

Final Foundation Investigation Report (FIR)

Highway 61 Culvert Replacement

Station 14+588, Township of Blake

Gannett Fleming

Ontario Ministry of Transportation (MTO)

GWP 6176-15-00

GEOCRES No. 52A00-262

Assignment No.: 6020-E-0021

Latitude: 48.198329; Longitude: -89.46484

September 15, 2022

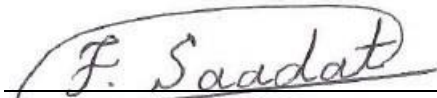
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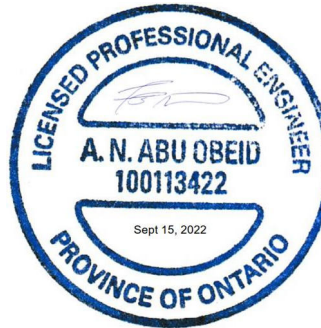


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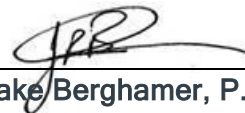


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2022-09-15

Revisions and publications log

REVISION No.	DATE	DESCRIPTION
0A	December 29, 2021	Draft FIR issued for Client information only
0B	April 7, 2022	Draft FIDR issued for review and comment
0C	May 29, 2022	Revised Draft FIDR issued for review and comment
1A	September 15, 2022	Final FIR issued

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1 Introduction

Englobe Corp. (Englobe) has been retained by Gannett Fleming (Client), on behalf of the Ministry of Transportation of Ontario (MTO, Owner), to carry out a foundation investigation and prepare Foundation Investigation (FIR) and Foundation Investigation and Design (FIDR) Reports for the proposed replacement of an existing culvert at approximate Station 14+588 on Highway No. 61 in the Township of Blake, Ontario (Site) shown on Drawing No. 1, Appendix A. This assignment was performed at the request of the Client as per the project Terms of Reference outlined in MTO Request for Quotation (RFQ) Version 3.2 under Assignment Number 6020-E-0021 (GEOCREs No. 52A00-262).

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2 Site Description

The existing 36.85 m long culvert structure is a Creosote Timber Culvert (CTC) culvert crossing Highway 61 at approximate Station 14+588, approximately 400 m south of the Cooper Cliff Road and Highway 61 intersection, in the Township of Blake. Highway 61 at this culvert crossing is a two-lane undivided highway with asphalt surface and partially paved shoulders on both sides running in an approximate north-south direction, as shown on Drawing No. 1 in Appendix A. Highway 61 is constructed on an embankment about 12.5 m wide (including shoulders) and up to approximately 4.6 m in height above the crown of the culvert, with the centreline of the roadway at an approximate elevation 265 m at the culvert location. The pavement surface is generally in good to fair condition with some longitudinal and transvers cracks across the asphalt surface. The sides of the roadway at the culvert crossing were observed to be heavily vegetated with bushes, shrubs, and mature trees. An access to a private property at the east side of Highway 61 is located about 110 m to the north of the culvert crossing. On the west side of the Highway 61, a shallow marsh with low hanging hydro lines were observed. Presence of beaver dam on the east (Rt) side of the culvert was reported in the Culvert Review Report dated August 2020 by others.

The existing culvert structure is crossing Highway 61 at skew alignment (approximately 95 degree) from east (upstream) to west (downstream). The existing culvert structure is a 1.34 m wide and 1.04 m high at the upstream and 1.34 m wide and 1.04 m high at the downstream, as shown on Drawing No. 2 in Appendix A and described in detail and shown on the sketches and Figures in GF Culvert Inspection Report in Appendix D. The existing CTC culvert is old and was observed to be deteriorated and missing timber pieces from the soffit. According to GF, the water bond upstream (US) with no observable channel (wide open); at the downstream (DS), the channel was 2 m wide with banks at ~3H:1V and dry. The top of the culvert elevations at the inlet and outlet are 260.3 and 260.4 m (culvert slope is flat), respectively with clearance of 370 mm and 1040 mm, respectively. Water was observed standing in the culvert as shown on field inspection photos in GF Culvert Inspection Report in Appendix D.

2.1 Site Physiography and Surficial Geology

Based on published Northern Ontario Geology Terrain Study (NOEGTS) of the general area by J. F. Gartner, J.D. Mollard, and M.A. Road (1981), the Site is located within the Glaciolacustrine Plain with native overburden/sediments within the immediate project area consisting mainly of sandy soil deposits with minor portions of gravel.



3 Investigation Procedures

3.1 Site Investigation

The purpose of the geotechnical investigation was to explore and record the subsurface conditions at both ends of the existing culvert and in the roadway embankment at the culvert crossing. The fieldwork was carried out between October 25 and November 10, 2021 and consisted of two boreholes on the roadway extending down to a maximum depth of 19.2 m below existing ground/road surface (bgs) and two boreholes off the roadway at the culvert inlet and outlet to a maximum depth of 6.7 mbgs.

The fieldwork included locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transportation to the Englobe North Bay laboratory, plus overall drill supervision.

Englobe's staff visited the Site before the planned site investigation to mark out the proposed borehole locations. Utility clearance was obtained from Ontario-1-Call. Public utility authorities were informed, and all utility clearance documents were obtained before the commencement of drilling work. A traffic control plan was prepared and implemented by Workforce Inc. of Sudbury, Ontario, according to Ontario Traffic Manual Book 7 during the fieldwork. The drilling rigs used for drilling were owned and operated by Maple Leaf Drilling Ltd. of Sunnyside, Manitoba. Boreholes were advanced using a CME 750 track mounted drill and a B20 portable drilling rig.

The fieldwork for this investigation included four (4) sampled boreholes (BH) were advanced. BH Nos. 1 and 2 were advanced in the roadway shoulders through the embankment. BH Nos. 3 and 4 were advanced at the inlet (Rt) and outlet (Lt) ends of the culvert, respectively. The locations of the boreholes are shown on Drawing No. 2 in Appendix C and are provided in the Table below.

Table 1 Borehole Locations

Borehole No.	Borehole Location (MTM Nad 83)		Borehole Location (Geographic)	
1	N 5340081.8	E 344584.4	Lat: 48.19830°	Long: - 89.46477°
2	N 5340078.7	E 344576.4	Lat: 48.19827°	Long: - 89.46488°
3	N 5340089.6	E 344602.0	Lat: 48.19837°	Long: - 89.46453°
4	N 5340102.9	E 344555.9	Lat: 48.19849°	Long: - 89.46515°

BH Nos. 1 and 2 were advanced using a hollow stem auger aided by track-mounted CME 750 drilling rig equipped with wash boring equipment, N-size casing, rock coring equipment (NQ size core) and routine geotechnical sampling equipment. BH Nos. 3 and 4, which were drilled off the roadway near the inlet and outlet, were advanced using a B20 portable drilling rig equipped with a solid stem auger.

Soil samples were obtained at regular intervals of depth at the borehole locations using a standard 51 mm split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures ASTM D1586. Dynamic Cone Penetration Test (DCPT) was carried out in BH No. 1 from elevation 247.8 m to 245.8 m. The DCPT was carried out after drilling was not possible to proceed with hollow stem auger (below elevation 247.8 m) through the flowing sand. All soil samples taken during this investigation were stored in labeled airtight containers for transport to the Englobe North Bay laboratory for visual examination and select laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of the individual boreholes. Two 19 mm diameter standpipes were installed in Borehole Nos. 3 and 4 prior to backfilling to allow for follow-up monitoring of the stabilized groundwater levels. The remaining boreholes were backfilled upon completion of drilling in accordance with requirements of Ontario Regulation 903.

The location of the individual boreholes was determined in the field using highway chainage established by the Ministry of Transportation and offsets relative to highway centreline. The MTO coordinates, northing and easting, were then established for the boring locations using coordinates from MTM Zone 15, NAD 83 CSRS. Elevations contained in this report are referenced to an on-site geodetic datum. The borehole elevations are based on the GPS RTK survey carried out by Englobe.

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4 Laboratory Investigation

All soil and rock samples obtained during the investigation were transported to Englobe Laboratory in North Bay, Ontario. This laboratory is certified by the Ministry of Transportation Ontario (MTO) under RAQS program at Medium Complexity level for Soil and Rock Testing including Testing for Foundation Engineering. All retrieved samples were subject to visual identification and tactile categorization to describe the soils. The laboratory tests to determine index properties were performed in accordance with the Ministry of Transportation Ontario (MTO) test procedures, which follow the American Society for Testing Materials (ASTM) test procedures. Laboratory testing consisted of grain size distribution; sieve and hydrometer analysis according to ASTM D422 and LS-702, Atterberg's Limits ASTM D4318 and LS-703/704, water content ASTM D2216 and LS-701. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix B), with a summary of results presented on the laboratory sheets in Appendix C (Figures Nos. L-1 to L-9).

Chemical tests on one representative soil sample to determine the soil corrosivity characteristics (pH, chloride, resistivity, sulphate) were carried out by an accredited independent laboratory (Bureau Veritas in Mississauga) to assess soil condition for buried structural steel and concrete elements. Laboratory tests are included in Appendix C.

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5 Subsurface Conditions

The subsurface conditions revealed by the investigation program are summarized in Table 2 below and on the stratigraphic profile presented on Drawing No. 2 (Appendix A) and on the detailed Records of Borehole Logs (Appendix B). It should be noted that the stratigraphic delineation presented on the borehole logs and soil strata plot is interpreted from the results of non-continuous sampling, response to drilling progress, recorded SPT 'N'-values, plus field observations. Typically, such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological units. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location and are shown on the drawings for illustration purposes only.

Table 2 Summary of Generalized Stratigraphy in Boreholes with Depth and Elevation (m)

Deposit/Layer Description	Depths/Elevations (m)			
	Borehole No. 1	Borehole No. 2	Borehole No. 3	Borehole No. 4
Asphalt/Topsoil	0 - 0.04 (El. 265)	0 - 0.04 (El. 265)	0 - 0.1 (El. 259.8 - 259.7)	0 - 0.1 (El. 260.4 - 260.3)
Pavement Granular Base: Loose to Compact Sand and Gravel	0.04 - 0.3 (El. 265 - 264.7)	0.04 - 0.8 (El. 265 - 264.3)	--	--
Embankment Fill: Compact to Dense Gravelly Sand/Sand with some Silt	0.3 - 3.8 (El. 264.7 - 261.2)	0.8 - 3.8 (El. 264.3 - 261.2)	--	--
Embankment Fill: Loose to Compact Silt/Silt and Clay, with trace of Sand.	3.8 - 6.1 (El. 261.2 - 258.9)	3.8 - 6.4 (El. 261.2 - 258.6)	--	--
Buried Organics	-	6.4-6.65 (El. 258.6-258.35)	-	-
Native: Loose to Dense Silt/Stiff to Very Stiff Silt and Clay.	6.1 - 12.2 (El. 258.9 - 252.8)	6.65 - 12.2 (El. 258.35 - 252.8)	0.1 - 4.1 (El. 259.7 - 255.7)	0.1 - 3.8 (El. 260.3 - 256.6)
Native: Dense Sandy Gravel /Gravelly Sand.	--	12.2 - 13.7 (El. 252.8 - 251.3)	--	5.3 - 6.7 (El. 255.1 - 253.7)
Native: Dense Sandy Silt/Silty Sand	12.2 - 17.2 (El. 252.8 - 247.8)	13.7 - 18.9 (El. 251.3 - 246.1)	--	3.8 - 5.3 (El. 256.6 - 255.1)
Native: Inferred Sandy Silt.	17.2 - 19.2 (El. 247.8- 245.8)	--	--	--

5.1 Asphalt and Pavement Structure

A thin layer of approximate 40 mm asphalt was observed in both BH Nos. 1 and 2 which were drilled on the shoulders through the embankment. The asphalt cover is underlain by a granular fill layer consisting mainly of brown sand and gravel, trace silt. The pavement structure/granular fill extended to approximate depth of 0.3 m (El. 264.7 m) in BH No. 1 and 0.8 m (El. 264.3m) in BH No. 2.

5.2 Topsoil

A thin topsoil layer (organic silt) of approximately 0.1 m thickness was observed in BH Nos. 3 and 4, located beyond the paved shoulders.

5.3 Embankment Fill

The encountered embankment fill materials underlying the pavement structure extended down to 6.1 mbgs (El. 258.9 m) in BH No.1 and 6.4 mbgs (El. 258.6 m) in BH No 2. The embankment fill materials varied in composition with depth. A layer of sand fill (3.0 to 3.5 m thick) was encountered below pavement structure extending down to EL. 261.2 m in both boreholes. The sand fill is followed by silt/silt and clay fill which was observed to be 2.3 m thick and extended between El. 261.2 m and 258.9 m in BH No. 1, and 2.6 m thick and extended between El. 261.2 m to 258.6 m in BH No. 2.

The embankment fill, immediately below the pavement structure, is mainly composed of brown gravelly sand/sand with different portions of silt and clay. The gravelly sand/sand fill layer extended to approximately 3.8 m depth (El. 261.2m). This gravelly sand/sand fill layer was almost dry with approximate moisture content of 4% measured in the geotechnical laboratory. The results for grain size analyses of representative samples comprising the embankment fill are summarized in Table 3 and presented on Figure No. L-1, Appendix C.

Table 3 Particle Size Distribution Results of the Gravelly Sand/Sand Fill

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1 / SS-3	1.75 (263.3)	21	58	21		SM
BH No. 1 / SS-6	2.5 (262.5)	23	52	25		SM

The gravelly sand/sand fill layer was generally compact to dense, based on recorded SPT 'N' values ranging from 19 to 47 blows/300 mm.

The upper gravelly sand/sand layer was underlain by silt/silt and clay fill deposit approximately 2.3 to 2.6 m thick and extending to a maximum depth of 6.4 m (EL. 258.6 m). The silt/silt and clay deposit included minor portions of sand and gravel and was observed to be brown to grey and damp with an approximate moisture content of 32% measured in the geotechnical laboratory.

A representative soil sample from this silt/silt and clay fill layer was subjected to grain size analysis and the results are summarized in Table 4 and provided in Figure No. L-2, Appendix C.

Table 4 Particle Size Distribution Results of the Silt/Silt and Clay Fill

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1 / SS-6	4.1 (260.9)	0	3	83	13	ML

The silt fill layer was generally loose based on recorded SPT 'N' values ranging from 8 to 9 blows/300 mm, and the silt and clay fill layer was generally stiff to very stiff with measured undrained shear strength ranging from 85 kPa to 115 kPa. The silt and clay layer has low sensitivity ranged between 2 and 3.

5.4 Buried Organics

A thin buried black organic material of approximately 0.25 m thick was observed in BH No. 2 below the embankment fill and above the native silt/silt and clay between elevation 258.6 m to 258.35 m.

5.5 Native Silt/Silt & Clay (ML to CH)

Underlying the embankment fill in BH Nos. 1 and 2 and at shallow depth in BH Nos. 3 and 4, a native deposit of silt/silt and clay was encountered. The native silt/silt and clay in BH Nos. 1 and 2 was observed between elevations 258.35 m to 258.9 m and it extended to an approximate elevation of 252.8 m.

The silt/silt and clay layer was observed below the top soil in BH Nos. 3 and 4 and extended to El. 256.6 m in BH No. 4 and to EL. 255.7 m in BH No. 3 (auger and SPT spoon sampler refusal). The refusal was encountered in BH No. 3 probably on boulders.

This deposit mainly consisted of silt and clay with different portions of sand and gravel. Occasional boulders/cobbles were encountered in BH No. 2 and BH No. 3. The layer was observed to be brown to grey in general. The compactness/consistency of this deposit generally varied from loose to dense/firm to hard based on recorded SPT 'N' values ranging from 5 to 43 blows/300 mm. Higher SPT 'N' values (i.e. 50 to 109 blows/300 mm) were recorded due to presence of boulders and cobbles in this till-like deposit near bottom.

The natural moisture contents measured on samples recovered from the deposit ranged from 12 to 47% and was on average 29%. Six gradation analyses and three Atterberg limits (Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI)) were carried out on samples from this deposit, and the results are summarized in Table 5 and provided in Figures. L-3, L-4 and L-9, Appendix C.

Table 5 Particle Size Distribution and Atterberg Limits Results of the Native Silt/Silt and Clay

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Atterberg Limits (%)			Water Content (%)	Soil Classification
		Gravel	Sand	Silt	Clay	LL	PL	PI		
BH No. 1/SS-15	11.0 (254.0)	0	3	42	55	51	23	28	47	CH
BH No. 2/SS-11	7.9 (257.1)	3	5	51	41	53	29	24	35	CH
BH No. 3/SS-2	1.0 (258.8)	1	4	39	55	38	25	13	33	MI
BH No. 3/SS-5	3.2 (256.6)	1	5	74	21	--	--	--	24	ML
BH No. 4/AS-1	0.4 (260.0)	1	9	72	17	--	--	--	24	ML
BH No. 4/SS4	2.6 (257.8)	4	17	67	12	--	--	--	32	ML

5.6 Native Sandy Gravel/Gravelly Sand (GP to SM)

Below the native silt/silt and clay in BH No. 2 and below the native silty sand in BH No. 4, a native deposit of brown sandy gravel/gravelly sand was encountered. The sandy gravel/gravelly sand observed between El. 252.8 m to El. 251.3 m in BH No. 2. In BH No. 4, the sandy gravel/gravelly sand encountered at El. 256.1 m and extended to the maximum depth of drilling (El. 253.7 m). The sandy gravel/gravelly sand layer was observed to be compact to dense based on SPT 'N' values ranging from 17 to 50 blows/300 mm.

The natural moisture content of the sandy gravel/gravelly sand was approximately 12%. Gradation analyses were carried out on three (3) samples from this deposit, and the results are summarized in Table 6 and provided in Figure Nos. L-5, and L-6, Appendix C.

Table 6 Particle Size Distribution Results of the Native Sandy Gravel /Gravelly Sand

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 2/SS-16	12.3 (252.7)	78	22	0		GP
BH No. 4/SS-9	6.2 (254.2)	30	46	18	6	SM

5.6.1 Native Sandy Silt/Silty Sand (ML to SM)

Below the native silt/silt and clay layer in BH Nos. 1 and 4, and below the native sandy gravel/gravelly sand in BH No. 2, a sandy silt/silty sand deposit was encountered. The sandy silt/silty sand was encountered between EL. 251.3 m to 256.6 m and it extended to the maximum depth of EL. 246.1 m. In BH No. 1, due to difficulty with auger drilling through the running/flowing sand, auger drilling was terminated within the sandy silt/silty sand at EL. 247.8 m and Dynamic Cone Penetration test (DCPT) was advanced beyond EL. 247.8 m to EL. 245.8 m (through the inferred sandy silt/ silty sand deposit).

The layer consisted mainly of silt and sand with different portions of clay and gravel. Occasional boulders and cobbles were encountered through the sandy silt/silty sand deposit resulting in recording high SPT 'N' values or SPT spoon sampler refusal. This sandy silt/silty sand layer was observed to be dense based on SPT 'N' values ranging from 24 to 49 blows/300 mm. Higher SPT 'N' values (i.e. 50 to 73 blows/300 mm) were recorded due to presence of cobbles in the deposit.

The natural moisture contents measured on samples recovered from the deposit ranged from 12 to 17%. Gradation analyses were carried out on three samples of this deposit, and the results are summarized in Table 7 and provided in Figure Nos. L-7 and L-8, Appendix C.

Table 7 Particle Size Distribution Results of the Native Sandy Silt/Silty Sand

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1 / SS-17	14 (251.0)	5	32	52	11	ML
BH No. 2 / SS-20	18.6 (246.4)	8	28	55	9	ML
BH No. 4/SS-6	4.1 (256.3)	19	40	34	6	SM

5.7 Groundwater Conditions

Groundwater and cave-in levels were measured in the open boreholes during the course of the fieldwork as summarized in Table 8. The wells and the boreholes were dry on completion as shown on the individual Record of Borehole Log Sheets (Appendix B).

Table 8 Groundwater Levels

BH No.	Drilling Date	Ground Surface Elev. (m)	Borehole Bottom		Monitoring Date	GW in Well		Monitoring Date	GW in Well	
			Depth (m)	Elev. (m)		Depth (m)	Elev. (m)		Depth (m)	Elev. (m)
BH No. 1	Oct 25, 2021	265.0	19.2	245.8	--	--	--	--	--	--
BH No. 2	Oct 26, 2021	265.0	18.9	246.1	--	--	--	--	--	--
BH No. 3	Nov 9, 2021	259.8	4.1	255.7	Nov 9, 2021	Dry	--	Dec 21, 2021	Dry	--
BH No. 4	Nov 10, 2021	260.4	6.7	253.7	Nov 10, 2021	Dry	--	Dec 21, 2021	Dry	--

The groundwater and surface water levels should be expected to fluctuate seasonally/yearly. The stabilized groundwater level is anticipated to correspond with the creek water level. The lowest creek level is anticipated to be above the average invert elevation of the culvert at elevation 259.15 m. The water level in the creek was measured in January 2022 and was at EL. 259.0 m adjacent to BH No. 3 and EL. 260.2 m adjacent to BH No. 4.

5.8 Soil Corrosivity Testing

A representative soil sample collected from BH No. 1 was subjected to corrosivity chemical tests by Bureau Veritas Laboratories in Thunder Bay to determine its potential corrosivity by measuring resistivity, pH, sulphate and chloride content of the sample within the estimated infrastructure depths. The results are presented in Table 9.

Table 9 Soil Corrosivity Chemical Analysis Results

BH No.	Sample	Depth (Elev.) (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm-cm)
BH No. 1	SS-15	11.2 (254.0)	5.13	<0.0020	0.0260	2300



6 General Comments

The field investigation was carried out using track mounted CME 750 drilling rigs and a portable B20 drilling rig owned and operated by Maple Leaf Drilling Ltd. Laboratory testing of select soil samples was undertaken at the Englobe Laboratory in North Bay. The fieldwork for this site investigation was under the full-time supervision of Englobe technical staff. The report was written by Mr. Farbod Sadaat, Ph.D., P.Eng., and peer reviewed by Mr. Ala Abu Obeid, M.Sc., P.Eng., PMP. The report was also reviewed by the MTO Designated Contact Mike Tanos, P.Eng., with independent review by Jake Berghamer, P.Eng.

7 STATEMENT OF LIMITATIONS

The design recommendations given in this geotechnical report are applicable only to the project described in the text and only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions, however, may vary from those assumed, in which case changes and modifications may be required to our geotechnical recommendations.

The comments in this report are intended solely for the guidance of the design engineer and address the geotechnical conditions only. The number of boreholes required to determine the localized conditions between boreholes directly affecting construction costs, equipment, scheduling, etc. would in fact be greater than what has been carried out for design purposes. Therefore, contractors bidding on this project or undertaking this work should make their own interpretations of the factual borehole results and carry out further work as they deem necessary to assess the scope of the project.

Foundation Design of this report is intended solely for the use of the client and the design team for the detail design of this specific project on behalf of the Ministry of Transportation and is not intended to be included in the tender documents; and shall not be used for any other purposes or by any other parties including the construction Contractor.

Appendix A

Drawings

Drawing No. 1 - Site Location Plan & Key Map

Drawing No. 2 - Borehole Location Plan & Embankment Profile

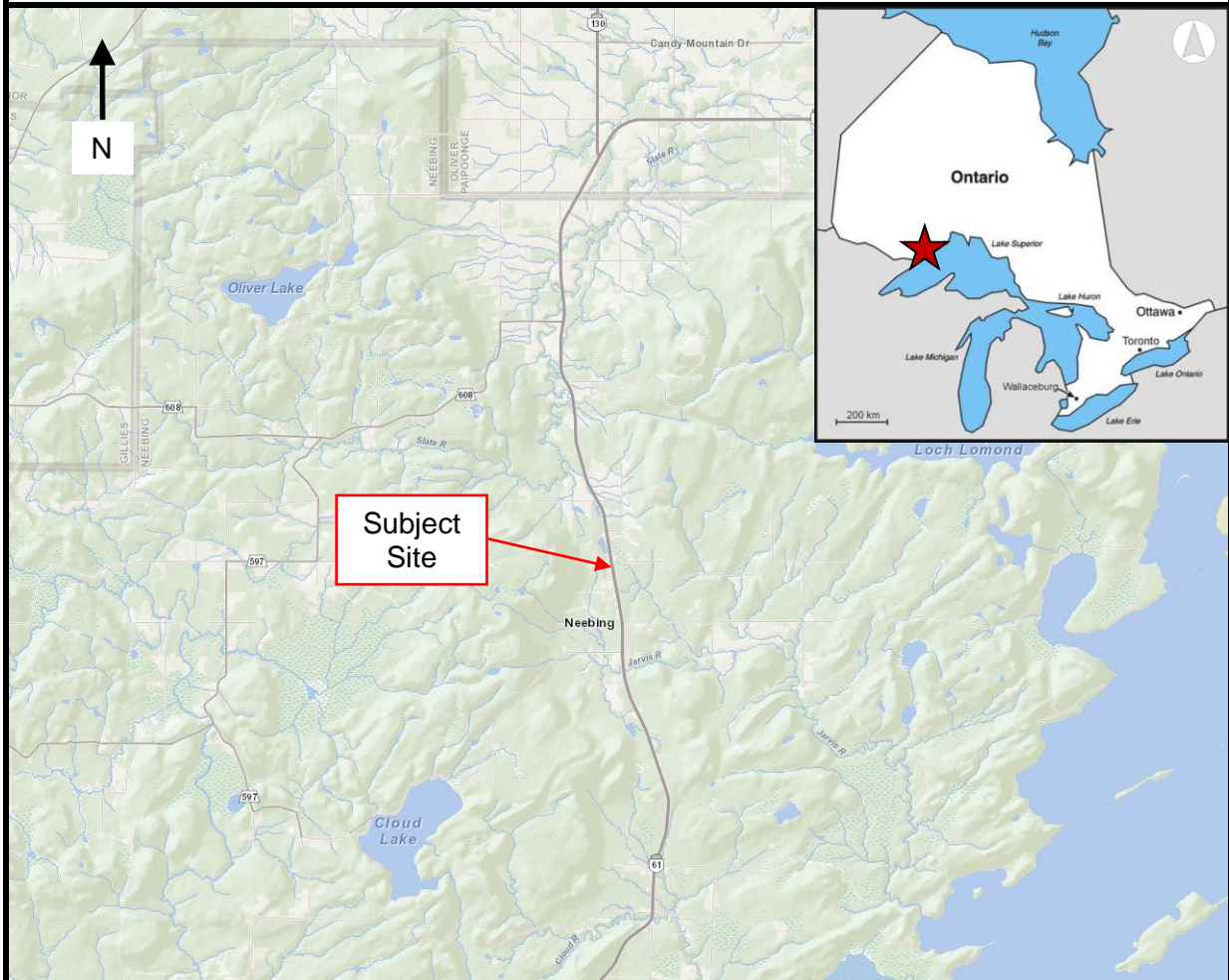


ENGLOBE

KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL FOUNDATION INVESTIGATION REPORT

Station 14+588 Culvert

Culvert Replacement

Highway No. 61, Twp. of Blake Assignment

Number 6020-E-0021

GWP 6176-15-00

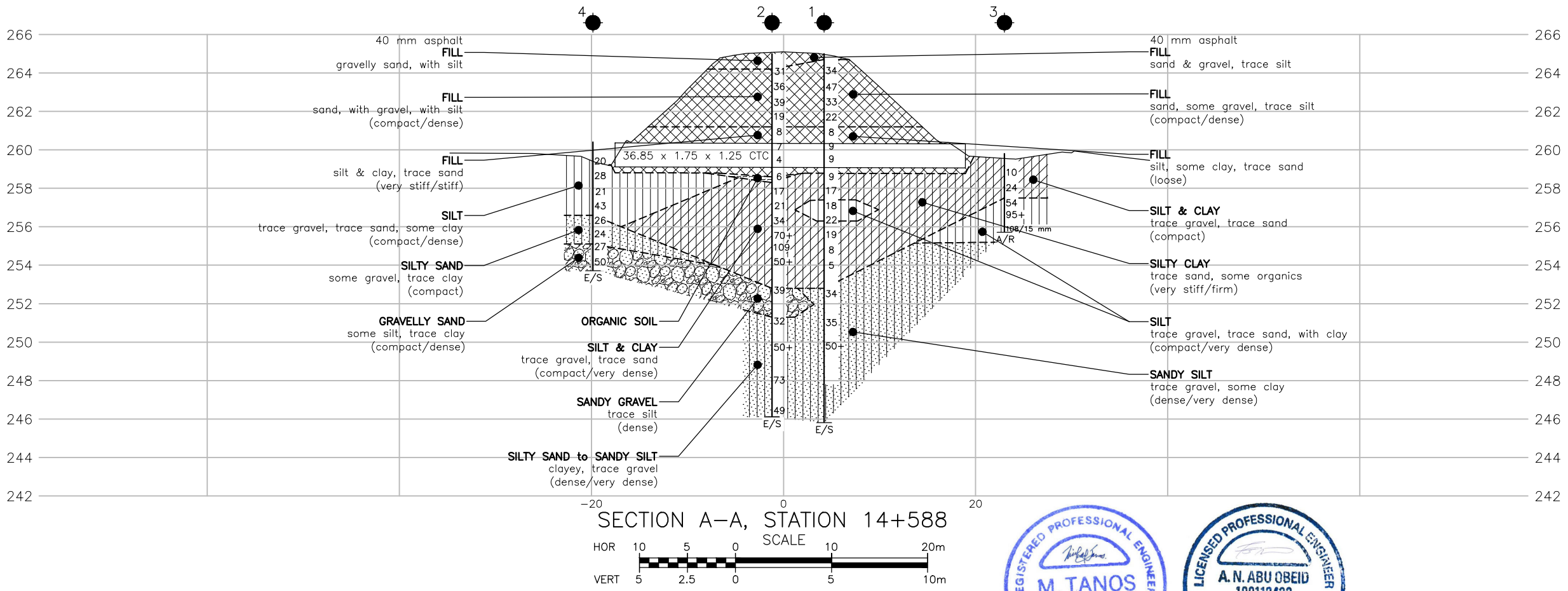
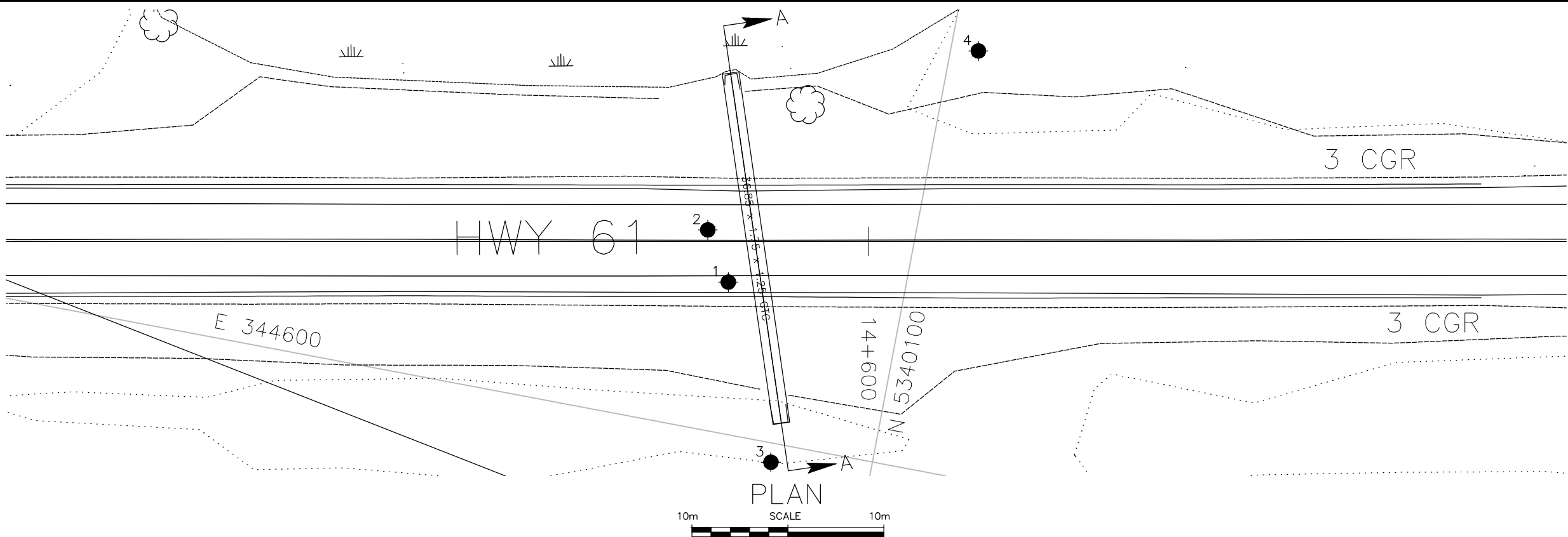
Reference No: 02109931

September 2022



CAD FILE LOCATION AND NAME: E:\152\Projects For Other Offices\02109931 - EDN, HYD & DSS - Hwy 61, 6012-E-0021 (05T)\Drawings\02109931 - 14+588.dwg
MODIFIED: 5/28/2022 5:57:20 PM BY: MTC/DU
DATE PLOTTED: 9/6/2022 1:39:07 AM BY:

PR-D-707 BR-03
MINISTRY OF TRANSPORTATION, ONTARIO



DISTRICT
CONT. No.
GWP No. 6176-15-00

REHABILITATION OF HWY 61
CULVERT REPLACEMENT
STATION ±14+588

BOREHOLE LOCATIONS
AND SOIL STRATIGRAPHY

SHEET
2

ENGLOBE

KEY PLAN
N.T.S.

N

DCPT

Water Level at Time of Investigation

Auger Refusal at Elevation

End of Sampling

Piezometer

Borehole

Blows/0.3 m (Std Pen Test, 475 J/blow)

Blows/0.3 m (60° Cone, 475 J/blow)

Auger Refusal at Elevation

End of Sampling

Piezometer

BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	269.9	4.2 m Rt	5340081.8	344584.4
2	269.9	1.2 m Lt	5340078.7	344576.4
3	332.2	23.0 m Rt	5340089.6	344602.0
4	332.6	19.8 m Lt	5340102.9	344555.9

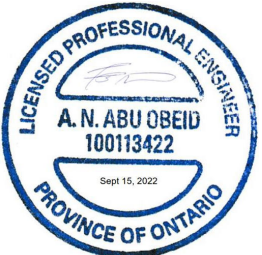
NOTES:
The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

Base plan and alignment provided in digital format by Aecom on July 27, 2021

Coordinates based on MTM Zone 15 NAD83 CSRS

GEOCRES No. 52A00-262

This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.



REVISIONS	NOV/21	DM	DRAFT				
	MAY/22	DM	REVISED DRAFT				
	SEP/22	DM	FINAL				
DESCRIPTION							
DESIGN	CHK	CODE	LOAD			DATE MAY/22	
DRAWN	DM	CHK	FS	SITE	STRUCT	SCHEME	DWG 2

Appendix B

Subsurface Data

Enclosure No. 1 List of Abbreviations and Symbols
Enclosure Nos. 2 to 7 Record of Borehole Sheets



ENGLOBE



LIST OF SYMBOLS AND DEFINITIONS FOR GEOTECHNICAL SAMPLING AND COMMON LITHOLOGIES

The following is a reference sheet for commonly used symbols and definitions within this report and in any figures or appendices, including borehole logs and test results. Symbols and definitions conform to the standard proposed by the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) wherever possible. Discrepancies may exist when comparing to third-party results using the Unified Soil Classification System (USCS).

PART A – SOILS

Standard Penetration Test (SPT) 'N'

The number of blows required to drive a 50-mm (2 in) split barrel sampler 300 mm (12 in). The standard hammer has a mass of 63.5 kg (140 lbs) and is dropped vertically from a height of 760 mm (30 in). Additional information can be found in ASTM D1586-11 and in §4.5.2 of the CFEM 4th Ed.

For penetration less than 300 mm, 'N' is recorded with the penetration that was achieved.

Non-Cohesive Soils

The relative density of non-cohesive soils relates empirically to SPT 'N' as follows:

Relative Density	'N'
Very Loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	> 50

Cohesive Soils

The consistency and undrained shear strength of cohesive soils relates empirically to SPT 'N' as follows:

Consistency	Undrained Shear Strength (kPa)	'N'
Very Soft	< 12	0 – 2
Soft	12 – 25	2 – 4
Firm	25 – 50	4 – 8
Stiff	50 – 100	8 – 15
Very Stiff	100 – 200	15 – 30
Hard	> 200	> 30

PART B – ROCK

The following parameters are used to describe core recovery and to infer the quality of a rockmass.

Total Core Recovery, TCR (%)

The total length of solid drill core recovered, regardless of the quality or length of the pieces, taken as a percentage of the length of the core run.

Solid Core Recovery, SCR (%)

The total length of solid, full-diameter drill core recovered, taken as a percentage of the length of the core run.

Rock Quality Designation, RQD (%)

The sum of the lengths of solid drill core greater than 100 mm long, taken as a percentage of the length of the core run. RQD is commonly used to infer the quality of the rockmass, as follows:

Rockmass Quality	RQD (%)
Very Poor	< 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	> 90

Weathering

The terminology used to describe the degree of weathering for recovered rock core is defined as follows, as suggested by the *Geological Society of London*:

Completely weathered: All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.

Highly weathered: More than half the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a discontinuous framework or as core stone.

Moderately weathered: Less than half the rock material is decomposed and/or disintegrates to soil. Fresh or discolored rock is present either as a continuous framework or as core stone.

Slightly weathered: Discoloration indicates weathering of rock material and discontinuity of surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than its fresh condition.

Fresh: No visible signs of weathering.

PART C – SAMPLING SYMBOLS

Symbol	Description
SS	Split spoon sample
TW	Thin-walled (Shelby Tube) sample
PH	Sampler advanced by hydraulic pressure
WH	Sampler advanced by static weight
SC	Soil core

PART D – IN-SITU AND LAB TESTING

SOIL NAMING CONVENTIONS

Particle sizes are described as follows:

Particle Size Descriptor		Size (mm)
Boulder		> 300
Cobble		75 – 300
Gravel	Coarse	19 – 75
	Fine	4.75 – 19
Sand	Coarse	2.0 – 4.75
	Medium	0.425 – 2.0
	Fine	0.075 – 0.425
Silt		0.002 – 0.075
Clay		< 0.002

The principle constituent of a soil is written in uppercase. The minor constituents of a soil are written according to the following convention:

Descriptive Term	Proportion of Soil (%)
Trace	1 – 10
Some	10 – 20
(ey) or (y)	20 – 35
And	35 – 50

Eg.: A soil comprising 65% Silt, 21% Sand and 14% Clay would be described as a: Sandy SILT, Some Clay

RECORD OF BOREHOLE No. 1

1 OF 2

METRIC

W.P. GWP 6176-15-00 LOCATION 14+585, 4.3 m Rt, Blake Twp. ORIGINATED BY RT
 DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DM
 DATUM Geodetic DATE 2021.10.25 - 2021.10.25 MTM Zone 15 344584.368 E 5340081.761 N
 LATITUDE 48.198302 LONGITUDE -89.46477 CHECKED BY FS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
265.0 0.0	FILL - SAND & GRAVEL - trace silt, brown, compact		1	AS		264							
	- trace clay		2	SS	34								
263.5 1.5	SAND - with gravel, silt, brown, compact to dense		3	SS	47	263							21 58 (21)
			4	SS	33	262							
			5	SS	22	261							
261.2 3.8	SILT - some clay, trace sand, brown, loose		6	SS	8	260							0 3 83 13
	- grey		7	SS	9	259							
	- cobbles		8	SS	9	258							
258.9 6.1	SILTY CLAY - some organics, very stiff		9	SS	9	257							
	- some sand, trace gravel		10	SS	17	256							
257.4 7.6	SILT - with clay, trace sand, grey, compact		11	SS	18	255							
	- and sand, brown/black		12	SS	22	254							
256.3 8.7	CLAY - brown/grey, stiff to firm		13	SS	19	253							
	- with sand, grey/red		14	SS	8	252							
	- trace sand, red		15	SS	5	251							
	- some silt, trace gravel, red/black												
	- and silt, trace silt, gravel, black, high plasticity												
252.8 12.2	SILT - some clay, trace gravel, dense to very dense		16	SS	34								
			17	SS	35								

Continued Next Page

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

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 14+588.GPJ ONTARIO MTO.GDT 22-4-6

METRIC







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

RECORD OF BOREHOLE No. 2

1 OF 2

METRIC

W.P. GWP 6176-15-00 LOCATION 14+583, 4.0 m Lt, Blake Twp. ORIGINATED BY RT
DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger / Wash Bore COMPILED BY DM
DATUM Geodetic DATE 2021.10.26 - 2021.10.26 MTM Zone 15 344576.43 E 5340078.651 N
LATITUDE 48.198274 LONGITUDE -89.464877 CHECKED BY FS

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								
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	WATER CONTENT (%)						
265.0 0.0	40 mm asphalt FILL - SAND - with gravel, silt, brown, dense		1	AS		264									23 52 (25)	
			2	SS	31											
			3	SS	36											
			4	SS	39											
	- compact		5	SS	19											
261.2 3.8	SILTY CLAY - trace sand, brown, damp, very stiff to stiff		6	SS	8	261										
	- trace organics, sand, grey		7	SS	7	260										
	- trace sand, gravel, damp		8	SS	4											
			9	SS	6	259										
			10	SS	17	258										
258.6 6.4	- with organics															
258.4 6.7	OGANICS - (250 mm), black															
	SILT - some clay, grey, dry, compact															
	- trace sand, gravel, red		11	SS	21	257										
	- with clay, red, high plasticity															
	- some clay, trace gravel		12	SS	70+	256								Spoon Bouncing Auger Refusal Start Wash Boring		
	- cobbles															
			13													
			14	SS	109	255										
			15	SS	50+	254										
252.8 12.2	GRAVEL - with sand, trace silt, brown, dense		16	SS	39	253								78 22 (0)		
							252									
251.3 13.7	SILTY SAND - brown, moist		17	SS	32	251										

Continued Next Page

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

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 14+588.GPJ ONTARIO MTO.GDT 22-4-6

RECORD OF BOREHOLE No. 2

2 OF 2

METRIC

W.P. GWP 6176-15-00 LOCATION 14+583, 4.0 m Lt, Blake Twp. ORIGINATED BY RT
 DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger / Wash Bore COMPILED BY DM
 DATUM Geodetic DATE 2021.10.26 - 2021.10.26 MTM Zone 15 344576.43 E 5340078.651 N
 LATITUDE 48.198274 LONGITUDE -89.464877 CHECKED BY FS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
249.8			18	SS	50+								Spoon Refusal
15.2	SILT - clayey, trace gravel, brown, wet, very dense to dense					249							
	- trace sand, gravel, gey, wet		19	SS	73	248							
						247							
			20	SS	49								
246.1													
18.9	End of Borehole at 18.9 m bgs												

RECORD OF BOREHOLE No. 3

1 OF 1

METRIC

W.P. GWP 6176-15-00 LOCATION 14+591, 21.0 Rt, Blake Twp. ORIGINATED BY MQ
 DIST Thunder Bay HWY 61 BOREHOLE TYPE Solid Stem Auger COMPILED BY DM
 DATUM Geodetic DATE 2021.11.09 - 2021.11.09 MTM Zone 15 344601.984 E 5340089.616 N
 LATITUDE 48.198371 LONGITUDE -89.464532 CHECKED BY FS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
259.8 0.0	100 mm organic soil SILT - some sand, trace clay, brown, dry - some clay, brown, dry, compact to very dense, medium plasticity - with clay, trace sand, gravel																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		</

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

RECORD OF BOREHOLE No. 4

1 OF 1

METRIC

W.P. GWP 6176-15-00 LOCATION 14+608, 22.0 Lt, Blake Twp. ORIGINATED BY MQ
 DIST Thunder Bay HWY 61 BOREHOLE TYPE Solid Stem Auger COMPILED BY DM
 DATUM Geodetic DATE 2021.11.10 - 2021.11.10 MTM Zone 15 344555.871 E 5340102.865 N
 LATITUDE 48.198493 LONGITUDE -89.465151 CHECKED BY FS

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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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260.4 0.0	100 mm organic soil SILT - some clay, trace sand, gravel, brown, dry, compact to dense - trace gravel - some sand, clay, trace gravel - some sand		1	AS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

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

Appendix C

Borehole Plan and Laboratory Data

Figure No. L-1: Fill: Silt and Sand Grain Size Distribution Curve

Figure No. L-2: Fill: Silty Sand Grain Size Distribution Curve

Figure No. L-3: Fill: Silt and Clay Grain Size Distribution Curve

Figure No. L-4: Fill: Sand Grain Size Distribution Curve

Figure No. L-5: Silt Grain Size Distribution Curve

Figure No. L-6: Silt Grain Size Distribution Curve

Figure No. L-7: Sandy Silt Grain Size Distribution Curve

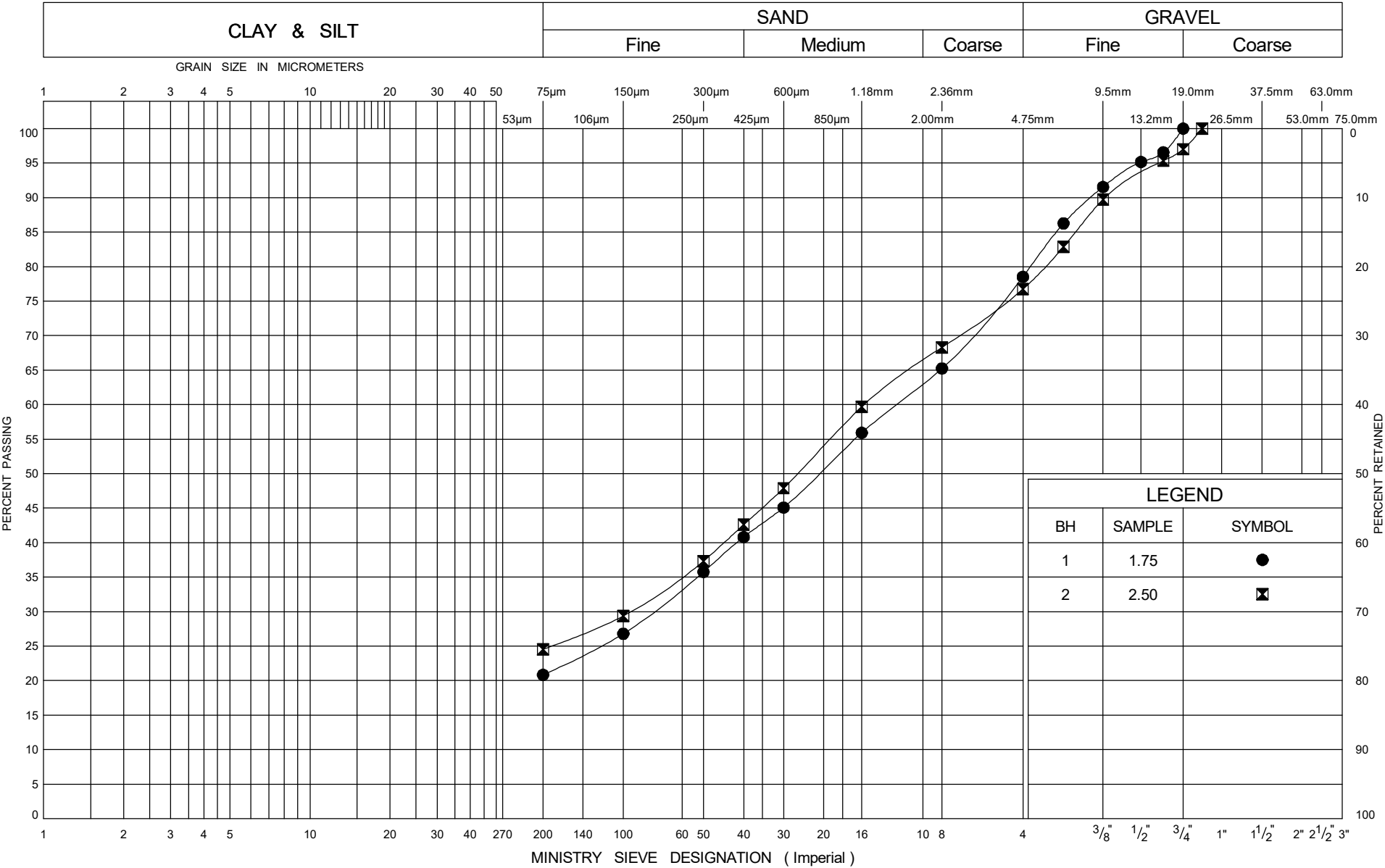
Figure No. L-8: Atterberg Limits Summary

Chemical Test Results



eNGLOBE

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

FILL - SAND

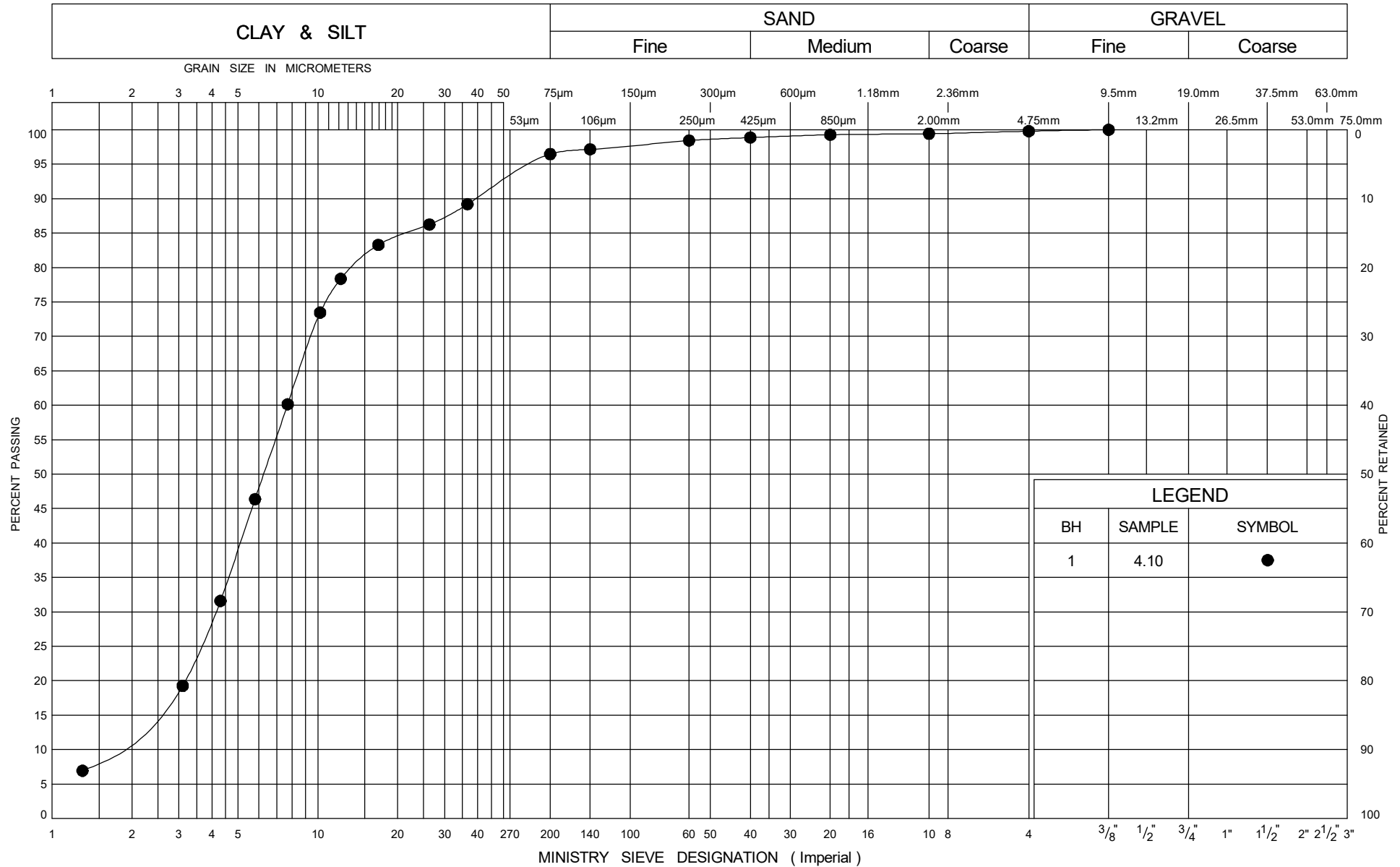
Figure: L-1

GWP 6176-15-00

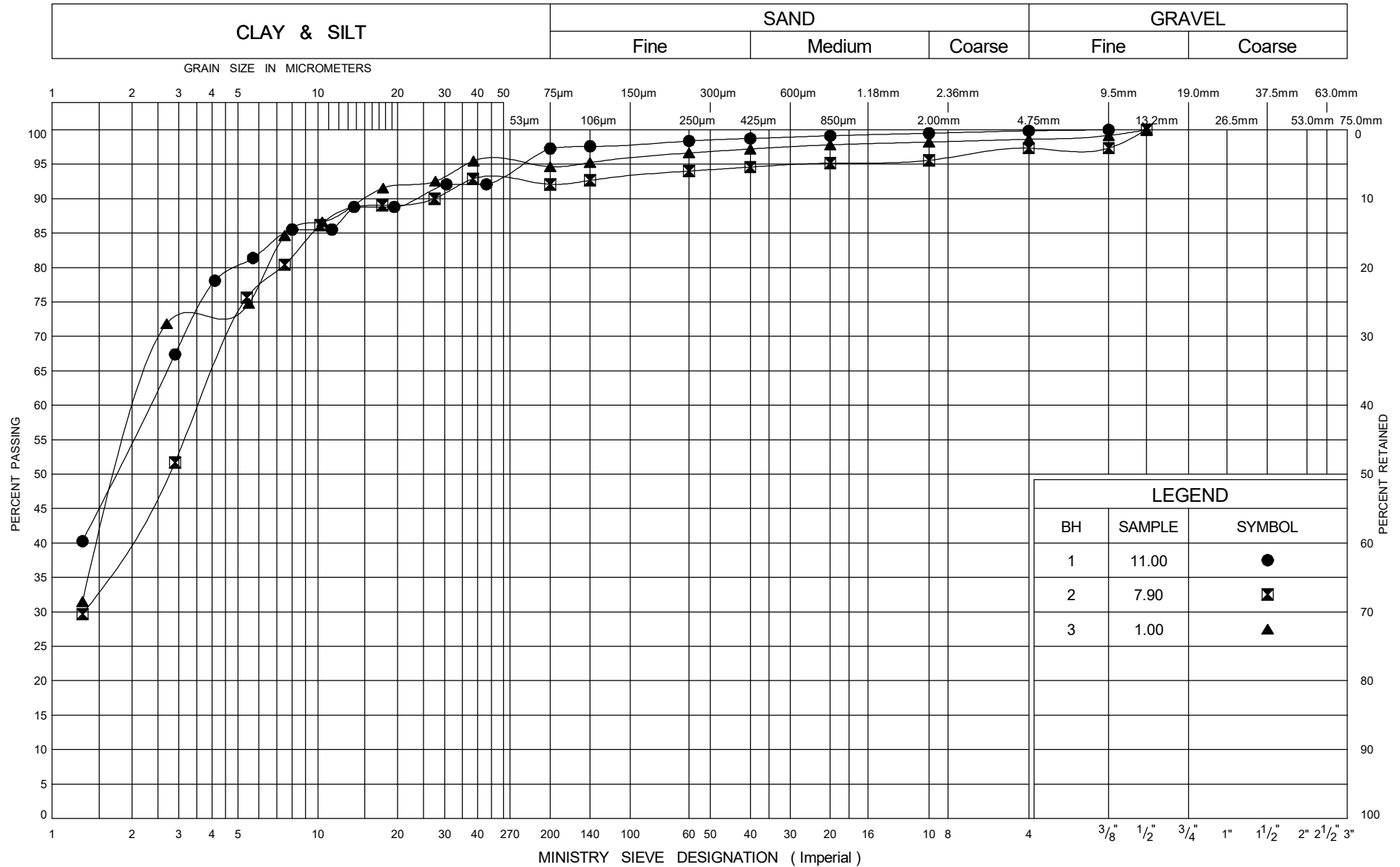
Highway 61, NWR



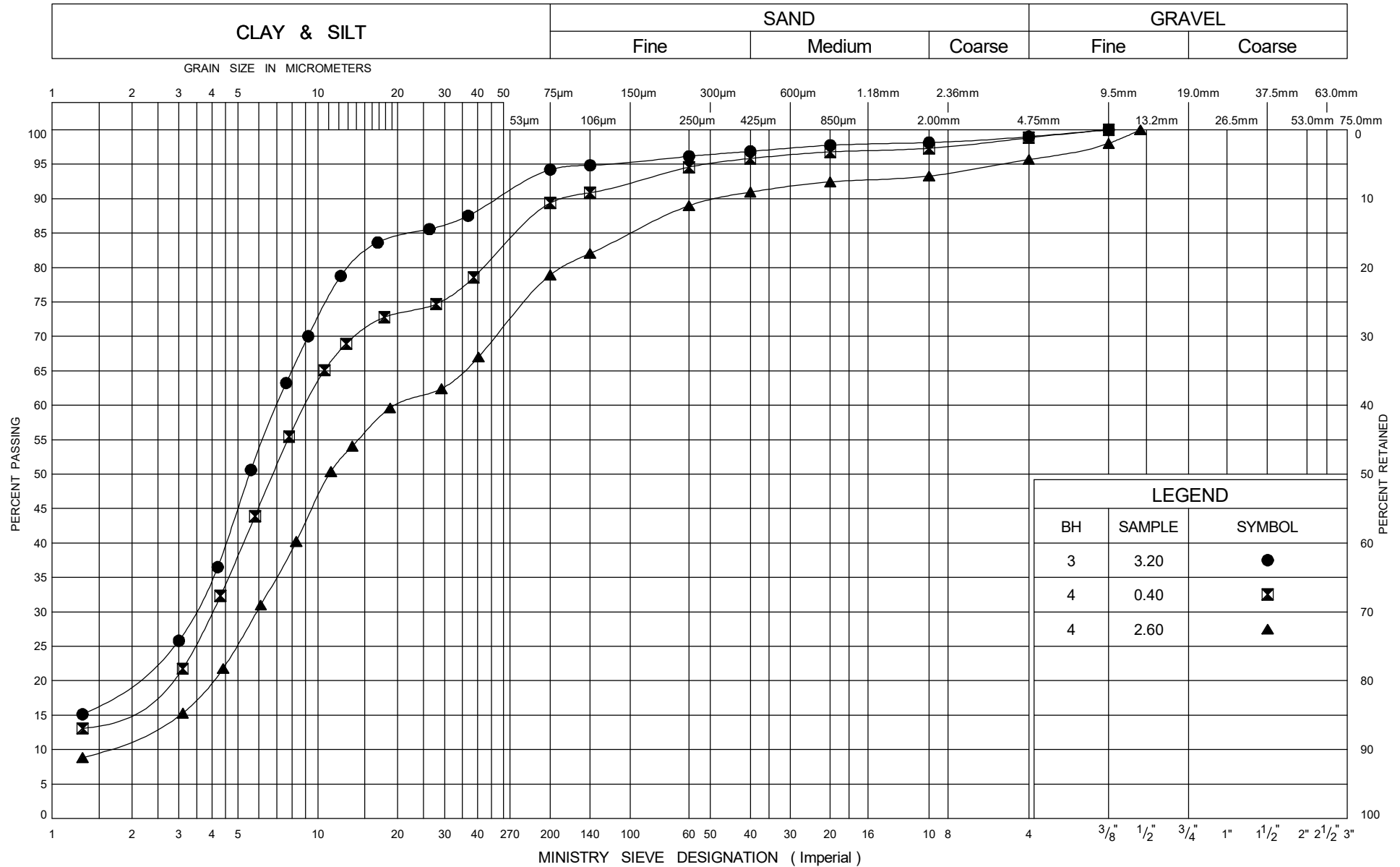
UNIFIED SOIL CLASSIFICATION SYSTEM



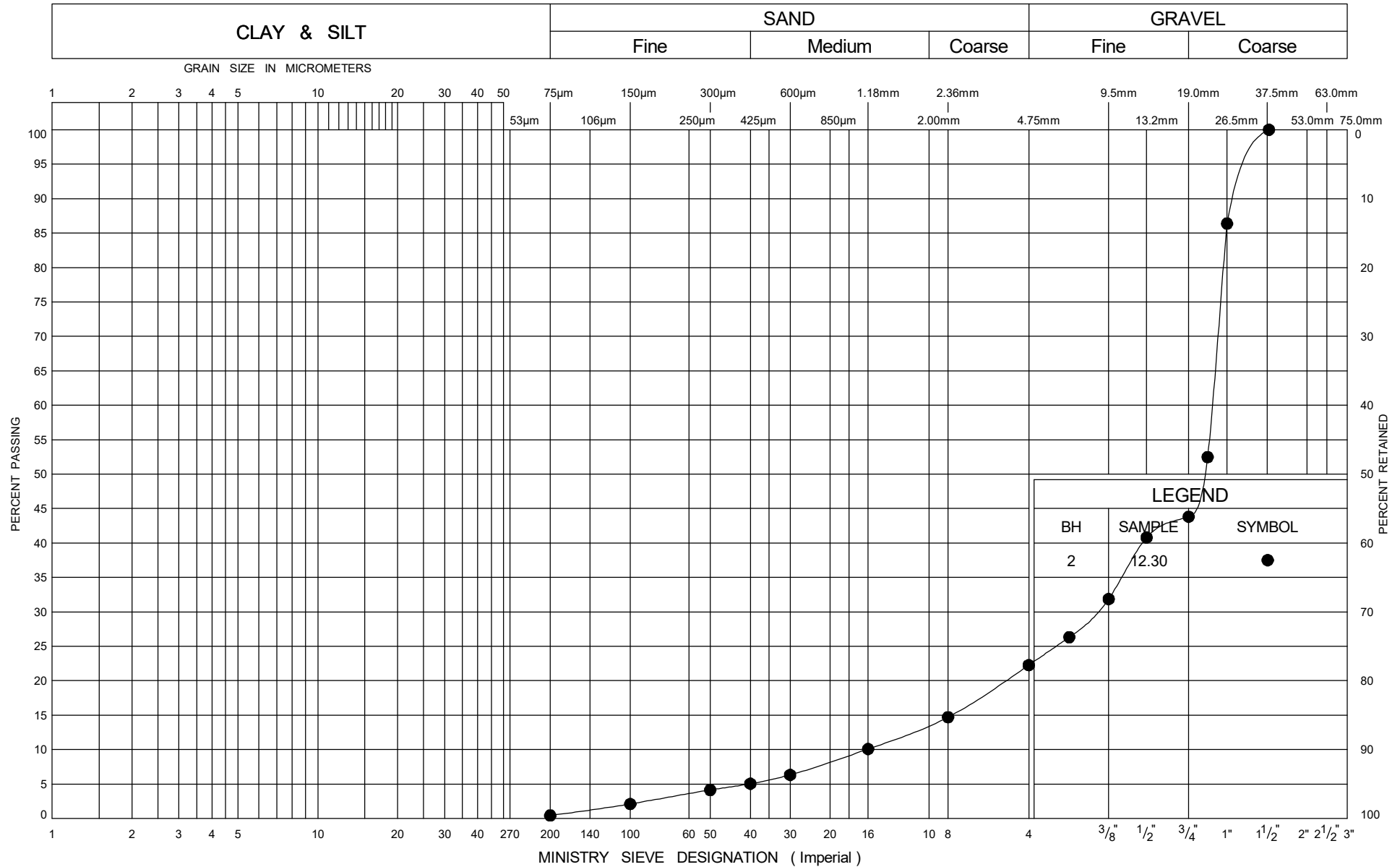
UNIFIED SOIL CLASSIFICATION SYSTEM



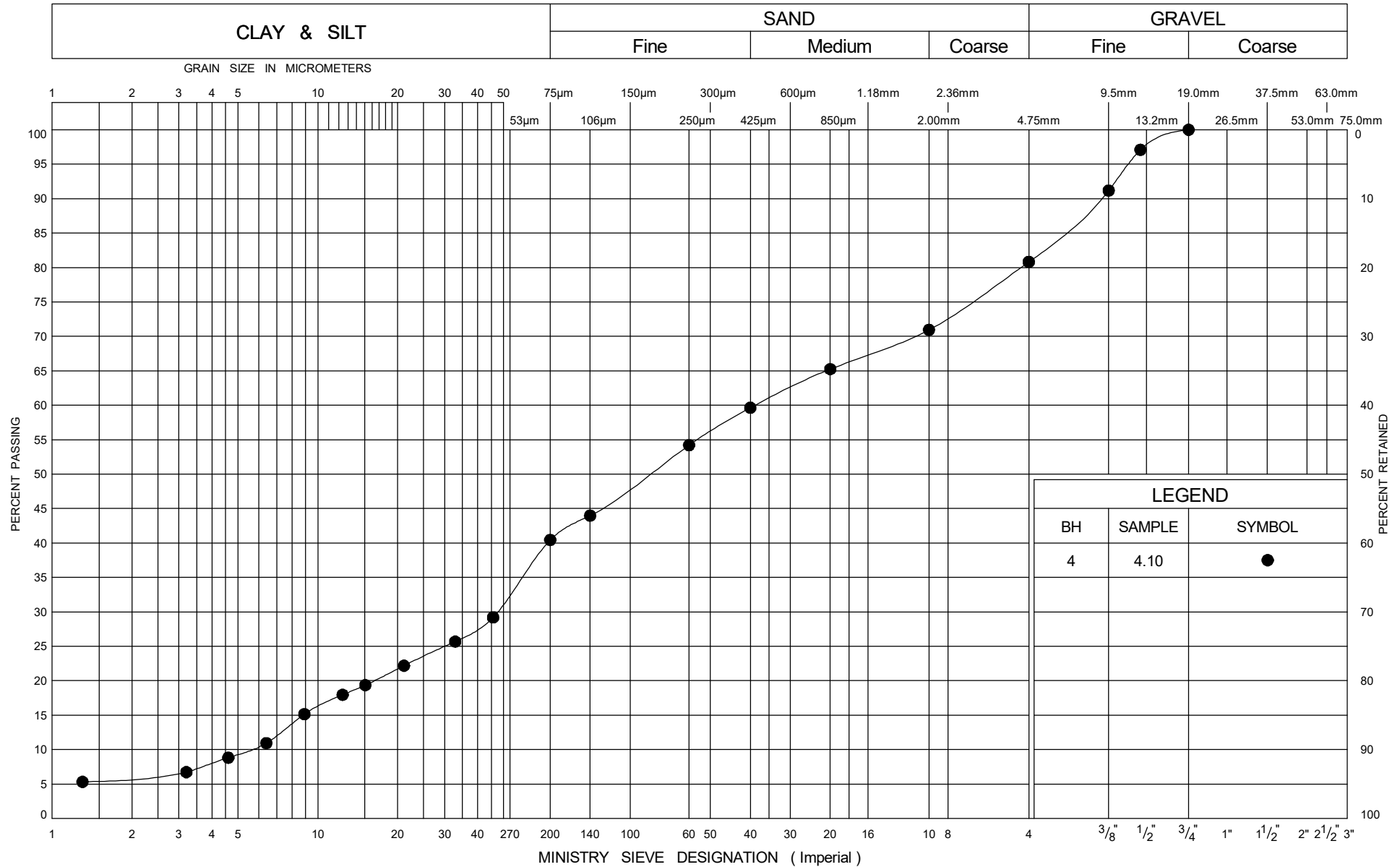
UNIFIED SOIL CLASSIFICATION SYSTEM



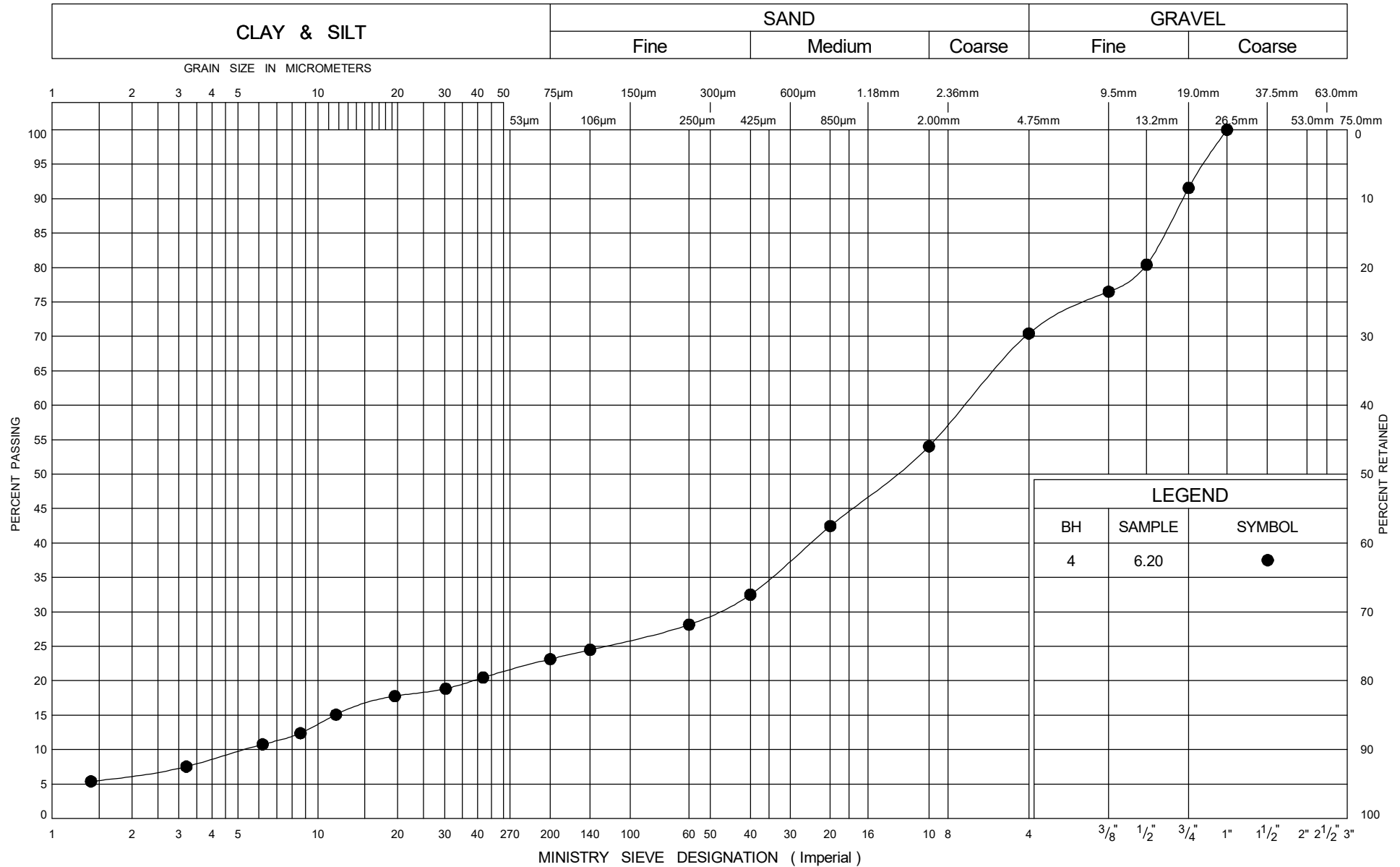
UNIFIED SOIL CLASSIFICATION SYSTEM



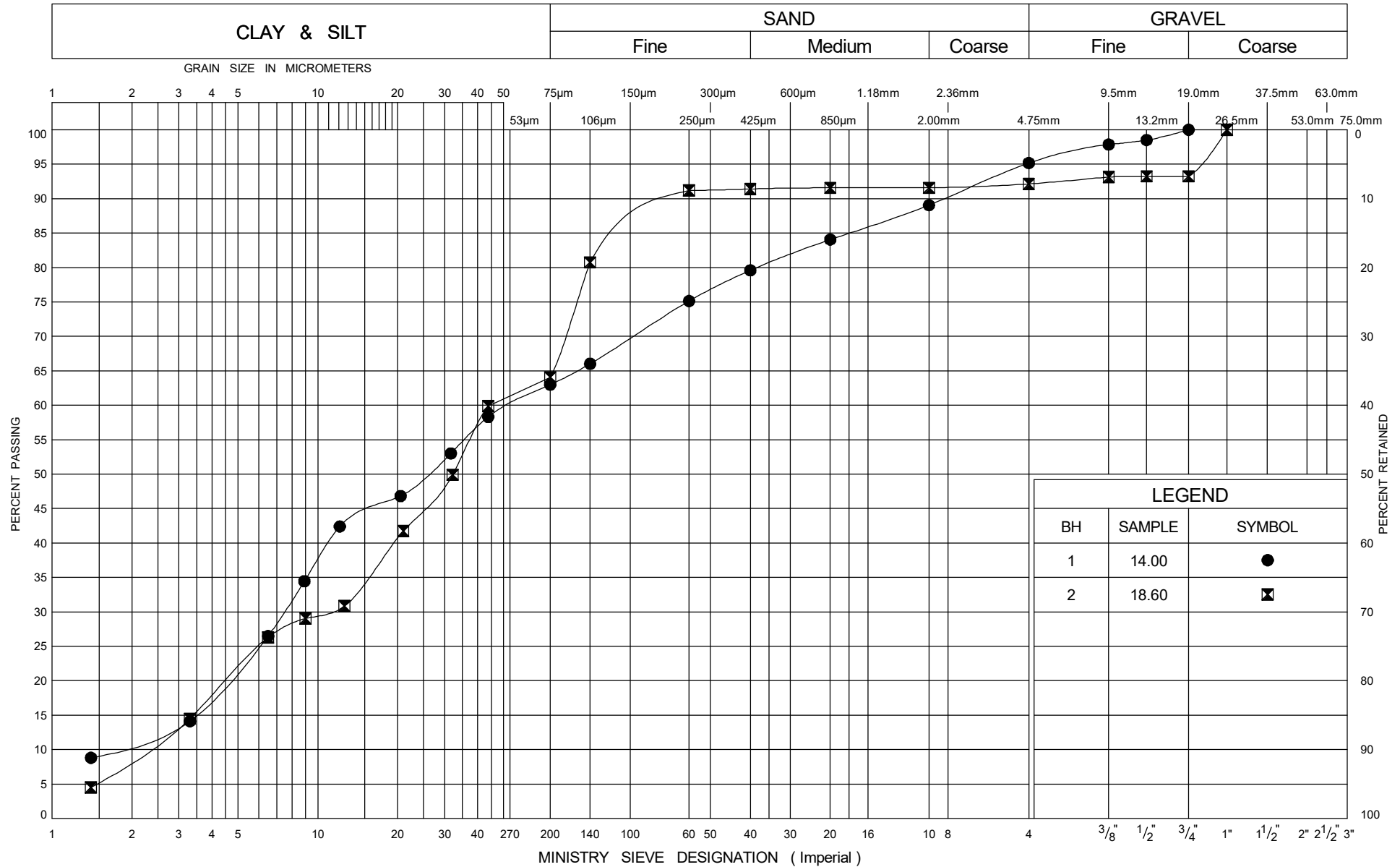
UNIFIED SOIL CLASSIFICATION SYSTEM

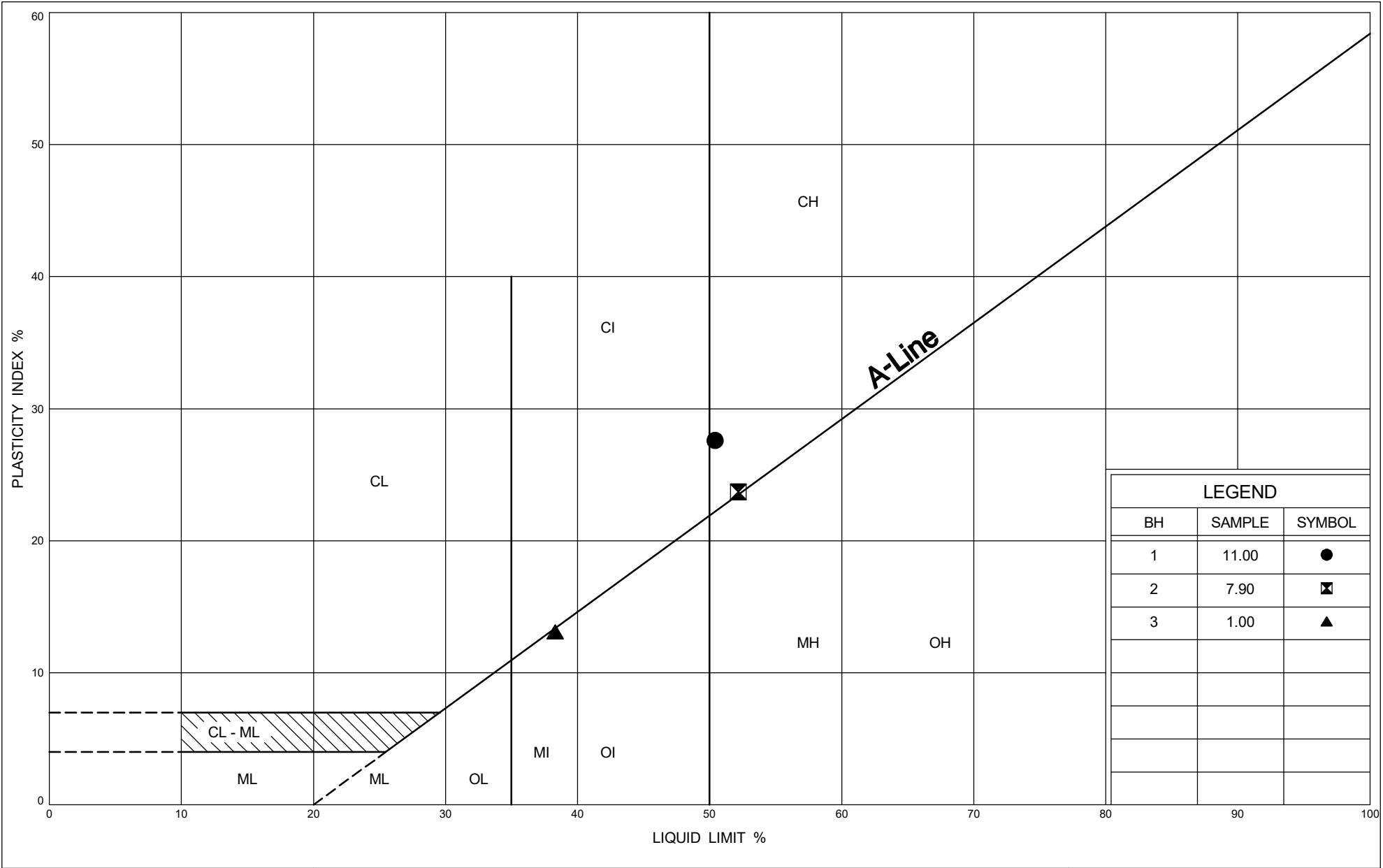


UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM







Your Project #: 2109931
Site Location: HIGHWAY 61, NEEBING, ON
Your C.O.C. #: na

Attention: Diana McKay

DST Consulting Engineers Inc
Thunder Bay - Standing Offer
605 Hewitson Street
Thunder Bay, ON
CANADA P7B 5V5

Report Date: 2022/01/07
Report #: R6953568
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1Z7709

Received: 2021/11/29, 12:17

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	4	2021/12/06	2021/12/06	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	4	2021/12/03	2021/12/03	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	4	2022/01/07	2021/12/02	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	4	2021/12/21	2022/01/07	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	4	2021/12/03	2022/01/06	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas 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 Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas 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.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas 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 Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas 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 Bureau Veritas, 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 #: 2109931
Site Location: HIGHWAY 61, NEEBING , ON
Your C.O.C. #: na

Attention: Diana McKay

DST Consulting Engineers Inc
Thunder Bay - Standing Offer
605 Hewitson Street
Thunder Bay, ON
CANADA P7B 5V5

Report Date: 2022/01/07
Report #: R6953568
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1Z7709

Received: 2021/11/29, 12:17

Encryption Key

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

Deepthi Shaji, Project Manager

Email: Deepthi.Shaji@bureauveritas.com

Phone# (905)817-5700 Ext:7065843

=====

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.



BUREAU
VERITAS

Bureau Veritas Job #: C1Z7709

Report Date: 2022/01/07

DST Consulting Engineers Inc

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING, ON

Sampler Initials: RT

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		RK0370			RK0370			RK0371		
Sampling Date		2021/10/15 14:00			2021/10/15 14:00			2021/10/23 09:30		
COC Number		na			na			na		
	UNITS	20+375 BH2, S#15	RDL	QC Batch	20+375 BH2, S#15 Lab-Dup	RDL	QC Batch	20+040 BH1, S#10	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	1500		7746098				780		7746098
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Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	180	20	7764954	170	20	7764954	490	20	7764954
Conductivity	mS/cm	0.661	0.002	7770495				1.28	0.002	7770495
Available (CaCl2) pH	pH	7.17		7770243				7.63		7770243
Soluble (20:1) Sulphate (SO4)	ug/g	300	20	7760268	310	20	7760268	670	20	7760268

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas ID		RK0372	RK0373		
Sampling Date		2021/10/25 11:50	2021/10/28 13:30		
COC Number		na	na		
	UNITS	14+588 BH1, S#15	26+418 BH2, S#10	RDL	QC Batch
Calculated Parameters					
Resistivity	ohm-cm	2300	2100		7746098
Inorganics					
Soluble (20:1) Chloride (Cl-)	ug/g	260	270	20	7764954
Conductivity	mS/cm	0.439	0.469	0.002	7770495
Available (CaCl2) pH	pH	5.13	7.21		7770243
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	20	7760268
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					



BUREAU
VERITAS

Bureau Veritas Job #: C1Z7709
Report Date: 2022/01/07

DST Consulting Engineers Inc
Client Project #: 2109931
Site Location: HIGHWAY 61, NEEBING , ON
Sampler Initials: RT

TEST SUMMARY

Bureau Veritas ID: RKO370
Sample ID: 20+375 BH2, S#15
Matrix: Soil

Collected: 2021/10/15
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7764954	2021/12/06	2021/12/06	Alina Dobreanu
Conductivity	AT	7770495	2021/12/03	2021/12/03	Kien Tran
pH CaCl2 EXTRACT	AT	7770243	2021/12/02	2021/12/02	Taslina Aktar
Resistivity of Soil		7746098	2022/01/07	2022/01/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7760268	2021/12/03	2022/01/06	Avneet Kour Sudan

Bureau Veritas ID: RKO370 Dup
Sample ID: 20+375 BH2, S#15
Matrix: Soil

Collected: 2021/10/15
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7764954	2021/12/06	2021/12/06	Alina Dobreanu
Sulphate (20:1 Extract)	KONE/EC	7760268	2021/12/30	2022/01/06	Avneet Kour Sudan

Bureau Veritas ID: RKO371
Sample ID: 20+040 BH1, S#10
Matrix: Soil

Collected: 2021/10/23
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7764954	2021/12/06	2021/12/06	Alina Dobreanu
Conductivity	AT	7770495	2021/12/03	2021/12/03	Kien Tran
pH CaCl2 EXTRACT	AT	7770243	2021/12/02	2021/12/02	Taslina Aktar
Resistivity of Soil		7746098	2022/01/07	2022/01/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7760268	2021/12/03	2022/01/06	Avneet Kour Sudan

Bureau Veritas ID: RKO372
Sample ID: 14+588 BH1, S#15
Matrix: Soil

Collected: 2021/10/25
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7764954	2021/12/06	2021/12/06	Alina Dobreanu
Conductivity	AT	7770495	2021/12/03	2021/12/03	Kien Tran
pH CaCl2 EXTRACT	AT	7770243	2021/12/02	2021/12/02	Taslina Aktar
Resistivity of Soil		7746098	2022/01/07	2022/01/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7760268	2021/12/03	2022/01/06	Avneet Kour Sudan

Bureau Veritas ID: RKO373
Sample ID: 26+418 BH2, S#10
Matrix: Soil

Collected: 2021/10/28
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7764954	2021/12/06	2021/12/06	Alina Dobreanu
Conductivity	AT	7770495	2021/12/03	2021/12/03	Kien Tran
pH CaCl2 EXTRACT	AT	7770243	2021/12/02	2021/12/02	Taslina Aktar
Resistivity of Soil		7746098	2022/01/07	2022/01/07	Automated Statchk



BUREAU
VERITAS

Bureau Veritas Job #: C1Z7709
Report Date: 2022/01/07

DST Consulting Engineers Inc
Client Project #: 2109931
Site Location: HIGHWAY 61, NEEBING , ON
Sampler Initials: RT

TEST SUMMARY

Bureau Veritas ID: RKO373
Sample ID: 26+418 BH2, S#10
Matrix: Soil

Collected: 2021/10/28
Shipped:
Received: 2021/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	7760268	2021/12/03	2022/01/06	Avneet Kour Sudan



BUREAU
VERITAS

Bureau Veritas Job #: C1Z7709

Report Date: 2022/01/07

DST Consulting Engineers Inc

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING , ON

Sampler Initials: RT

GENERAL COMMENTS

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

Package 1	16.7°C
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Results relate only to the items tested.



**BUREAU
VERITAS**

Bureau Veritas Job #: C1Z7709

Report Date: 2022/01/07

QUALITY ASSURANCE REPORT

DST Consulting Engineers Inc

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING , ON

Sampler Initials: RT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7760268	Soluble (20:1) Sulphate (SO ₄)	2022/01/06	112	70 - 130	99	70 - 130	<20	ug/g	1.9	35
7764954	Soluble (20:1) Chloride (Cl ⁻)	2021/12/06	93	80 - 120	107	80 - 120	<20	ug/g	6.0	35
7770243	Available (CaCl ₂) pH	2021/12/02			100	N/A				
7770495	Conductivity	2021/12/03			99	90 - 110	<0.002	mS/cm		

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.



BUREAU
VERITAS

Bureau Veritas Job #: C1Z7709

Report Date: 2022/01/07

DST Consulting Engineers Inc

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING , ON

Sampler Initials: RT

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Brad Newman, B.Sc., C.Chem., Scientific Service 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.



6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/6

CHAIN OF CUSTODY RECORD

Page ____ of ____

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required	
Company Name: DST Consulting Engineers	Company Name: DST Consulting Engineers	Quotation #:	<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS		
Contact Name: Accounts Payable	Contact Name: Diana McKay	P.O. #/ AFE#:			Rush TAT (Surcharges will be applied)		
Address: 605 Hewitson St.	Address: same	Project #:	2109931		<input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days		
Phone: _____ Fax: _____	Phone: _____ Fax: _____	Site Location: Highway 61, Neebing Ontario			Date Required:		
Email: ap@dstgroup.com	Email: dmckay@dstgroup.com	Site #:			Rush Confirmation #:		
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS LABORATORIES' DRINKING WATER CHAIN OF CUSTODY		Site Location Province: Ontario			LABORATORY USE ONLY		
Regulation 153		Other Regulations		Analysis Requested		CUSTODY SEAL Y / N	
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw				Present Intact	
<input checked="" type="checkbox"/> Table 2 <input checked="" type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse		<input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw				N N/A 16/17/17	
<input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other		<input type="checkbox"/> PWQO <input type="checkbox"/> Region _____				Y M	
<input type="checkbox"/> Table _____		<input type="checkbox"/> Other (Specify) _____				COOLING MEDIA PRESENT: Y / <input checked="" type="checkbox"/> N	
FOR RSC (PLEASE CIRCLE) Y / N		<input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED)				COMMENTS	
<input type="checkbox"/> REG 406 Table _____		<input type="checkbox"/> REG 406 Table _____					
Include Criteria on Certificate of Analysis: Y / N		SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS					
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / Cr / V	DO NOT ANALYZE
1	20+375 BH2, S#15	2021/10/15	14:00	Soil	1		
2	20+040 BH1, S#10	2021/10/23	9:30	Soil	1		
3	14+588 BH1, S#15	2021/10/25	11:50	Soil	1		
4	26+418 BH2, S#10	2021/10/28	13:30	Soil	1		
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)
Ron Morrison		Nov. 29/21	10:17	James Klapperich		2021/11/29	12:17
						12/11/30	0859

Rec'd In Thunder Bay

M1129-160

SPJ

ENV-1560

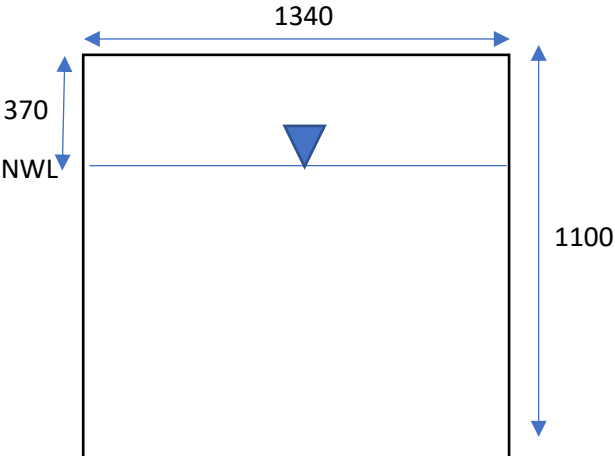
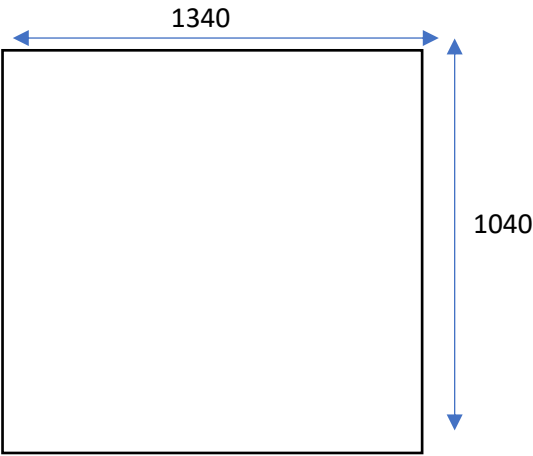
C12 7709

Appendix D
Culvert Inspection Report
(as provided by Gannett Fleming)



eNGLOBE

FIELD INSPECTION FORM

A. GENERAL INFORMATION			
Project #	6176-15-00 - Highway 61	Project Description	From 0.5km north of Jarvis Bay Road to 0.4km South of Hwy 130
Date	October 5, 2021	Weather Conditions	Sunny
Inspector 1	David Jackson	Inspector 2 /Reviewer	-
B. CULVERT ID / LOCATION			
Culvert ID	C26	Chainage	14+588
UTM Easting	344581.0742	UTM Northing	5340082.0008
Description	South of the Copper Cliff Road & Highway 61 intersection		
C. STRUCTURE DETAILS			
Material – CTC			
Dimensions – 1340 X 1100 US / 1340 x 1040 DS			
Clearance (soffit to normal water level) – 370mm / N/A			
High Water Mark (on structure) – N/A			
Structures (U/S / D/S of Crossing) – N/A			
Debris – US filled			
D. ENVIRONMENTAL CONDITIONS			
Watercourse Type and Creek Material – Dry on US, Pond DS			
Bank Conditions (stability) – Stable			
Channel Dimensions (width and depth) – No channel (wide open) US / 2m, 3:1, dry DS			
Observed Flow Conditions (ephemeral/permanent) – Permanent			
E. SITE CONDITIONS			
Road Condition (sag, settlement, etc.) – OK			
Physical Culvert Condition (rust, damage, etc.) – Filled in and failing structure			
Culvert Appearance (general comments) – Replace			
Site Sketch – <div style="display: flex; justify-content: space-around; align-items: flex-end; margin-top: 20px;"> <div style="text-align: center;">  <p>U/S</p> </div> <div style="text-align: center;">  <p>D/S</p> </div> </div>			

Creosote Timber Box Culvert (Culvert #26) @ 14+588

C26 - #1 – Upstream Channel Conditions



C26 - #2 – Upstream Face of the Culvert



C26 - #3 – Downstream Channel Conditions



C26 - #4 – Downstream Face of the Culvert

