



Foundation Investigation Report

CPR at Hwy 17 Overpass Replacement at Martin, Kenora

Agreement No. 6021-E-0019

Work Item No. 10

GWP No. 6109-17-00

Geocres No.: 52G03-001

Latitude: 49.2436 Longitude: -91.0734

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Prepared For:

Ontario Ministry of Transportation
Geotechnical Section, Northwestern Region
615 James Street South
Thunder Bay, ON P7E 6P6
Attn: Jean Pierre Perron, P.Eng.

Prepared By:

EXP Services Inc.
1595 Clark Boulevard
Brampton, ON L6T 4V1
Canada

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1 FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This report presents the results of the geotechnical investigation completed by EXP Services Inc. (EXP) for the replacement of the existing CPR Overpass/Bridge at Hwy 17 with a single span bridge. The existing structure is located approximately 8.6 km west of English River at Martin, Kenora, Ontario (Latitude: 49.2436; Longitude: -91.0734) in the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Assignment No. 6021-E-0019, Work Item No. 10. The terms of reference (TOR) were provided by MTO in an email dated June 27, 2023.

The purpose of the investigation is to evaluate the subsurface conditions at each abutment of the proposed structure, and based on these data, to permit detailed design for the existing bridge replacement. The site-specific geotechnical investigation consisted of a field investigation program including visual inspections, drilling, soil sampling, and laboratory testing.

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

1.2 Site Description and Geological Setting

1.2.1 Site Description

The existing CP Rail overpass is located on Highway 17 in the township of Martin, 8.6 km west of English River at Martin, Kenora, Ontario. At the site, Highway 17 is a two-lane paved roadway with a speed limit of 90 km/h (unless otherwise posted). Highway 17 generally runs in the east-west direction, but at the site it runs in a southwest to northeast direction. The CPR tracks intersect the highway in approximately an east to west direction at a skew angle of about 29°. For the purpose of the report, the abutment/approach embankment northeast and southwest of the intersection with the CPR tracks will be labelled “north” and “south” abutment/approach embankment, respectively.

Based on the information provided by MTO, the existing bridge was constructed in 1963. The structure is a three-spanned concrete structure with two spans at approximately 15.5 m and 1 span at 14.6 m with a total length of about 45.7 m. The width of the bridge is estimated to be about 12.9 m. Drawings of the existing structure do not indicate the foundations details; however, it can be assumed the abutments and piers are supported on spread footings due to the shallow bedrock and extensive cobbles and boulders in the overburden. The CPR tracks run between the piers with the top of rail and bottom of rail ranging from approximately Elev. 474.74 m to 474.78 m and Elev. 474.60 m to 474.63 m, respectively. A 43.86 m long 750 mm CSP culvert runs underneath the approach embankment situated between the northern pier and north abutment. Additionally, a 48.34 m long 750 mm CSP culvert is located underneath the south approach embankment, approximately 144 m from the south abutment. A gabion wall, approximately 1.8 m high above the ground surface, runs along the bottom of the north abutment forward slope.

The drawing (Plan E-8080-1, Proposed Crossing at Canadian Pacific Railways and King’s Highway 17, dated 1987) provided by MTO shows that the existing elevation of the mid-bridge is about Elev. 483.4 m and the existing highway north and south approaches are at about Elev. 483.0 m. The north and south road approaches have approximately 8.7 m and 8.5 m high embankments (from top of embankment to the lowest point in front of the forward slope). The existing forward slope was estimated from the drawing to range from 1.7H:1V to 2.5H:1V above the gabion

retaining wall at the north abutment and 1.5H:1V to 3.3H:1V at the south abutment based on the drawing. At the north approach, the side slope was approximately 2H:1V on the west side and ranges from 1.8H:1V to 2.7H:1V on the east side. At the south approach, the side slope ranges from 1.2H:1V to 2H:1V on the west side and 3.5H:1V on the east side. Based on observations on the site, these forward abutment slopes appear to be stable (i.e., no visible sign of slope instability). The elevation of the natural ground surface is around 472 m to 474 m within the vicinity of the structure. A gravel access road that leads to a switch station is located on northeast side of the overpass just before the approach embankment.

Photographs 1 to 6 taken by EXP in October 2023 and presented in Appendix A show the site and structure. Photographs 1, 2 and 3 show the surface conditions of the existing bridge along the bridge deck, north approach embankment, and south approach embankment. The existing surface has been repaved at some point, however longitudinal and transversal cracking is present throughout the roadway. Extensive rutting along the highway can be seen as well. Photograph 4 shows a profile view of the existing substructure from the point of view of the NW corner. Photograph 5 shows the substructure at the south abutment and the southern pier. Bedrock outcrops can be seen under the pier/near the bottom of the forward slope. Power lines run perpendicular to the bridge structure closely adjacent to the south abutment. Photograph 6 shows the north abutment, northern pier, and the gabion retaining wall running along the bottom of the forward slope.

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 gravel and sand which includes proglacial river and deltaic deposits. According to Map 2542 (Bedrock Geology of Ontario, West-Central Sheet, 1991), the bedrock geology of the site is of gneissic tonalite suite: tonalite to granodiorite – foliated to gneissic – with minor supracrustal inclusions. The map also indicates massive granodiorite to granite (massive to foliated granodiorite to granite) and mafic metavolcanic and metasedimentary rocks within the vicinity of the site.

1.3 Previous Investigations

The previous report at the site available in the MTO GEOCREs library is:

- Geocres No. 53G-003. “Hwy. 17 Revision, Line C & C.P.R. Overhead, Approx. 6 Miles West of English River, W.P. 908-60. District #19. W.J. F-59-113” prepared by Department of Highways - Ontario, dated April 6, 1960.

1.4 Investigation Procedures

1.4.1 Site Investigation and Field Testing

The field investigation was performed between October 2 and 14, 2023 by EXP. The field program consisted of drilling six (6) sampled boreholes, numbered BH23-1 to BH23-6, and the performance of conventional standard penetration tests (SPT). Three (3) boreholes were drilled at either side of the existing structure, strategically staggered to facilitate the design of foundations for the abutments, pads for the temporary modular bridge, temporary protection systems, and approach embankments as per the TOR and MTO Guideline for Foundation Services (April 2022). The locations of boreholes drilled during current investigation are shown on Drawing 1 in Appendix B.

All boreholes drilled during this fieldwork were advanced using a truck mounted CME 750 drill rig equipped with hollow stem augers and standard soil sampling /bedrock sampling equipment and NW casing, operated by a

specialist drilling contractor, Maple Leaf Drilling Ltd. All the boreholes (BH23-1 to BH23-6) were advanced to a depth of between 4.4 m and 14.2 m below the ground surface.

For the drilling program, 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 compactness of cohesionless soils. When a hard stratum was reached, sampling of hard material was performed by diamond core drilling, using a 1.5 m long HQ double tube wireline core barrel. Core samples of the bedrock in BH23-1, BH23-3, BH23-4, BH23-5 and BH23-6 were obtained using a 1.5 m long HQ double tube wireline core barrel (core diameter ~65 mm).

Upon completion of the boreholes, groundwater level measurements were carried out in boreholes in accordance with MTO guidelines. A temporary standpipe piezometer was installed in BH23-3 to permit monitoring of the groundwater level at the site. The groundwater records after completion of drilling boreholes and in the piezometer were presented in the borehole log sheets in Appendix C. Upon completion of drilling and field testing, the boreholes were decommissioned by bentonite and auger cuttings. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act). The piezometer in borehole BH23-3 was removed and the borehole was decommissioned on October 13, 2023.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by EXP personnel using a GPS (Garmin Montana 680) and a basic level and survey rod, respectively, having an accuracy of 0.5 m to 2 m in the horizontal direction and 0.1 m in the vertical direction. The borehole coordinates obtained by the GPS were verified by measuring the distances from a known point on the bridge (i.e., the edge of north abutment) using a measuring tape. The bottom of rail at the overpass location was used for a benchmark (BM). Based on the AutoCAD drawings provided by MTO, the elevation of the BM was Elev. 474.6 m. The BM is shown on Drawing 1 in Appendix B.

The fieldwork was supervised by an EXP geotechnical representative who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification and retrieved soil samples for subsequent laboratory testing and identification. All recovered soil samples were placed in labelled moisture-proof bags and returned to EXP’s Thunder Bay laboratory for additional visual, textual, olfactory examination and selective testing.

Table 1.1. Summary of boreholes completed by EXP

Structure	Borehole No.	Location (MTM NAD 83 Zone 12)		Ground Surface Elevation ¹ (m)	Borehole Depth ² (m)	Bedrock Coring Length (m)
		Northing	Easting			
North Abutment	BH23-1	5456758.8	226656.9	483.0	12.2	0.8
	BH23-2	5456773.5	226682.9	483.0	7.6	-

Structure	Borehole No.	Location (MTM NAD 83 Zone 12)		Ground Surface Elevation ¹ (m)	Borehole Depth ² (m)	Bedrock Coring Length (m)
		Northing	Easting			
	BH23-3	5456756.4	226664.6	483.0	14.2	3.0
South Abutment	BH23-4	5456713.3	226618.6	483.0	4.4	1.0
	BH23-5	5456698.6	226592.6	482.8	7.5	0.6
	BH23-6	5456715.8	226610.7	483.0	9.4	4.1

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

1.4.2 Laboratory Testing

All soil and rock 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 and particle size distribution for approximately 25% of the collected soil samples. Two (2) soil samples were selected for chemical analysis and tested at a CALA-certified and accredited laboratory. Uniaxial compression tests were carried out on selected rock core samples.

1.5 Subsurface Conditions

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

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

In general, the subsoil condition at the proposed bridge replacement location consists of asphalt over sand fill (embankment fill), followed by various native cohesionless layers comprised of silt, silt and sand, and sand, which was underlain by granite to granodiorite bedrock. Cobbles and boulders were frequently encountered throughout the fill and native soil.

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.

1.5.1 Subsoils

1.5.1.1 Asphalt

A pavement structure consisting of asphalt was encountered at the surface of all boreholes. The thickness of the asphalt ranged between approximately 130 mm and 180 mm.

1.5.1.2 Sand (Fill)

Sand fill was encountered below the asphalt in all boreholes. The approximate elevation of the surface and base of the fill and thickness as encountered in the boreholes are summarized below in Table 1.2.

Table 1.2. Summary of sand fill

Borehole	Elevation ¹ (m)		Layer Surface Depth ² (m)	Layer Thickness (m)
	Top	Bottom		
BH23-1	482.9	473.9	0.1	9.0
BH23-2	482.8	476.1	0.2	6.7
BH23-3	482.9	473.8	0.1	9.1
BH23-4	482.9	479.6	0.1	3.3
BH23-5	482.6	476.0	0.2	6.6
BH23-6	482.8	477.7	0.2	5.1

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

The fill layer predominantly consists of sand with trace gravel to gravelly, trace silt to silty, and trace clay. Cobbles and boulders were also commonly encountered throughout the entire fill layer. The material was generally brown in color and moist. The SPT “N” values obtained within this layer ranged from 16 to 108 blows per 0.3 m penetration (excluding tests where the spoon bounced on cobbles/boulders), suggesting that the sand fill is compact to very dense in compactness.

Laboratory testing performed on selected samples consisted of thirty-one (31) moisture content tests and eleven (11) grain size distribution tests. The test results are as follows:

Moisture Content:

- 1.3% to 12.3%

Grain Size Distribution:

- 2% to 35% gravel;
- 49% to 95% sand;
- 2% to 29% silt;

- 2% to 6% clay;
- 3% to 26% silt and clay;

The results of the moisture content and grain size distribution tests are included on the borehole logs in Appendix C. The results of the grain size distribution test are also provided on Figure 1 and Figure 2 in Appendix D.

1.5.1.3 Silt

A native silt layer was encountered below the sand fill in boreholes BH23-1 and BH23-2. The approximate elevation of the surface and base of the layer and thickness as encountered in the boreholes are summarized below in Table 1.3.

Table 1.3. Summary of silt layer

Borehole	Elevation ¹ (m)		Layer Surface Depth ² (m)	Layer Thickness (m)
	Top	Bottom		
BH23-1	473.9	473.1	9.1	0.8
BH23-2	476.1	476.0	6.9	0.1

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

The composition of this material consisted predominantly of silt with trace to some sand and trace clay. Occasional cobbles/boulders were also encountered. The material was brown in color and moist to wet. The SPT “N” values obtained within this layer ranged from 5 blows per 0.3 m penetration (BH23-1) to 3 blows per 150 mm (during seating of the split-spoon) followed by 50 blows bouncing on a suspected cobble/boulder (BH23-2) at which point the test was terminated. These blow counts suggest the native silt is loose in compactness.

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

Moisture Content:

- 26.1% to 28.3%

Grain Size Distribution:

- 0% gravel;
- 9% to 14% sand;
- 84% to 88% silt;
- 2% to 3% clay;

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

1.5.1.4 Silt and Sand

A native silt and sand layer was encountered below the sand fill in boreholes BH23-3 and BH23-5. The approximate elevation of the surface and base of the layers and thickness as encountered in the boreholes are summarized below in Table 1.4.

Table 1.4. Summary of silt and sand layer

Borehole	Elevation ¹ (m)		Layer Surface Depth ² (m)	Layer Thickness (m)
	Top	Bottom		
BH23-3	473.8	473.1	9.2	0.7
BH23-5	476.0	475.9	6.8	0.1

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

The composition of this material consisted predominantly of silt and sand with trace clay, some gravel (BH23-5) and occasional cobbles/boulders. The material was brown in color and moist to wet.

In BH23-3, the SPT “N” value obtained within this layer was 13 blows per 0.3 m penetration. In BH23-5, the SPT “N” value obtained within this layer was 26 for the initial 75 mm of penetration during the seating of the split-spoon, followed by 50 bounces on a suspected cobble or boulder, at which point the test was terminated. These test results suggest that the layer is compact to dense in compactness.

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

Moisture Content:

- 11.2% to 15.6%

Grain Size Distribution:

- 0% gravel;
- 48% sand;
- 52% silt and clay;

The results of the moisture content and grain size distribution test are included on the borehole logs in Appendix C. The results of the grain size distribution test are also provided on Figure 4 in Appendix D.

1.5.1.5 Sand

A native sand layer was encountered below the native silt layer in boreholes BH23-1 and BH23-2 and below the silt and sand layer in BH23-3. Borehole BH23-2 was terminated in this layer. The approximate elevation of the surface and base of the layer and thickness as encountered in the boreholes are summarized below in Table 1.5.

Table 1.5. Summary of sand layer

Borehole	Elevation ¹ (m)		Layer Surface Depth ² (m)	Layer Thickness (m)
	Top	Bottom		
BH23-1	473.1	471.6	9.9	1.5
BH23-2	476.0	475.4	7.0	0.6
BH23-3	473.1	471.8	9.9	1.3

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

The composition of this material consisted predominantly of fine-grained sand with a gravel content that ranges from some gravel to gravelly, some silt, trace clay, trace oxidation layers, and occasional cobbles/boulders. The material was brown in color and moist to wet.

The SPT “N” values obtained within this layer ranged from 45 to 50 blows per 0.3 m penetration (excluding tests where the split-spoon bounced on cobbles/boulders), suggesting that the layer is dense to very dense in compactness.

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

Moisture Content:

- 7.3% to 8.9%

Grain Size Distribution:

- 20% to 29% gravel;
- 51% to 61% sand;
- 16% to 19% silt;
- 1% to 3% clay;

The results of the moisture content and grain size distribution tests are included on the borehole logs. The results of the grain size distribution tests are also provided on Figure 5 in Appendix D.

1.5.2 Bedrock

The presence of bedrock was proved in all boreholes by coring except in BH23-2 since the drilling in that borehole was terminated after SPT and auger refusal. The bedrock was confirmed using coring at all locations where it was encountered. The depth to bedrock ranged from approximately 11.2 m to 11.4 m (corresponding to Elev. 471.6 m to Elev. 471.8 m) to the north of the CPR tracks and a depth of 3.4 m to 7.5 m (corresponding to Elev. 475.9 m to Elev. 479.6 m) to the south of the CPR tracks. The bedrock surface depths and elevations encountered at these borehole locations are listed in Table 1.6. Photographs of rock cores are included in Appendix D.

Table 1.6. Depth and elevation of bedrock surface

Borehole	Depth Below Ground Surface ² (m)	Elevation ¹ (m)	Uniaxial Compressive Strength (MPa)	Comments
North Side of CPR Tracks				
BH23-1	11.4	471.6	-	Bedrock Cored
BH23-2	7.6	475.4	-	Bedrock Inferred from Refusal
BH23-3	11.2	471.8	128.4 (Run 1) 120.5 (Run 2)	Bedrock Cored
South Side of CPR Tracks				
BH23-4	3.4	479.6	-	Bedrock Cored
BH23-5	6.9	475.9	-	Bedrock Cored
BH23-6	5.3	477.7	70.1 (Run 3) 99.5 (Run 4)	Bedrock Cored

Notes:

1. The referenced ground surface elevations are geodetic.
2. Depths are relative to ground surface.

Based on the bedrock HQ cores (~ core diameter 65 mm) recovered, the bedrock at the site consists of granite to granodiorite. In general, the rock samples are described as fine to medium grained, grey/black to pink/white or grey/black with pink/white banding in colour, fractured to predominantly sound, and slightly weathered. The Rock Quality Designation (RQD) measured on the core samples ranged from approximately 68% to 100%, indicating a rock mass of fair to excellent, but typically good to excellent quality. The total core recovery (TCR) of bedrock cores ranged from 97% to 100%.

Uniaxial compression tests were performed on four (4) rock core samples, two (2) samples were from BH23-3 (Run 1 - sample taken between Elev. 471.4 m and 471.2 m and Run 2 - sample taken between Elev. 469.8 m and 469.6 m) and two (2) samples were from BH23-6 (Run 3 - sample taken between Elev. 476.4 m and 476.2 m and Run 4 - sample taken between Elev. 475.7 m and 475.5 m). The uniaxial compressive strength (UCS) was measured to be about 120.5 MPa to 128.4 MPa in BH23-3 and 70.1 MPa to 99.5 MPa in BH23-6, indicating strong to very strong (R4 to R5) rock according to the CFEM. The laboratory uniaxial compression tests results are presented on the borehole records in Appendix C, as well as, in Appendix D.

1.6 Groundwater and Surface Water Conditions

Groundwater was not encountered in any boreholes prior to the introduction of water used in the wash boring/coring process. A 50 mm diameter PVC piezometer was installed upon the completion of drilling BH23-3, where the groundwater reading was taken 2 days after installation.

A summary of the attempts to measure groundwater prior to wash boring/coring in open holes (including the depth where this measurement was taken) and in the temporary piezometer is provided in Table 1.7. It should be noted that fluctuations in the level of the groundwater may occur due to seasonal variations, (precipitation, snowmelt, rainfall), local soil permeability, construction remediation activities, and other related factors.

Table 1.7. Summary of observed groundwater levels

Borehole	Ground Surface Elevation ¹ (m)	Water level Depth ¹ / Elevation ² (m)	Date	Comment
BH23-1	483.0	Dry to depth ~3.7 m	Oct. 14, 2023	Open hole prior to wash boring
BH23-2	483.0	Dry to depth ~7.6 m (Elev. 475.4 m)	Oct. 13, 2023	Open hole
BH23-3	483.0	Dry to depth ~9.1 m	Oct. 6, 2023	Open hole prior to wash boring
		8.5 / 474.5	Oct. 13, 2023	Monitoring well ³
BH23-4	483.0	Dry to depth ~1.2 m	Oct. 5, 2023	Open hole prior to wash boring
BH23-5	482.8	Dry to depth ~6.9 m	Oct. 2, 2023	Open hole prior to coring
BH23-6	483.0	Dry to depth ~5.3 m	Oct. 2, 2023	Open hole prior to coring

Notes:

1. Depths are relative to ground surface.
2. The referenced ground surface elevations are geodetic.
3. Monitoring well installed October 11, 2023.

1.7 Chemical Analysis

Two soil samples were selected for chemical analysis during the current investigations performed by EXP. The soil samples collected by EXP were tested at a CALA-certified and accredited laboratory. The results of the corrosion potential chemical analysis testing including sulfide, chloride, sulfate, pH, electrical conductivity, and resistivity are summarized in Table 1.8.

Table 1.8. Summary of chemical analysis results

Borehole ID	Sample	Depth (m)	Chloride (ppm)	Sulphate (ppm)	pH	Electrical Conductivity (mS/cm)	Resistivity (ohm-cm)
BH23-1	S8	9.1 – 9.7	1100	75	5.67	1.8	560
BH23-3	S4	4.6 – 5.2	1600	58	6.56	2.8	360

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

This Foundation Investigation Report has been prepared by Daniel Mroz, M.E.Sc., EIT, and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Kole Pitkanen and Kristin McLean-Nunn. Traffic control was provided by Ahmad Masoumi, Kristin McLean-Nunn, and Kaden Thorne.

EXP Services Inc.



Daniel Mroz, M.E.Sc., EIT
Technical Specialist



Silvana Micic, Ph.D., P.Eng.
Senior Geotechnical Engineer
Project Manager



TaeChul Kim, M.E.Sc., P.Eng.
Senior Geotechnical/Foundation Specialist



Stan E. Gonsalves, M.Eng., P.Eng.
Executive Vice-President
Designated MTO Foundation Contact



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Ontario Water Resources Act:

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

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 A1. Bridge deck surface conditions, looking Northeast (October 2023)



Photograph A2. Surface conditions at top of north approach embankment, looking Northeast (October 2023)



Photograph A3. Surface conditions at top of south approach embankment, looking Southwest (October 2023)



Photograph A4. Bridge substructure at northwest corner (October 2023)



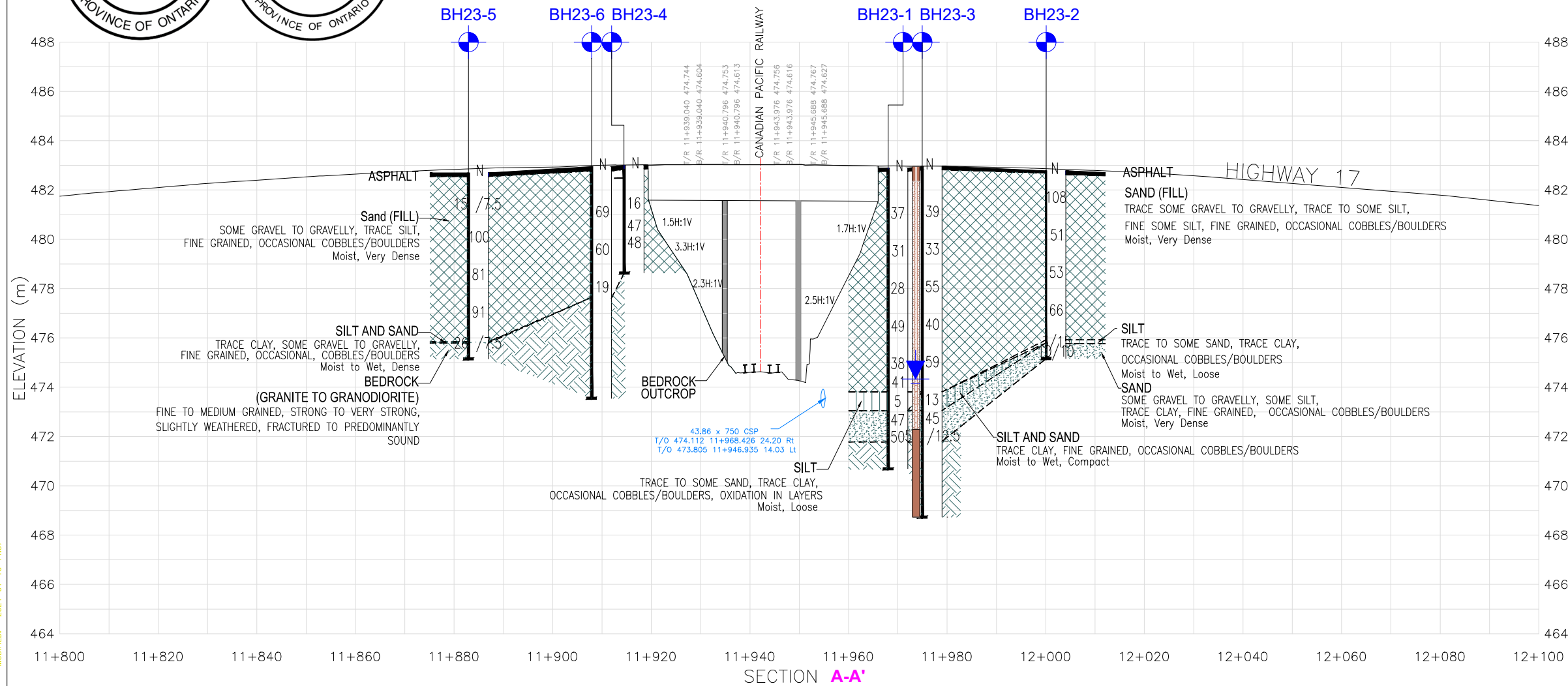
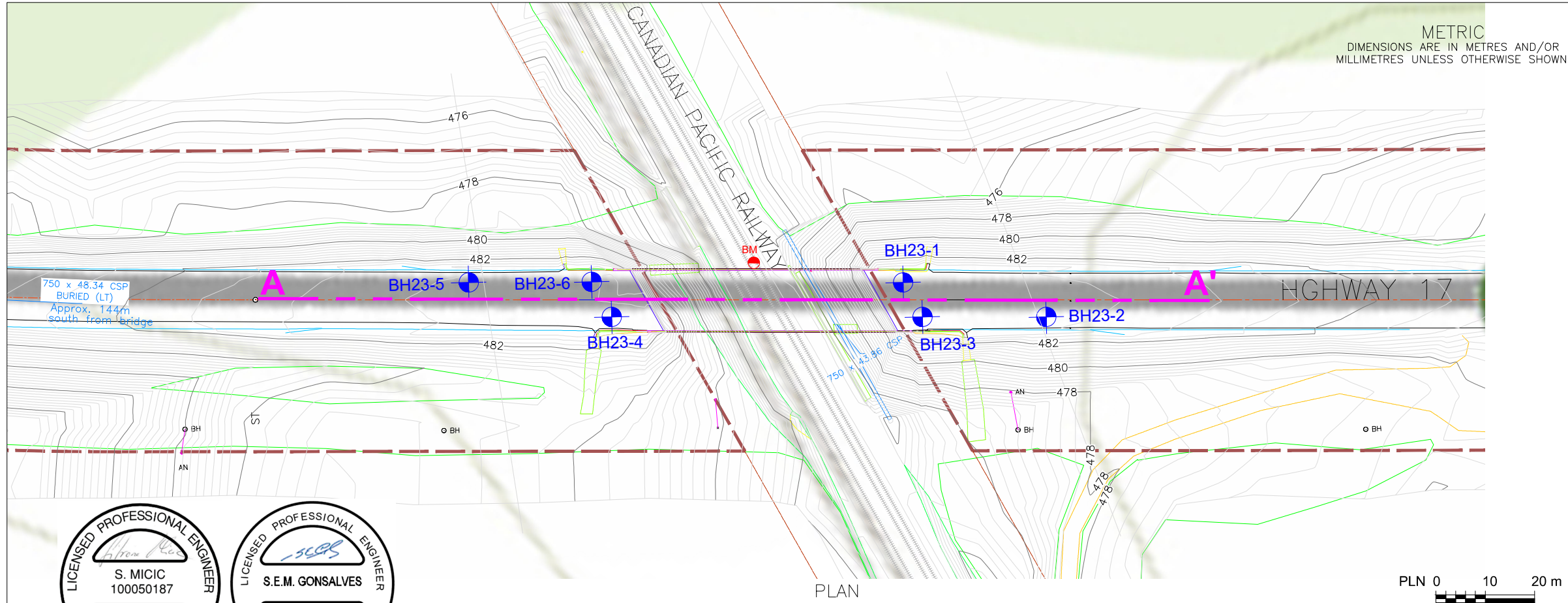
Photograph A5. Bridge substructure at south abutment, facing Southwest (October 2023)



Photograph A6. Bridge substructure at north abutment, facing Northeast (October 2023)

Appendix B –
Borehole Location Plan and Soil Strata

FILE NAME: \\PBRMFS0001\Data_Zeus\2003-Brampton\Proposals\Projects\International\WTO Projects\Retainer NWR\6021-E-0019\A 10 - Hwy 17 bridge replacement Kenora\working drawings\A 10 - Hwy 17 bridge replacement Kenora\plan and profile.dwg
MODIFIED: 2024-01-16 14:37

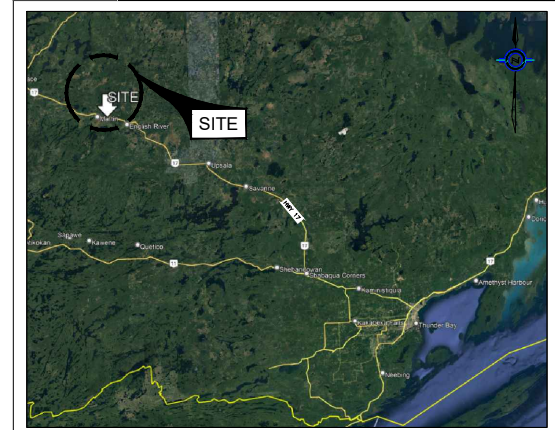


CONT No. 2021-E-0019
ASSIG No. 10
GWP No. 6109-17-00

CPR at Hwy 17 Overpass Replacement at Martin,
8.6 km west of English River at Martin, Kenora
Latitude: 49.2436°; Longitude: -91.0734°

BOREHOLE LOCATION PLAN & SOIL STRATA

exp. EXP SERVICES INC.



KEY PLAN
N.T.S.

LEGEND

- Borehole Location
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level in Piezometer (most recent) (W. L. STABILIZED)
- Piezometer
- Benchmark (rail line B/R) Elev. 474.6m Based on MTO Provided drawing (Plan E-8080-1 Dated May 1987)

SOIL STRATA SYMBOLS

ASPHALT	SAND
FILL	SAND & SILT
SILT	BEDROCK

BOREHOLE COORDINATES/ NAD 83/ MTM ON-15			
BH No.	ELEV.	NORTHING	EASTING
BH23-1	483.0	5456758.8	226656.9
BH23-2	483.0	5456773.5	226682.9
BH23-3	483.0	5456756.4	226664.6
BH23-4	483.0	5456713.3	226618.6
BH23-5	482.8	5456698.6	226592.6
BH23-6	483.0	5456715.8	226610.7

NOTES

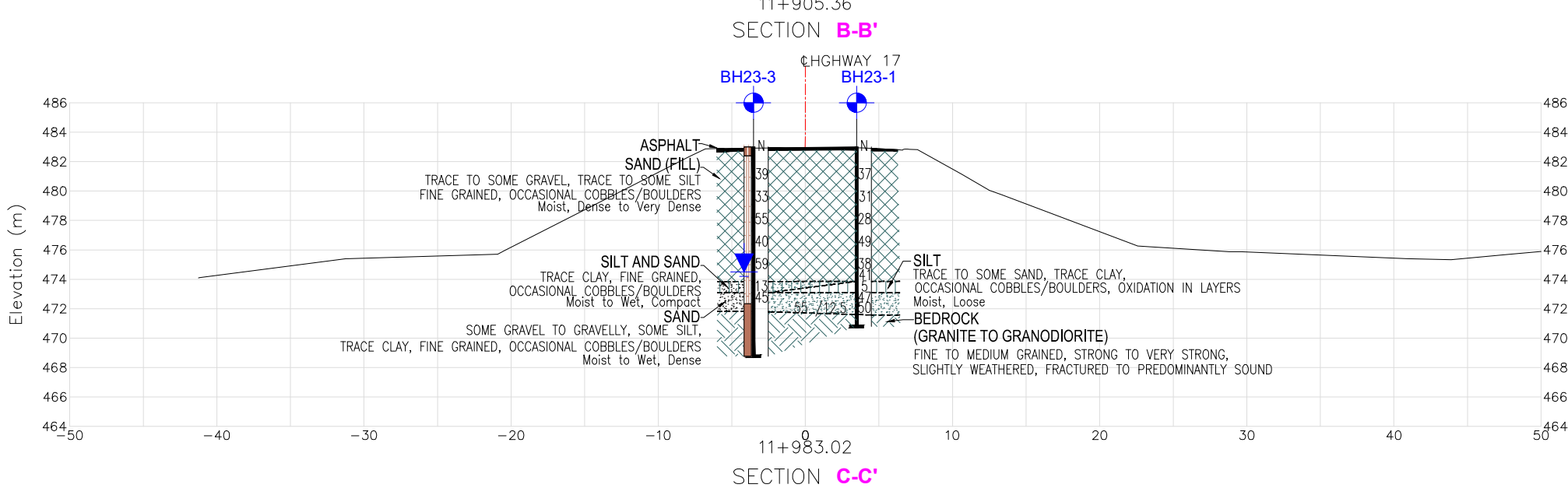
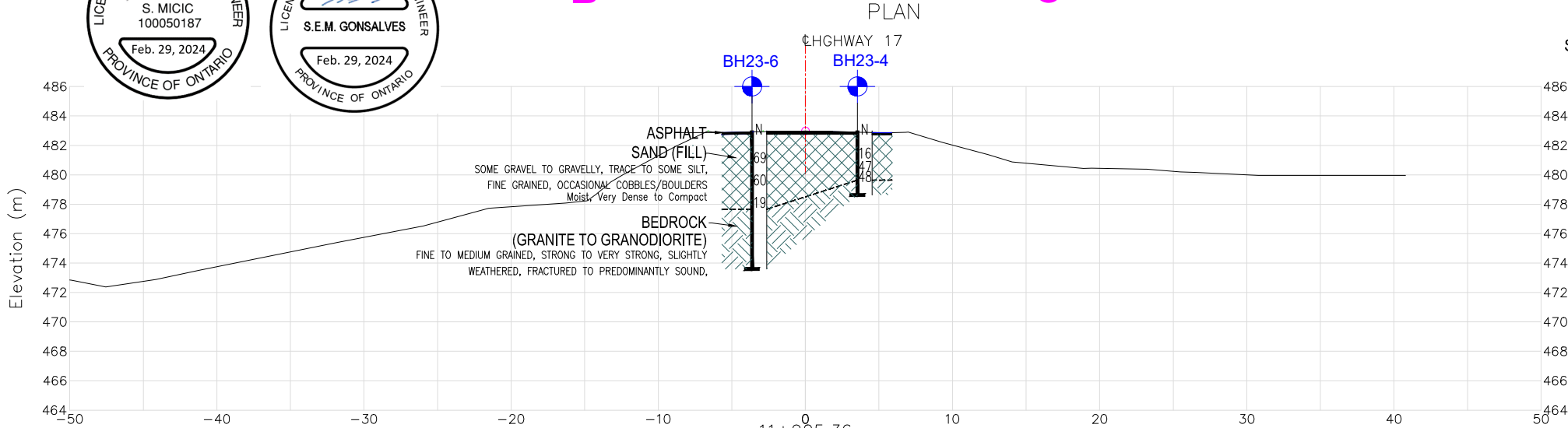
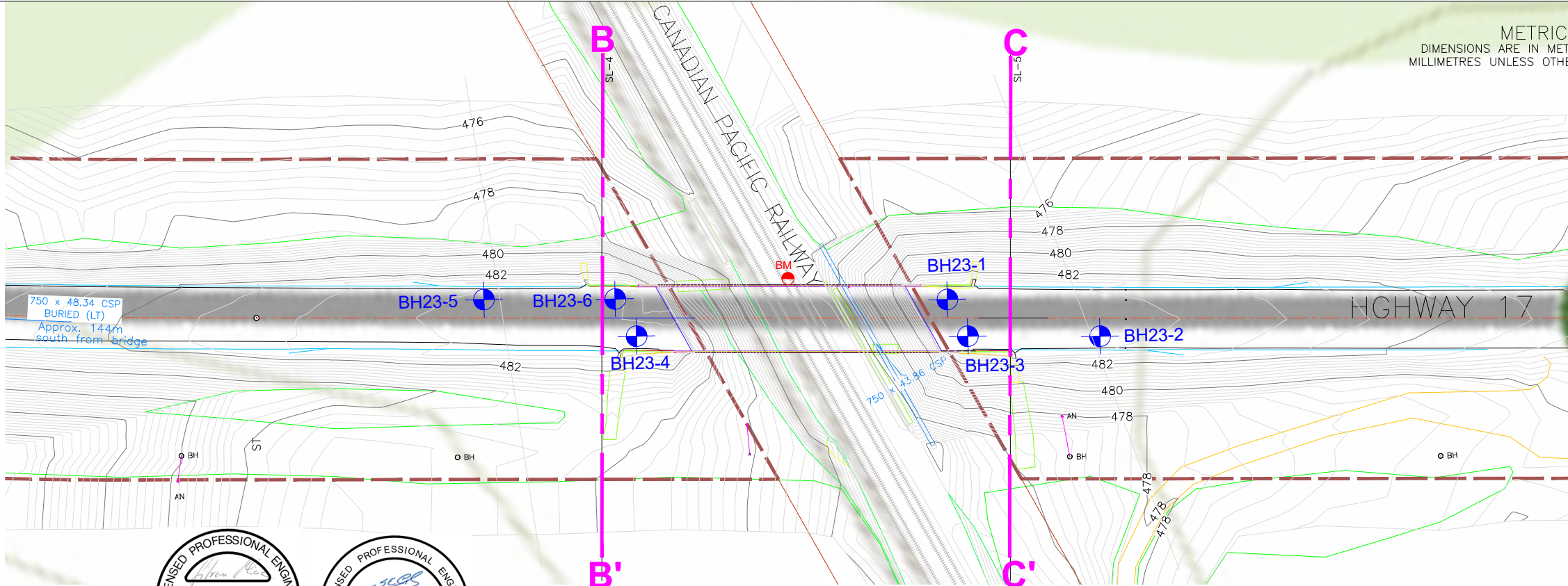
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

SUBMISSION FOR MTO REVIEW			
NO	DATE	BY	DESCRIPTION
PROJECT No.	ADM-22006096-A2	GEOCREs No.	-
SUBM'D SH	CHKD. SM	DATE	DEC. 16, 2024
DRAWN SH	CHKD. TC	APPRD SG	DWG 01

FILE NAME: \\PBRMFS0001\Data_Zeus\2003-Brampton\Proposals\Projects\International\MTD Projects\Retainer NWR\6021-E-0019\A 10 - Hwy 17 bridge replacement Kenora\working drawings\A 10 - Hwy 17 bridge replacement Kenora\plan and profile.dwg
MODIFIED: 2024-01-16 15:12



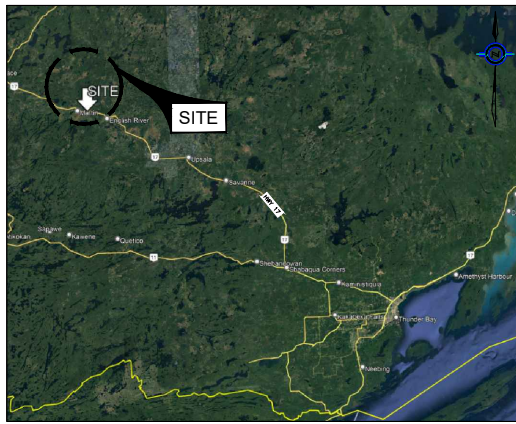
CONT No. 2021-E-0019
ASSIG No. 10
GWP No. 6109-17-00



CPR at Hwy 17 Overpass Replacement at Martin,
8.6 km west of English River at Martin, Kenora
Latitude: 49.2436°; Longitude: -91.0734°

SHEET
2

exp. EXP SERVICES INC.



KEY PLAN
N.T.S.

LEGEND

- Borehole Location
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level in Piezometer (most recent)
(W. L. STABILIZED)
- Piezometer
- Benchmark (Rail Line B/R) Elev. 474.6m Based
on MTO Provided Drawing (Plan E-8080-1
Dated May 1987)

SOIL STRATA SYMBOLS

- ASPHALT
- SAND
- FILL
- SAND & SILT
- SILT
- BEDROCK

BOREHOLE COORDINATES/ NAD 83/ MTM ON-15

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BH23-4	483.0	5456713.3	226618.6
BH23-5	482.8	5456698.6	226592.6
BH23-6	483.0	5456715.8	226610.7

NOTES

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NO	DATE	BY	DESCRIPTION
PROJECT No.	ADM-22006096-A2	GEOCRES No.	-
SUBM'D SH	CHKD. SM	DATE	DEC. 16, 2024
DRAWN SH	CHKD. TC	APPRD SG	DWG 02

Appendix C – Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

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

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

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

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

Terminology describing soil structure:

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

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

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

Fissured: material breaks along plane of fracture.

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

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

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

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

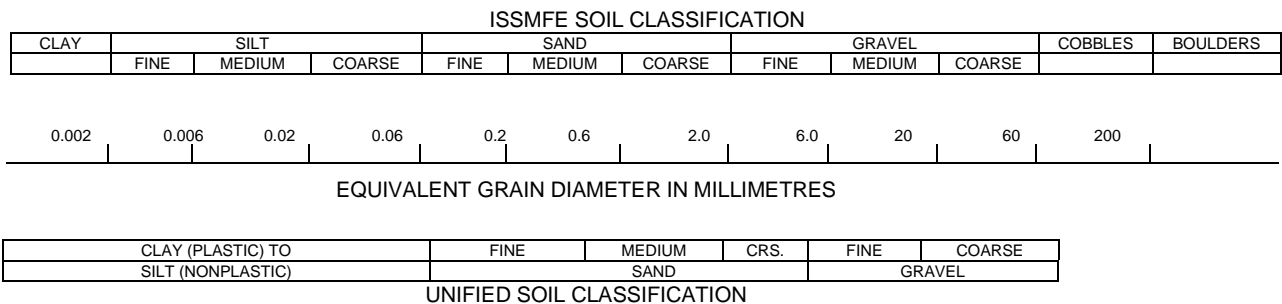
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

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

Uniformly Graded: predominantly on grain size.

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



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:

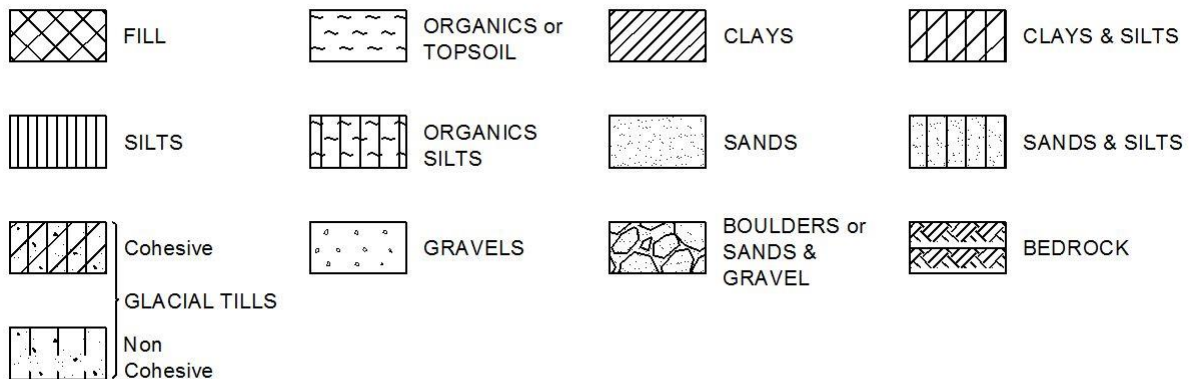
Table c: Consistency of Cohesive Soil

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 BH23-1

1 OF 1

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226675E 5456765N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2023.10.13 - 2023.10.14 LATITUDE 49.243937 LONGITUDE -91.073305 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						x P. PENETROMETER		
483.0							20	40	60	80	100	20	40	60	kN/m ³	GR SA SI CL		
482.0	ASPHALT [140 mm]																	
0.1	SAND (FILL) - trace gravel, trace silt, trace clay, fine grained, compact to dense, moist, brown, occasional cobbles/boulders		S1	AUGER														
			S2	SS	37													
	- some gravel to gravelly		S3	SS	31													
	- auger refusal on cobbles/boulders																	
	- auger refusal at about 3.7 m depth, wash boring techniques initiated																	
	- some silt to silty, trace clay		S4	SS	28													
	- trace silt		S5	SS	49													
			S6	SS	38													
	- some gravel to gravelly, trace silt		S7	SS	41													
473.9																		
9.1	SILT - trace to some sand, trace clay, loose, moist, brown, oxidation in layers, occasional cobbles/boulders		S8	SS	5													
473.1																		
9.9	SAND - some gravel to gravelly, some silt, trace clay, fine grained, dense to very dense, moist to wet, brown, oxidation in layers, occasional cobbles/boulders		S9	SS	47													
			S10	SS	50													
471.6																		
11.4	BEDROCK (GRANITE TO GRANODIORITE) - fine to medium grained, strong to very strong, slightly weathered, sound, grey/black to pink/white		R1	CORE														
470.8																		
12.2	End of Borehole																	
	- Borehole moved 1.0 m east upon auger refusal at 3.4 m depth																	
	- No groundwater encountered prior to wash boring at 3.7 m depth. Groundwater level was not measured in borehole after water was introduced for wash boring / coring process																	

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON_V3.GPJ ONTARIO MTO.GDT 1/12/24

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

Brampton, Ontario

RECORD OF BOREHOLE No BH23-2

1 OF 1

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226688E 5456779N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2023.10.11 - 2023.10.14 LATITUDE 49.244065 LONGITUDE -91.072887 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIALX P. PENETROMETER		W _P	W	W _L		GR SA SI CL				
483.0								20	40	60	80	100						
480.8	ASPHALT [150 mm]																	
0.2	SAND (FILL) - trace gravel, trace to some silt, fine grained, very dense, moist, brown, occasional cobbles/boulders - some gravel to gravelly below ~0.8 m depth		S1	AUGER														
			S2	SS	108													23 67 (10)
			S3	SS	51													
			S4	SS	53													27 63 7 3
			S5	SS	66													
476.1																		
476.0	SILT - trace to some sand, trace clay, loose, moist to wet, brown, occasional cobbles/boulders		S6	SS	3 for 6" (50 bounce)													0 9 88 3
7.0			S7	SS	10 for 4" (50 bounce)													
475.4	SAND - some gravel to gravelly, some silt, trace clay, fine grained, very dense, moist, brown, occasional cobbles/boulders																	
7.6	End of Borehole - SPT and auger refusal - No groundwater observed prior to backfill																	

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

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON V3.GPJ ONTARIO MTO.GDT 1/12/24

Brampton, Ontario

RECORD OF BOREHOLE No BH23-3

1 OF 2

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226664E 5456760N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2023.10.05 - 2023.10.11 LATITUDE 49.243891 LONGITUDE -91.073211 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										
483.0								20	40	60	80	100						
482.0	0.1	ASPHALT [140 mm]																
		SAND (FILL) - trace to some gravel, trace to some silt, fine grained, dense to very dense, moist, brown, occasional cobbles/boulders		S1	AUGER		482						○					
				S2	SS	39	481						○					
							480						○					
				S3	SS	33	479											
							478						○					
							477						○					
				S4	SS	55	476											
							475						○					
				S5	SS	40	474											
							473						○					
				S6	SS	59	472											
							471											
				S7	SS	13	470											
							469											
				S8	SS	45							○					
				S9	SS	55 for 5" (50 bounce)							○					
				R1	CORE													
				R2	CORE													

Continued Next Page

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

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON_V3.GPJ ONTARIO MTO.GDT 1/12/24

Brampton, Ontario

RECORD OF BOREHOLE No BH23-3

2 OF 2

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226664E 5456760N ORIGINATED BY KM
DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
DATUM Geodetic DATE 2023.10.05 - 2023.10.11 LATITUDE 49.243891 LONGITUDE -91.073211 CHECKED BY JK/SM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W		
							20	40	60	80	100					
	to wash boring at 9.1 m depth. Groundwater level was not measured in borehole after water was introduced for wash boring / coring process - Groundwater measured in temporary piezometer at 8.5 m below ground surface on October 13, 2023															

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON_V3.GPJ ONTARIO MTO.GDT 1/12/24




Brampton, Ontario

RECORD OF BOREHOLE No BH23-4

1 OF 1

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226610E 5456710N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2023.10.05 - 2023.10.05 LATITUDE 49.243435 LONGITUDE -91.073942 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										
483.0								20	40	60	80	100						
480.0	ASPHALT [130 mm]																	
0.1	SAND (FILL) - some gravel to gravelly, trace to some silt, fine grained, compact to dense, moist, brown, occasional cobbles/boulders - auger refusal [#1] on cobbles/boulders - auger refusal [#3] on cobbles/boulders at about 0.6 m depth, wash boring techniques initiated - auger refusal [#2] on cobbles/boulders at about 1.2 m		S1	AUGER														
			S2	SS	16													
			S3	SS	47													
	- gravelly, cobbles		S4	SS	48													
479.6	BEDROCK (GRANITE TO GRANODIORITE) - fine to medium grained, strong to very strong, slightly weathered, fractured to predominantly sound, grey/black to pink/white		R1	CORE														
3.4																		
478.6	End of Borehole																	
4.4	- No groundwater encountered prior to wash boring at 1.2 m depth. Groundwater level was not measured in borehole after water was introduced for wash boring / coring process - Borehole moved 1.0 m southwest upon auger refusal [#1] at 0.4 m depth - Borehole moved 1.0 m southwest upon auger refusal [#2] at 1.2 m depth - Borehole moved 1.0 m southwest upon auger refusal [#3] at 0.6 m depth																	

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON_V3.GPJ ONTARIO MTO.GDT 1/12/24

Brampton, Ontario

RECORD OF BOREHOLE No BH23-5

1 OF 1

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226588E 5456696N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2021.12.15 - 2021.12.17 LATITUDE 49.243305 LONGITUDE -91.074236 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER							
482.8	ASPHALT [150 mm]														
480.6	SAND (FILL) - some gravel to gravelly, trace silt, fine grained, very dense, moist, brown, occasional cobbles/boulders		S1	AUGER			482								20 73 (7)
0.2	- auger refusal [#1] on cobbles/boulders - SPT and auger refusal [#2] on cobbles/boulders		S2	SS	15 for 3" (50 ounce)		481								
	- SPT and auger refusal [#3] on cobbles/boulders - SPT and auger refusal [#4] on cobbles/boulders		S3	SS	100		480								
							479								
			S4	SS	81		478								
	- some gravel, some silt to silty		S5	SS	91		477								12 64 19 5
476.0	- silty		S7	AUGER			476								16 49 29 6
476.8	SILT AND SAND - trace clay, some gravel to gravelly, fine grained, dense, moist to wet, brown, occasional cobbles/boulders		S6	SS	26 for 3" (50 ounce)										Recovery=100% RQD=82%
6.9			R1	CORE											
475.3	BEDROCK (GRANITE TO GRANODIORITE) - fine to medium grained, strong to very strong, slightly weathered, fractured to predominantly sound, grey/black to pink/white														
7.5	End of Borehole														
	- No groundwater encountered prior to coring at 6.9 m depth. Groundwater level was not measured in borehole after water was introduced for wash boring / coring process														
	- Borehole moved 1.0 m southwest upon auger refusal [#1] at 1.2 m depth														
	- Borehole moved 1.0 m southwest upon SPT and auger refusal [#2] at 1.2 m depth														
	- Borehole moved 1.0 m southwest upon SPT and auger refusal [#3] at 2.3 m depth														
	- Borehole moved 1.0 m southwest upon SPT and auger refusal [#4] at 2.3 m depth														

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

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON V3.GPJ ONTARIO MTO.GDT 1/12/24

Brampton, Ontario

RECORD OF BOREHOLE No BH23-6

1 OF 1

METRIC

W.P. GWP No. 6109-17-00 LOCATION CPR on Hwy 17 ~8.6 km West of English River MTM ON-16 226611E 5456716N ORIGINATED BY KM
 DIST Kenora HWY 17 BOREHOLE TYPE CME 750 Rubber Tire / HSA / HWT COMPILED BY KM
 DATUM Geodetic DATE 2023.10.02 - 2023.10.04 LATITUDE 49.243489 LONGITUDE -91.073927 CHECKED BY JK/SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER											
483.0							20	40	60	80	100	20	40	60	kN/m ³	GR SA SI CL			
480.8	ASPHALT [180 mm]																		
0.2	SAND (FILL) - some gravel to gravelly, trace silt, fine grained, very dense, moist, brown, occasional cobbles/boulders		S1	AUGER															
	- some gravel		S2	SS	69														
	- trace to some silt		S3	SS	60											19 70 (11)			
	- compact		S4	SS	19														
477.7																			
5.3	BEDROCK (GRANITE TO GRANODIORITE) - fine to medium grained, strong to very strong, slightly weathered, fractured to predominantly sound, grey/black with pink/white banding to pink/white		R1	CORE												Recovery=97% RQD=68%			
			R2	CORE												Recovery=100% RQD=96%			
			R3	CORE												Recovery=100% RQD=97% UCS test=70.1 MPa			
			R4	CORE												Recovery=100% RQD=100% UCS test=99.5 MPa			
			R5	CORE												Recovery=100% RQD=94%			
473.6																			
9.4	End of Borehole																		
	- No groundwater encountered prior to coring at 5.3 m depth. Groundwater level was not measured in borehole after water was introduced for wash boring / coring process																		

ONTARIO MTO ADM-21019842-J0 - MTO 10 - HWY 17 - HWY 17 OVERPASS REPLACEMENT, MARTIN, KENORA, ON_V3.GPJ ONTARIO MTO.GDT 1/12/24

Appendix D –
Laboratory Data and Bedrock Coring Photograph



Photograph D1. Rock cores from BH23-1, Run 1 – 11. 4 m to 12.2 m (October 2023)



Photograph D2. Rock cores from BH23-3, Run 1 and Run 2 – 11. 2 m to 14.2 m (October 2023)



Photograph D3. Rock cores from BH23-4, Run 1 – 3.4 m to 4.4 m (October 2023)



Photograph D4. Rock cores from BH23-5, Run 1 – 6.9 m to 7.5 m (October 2023)

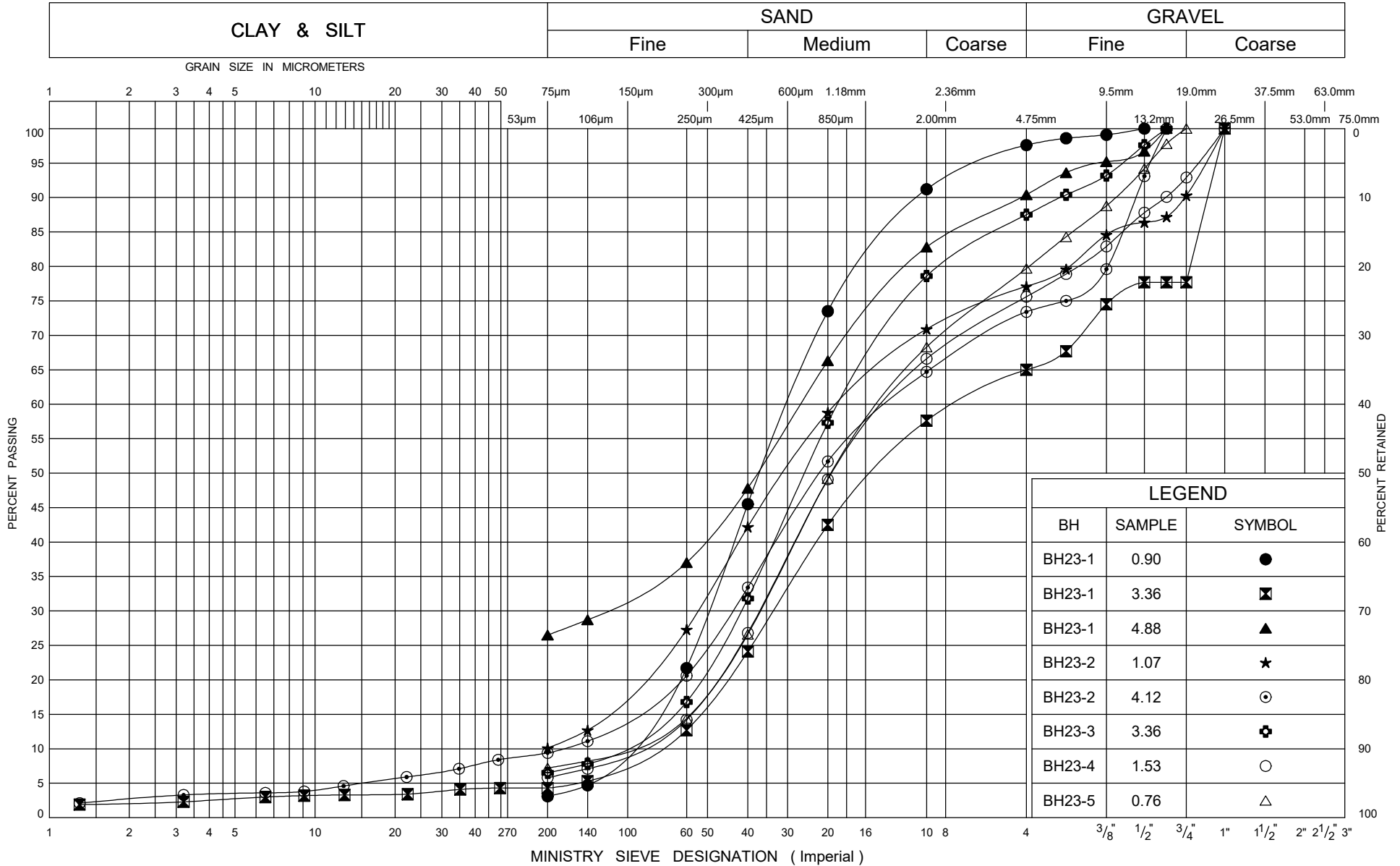


Photograph D5. Rock cores from BH23-6, Run 1 to Run 3 – 5.3 m to 7.2 m (October 2023)

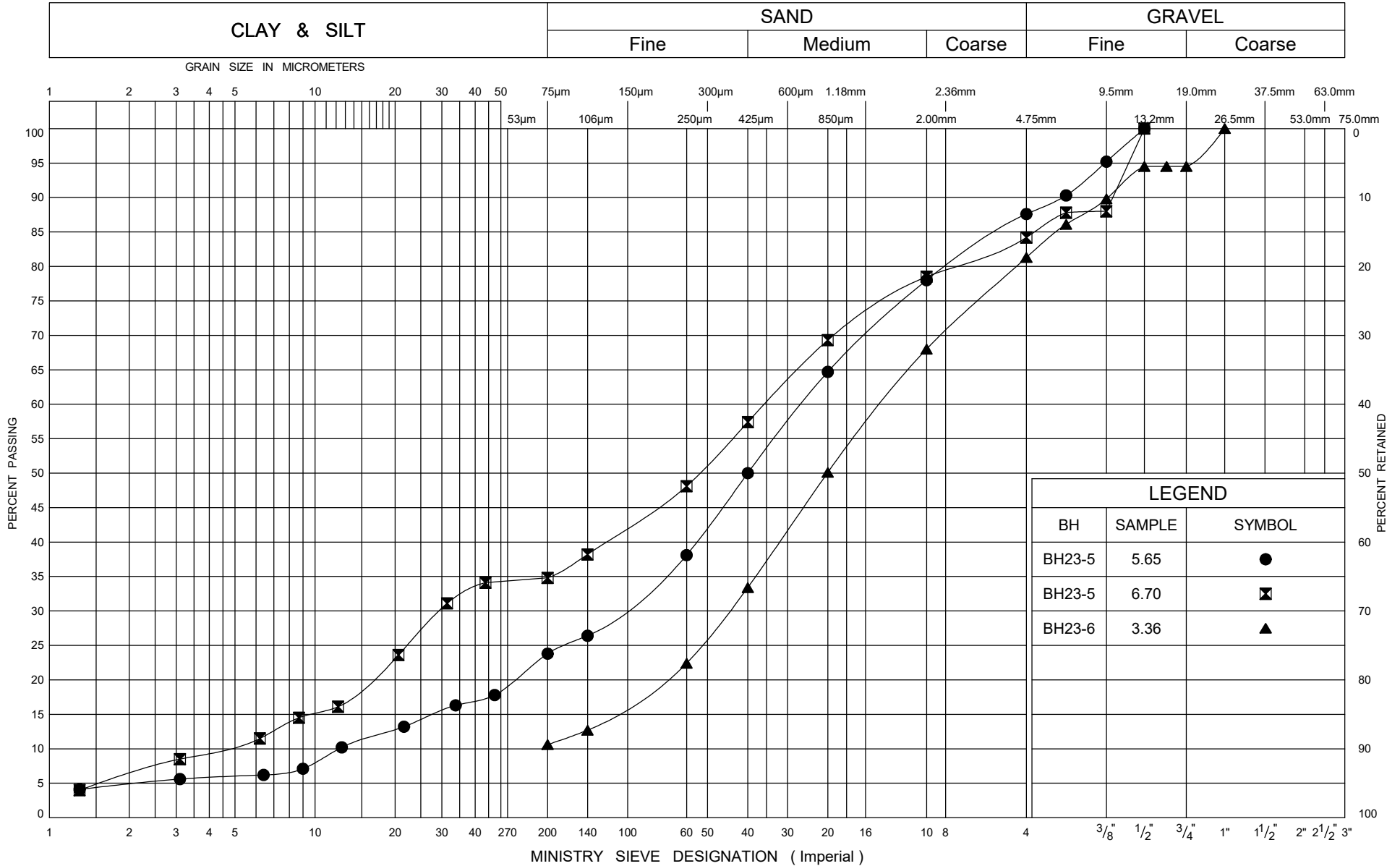


Photograph D6. Rock cores from BH23-6, Run 4 and Run 5 – 7.2 m to 9.4 m (October 2023)

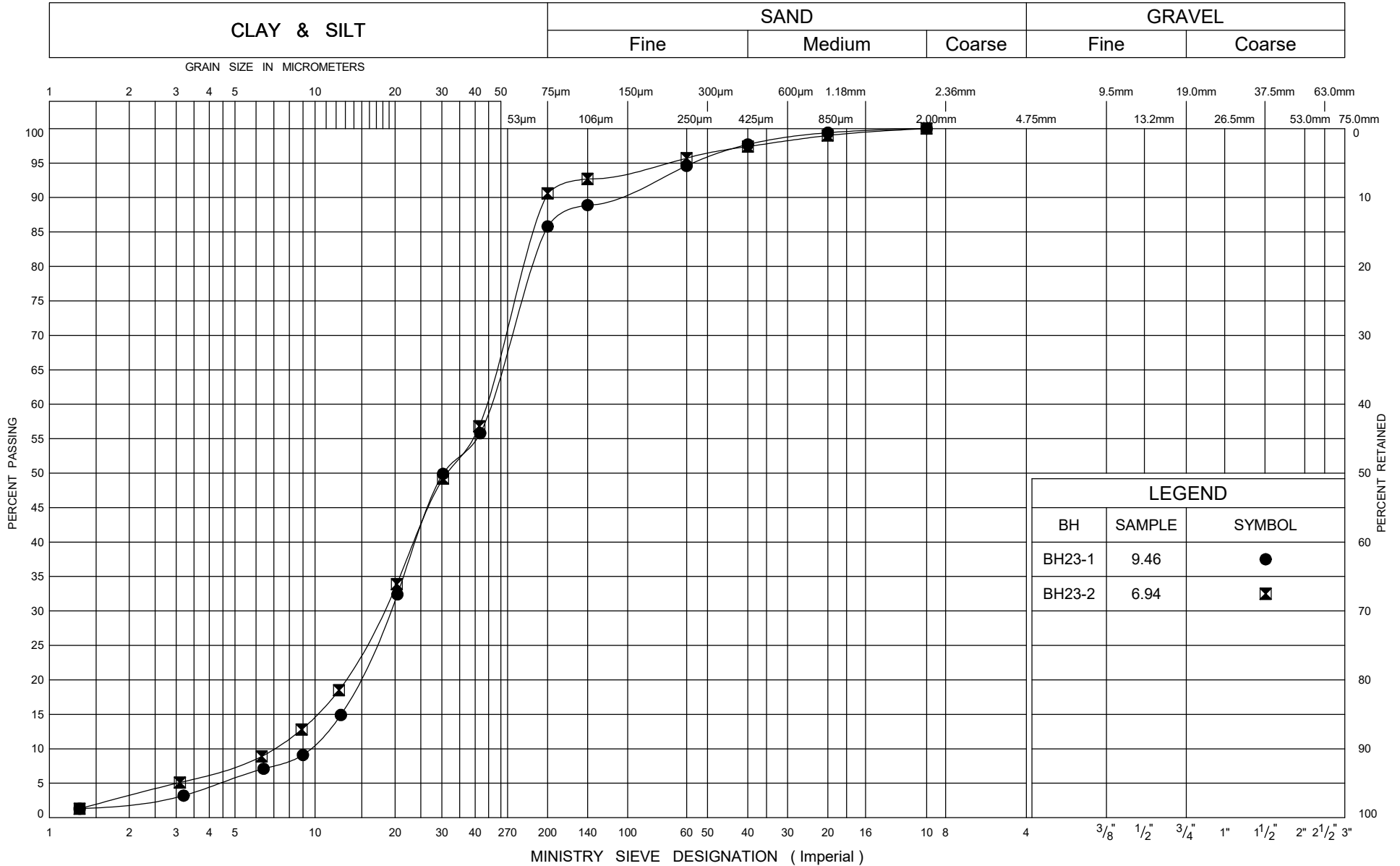
UNIFIED SOIL CLASSIFICATION SYSTEM



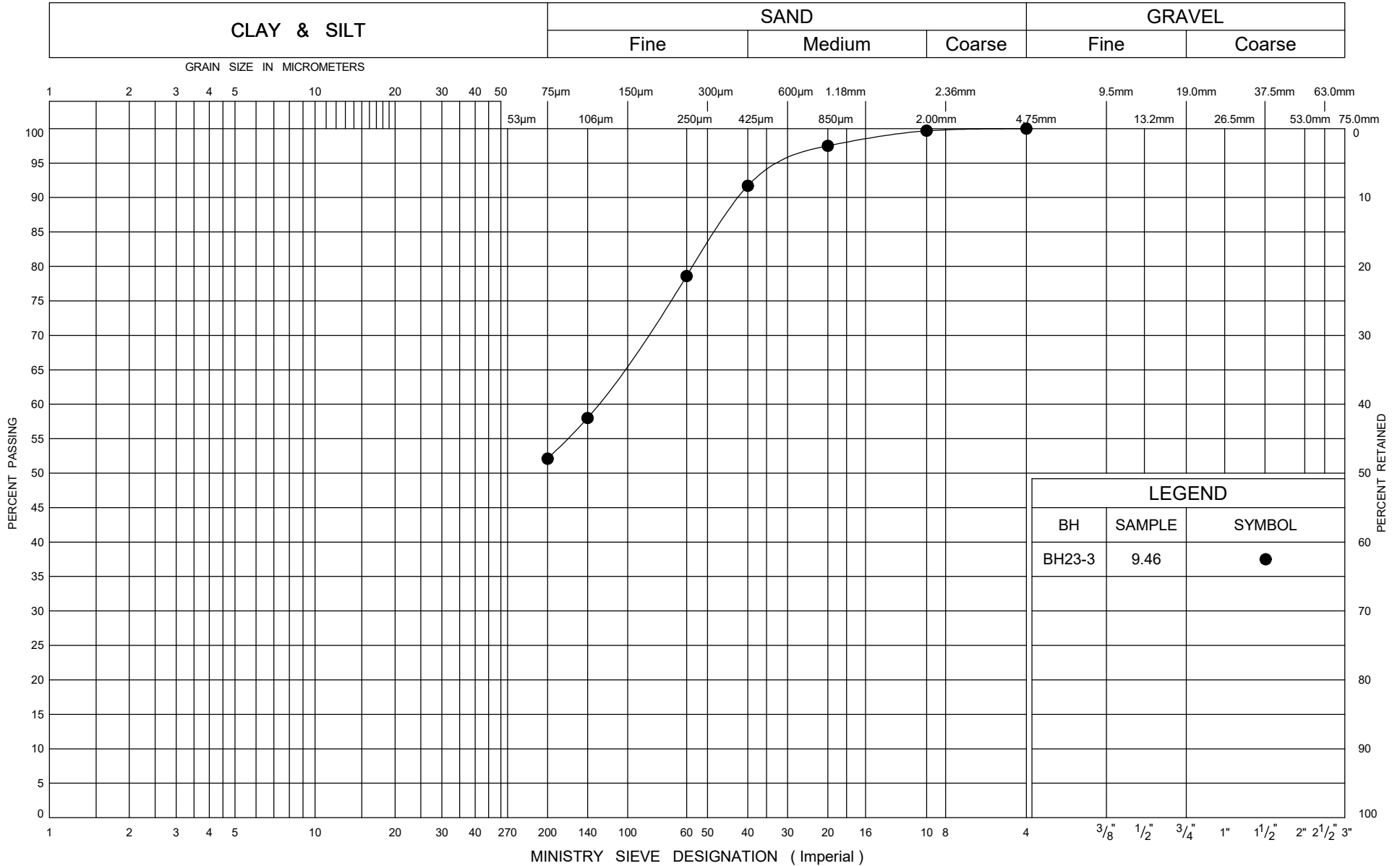
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

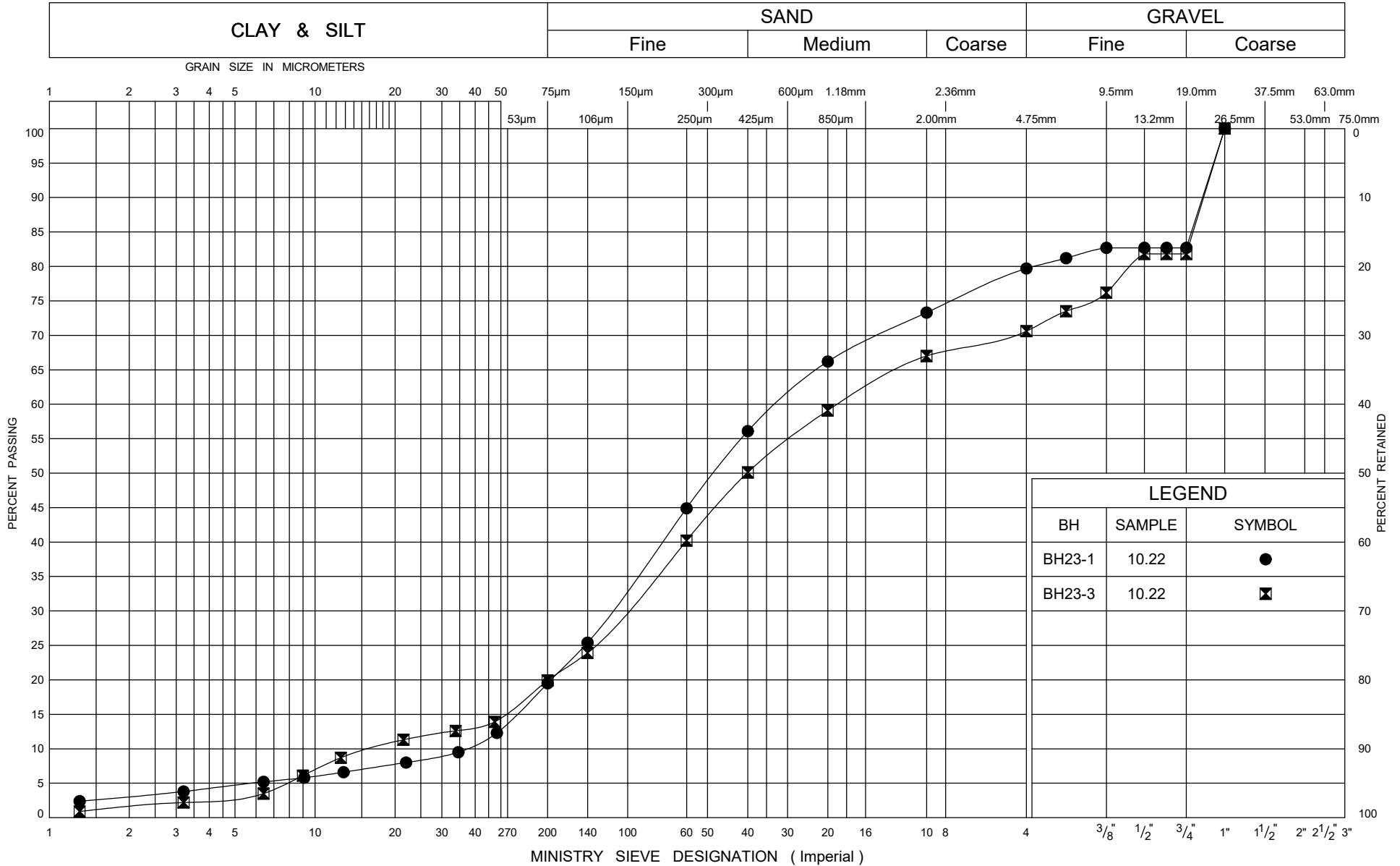
Silt and Sand

FIG No 4

GWP No. 6109-17-00

6021-E-0019, Assignment 10

UNIFIED SOIL CLASSIFICATION SYSTEM





BUREAU
VERITAS

Bureau Veritas Job #: C3W6139

Report Date: 2023/10/24

exp Services Inc

Client Project #: ADM-21019842-J0

Site Location: HWY 17 OVERPASS

Sampler Initials: KM

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		XIO423		XIO424		
Sampling Date		2023/10/14 02:00		2023/10/15 03:00		
	UNITS	BH23-1 (S8)	RDL	BH23-3 (S4)	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	560		360		8995535
Inorganics						
Soluble (20:1) Chloride (Cl-)	ug/g	1100	40	1600	100	8998694
Conductivity	mS/cm	1.8	0.002	2.8	0.002	8998914
Available (CaCl2) pH	pH	5.67		6.56		8999861
Soluble (20:1) Sulphate (SO4)	ug/g	75	20	58	20	8998703
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						