth		S4	CORE												UCS test at 2.8 m depth = 103 MPa Recovery=99%, RQD=56% UCS test at 3.5 m depth = 95 MPa	
3.9	End of Borehole																
	- no obtainable groundwater level due to caved borehole																

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-4

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252950.6E 5563540.8N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.05 - 2020.11.05 LATITUDE 50.20676 LONGITUDE -90.72638 CHECKED BY DG/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	20	40	60	80						100	20	40
414.2	Topsoil																		
414.0	<p>TOPSOIL trace gravel, some sand, some silt, occasional to some cobbles, occasional boulders, dark brown, wet, loose</p> <p>Silty SAND some gravel, occasional cobbles and boulders, some peat to peaty in upper 0.3 m dark brown, wet to moist, loose to compact</p> <p>End of Borehole - refusal - no groundwater encountered - bedrock outcrop observed about 3 m from borehole</p>		S1	AS															
			S2	AS															
				S3	AS														
				S4	AS														
413.4																			
0.8																			

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-5

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252961.8E 5563545.4N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.05 - 2020.11.05 LATITUDE 50.2068 LONGITUDE -90.72623 CHECKED BY DG/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	20	40	60		GR SA SI CL	
413.9	Topsoil															
0.0	TOPSOIL trace gravel, some sand, some silt, occasional cobbles, dark brown, moist to wet, loose Sandy GRAVEL some silt, occasional cobbles and boulders, light brown, moist, compact End of Borehole - refusal - no groundwater encountered - bedrock outcrop observed about 3 m from borehole		S1	AS												
			S2	AS												
413.3			S3	AS												
416.8			S4	AS												
0.7															45 39 16 0	

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-6

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252974.1E 5563552.9N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.04 - 2020.11.04 LATITUDE 50.20687 LONGITUDE -90.72605 CHECKED BY DG/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	20	40	60	80						100	20
413.8 0.1	Topsoil		S1	AS														
413.0 0.8	<p>TOPSOIL trace gravel, some sand, some silt, brown, moist to wet, loose</p> <p>Silty SAND occasional cobbles, brown, moist, loose to compact, roots in upper 0.5 m - trace peat at about 0.3 m depth</p> <p>End of Borehole - refusal</p> <p>- no groundwater encountered</p> <p>- bedrock outcrop observed about 3 m from borehole</p>		S2	AS														
			S3	AS														
			S4	AS														
						413												

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-6I

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252978.1E 5563553.7N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.05 - 2020.11.05 LATITUDE 50.20687 LONGITUDE -90.726 CHECKED BY DG/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	20	40	60	80						100	20	40
413.9	Topsoil																		
413.4	<p>TOPSOIL trace gravel, some sand, some silt, occasional cobbles, brown, moist to wet, loose</p> <p>Silty SAND occasional cobbles and boulders, brown, moist, compact</p> <p>End of Borehole refusal</p> <p>- no groundwater encountered</p> <p>- bedrock outcrop observed about 3 m from borehole</p>		S1	AS															
0.5			S2	AS															
				S3	AS														

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-7

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252984.2E 5563556.5N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.04 - 2020.11.04 LATITUDE 50.2069 LONGITUDE -90.72591 CHECKED BY DG/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			20	40	60	80	100						20	40
414.5	Topsoil																	
414.4	TOPSOIL trace gravel, some sand, some silt, occasional cobbles, brown, moist to wet, loose Silty SAND occasional cobbles, brown, moist, compact to dense End of Borehole refusal - no groundwater encountered - bedrock outcrop observed about 3 m from borehole	S1	AS															
414.3		S2	AS															
414.2																		

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-8

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252962.4E 5563512.3N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.02 - 2020.11.02 LATITUDE 50.2065 LONGITUDE -90.72621 CHECKED BY DG/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	20	40	60	80						100	20	40	60
411.9	Peat																			
419.8	PEAT AND SAND some cobbles and boulders, dark brown, wet, loose		S1	AS																
0.3	End of Borehole refusal		S2	AS																
	- three additional hand probes / digging were conducted in about a 2.5 m radius, all with similar findings																			
	- groundwater was measured 0.2 m below ground surface																			

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-9

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252972.7E 5563518.9N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.02 - 2020.11.02 LATITUDE 50.20656 LONGITUDE -90.72607 CHECKED BY DG/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	20	40	60	80	100	W _p	W			W _L	GR
411.6	Peat																	
0.0	PEAT AND SAND some silt, some cobbles and boulders, dark brown, wet, loose	S1	AS															
411.3			S2	AS														
0.3	End of Borehole refusal - five additional hand probes / digging were conducted in about a 3.0 m radius, all with similar findings - groundwater was measured 0.2 m below ground surface																	

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-10

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252986.0E 5563526.4N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.02 - 2020.11.02 LATITUDE 50.20663 LONGITUDE -90.72588 CHECKED BY DG/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	20	40	60	80						100	20
413.1	Peat																	
0.0	PEAT AND SAND some gravel, some silt, some cobbles and boulders, dark brown to black, wet, loose Silty SAND with Gravel some cobbles, occasional boulders, brown, moist, compact to dense End of Borehole refusal - no groundwater encountered - bedrock outcrop observed about 1.5 m from borehole		S1	AS														
412.8			S2	AS														
410.6																		
0.5																		

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Brampton, Ontario

RECORD OF BOREHOLE No HP20-11

1 OF 1

METRIC

W.P. GWP No. 6530-17-00 LOCATION Hwy 599 ~4.6 km South of Savant Lake CNR Crossing MTM ON-15 252992.1E 5563529.1N ORIGINATED BY EF
 DIST Thunder Bay HWY 599 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM
 DATUM Local DATE 2020.11.02 - 2020.11.02 LATITUDE 50.20665 LONGITUDE -90.7258 CHECKED BY DG/SM

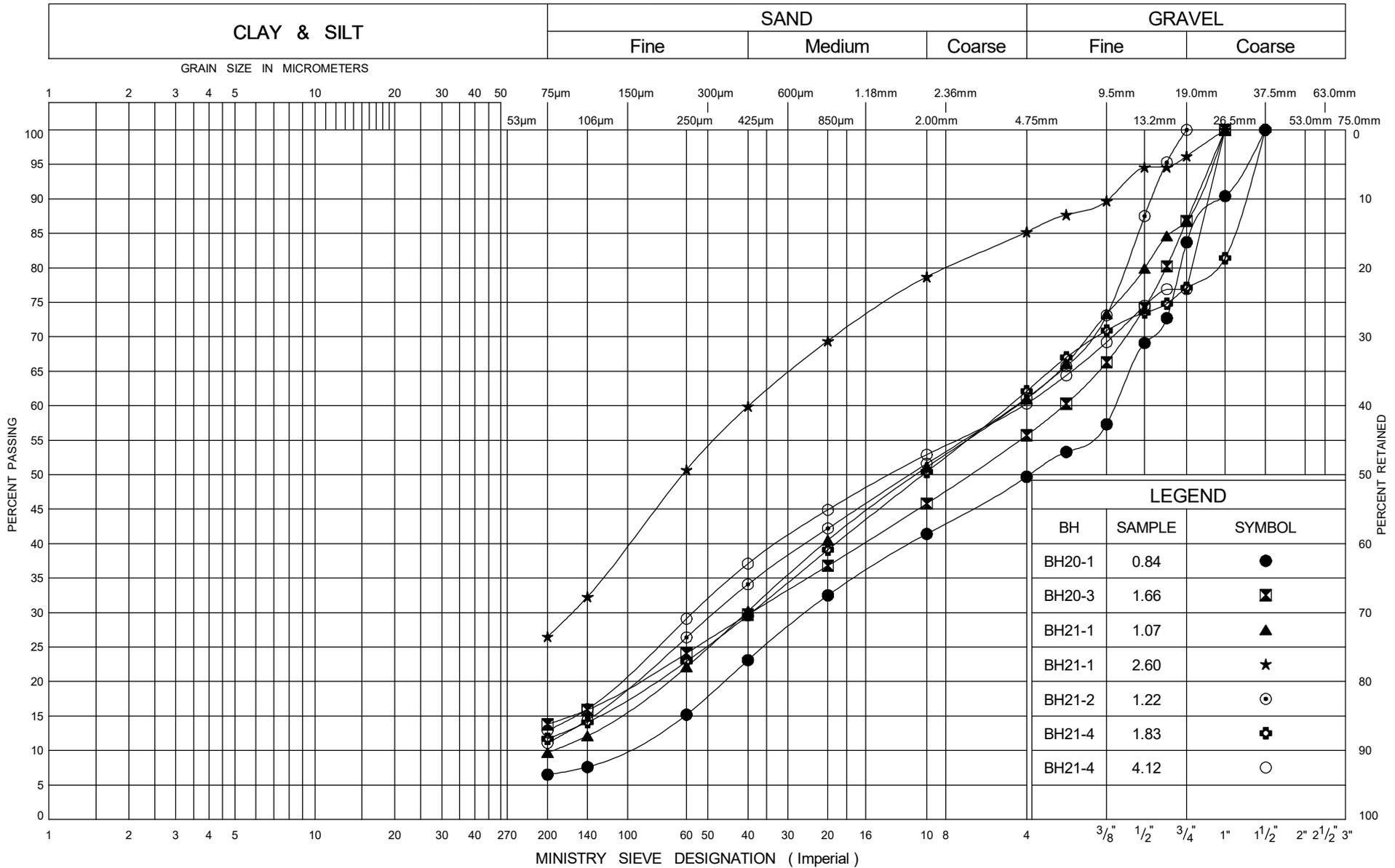
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
414.9	Topsoil																
0.0	TOPSOIL trace gravel, some sand, some silt, occasional cobbles, dark brown, moist to wet, loose Silty SAND with Gravel some cobbles, occasional boulders, brown, moist, compact to dense End of Borehole refusal - no groundwater encountered - bedrock outcrop observed about 1.5 m from borehole		S1	AS													
414.6			S2	AS													
0.3			S3	AS													
414.2																25 50 (25)	
0.7																	

ONTARIO MTO ADM-00262199-H0 - MTO 188 - HWY 599 - EL.GPJ ONTARIO.MTO.GDT 2/1/22

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

Appendix D –
Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

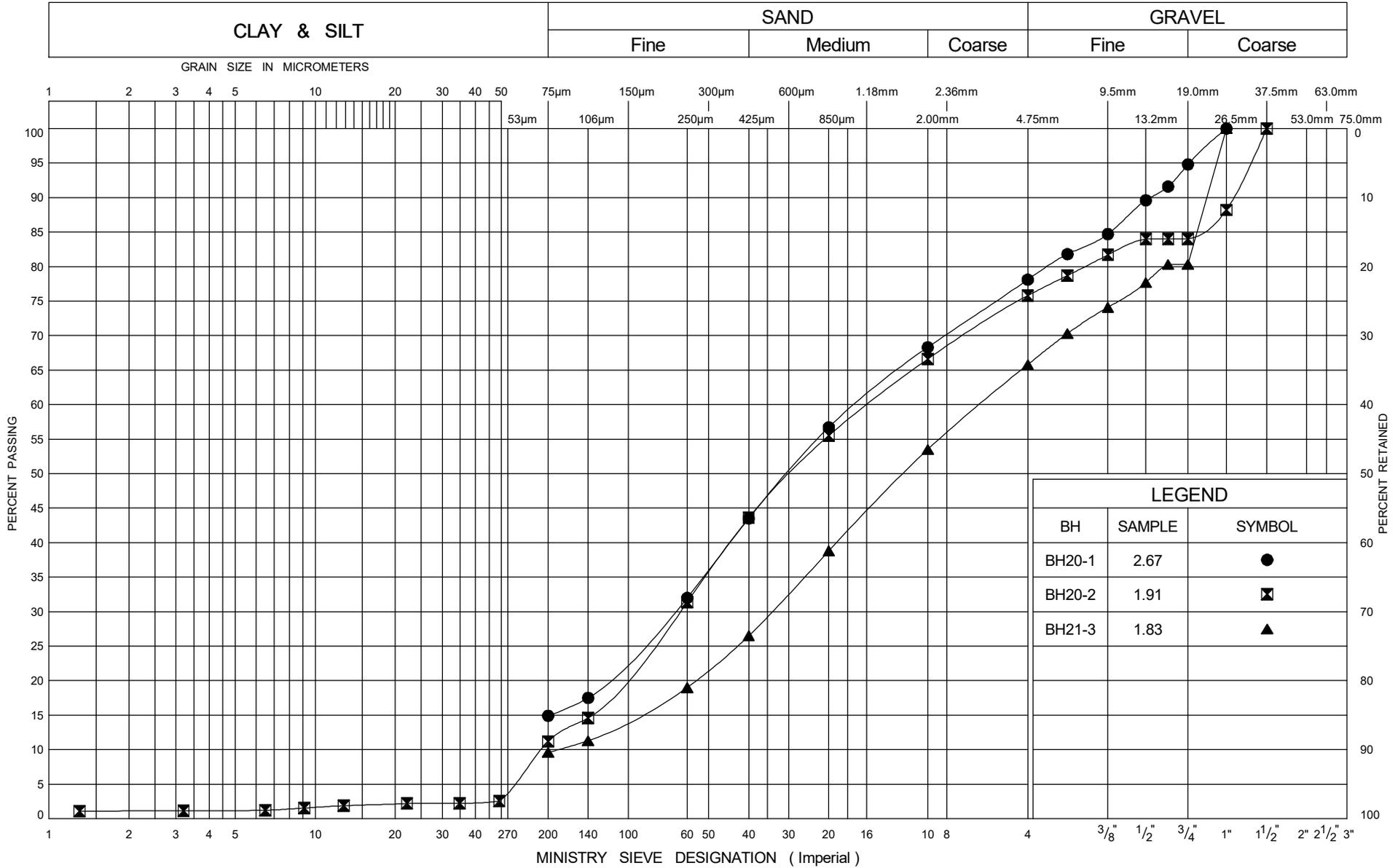
Fill: Sand and Gravel / Gravel

FIG No 1

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

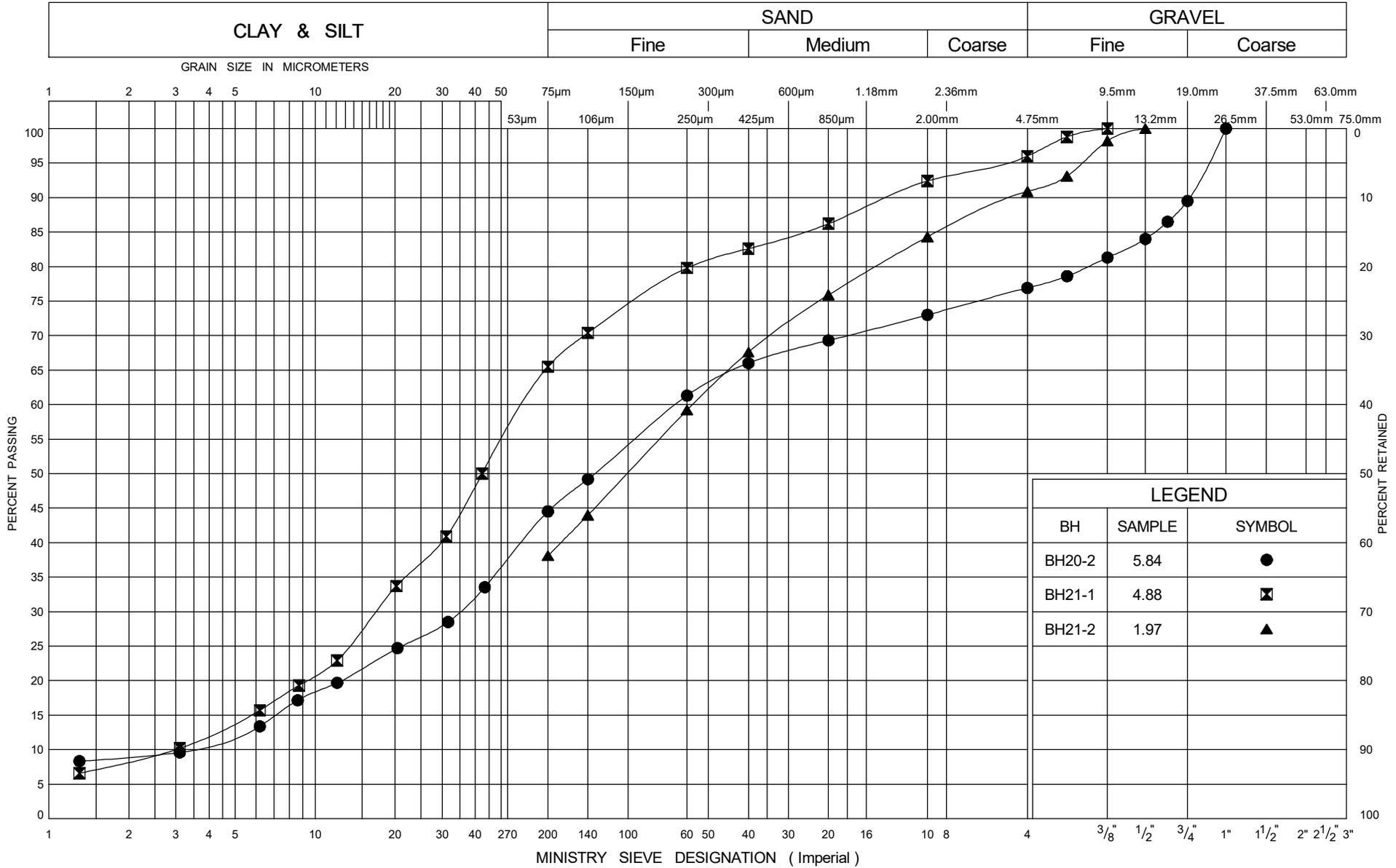
Fill: Gravelly Sand

FIG No 2

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

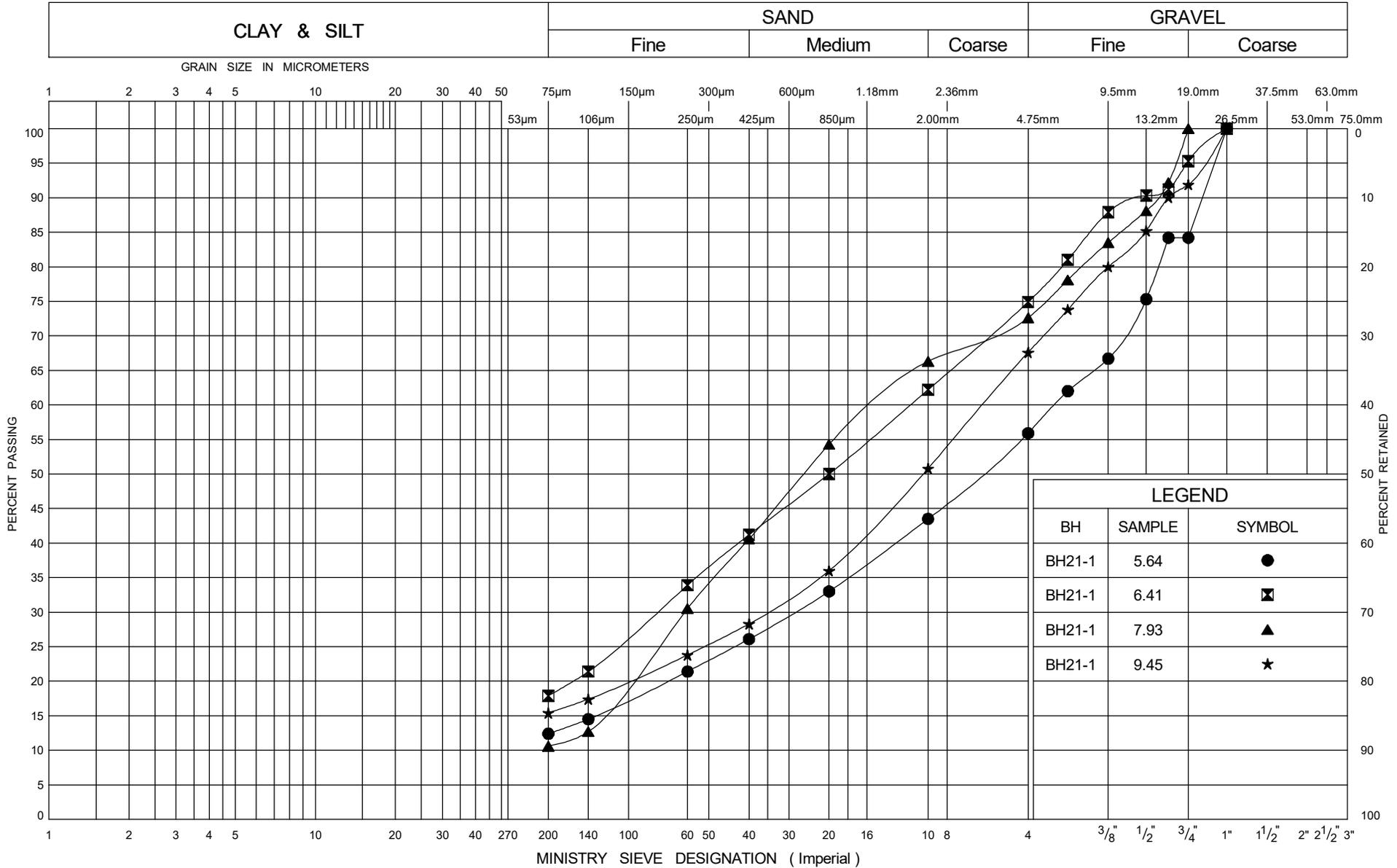
Silty Sand to Sandy Silt

FIG No 3

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

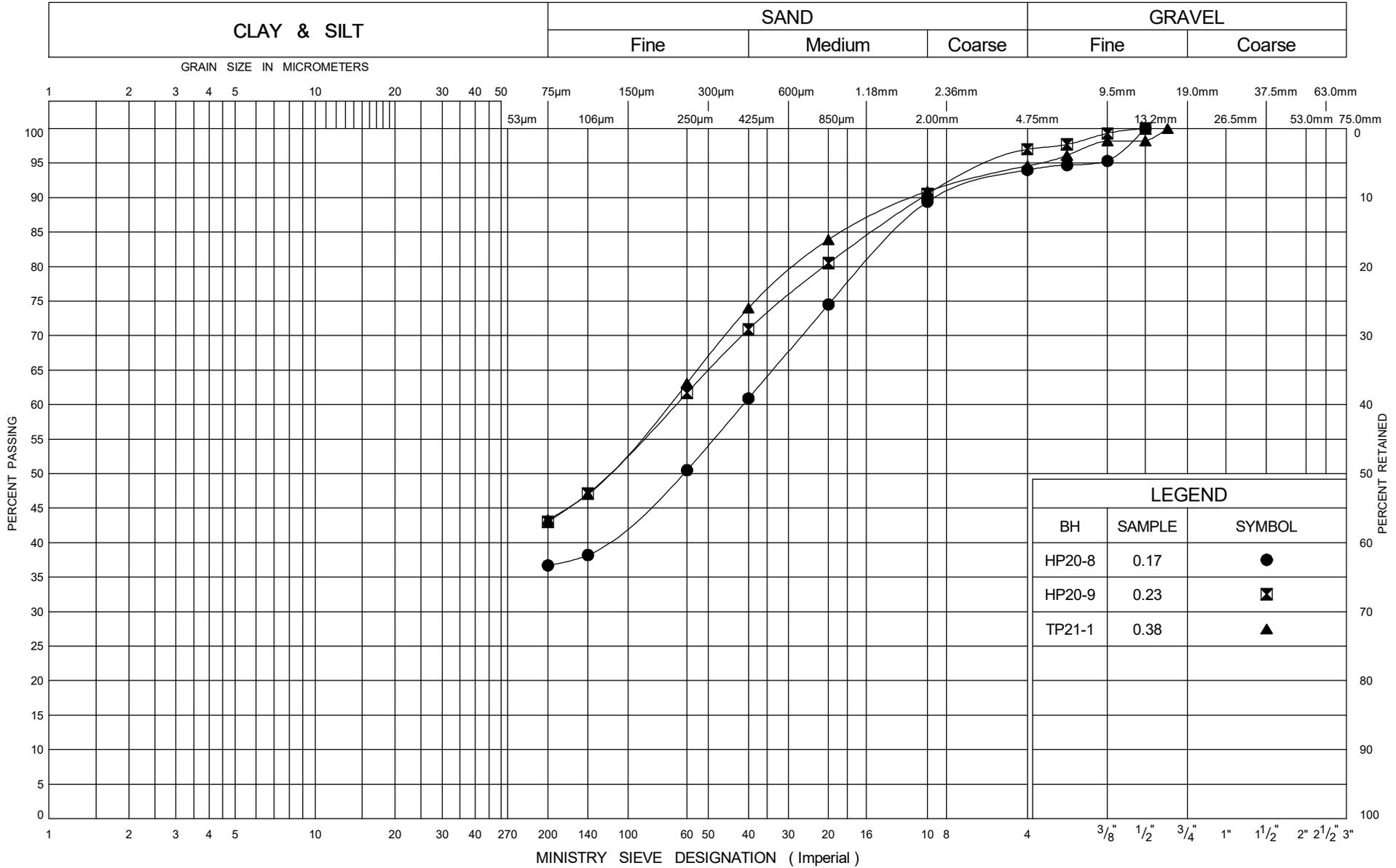
Gravelly Sand

FIG No 4

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

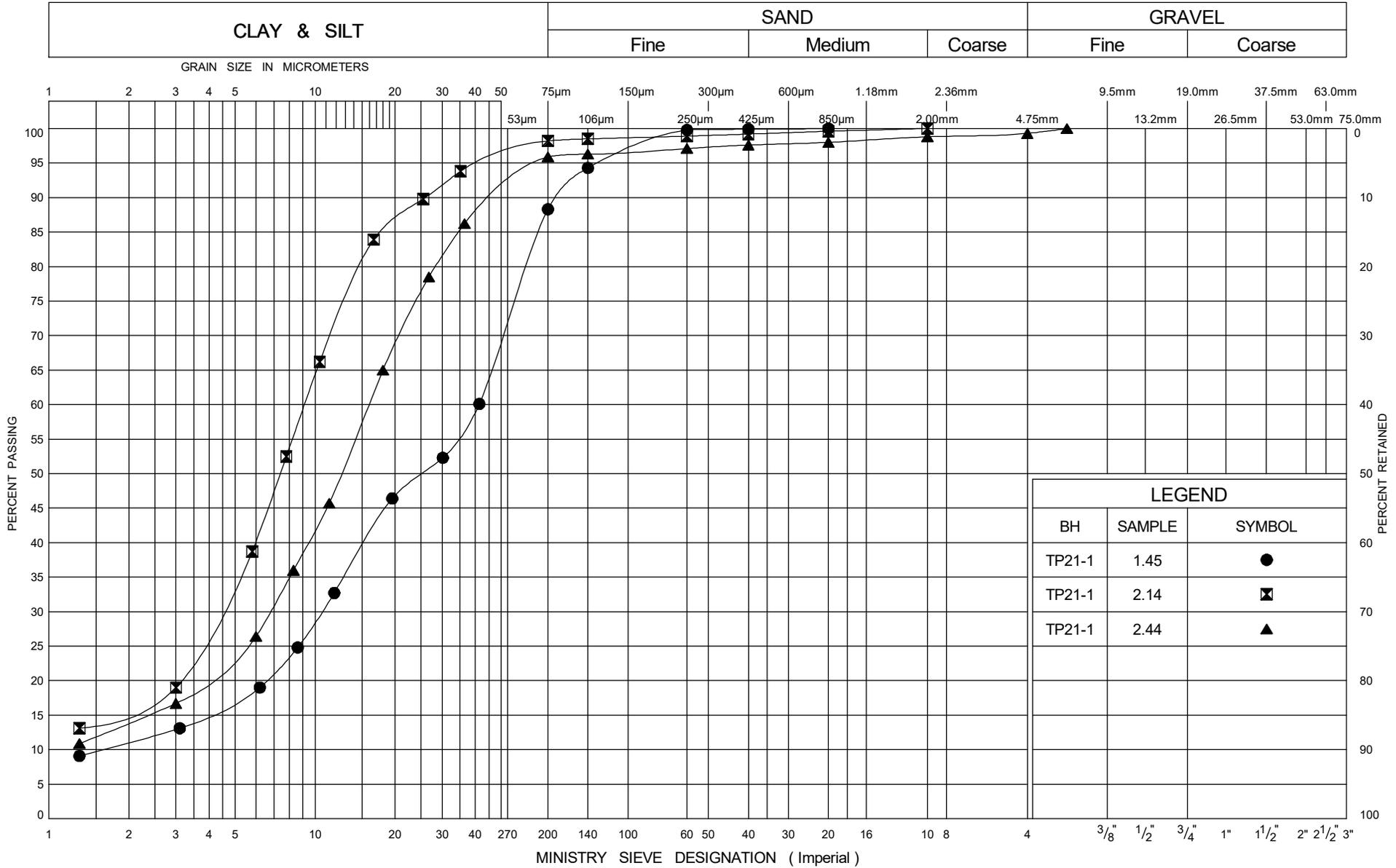
Peat and Sand

FIG No 6

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

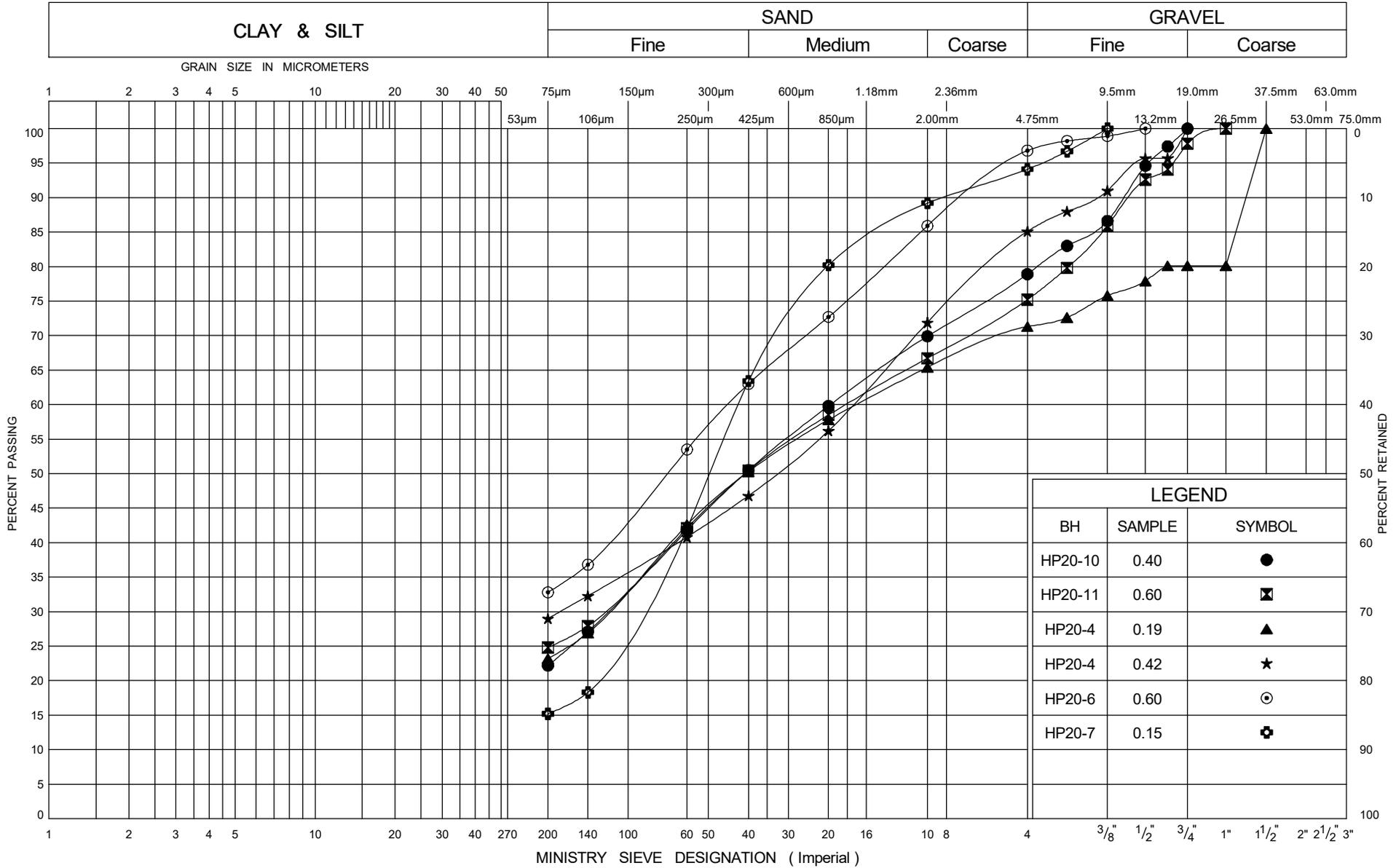
Silt to Clayey Silt

FIG No 7

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

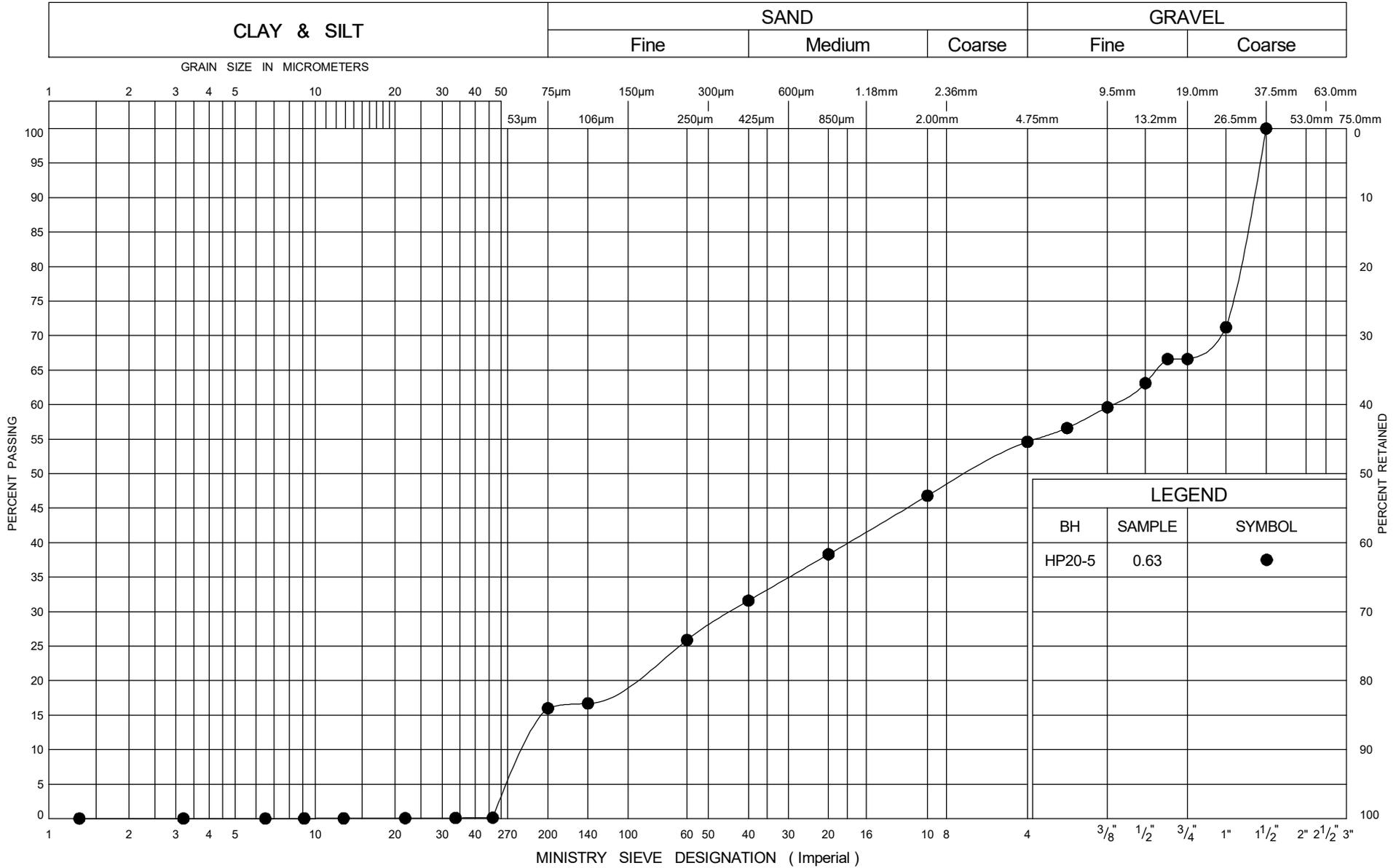
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
Silty Sand / Silty Sand with Gravel

FIG No 8
W P GWP No. 6530-17-00
6019-E-0004, Assignment 8

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

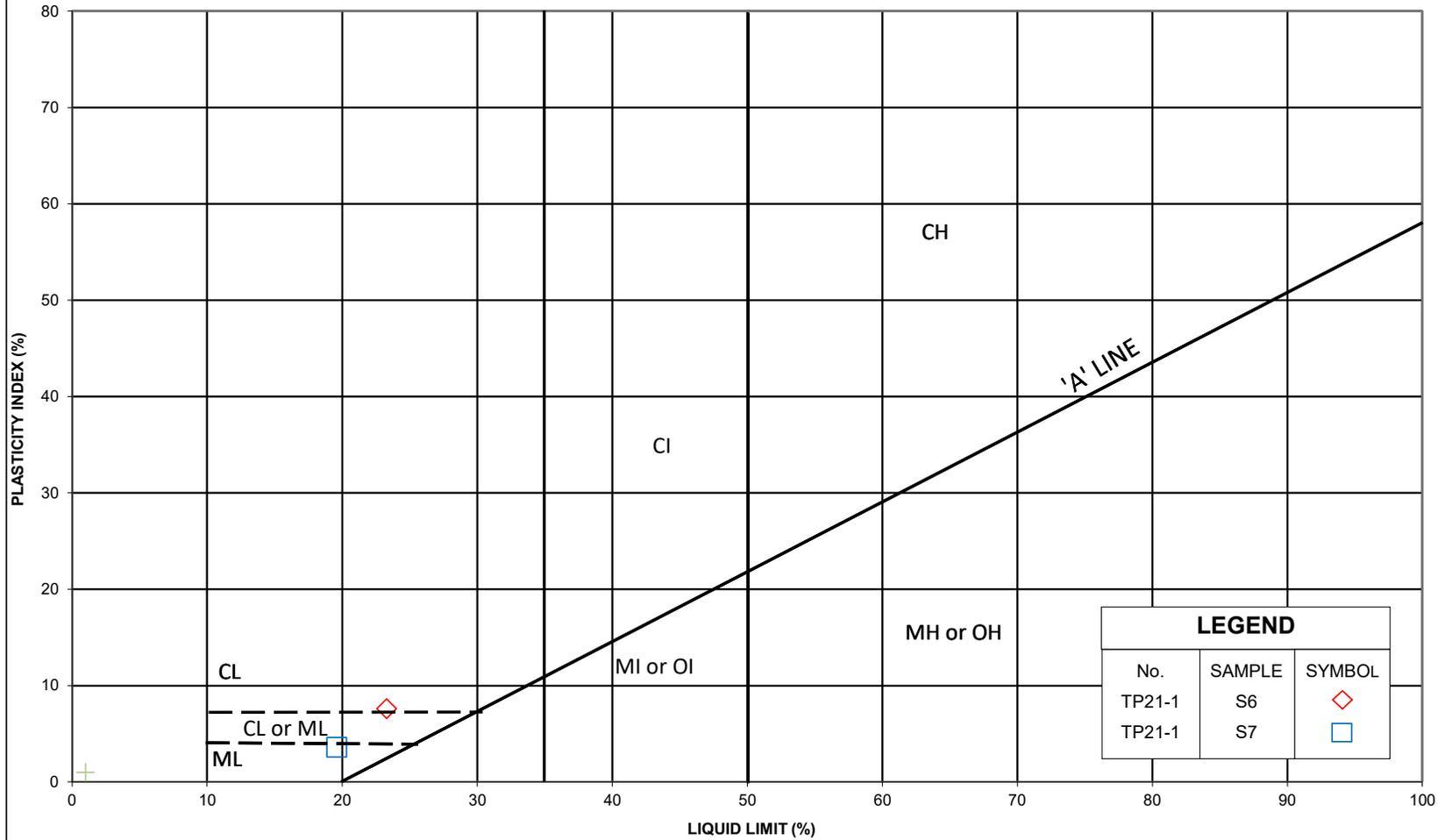
Sandy Gravel

FIG No 9

W P GWP No. 6530-17-00

6019-E-0004, Assignment 8

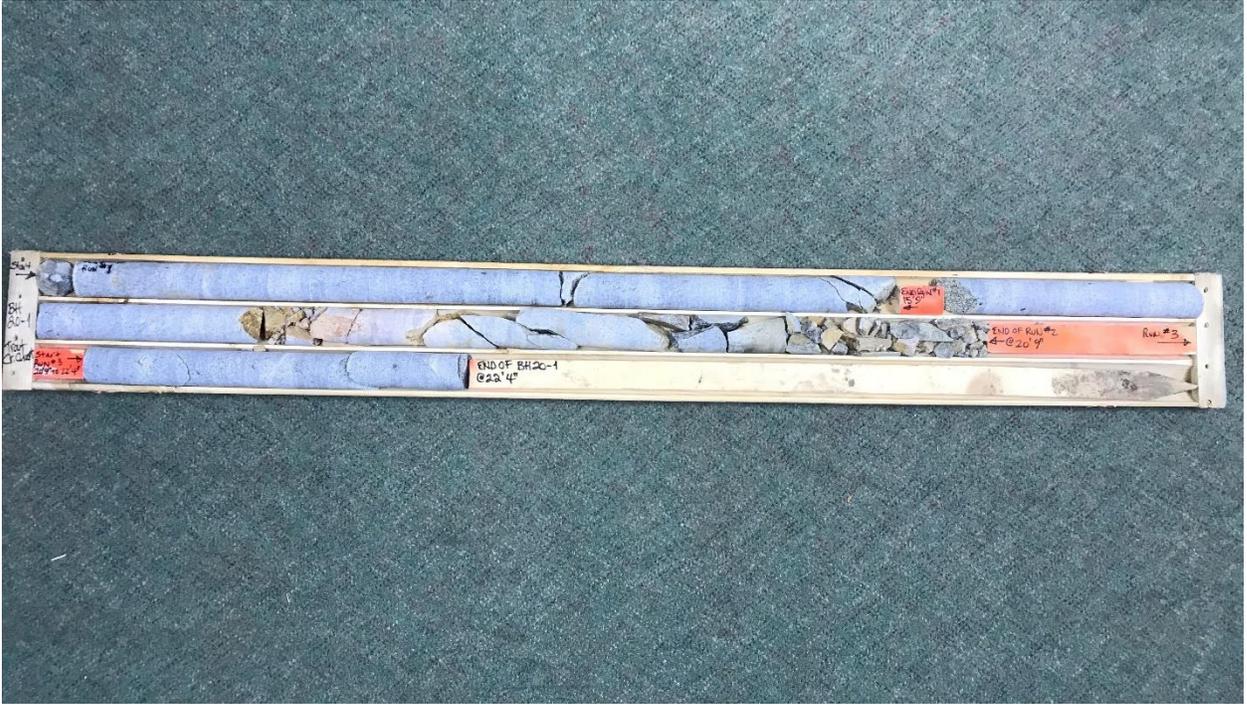
Trout Creek Culvert Replacement
GWP No. 6530-17-00, Highway 599, Savant Lake, Ontario



PLASTICITY CHART
SILT to Clayey SILT

FIGURE No. 10
 ADM-00262199-H0
 January 20, 2022

Appendix E –
Bedrock Core Photographs



Photograph E1. Bedrock Core Samples, Borehole **BH20-1**, November 2020



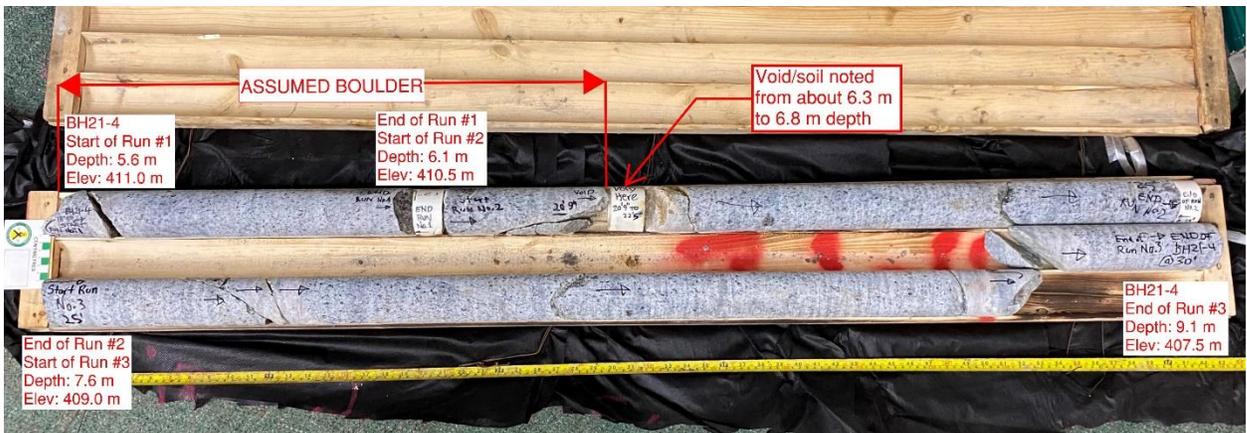
Photograph E2. Bedrock Core Samples, Borehole **BH20-2**, November 2020



Photograph E3. Bedrock Core Samples, Borehole **BH21-2**, November 2021



Photograph E4. Bedrock Core Samples, Borehole **BH21-3**, November 2021



Photograph E5. Assumed Boulder (5.6 m to 6.8 m depth) and Bedrock Core Samples (6.8 m to 9.1 m), Borehole **BH21-4**, November 2021

Appendix F –
Chemical Analysis



Your Project #: ADM-00262199-A0
 Site Location: TROUT CREEK CULVERT, HWY 599
 Your C.O.C. #: n/a

Attention: Ahileas Mitsopoulos

exp Services Inc
 Thunder Bay Branch
 1142 Roland St
 Thunder Bay, ON
 CANADA P7B 5M4

Report Date: 2020/11/24
 Report #: R6423596
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C0U9063
Received: 2020/11/19, 13:50

Sample Matrix: Soil
 # Samples Received: 3

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	3	2020/11/21	2020/11/23	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	3	2020/11/24	2020/11/24	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2020/11/24	2020/11/24	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2020/11/20	2020/11/24	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	2020/11/21	2020/11/23	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.



Your Project #: ADM-00262199-A0
Site Location: TROUT CREEK CULVERT, HWY 599
Your C.O.C. #: n/a

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2020/11/24
Report #: R6423596
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C0U9063
Received: 2020/11/19, 13:50

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Julie Clement, Technical Account Manager

Email: Julie.CLEMENT@bvlab.com

Phone# (613)868-6079

=====
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BUREAU
VERITAS

BV Labs Job #: COU9063
Report Date: 2020/11/24

exp Services Inc
Client Project #: ADM-00262199-A0
Site Location: TROUT CREEK CULVERT, HWY 599
Sampler Initials: EF

RESULTS OF ANALYSES OF SOIL

BV Labs ID		OFG477	OFG478	OFG479			OFG479	
Sampling Date		2020/11/03 12:00	2020/11/05 10:00	2020/11/02 15:00			2020/11/02 15:00	
COC Number		n/a	n/a	n/a			n/a	
	UNITS	BH20-01 S7	HP20-05 S4	HP20-11 S2	RDL	QC Batch	HP20-11 S2 Lab-Dup	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	7900	34000	13000		7067730		
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	23	<20	30	20	7069474		
Conductivity	mS/cm	0.13	0.029	0.080	0.002	7072990		
Available (CaCl2) pH	pH	7.66	4.76	6.13		7072893	6.03	7072893
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	<20	20	7069471		
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate								



BUREAU
VERITAS

BV Labs Job #: COU9063
Report Date: 2020/11/24

exp Services Inc
Client Project #: ADM-00262199-A0
Site Location: TROUT CREEK CULVERT, HWY 599
Sampler Initials: EF

TEST SUMMARY

BV Labs ID: OFG477
Sample ID: BH20-01 S7
Matrix: Soil

Collected: 2020/11/03
Shipped:
Received: 2020/11/19

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7069474	2020/11/21	2020/11/23	Deonarine Ramnarine
Conductivity	AT	7072990	2020/11/24	2020/11/24	Neil Dassanayake
pH CaCl2 EXTRACT	AT	7072893	2020/11/24	2020/11/24	Neil Dassanayake
Resistivity of Soil		7067730	2020/11/24	2020/11/24	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7069471	2020/11/21	2020/11/23	Deonarine Ramnarine

BV Labs ID: OFG478
Sample ID: HP20-05 S4
Matrix: Soil

Collected: 2020/11/05
Shipped:
Received: 2020/11/19

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7069474	2020/11/21	2020/11/23	Deonarine Ramnarine
Conductivity	AT	7072990	2020/11/24	2020/11/24	Neil Dassanayake
pH CaCl2 EXTRACT	AT	7072893	2020/11/24	2020/11/24	Neil Dassanayake
Resistivity of Soil		7067730	2020/11/24	2020/11/24	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7069471	2020/11/21	2020/11/23	Deonarine Ramnarine

BV Labs ID: OFG479
Sample ID: HP20-11 S2
Matrix: Soil

Collected: 2020/11/02
Shipped:
Received: 2020/11/19

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7069474	2020/11/21	2020/11/23	Deonarine Ramnarine
Conductivity	AT	7072990	2020/11/24	2020/11/24	Neil Dassanayake
pH CaCl2 EXTRACT	AT	7072893	2020/11/24	2020/11/24	Neil Dassanayake
Resistivity of Soil		7067730	2020/11/24	2020/11/24	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7069471	2020/11/21	2020/11/23	Deonarine Ramnarine

BV Labs ID: OFG479 Dup
Sample ID: HP20-11 S2
Matrix: Soil

Collected: 2020/11/02
Shipped:
Received: 2020/11/19

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	7072893	2020/11/24	2020/11/24	Neil Dassanayake



BUREAU
VERITAS

BV Labs Job #: COU9063

Report Date: 2020/11/24

exp Services Inc

Client Project #: ADM-00262199-A0

Site Location: TROUT CREEK CULVERT, HWY 599

Sampler Initials: EF

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.7°C
-----------	-------

Results relate only to the items tested.



BUREAU
VERITAS

BV Labs Job #: C0U9063
Report Date: 2020/11/24

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: ADM-00262199-A0
Site Location: TROUT CREEK CULVERT, HWY 599
Sampler Initials: EF

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7069471	Soluble (20:1) Sulphate (SO4)	2020/11/23	NC	70 - 130	104	70 - 130	<20	ug/g	NC	35
7069474	Soluble (20:1) Chloride (Cl-)	2020/11/23	NC	70 - 130	107	70 - 130	<20	ug/g	3.0	35
7072893	Available (CaCl2) pH	2020/11/24			100	97 - 103			1.7	N/A
7072990	Conductivity	2020/11/24			103	90 - 110	<0.002	mS/cm	1.3	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).



BUREAU
VERITAS

BV Labs Job #: COU9063

Report Date: 2020/11/24

exp Services Inc

Client Project #: ADM-00262199-A0

Site Location: TROUT CREEK CULVERT, HWY 599

Sampler Initials: EF

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Anastassia Hamanov, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

