

# Foundation Investigation Report (FIR)

Highway 61 Culvert Replacement

Station 20+200, Township of Blake

Gannett Fleming

Ontario Ministry of Transportation (MTO)

GWP 6176-15-00

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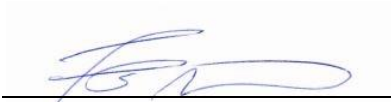


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# Gannett Fleming

## GWP 6176-15-00

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# 1

## 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 (C8) at approximate Station 20+200 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. 52A-268).

# 2

## 2 Site Description

The existing 53.53 m long culvert structure (C8) is a Corrugated Steel Pipe (CSP) culvert crossing Highway 61 at approximate Station 20+200, approximately 220 m north of Blake Hall 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 15.5 m wide (including shoulders) and up to approximately 8.5 m in height above the crown of the culvert, with the centreline of the roadway at an approximate elevation 234.4 m at the culvert location. The pavement surface is generally in good to fair condition with some transvers cracks across the asphalt surface. The topography of the surrounding area varies in the vicinity of the crossing. 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 50 m to the north of the culvert crossing.

The existing culvert structure is crossing Highway 61 at almost an approximate 20° skewed alignment from east (upstream) to west (downstream). The existing culvert structure is 1400 mm wide and 1375 mm high at the upstream and 1400 mm wide and 1140 mm 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 culvert edges extend out beyond the embankment without wing walls. The channel dimensions were described by GF in general as 1 m wide channel with banks at 2H:1V and water depth of 50 mm upstream (US) and downstream (DS). The top of the culvert elevations at the inlet and outlet are El. 226.7 and El. 225.1 m, respectively with clearance of 1325 mm and 1140 mm (i.e. dry), respectively. Flow through the culvert is from east/right (Rt) to the west/left (Lt) as shown on Drawing No. 2 in Appendix A.

## 2.1 Site Physiography and Surficial Geology

Based on published Northern Ontario Geology Terrain Study (NOEGTS) of the general area by D.G. Mollard, and J.D. Mollard (1983), the Site is located within the Glaciolacustrine Plain with native overburden/sediments within the immediate project area consisting mainly of silt and sandy soil deposits (mLP and sLP).

Sediments in Glaciolacustrine Plains consist of varved and massive, fine grained materials deposited in glacial lake basins of varying size and depth. These sediments deposited into glacial lakes which inundated large parts of the Thunder Bay area. Glaciolacustrine silt deposits (mLP) with clay contents may have high water retention capacity, low permeability, and poor internal drainage. These characteristics are largely controlled by a network of closely spaced joints. Generally, these landforms possess low density, low bearing strength, and moderate to high compressibility, unless the fine-grained sediments have been consolidated by the weight of overriding glacier ice or by the effects of desiccation. Lacustrine sand plains (sLP) contain mostly fine and medium sand with minor silt. Coarse sand, gravel, cobbles, boulders, and till are rare in these deposits. A high-water table may occur at sites located some distance from the groundwater lowering effects of deep valleys and ravines. Sandy lacustrine materials are typically nonplastic and have high permeability, low compressibility, moderate to high bearing capacity, and high shear strength. They are generally not frost susceptible unless they contain significant amounts of silt and very fine sand.

Bedrock plateaus (RL) and Bedrock knob landscape (RN) occur within the township of Blake. Areas mapped as bedrock plateau (RL) contain bold mesa-like features that have a capping of resistant rock consisting of eroded remnants of Proterozoic diabase sheets. The surface aspect of mesas and plateaus varies from nearly level to moderately sloping. Cliffs around part or all of these elevated features are strewn with coarse talus debris. Bedrock knob landscape (RN) is characterized by an irregular bedrock surface having complex multiple slopes of varying steepness. The cover of glacial deposits overlying the bedrock knobs is generally thin and discontinuous. Much of the glacial overburden consists of bouldery, sand-rich till that was transported only a short distance by the ice.

# 3

## 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 May 11 and August 2, 2022 and consisted of two boreholes on the roadway extending to a maximum depth of 21.0 m below existing ground/road surface (mbgs) and two boreholes off the roadway at the culvert inlet and outlet extending to a maximum depth of 8.8 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). 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 A and are provided in the Table below.

**Table 1 Borehole Locations**

Borehole No.	Borehole Location (MTM Nad 83)		Borehole Location (Geographic)		
1	N 5345443	E 343175	Lat: 48.24660°	Long: - 89.48325°	EL. 234.2 m
2	N 5345439	E 343165	Lat: 48.24658°	Long: - 89.48338°	EL. 234.6 m
3	N 5345442	E 343201	Lat: 48.24660°	Long: - 89.48290°	EL. 227.9 m
4	N 5345451	E 343141	Lat: 48.24668°	Long: - 89.48370°	EL. 226.6 m

BH Nos. 1 and 2 were advanced using a hallow 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 and tripod.

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). 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. The 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.

# 4

## Laboratory Investigation

All soil and rock samples obtained during the investigation were transported to Englobe Laboratory in Thunder 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 subjected 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 included 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-7).

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.

# 5

## 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	0.05 (El. 234.2)	0.09 (El. 234.6)	--	--
Embankment Fill: Loose to Compact Sand, some silt to silty, trace gravel	0.05 - 5.3 (El. 234.1 - 228.9)	0.09 - 6.4 (El. 234.5 - 228.2)	--	--
Embankment Fill: Firm to Very Stiff Silty Clay, trace to some sand, trace wood fragments	5.3 - 8.4 (El. 228.9 - 225.8)	6.4 - 13.0 (El. 228.2 - 221.6)	--	--
Embankment Fill: Loose Sand, some Silt, trace Gravel, trace Clay, wood fragments	8.4 - 9.1 (El. 225.8 - 225.1)	--	--	--
Embankment Fill: Stiff Silty Clay	9.1 - 11.4 (El. 225.1 - 222.8)	--	--	--
Native: Firm to Stiff Silty Clay, trace Sand, trace wood fragments, trace organics	11.4 - 20.4 (El. 222.8 - 213.8)	--	2.3 - 5.3 (El. 225.6 - 222.6)	--

Deposit/Layer Description	Depths/Elevations (m)			
	Borehole No. 1	Borehole No. 2	Borehole No. 3	Borehole No. 4
Native: Very Loose to Compact Clayey Silt, trace to some Sand, trace organics, trace wood fragments	--	13.0 - 16.8 (El. 221.6 - 217.8)	0 - 2.3 (El. 227.9- 225.6) 5.3 - 8.8 (El. 222.6 - 219.1)	0 - 3.8 (El. 226.6 - 222.8)
Native: Loose to Compact Sandy Silt to Silty Sand, some Gravel, trace Clay	20.4 - 21.0 (El. 213.8 - 213.2)	16.8 - 20.4 (El. 217.8 - 214.2)	--	3.8 - 4.9 (El. 222.8 - 221.7)

## 5.1 Asphalt

A thin layer of approximate 50 to 85 mm asphalt was encountered in both BH Nos. 1 and 2 which were drilled on the shoulders through the embankment.

## 5.2 Embankment Fill

The encountered embankment fill materials underlying the asphalt layer in Borehole Nos. 1 and 2 extended down to 11.4 and 13.0 mbgs, respectively (El. 228.2 to 221.6 m, respectively). The embankment fill materials varied in composition with depth.

The asphalt layer was directly underlain by a sand fill layer consisting mainly of brown sand, some silt to silty, trace gravel. The sand fill extended to approximate depth of 5.3 mbgs (El. 228.9 m) in BH No. 1 and 6.4 mbgs (El. 228.2 m) in BH No. 2. This sand fill layer was almost dry with approximate moisture content of 8% measured in the geotechnical laboratory. Three representative samples from this sand layer underwent grain size analysis and the results are summarized in Table 3 and provided in Figure No. L-3, Appendix C.

**Table 3 Particle Size Distribution Results of the Sand Fill**

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1 / SS-5	3.1 (231.1)	7	68	24		SM
BH No. 2 / SS-2	0.9 (233.7)	5	82	13		SM
BH No. 2 / SS-6	3.9 (230.7)	7	63	25	4	SM

The sand fill layer was generally loose to compact, based on recorded SPT 'N' values ranging from 4 to 27 blows/300 mm

Below the sand fill layer in both boreholes, a 3.1 to 6.6 m thick firm to very stiff silty clay fill layer was encountered between El. 228.9 and 225.8 m in BH No. 1 and between El. 228.2 and 221.6 m in BH No. 2. This silty clay fill layer was observed to be brown/grey and moist. Below this silty clay fill layer, a 0.7 m thick loose sand fill layer was encountered between El. 225.8 and El. 225.1 m in BH No. 1. This sand fill layer was observed to be brown and wet. Underlying this sand fill layer, a 2.3 m thick stiff lower silty clay fill layer was encountered between El. 225.1 and 222.8 m. This lower silty clay fill layer was observed to be brown/grey and moist. The silty clay fill layer contained trace wood fragments in BH No. 2.

The results for grain size analyses and Atterberg limits (Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI)) of four (4) representative soil samples of the upper silty clay fill layer are summarized in Table 4 and presented on Figure Nos. L-1 and L-4 in Appendix C.

**Table 4 Particle Size Distribution and Atterberg Limit Results of the Silty Clay Fill**

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-9	6.3 (227.9)	0	1	50	49	44	26	18	39	CI
BH No. 2/SS-9B	6.4 (228.2)	0	15	37	49	--	--	--	37	CI
BH No. 2/SS-11	7.8 (226.8)	0	1	53	45	45	26	19	34	CI
BH No. 2/SS-15	10.9 (223.8)	0	3	51	47	48	29	19	29	CI

The upper silty clay fill layer was generally soft to very stiff, based on recorded SPT 'N' values ranging from 4 to 19 blows/300 mm.

As indicated above, the upper silty clay fill layer in BH No. 1 was underlain by sand fill deposit approximately 0.7 m thick and extending to a maximum depth of 9.1 mbgs (EL. 225.1 m). The sand deposit included different portions of gravel, silty clay and was observed to be brown and wet with an approximate moisture content of 16% measured in the geotechnical laboratory. The sand fill layer also contained wood fragments.

A representative soil sample from this sand fill layer was subjected to grain size analysis and the results are summarized in Table 5 and provided in Figure No. L-3, Appendix C.

**Table 5 Particle Size Distribution Results of the Sand Fill**

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1/SS-12	8.5 (225.7)	7	71	16	6	SP - SM

The sand fill layer was generally loose, based on recorded SPT 'N' value of 6 blows/300 mm.

As indicated above, the sand layer in BH No. 1 was underlain by a lower silty clay fill deposit approximately 2.3 m thick and extending to a maximum depth of 11.4 mbgs (EL. 222.8 m). The silty clay layer was observed to be brown/grey and moist with an approximate moisture content of 34% measured in the geotechnical laboratory.

A representative soil sample from this lower silty clay fill layer was subjected to grain size analysis and Atterberg limits and the results are summarized in Table 6 and provided in Figure Nos. L-1 and L-4, Appendix C.

**Table 6 Particle Size Distribution and Atterberg Limit Results of the Lower Silty Clay Fill**

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	10.9 (275.8)	0	8	51	41	48	26	22	34	CI

The lower silty clay fill layer was generally stiff, based on recorded SPT 'N' values ranging from 10 to 17 blows/300 mm.

## 5.3 Native Silty Clay

A native silty clay deposit was encountered underlying the embankment fill in BH No. 1 and underlying the native clayey silt in BH No. 3. The native silty clay in BH No. 1 was encountered at approximate depth of 11.4 mbgs (El. 222.8 m) and it extended down to an approximate depth of 20.4 mbgs (El. 213.8 m). The native deposit of silty clay in BH No. 3 was encountered at an approximate depth of 2.3 mbgs (El. 225.6 m) and extended to a depth of 5.3 mbgs (El. 222.6 m).

The layer consisted mainly of silty clay with minor portions of sand. The layer was observed to be moist with measured natural moisture content of 31 to 39%.

Four (4) representative samples from this deposit underwent gradation analyses and Atterberg limits, and the results are summarized in Table 7 and provided in Figure Nos. L-1, L-2, and L-6, Appendix C.

**Table 7 Particle Size Distribution and Atterberg Limit Results of the Native Silty 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-17	12.4 (221.8)	0	4	56	40	39	24	15	33	CL
BH No. 1/SS-19	14.0 (220.2)	0	4	61	35	35	22	13	36	CL
BH No. 3/SS-4	2.4 (225.5)	0	5	51	44	60	30	30	36	CH
BH No. 3/SS-6	4.1 (223.8)	0	1	56	43	44	28	16	39	CI

The consistency of this deposit generally varied from firm to stiff based on recorded SPT 'N' values ranging from 4 to 17 blows/300 mm.

## 5.4 Native Clayey Silt

Underlying the silty clay fill in BH No. 2, at surface and underlying the native silty clay in BH No. 3, and at surface in BH No. 4, a native deposit of clayey silt was encountered.

The native clayey silt was encountered in BH No. 2 at an approximate depth of 13.0 mbgs (El. 221.6 m) and it extended to a depth of 16.8 mbgs, (El. 217.8 m). The native clayey silt was encountered in BH No. 3 at surface (El. 227.9 m) and it extended to a depth of 2.3 mbgs (El. 225.6 m). The native deposit of clayey silt was also encountered underlying the native silty clay in BH No. 3 at an approximate depth of 5.3 mbgs (El. 222.6 m) and it extended down to the maximum depth of drilling (i.e. 8.8 mbgs, El. 219.1 m). The native deposit of clayey silt was encountered in BH No. 4 at surface and it extended down to an approximate depth of 3.8 mbgs (El. 222.8 m).

This deposit mainly consisted of clayey silt with minor portions of sand. The natural moisture contents measured on samples recovered from the deposit ranged from 20 to 40%.

Six (6) representative samples from the deposit underwent gradation analyses and Atterberg limits, and the results are summarized in Table 8 and provided in Figure Nos. L-1, L-2, and L-7, Appendix C.

**Table 8 Particle Size Distribution and Atterberg Limits Results of the Native Clayey Silt**

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Atterberg Limits (%)			Water Content (%)	Soil Classification
		Gravel	Sand	Silt	Clay	LL	PL	PI		
BH No. 2/SS-18	13.3 (221.3)	0	13	63	24	25	17	8	27	CL-ML
BH No. 2/SS-20	15.5 (219.1)	1	5	82	12	--	--	--	20	ML
BH No. 3/SS-8	5.6 (222.3)	0	2	84	14	--	--	--	32	ML
BH No. 3/SS-10	7.9 (220.0)	0	5	83	11	--	--	--	24	ML
BH No. 4/SS-2	0.9 (225.7)	0	22	43	34	44	26	18	39	CI
BH No. 4/SS-5	3.2 (223.4)	7	19	43	34	42	26	16	40	MI

The clayey silt layer was observed to be loose to compact based on recorded SPT 'N' values ranging from 2 to 20 blows/300 mm.

## 5.5 Native Sandy Silt to Silty Sand

Below the native silty clay in BH No. 1, below the native clayey silt in BH No. 2, and underlying the native clayey silt at BH No. 4, a sandy silt to silty sand deposit was encountered. The sandy silt in BH No. 1 was encountered at an approximate depth of 20.4 mbgs (El. 213.8) and extended down to the maximum depth of drilling in BH No. 1 (i.e. 21.0 mbgs, El. 213.2 m). In BH No. 2, the sandy silt deposit was encountered at an approximate depth of 16.8 mbgs (El. 217.8 m) and extended down to the maximum depth of drilling in BH No. 2 (i.e. 20.4 mbgs, El. 214.2 m). The silty sand in BH No. 4 was encountered at an approximate depth of 3.8 mbgs (El. 222.8) and extended down to the maximum depth of drilling (i.e. 4.9 mbgs, El. 221.7 m).

The layer consisted mainly of sand and silt with different portions of gravel and clay. The layer was observed to be wet with measured natural moisture content of 16 to 28%.

Three (3) representative samples from the deposit underwent gradation analyses and Atterberg limits, and the results are summarized in Table 9 and 10 and provided in Figure Nos. L-2 and L-5, Appendix C.

**Table 9 Particle Size Distribution and Atterberg Limits Results of the Native Sandy Silt**

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH No. 1/SS-23	20.6 (213.6)	15	33	45	7	ML
BH No. 2/SS-22	20.1 (214.5)	11	35	54		ML

**Table 10 Particle Size Distribution and Atterberg Limits Results of the Silty Sand**

Sample Tested	Sample Depth / Elev. (m)	Grain Size Analysis (%)				Atterberg Limits (%)			Water Content (%)	Soil Classification
		Gravel	Sand	Silt	Clay	LL	PL	PI		
BH No. 4/SS-6	3.9 (222.7)	22	36	29	14	31	20	11	28	ML

The sandy silt to silty sand deposit was observed to be loose to compact based on SPT 'N' values ranging from 5 to 25 blows/300 mm. High blow counts can be inferred to occur due to cobbles and/or boulders.

## 5.6 Groundwater Conditions

Groundwater and cave-in levels were measured in the open boreholes during the course of the fieldwork as summarized in Table 11. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix B).

**Table 11 Groundwater Levels**

BH No.	Drilling Date	Ground Surface Elev. (m)	Borehole Bottom		Monitoring Date	GW in Boreholes	
			Depth (m)	Elev. (m)		Depth (m)	Elev. (m)
BH No. 1	May 11, 2022	234.2	21.0	213.2	May 11, 2022	12.7	221.5
BH No. 2	May 11, 2022	234.6	20.4	214.2	May 11, 2022	14.7	219.9
BH No. 3	June 29, 2022	227.9	8.8	219.1	June 29, 2022	3.0	224.9
BH No. 4	Aug. 2, 2022	226.6	4.9	221.7	Aug. 2, 2022	2.9	223.7

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 224.7 m. The water level in the creek was measured in July 14, 2022 and was at EL. 225.7 m at the upstream adjacent to BH No. 3 and EL. 223.7 m at the downstream adjacent to BH No. 4.

## 5.7 Soil and Water 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 12.

**Table 12 Soil Corrosivity Chemical Analysis Results**

BH No.	Sample	Depth (Elev.) (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm-cm)
BH No. 1	SS-16	11.4 (222.8)	7.1	<0.0020	0.011	3200



## 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. Ala Abu Obeid, M.Sc., P.Eng., PMP, and peer 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

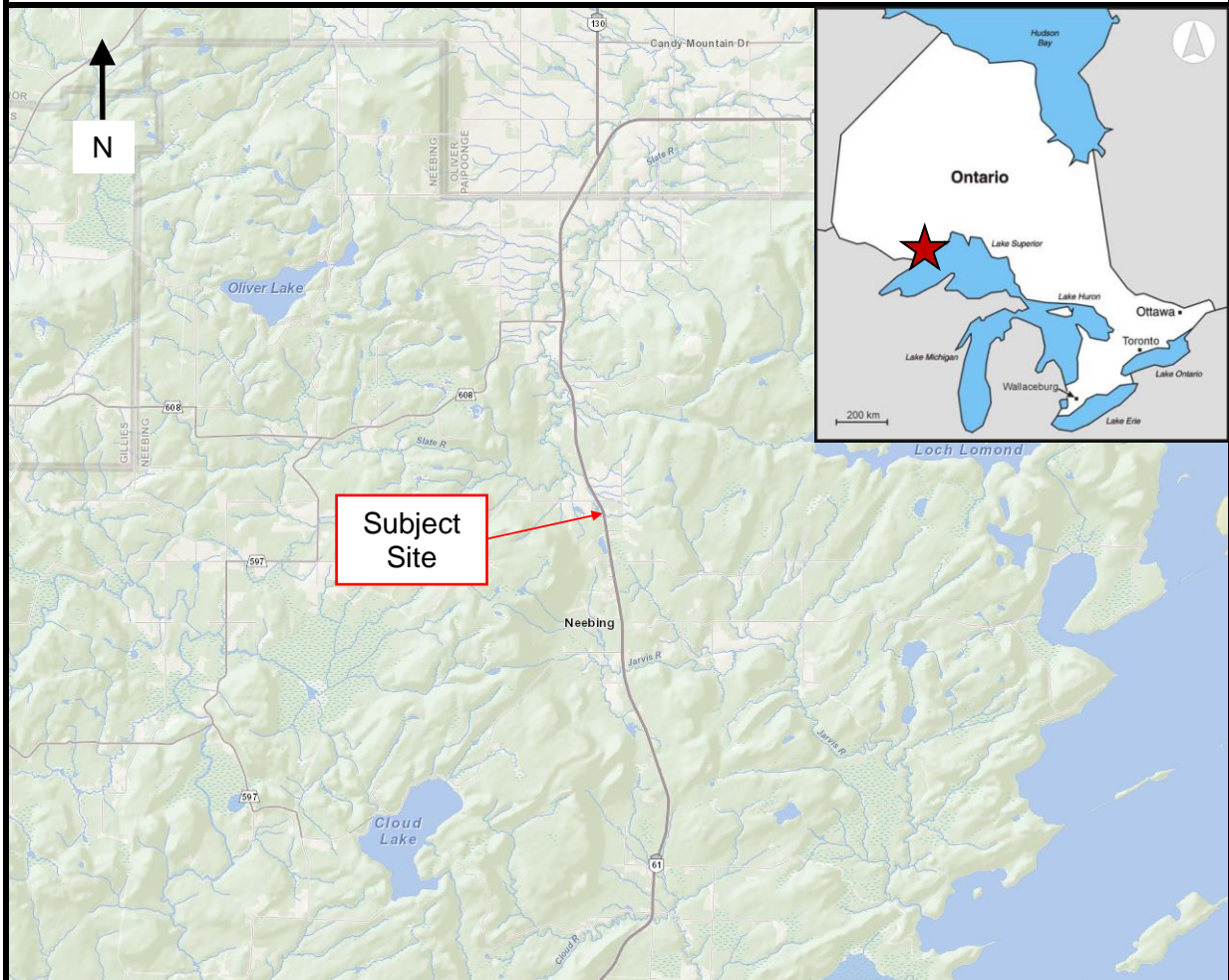


**eNGLOBE**

# KEY PLAN

Drawing No. 1

NOT TO SCALE



## FINAL FOUNDATION INVESTIGATION REPORT

Station 16+215 Culvert  
Culvert Replacement  
Highway No. 61, Twp. of Blake Assignment  
Number 6020-E-0021  
GWP 6176-15-00

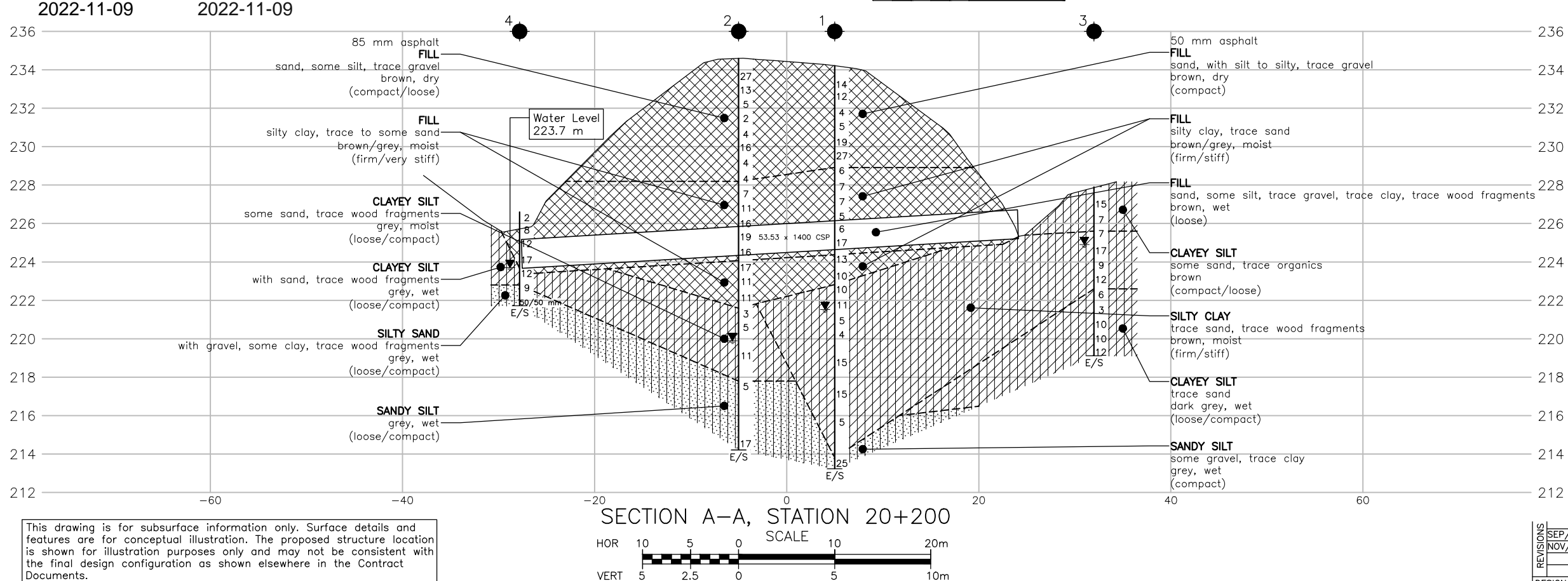
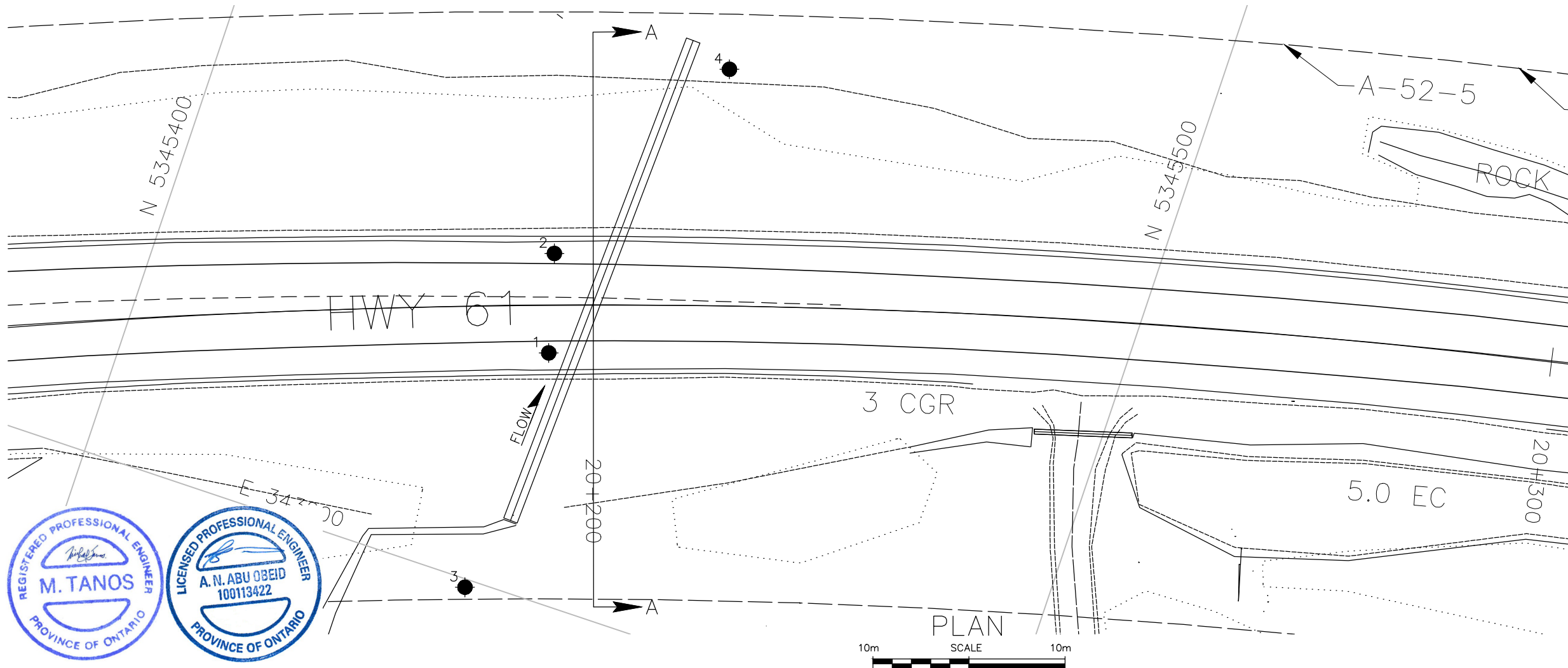
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July 2022



CAD FILE LOCATION AND NAME: E:\52\Projects For Other Offices\02109931 - EDN, HYD & DSS - Hwy 61, 6012-E-0021 (05T)\Drawings\02109931 - 20+040, 20+200, and 20+375, Brooks.dwg  
MODIFIED: 11/8/2022 7:26:21 PM BY: MITQDU  
DATE PLOTTED: 11/9/2022 12:32:45 PM BY:

PR-D-207 BM-03  
MINISTRY OF TRANSPORTATION, ONTARIO



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

REHABILITATION OF HWY 61  
CULVERT REPLACEMENT  
STATION ±20+200

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

E/S

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	234.2	5.0 m Rt	5345442.6	343174.9
2	234.6	5.0 m Lt	5345439.8	343164.9
3	227.9	32.0 m Rt	5345442.1	343200.8
4	226.6	27.8 m Lt	5345451.0	343140.9

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. 52A-268

REVISIONS

NO.	DATE	BY	DESCRIPTION
1	SEP/22	DM	DRAFT
2	NOV/22	DM	FINAL

DESIGN	CHK	CODE	LOAD	DATE
DRAWN	DM	CHK	AO	NOV/22

STRUC	SCHEME	DWG
		2

# Appendix B

## Subsurface Data

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



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## 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 4<sup>th</sup> 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 Fine
	19 – 75 4.75 – 19
	Coarse
	2.0 – 4.75
Sand	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 16+218, 5.5 m Rt, Blake Twp. ORIGINATED BY RT  
 DIST Thunder Bay HWY 61 BOREHOLE TYPE CME 750 - Hollow Stem COMPILED BY DMc  
 DATUM Geodetic DATE 2022.05.09 - 2022.05.09 MTM Zone 15 344313 E 5341691 N  
 LATITUDE 48.212792 LONGITUDE -89.468271 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE							
252.4							● QUICK TRIAXIAL	×	LAB VANE	WATER CONTENT (%)							
	ASPHALT - 70 mm		1	AS			40	80	120	160	200	20	40	60			
0.1	EMBANKMENT FILL - SAND - with silt to silty, trace gravel, brown, dry, loose to compact		2	SS	9												
	- trace clay, moist																
			3	SS	4							○				3 60 (37)	
			4	SS	6												
			5	SS	15												
	- with clay		6	SS	12							○				9 69 (22)	
			7	SS	9												
247.1	EMBANKMENT FILL - CLAY & SAND - trace gravel, brown, wet		8	SS	1												
5.3																	
246.3	VARVED SILT & CLAY - with sand to trace sand, trace gravel, trace organics, brown, wet		9	SS	7												
6.1	- brown/grey, moist		10	SS	7							┌─○─┐				4 26 31 40	
	- wet		11	SS	5												
244.0	SILT - some clay, trace sand, grey, wet, loose to very dense		12	SS	WH							┌─○─┐				0 4 82 14	
8.4																	
				SH													


Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MTO.GDT 7/26/22

## 2 OF 2

METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE
			NUMBER TYPE "N" VALUES		DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE WATER CONTENT (%) w <sub>p</sub> w                  w <sub>L</sub>
					20   40   60   80   100 40   80   120   160   200         20   40   60
					UNIT WEIGHT γ kN/m³
					REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	- trace sand, gravel		13 SS PM		242
					241
			14 SS WH		240
					239
			NR 50/ 25 mm		238
			15 SS 72		237
					236
235.8 16.6	End of Borehole at 16.6 m bgs				

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MTO.GDT 7/26/22

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

# RECORD OF BOREHOLE No. 2

1 OF 2

METRIC

W.P. GWP 6176-15-00 LOCATION 16+218, 7.0 m Lt, Blake Twp. ORIGINATED BY RT  
 DIST Thunder Bay HWY 61 BOREHOLE TYPE CME 750 - Hollow Stem COMPILED BY DMc  
 DATUM Geodetic DATE 2022.05.09 - 2022.05.10 MTM Zone 15 344300 E 5341689 N  
 LATITUDE 48.212775 LONGITUDE -89.468446 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W		W <sub>L</sub>	GR	SA	SI	CL
SHEAR STRENGTH kPa																				
○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE																				
WATER CONTENT (%)																				
251.9																				
0.1	ASPHALT - 60 mm		1	AS																
	EMBANKMENT FILL - SAND - fine grained, some silt, trace to some gravel, brown, dry, loose to compact		2	SS	13		251						○				5	79	(16)	
			3	SS	24		250													
			4	SS	10															
			5	SS	7		249						○				15	69	(16)	
			6	SS	5		248													
247.3																				
4.6	EMBANKMENT FILL - SANDY CLAY - brown, moist		7A	SS	1		247													
247.0	EMBANKMENT FILL - SANDY SILT - some clay, trace gravel, grey, wet, loose		7B									○				5	38	44	12	
4.9																				
246.6	EMBANKMENT FILL - CLAY & SILT - occasional wood chips, grey, moist, firm to stiff		8	SS	11		246													
5.3	- trace sand		9	SS	6							—○—			0	6	49	45		
245.0							245													
6.9	VARVED SILT & CLAY - trace to with sand, trace gravel, organics, grey, wet, soft to firm		10	SS	2															
			11	SS	WH		244													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MTO.GDT 7/26/22



## 2 OF 2

METRIC

DATUM	Geodetic	DATE	2022.05.09 - 2022.05.10	LATITUDE	48.212775	LONGITUDE	-89.468446	CHECKED BY	AO
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SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	
			13	SS	9	
			14	SS	8	
238.2	SILT - some clay, grey, moist, very dense		15	SS	88/ 125 mm	
13.7	- trace gravel, dry		16	SS	74	
			17	SS	102	
235.3	End of Borehole at 16.6 m bgs					
16.6						

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

# RECORD OF BOREHOLE No. 3

1 OF 1

METRIC

W.P. GWP 6176-15-00 LOCATION 16+215, 19.8 Rt, Blake Twp. ORIGINATED BY RT  
DIST Thunder Bay HWY 61 BOREHOLE TYPE B20 - Hollow Stem COMPILED BY DMc  
DATUM Geodetic DATE 2022.05.04 - 2022.05.05 MTM Zone 15 344329 E 5341684 N  
LATITUDE 48.212728 LONGITUDE -89.468056 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20	40	60						80	100	20
247.4																		
0.0	SAND & SILT - some gravel, organics, trace clay, brown		1	AS														
246.7																		
0.8	CLAY - some organics, silt, brown/grey, wet		2	AS											Organic Content 3.8 %			
245.9																		
1.5	VARVED SILT & CLAY - trace sand, moist, stiff to soft		3	SS	9										0 8 44 48			
245.1																		
2.3	SILT - trace clay, grey, wet, very loose		4	SS	4													
			5	SS	2										Organic Content 1.4 %			
			6	SS	2													
			7	SS	WH													
			8	SS	3										0 0 91 9 Organic Content 1.3 %			
			9	SS	WH													
240.7																		
6.7	End of Borehole at 6.7 m bgs																	

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE




ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MTO.GDT 7/26/22

# RECORD OF BOREHOLE No. 4

1 OF 1

METRIC

W.P. GWP 6176-15-00 LOCATION 16+216, 21.1 Lt, Blake Twp. ORIGINATED BY RT  
 DIST Thunder Bay HWY 61 BOREHOLE TYPE B20 - Hollow Stem COMPILED BY DMc  
 DATUM Geodetic DATE 2022.05.05 - 2022.05.05 MTM Zone 15 344283 E 5341689 N  
 LATITUDE 48.212776 LONGITUDE -89.468674 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
247.2																	
0.0	SAND - some silt to silty, trace to with organics, with to some clay, brown, wet		1	AS			247										
	- trace gravel		2	AS			246										4 44 37 14
245.7																	
1.5	SILT - some clay, trace sand, brown, moist, very loose to loose		3	SS	3		245										
	- trace sand, gravel, moist		4	SS	6		244									0 1 77 22	
	- trace sand, grey		5	SS	4		243										
	- wet		6	SS	1		242										
			7	SS	1		241										
			8	SS	8											0 1 87 12	
240.2	End of Borehole at 7.0 m																
7.0																	

ONTARIO MTO GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MTO.GDT 7/26/22

# Appendix C

## Laboratory Data

Figure No. L-1 and L-2: Atterberg Limits Summary

Figure No. L-3: Fill: Sand Grain Size Distribution Curve

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

Figure No. L-5: Fill: Sandy Silt to Silty Sand Grain Size Distribution Curve

Figure No. L-6: Silty Clay Grain Size Distribution Curve

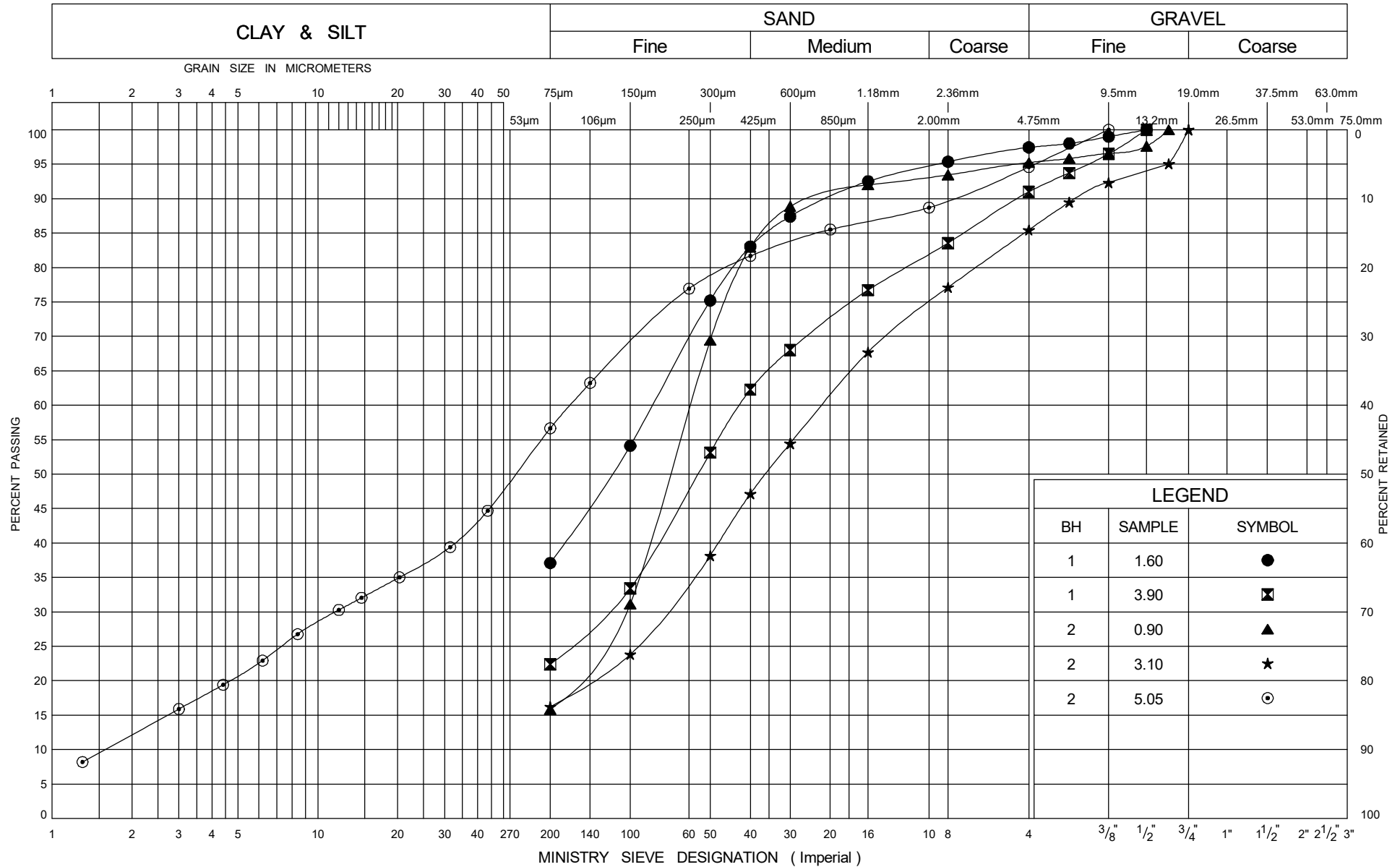
Figure No. L-7: Clayey Silt Grain Size Distribution Curve

Chemical Test Results



**ENGLOBE**

## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

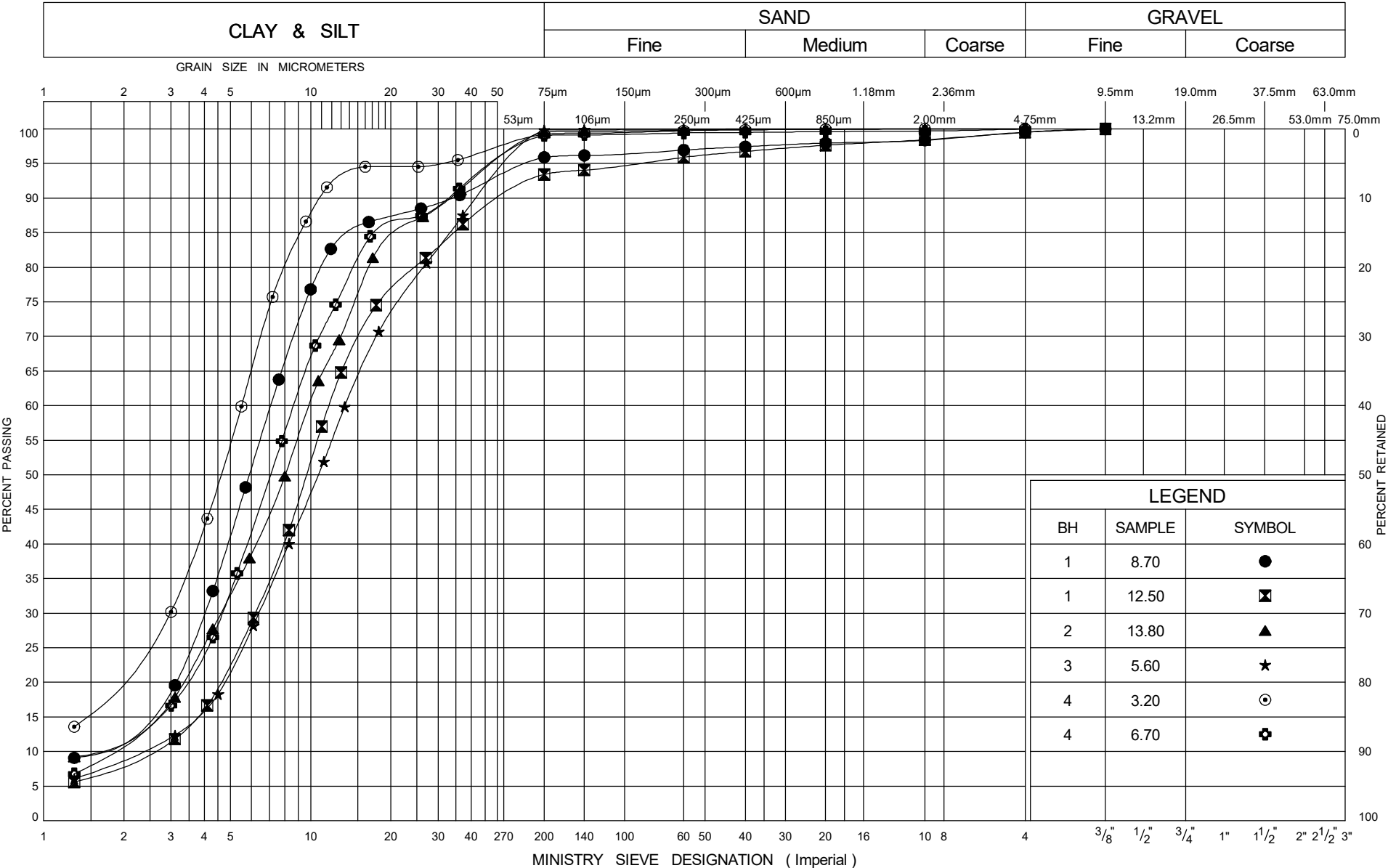
FILL - SAND to SANDY SILT

Figure No. L-1

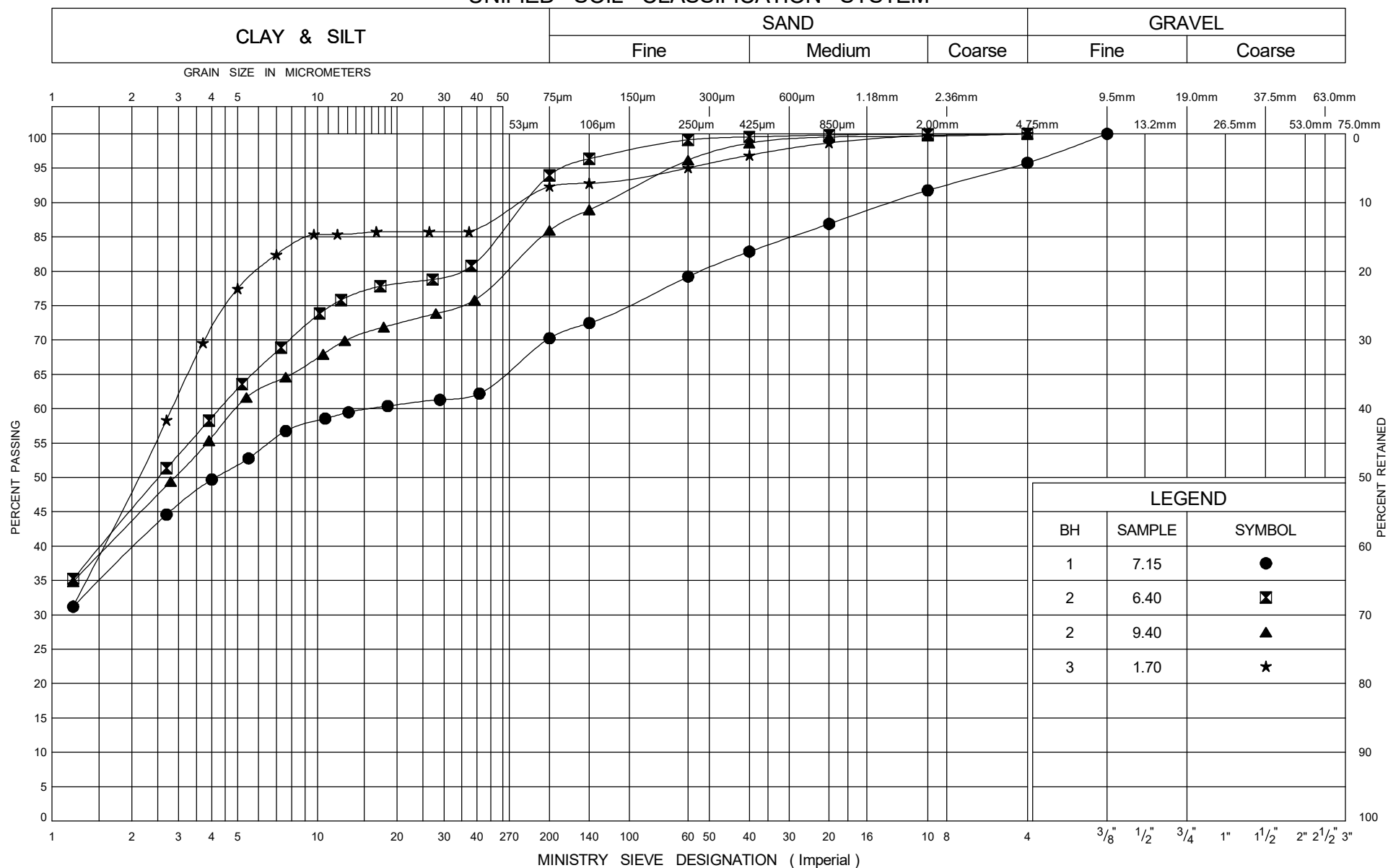
GWP 6176-15-00

Highway 61, GWP

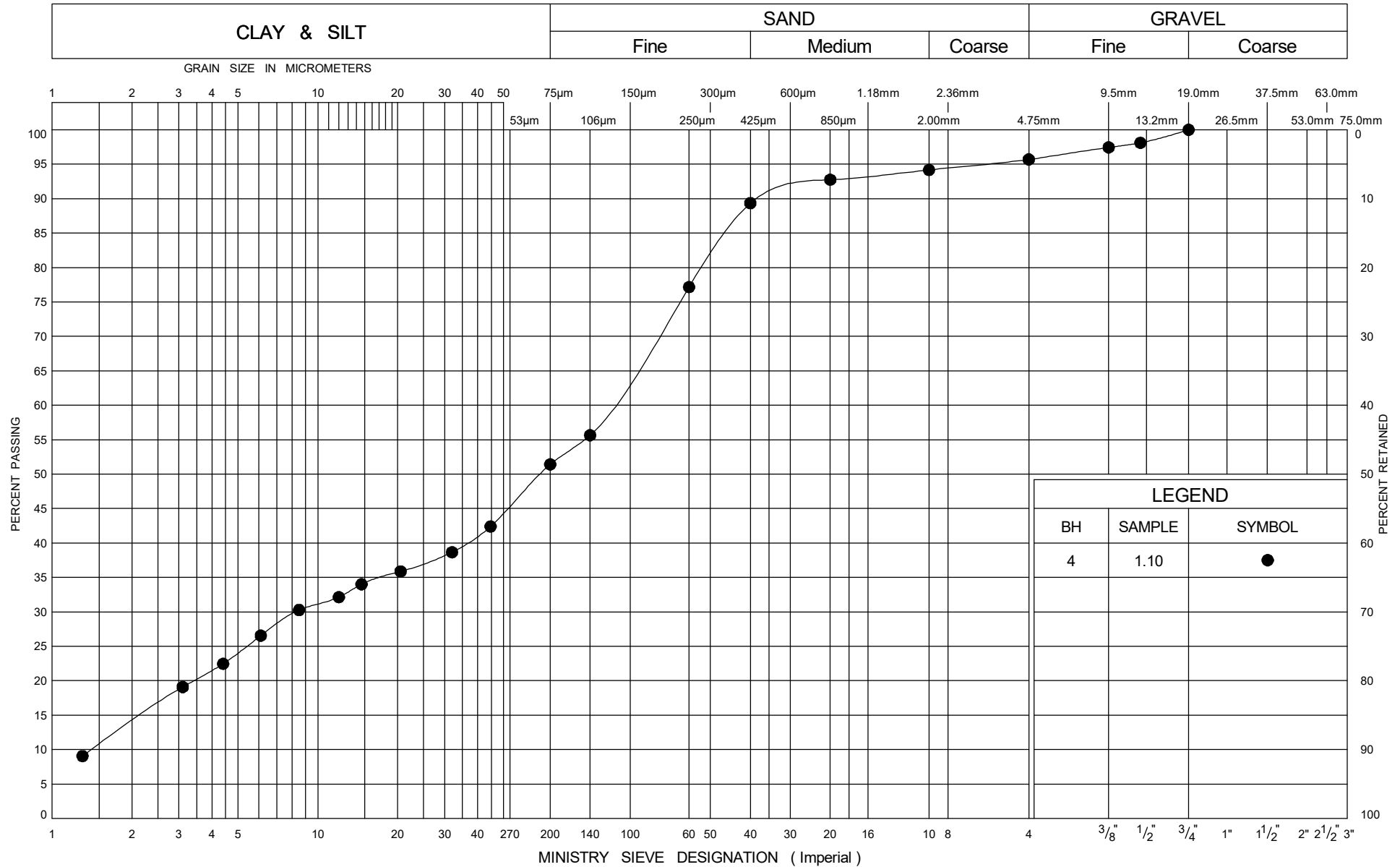
UNIFIED SOIL CLASSIFICATION SYSTEM



## UNIFIED SOIL CLASSIFICATION SYSTEM



## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

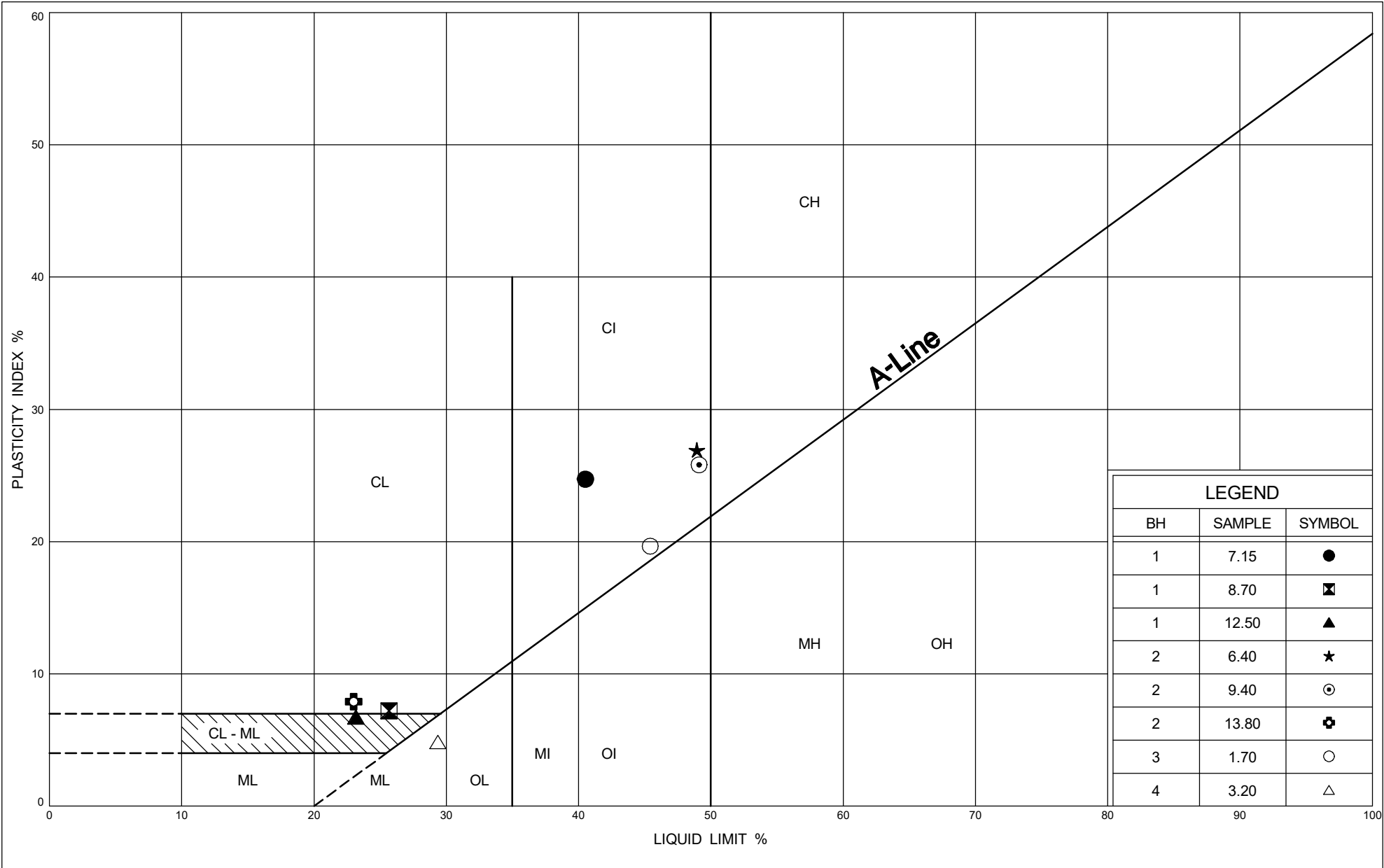
SILTY SAND

Figure No. L-4

GWP 6176-15-00

Highway 61, NWR



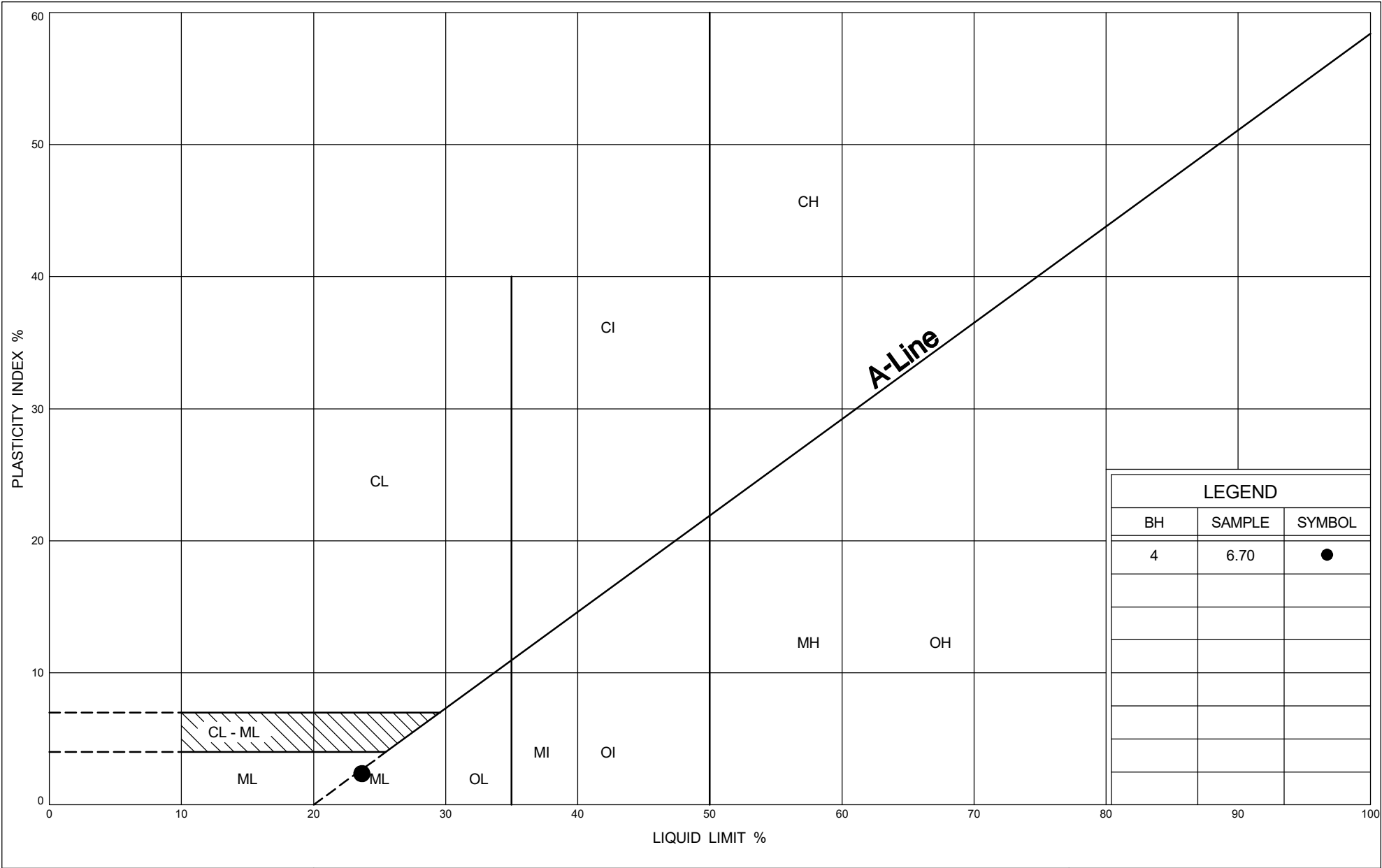


PLASTICITY CHART

Figure No. L-5  
GWP #6176-15-00  
Highway 61, NWR

ONTARIO MOT PLASTICITY CHART GWP 6176-15-00 - HIGHWAY 61 - CULVERT 16+215.GPJ ONTARIO MOT.GDT 6/20/22

Oct 75, FF - S - 21



PLASTICITY CHART

Figure No. L-6  
GWP #6176-15-00  
Highway 61, NWR



Your Project #: 2109931  
Site Location: HIGHWAY 61, NEEBING ONTARIO  
Your C.O.C. #: n/a

**Attention: Diana McKay**

Englobe Corp.  
Thunder Bay - Standing Offer  
605 Hewitson Street  
Thunder Bay, ON  
CANADA P7B 5V5

**Report Date: 2022/07/27**  
Report #: R7229510  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2K2504**

**Received: 2022/07/20, 15:11**

Sample Matrix: Soil  
# Samples Received: 3

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	3	2022/07/26	2022/07/26	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	3	2022/07/26	2022/07/26	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2022/07/26	2022/07/26	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2022/07/21	2022/07/27	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	2022/07/26	2022/07/26	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 ONTARIO  
Your C.O.C. #: n/a

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**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2K2504**

**Received: 2022/07/20, 15:11**

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

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### RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		TFJ445			TFJ446			TFJ447		
Sampling Date		2022/05/09 11:45			2022/05/11 03:15			2022/05/12 10:00		
COC Number		n/a			n/a			n/a		
	<b>UNITS</b>	<b>16+215</b>	<b>RDL</b>	<b>QC Batch</b>	<b>19+250</b>	<b>RDL</b>	<b>QC Batch</b>	<b>20+200</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>										
Resistivity	ohm-cm	740		8123845	530		8123845	3200		8123845
<b>Inorganics</b>										
Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	8130430	180	20	8130430	110	20	8130430
Conductivity	mS/cm	1.3	0.002	8130206	1.9	0.002	8130211	0.31	0.002	8130206
Available (CaCl2) pH	pH	7.69		8130626	7.54		8130626	7.10		8130626
Soluble (20:1) Sulphate (SO4)	ug/g	1500	60	8130435	1800	80	8130435	<20	20	8130435
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										



BUREAU  
VERITAS

Bureau Veritas Job #: C2K2504  
Report Date: 2022/07/27

Englobe Corp.  
Client Project #: 2109931  
Site Location: HIGHWAY 61, NEEBING ONTARIO  
Sampler Initials: RT

## TEST SUMMARY

**Bureau Veritas ID:** TFJ445  
**Sample ID:** 16+215  
**Matrix:** Soil

**Collected:** 2022/05/09  
**Shipped:**  
**Received:** 2022/07/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8130430	2022/07/26	2022/07/26	Alina Dobreanu
Conductivity	AT	8130206	2022/07/26	2022/07/26	Kien Tran
pH CaCl2 EXTRACT	AT	8130626	2022/07/26	2022/07/26	Taslina Aktar
Resistivity of Soil		8123845	2022/07/27	2022/07/27	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8130435	2022/07/26	2022/07/26	Alina Dobreanu

**Bureau Veritas ID:** TFJ446  
**Sample ID:** 19+250  
**Matrix:** Soil

**Collected:** 2022/05/11  
**Shipped:**  
**Received:** 2022/07/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8130430	2022/07/26	2022/07/26	Alina Dobreanu
Conductivity	AT	8130211	2022/07/26	2022/07/26	Kien Tran
pH CaCl2 EXTRACT	AT	8130626	2022/07/26	2022/07/26	Taslina Aktar
Resistivity of Soil		8123845	2022/07/27	2022/07/27	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8130435	2022/07/26	2022/07/26	Alina Dobreanu

**Bureau Veritas ID:** TFJ447  
**Sample ID:** 20+200  
**Matrix:** Soil

**Collected:** 2022/05/12  
**Shipped:**  
**Received:** 2022/07/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8130430	2022/07/26	2022/07/26	Alina Dobreanu
Conductivity	AT	8130206	2022/07/26	2022/07/26	Kien Tran
pH CaCl2 EXTRACT	AT	8130626	2022/07/26	2022/07/26	Taslina Aktar
Resistivity of Soil		8123845	2022/07/27	2022/07/27	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8130435	2022/07/26	2022/07/26	Alina Dobreanu



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VERITAS

Bureau Veritas Job #: C2K2504

Report Date: 2022/07/27

Englobe Corp.

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING ONTARIO

Sampler Initials: RT

### GENERAL COMMENTS

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

Package 1	25.0°C
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Results relate only to the items tested.

BUREAU  
VERITAS

Bureau Veritas Job #: C2K2504

Report Date: 2022/07/27

## QUALITY ASSURANCE REPORT

Englobe Corp.

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING ONTARIO

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
8130206	Conductivity	2022/07/26			100	90 - 110	<0.002	mS/cm	2.3	10
8130211	Conductivity	2022/07/26			100	90 - 110	<0.002	mS/cm	4.8	10
8130430	Soluble (20:1) Chloride (Cl <sup>-</sup> )	2022/07/26	116	70 - 130	102	70 - 130	<20	ug/g	NC	35
8130435	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2022/07/26	127	70 - 130	107	70 - 130	<20	ug/g	NC	35
8130626	Available (CaCl <sub>2</sub> ) pH	2022/07/26			100	97 - 103			0.096	N/A

N/A = Not Applicable

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

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

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

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

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





BUREAU  
VERITAS

Bureau Veritas Job #: C2K2504

Report Date: 2022/07/27

Englobe Corp.

Client Project #: 2109931

Site Location: HIGHWAY 61, NEEBING ONTARIO

Sampler Initials: RT

### VALIDATION SIGNATURE PAGE

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

Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

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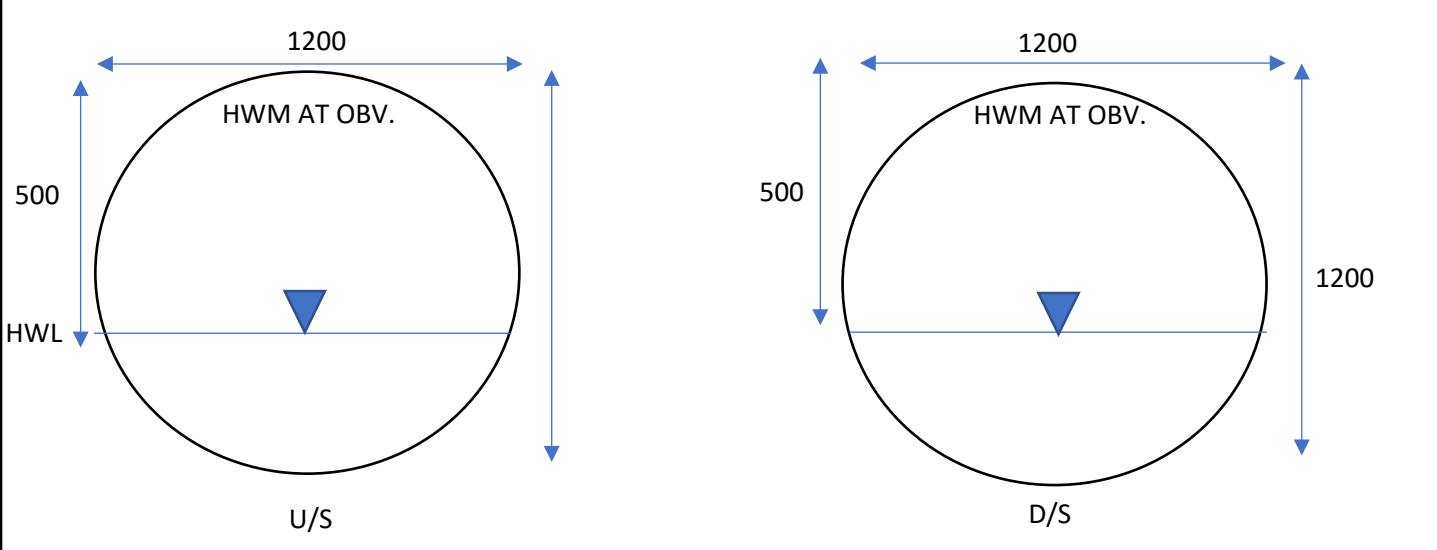


**Appendix D**  
**Culvert Inspection Report**  
**(as provided by Gannett Fleming)**



**eNGLOBE**

## FIELD INSPECTION FORM

<b>A. GENERAL INFORMATION</b>			
<b>Project #</b>	6176-15-00 - Highway 61	<b>Project Description</b>	From 0.5km north of Jarvis Bay Road to 0.4km South of Hwy 130
<b>Date</b>	October 5, 2021	<b>Weather Conditions</b>	Sunny
<b>Inspector 1</b>	David Jackson	<b>Inspector 2 /Reviewer</b>	-
<b>B. CULVERT ID / LOCATION</b>			
<b>Culvert ID</b>	C22	<b>Chainage</b>	16+215
<b>UTM Easting</b>	344306.4362	<b>UTM Northing</b>	5341686.9665
<b>Description</b>	South of the Valley Road West & Highway 61 intersection		
<b>C. STRUCTURE DETAILS</b>			
<b>Material – CSP through CTC</b>			
<b>Dimensions – 1200 x 1200 US / 1200 x 1200 DS</b>			
<b>Clearance (soffit to normal water level) – 500mm US and DS</b>			
<b>High Water Mark (on structure) – Obv.</b>			
<b>Structures (U/S / D/S of Crossing) – 1600mm DS</b>			
<b>Debris – N/A</b>			
<b>D. ENVIRONMENTAL CONDITIONS</b>			
<b>Watercourse Type and Creek Material – Wetland / muck</b>			
<b>Bank Conditions (stability) – Erosion and scour holes on both ends</b>			
<b>Channel Dimensions (width and depth) – 3m, 3:1, 600mm deep US and DS</b>			
<b>Observed Flow Conditions (ephemeral/permanent) – Permanent</b>			
<b>E. SITE CONDITIONS</b>			
<b>Road Condition (sag, settlement, etc.) – OK</b>			
<b>Physical Culvert Condition (rust, damage, etc.) – Damaged, rust and sagging</b>			
<b>Culvert Appearance (general comments) – Replace</b>			
<b>Site Sketch –</b>			
			



**Corrugated Steel Pipe through a Creosote Timber Box Culvert (Culvert #22) @ 16+215**

**C22 - #1 – Upstream Channel Conditions**



**C22 - #2 – Upstream Face of the Culvert**





**C22 - #3 – Downstream Channel Conditions**



**C22 - #4 – Downstream Face of the Culvert**

