

Final Foundation Investigation Report (FIR)

Highway 61 Culvert Replacement

Station 16+215, Township of Blake

Gannett Fleming

Ontario Ministry of Transportation (MTO)

GWP 6176-15-00

GEOCRES No. 52A-267

Assignment No.: 6020-E-0021

Latitude: 48.211146°

Longitude: -89.467976°

September 16, 2022

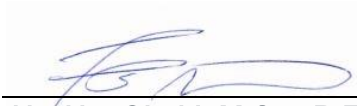
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Gannett Fleming GWP 6176-15-00

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2022-09-15

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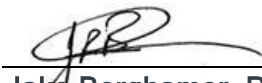


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Revisions and publications log

| REVISION No. | DATE | DESCRIPTION |
|--------------|--------------------|-------------------|
| 0A | August 4, 2022 | Draft FIDR issued |
| 0B | September 16, 2022 | Final FIR Issued |
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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 at approximate Station 16+215 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-267).

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2 Site Description

The existing 40.81 m long culvert structure is a corrugated steel pipe (CSP) installed through a creosoted timber culvert (CTC). The culvert is crossing Highway 61 at approximate Station 16+215, approximately 445 m south of the Valley Road West and Highway 61 intersection, in the Township of Blake. Highway 61 at this culvert crossing is a three-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 19.5 m wide (including shoulders) and up to approximately 5.0 m in height above the crown of the culvert, with the centreline of the roadway at an approximate elevation 252 m at the culvert location. The pavement surface is generally in good to fair condition with some longitudinal and transverse 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 west side of Highway 61 is located about 85 m to the north of the culvert crossing, with the Neebing Municipal Office access on the east side of Highway 61 located approximately 130 m north of the culvert crossing. Located approximately 140 m south of the culvert crossing on the east side of Highway 61 is the access for a private property. 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 an approximately perpendicular alignment (approximately 90 degree) from east (upstream) to west (downstream). The existing culvert structure is 1.30 m wide and 1.20 m high, the diameter of the inner CSP is approximately 1.20 m, 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 inner CSP was observed to be deteriorated (damaged, rust and sagging). The channel dimensions were described by GF in general as 3 m wide with banks at ~3H:1V and water depth of 600 mm at both the channel upstream (US) and downstream (DS). The top of the culvert elevations at the inlet and outlet are 247.4 and 247.2 m, respectively (i.e. culvert slope is almost flat) with clearance of 500 mm for both US and DS. 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 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.

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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 4 and May 10, 2022 and consisted of two boreholes on the roadway extending down to a maximum depth of 16.6 m below existing ground/road surface (mbgs) and two boreholes off the roadway at the culvert inlet and outlet to a maximum depth of 7.0 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 A and are provided in the Table below.

Table 1 Borehole Locations

| Borehole No. | Borehole Location (MTM Nad 83) | | Borehole Location (Geographic) | | |
|--------------|--------------------------------|------------|--------------------------------|-------------------|-------------|
| 1 | N 5341690.6 | E 344313.4 | Lat: 48.21279° | Long: - 89.46827° | EL. 252.4 m |
| 2 | N 5341689.1 | E 344299.9 | Lat: 48.21278° | Long: - 89.46845° | EL. 251.9 m |
| 3 | N 5341684.5 | E 344328.7 | Lat: 48.21273° | Long: - 89.46806° | EL. 247.4 m |
| 4 | N 5341689.0 | E 344283.7 | Lat: 48.21278° | Long: - 89.46867° | EL. 247.2 m |

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. 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.



4 Laboratory Investigation

All soil 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-5).

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 - 0.07 (El. 252.4) | 0 - 0.06 (El. 251.9) | -- | -- |
| Embankment Fill: Loose to Compact Sand, some Silt to Silty | 0.07 - 5.3 (El. 252.4-247.1) | 0.06 - 4.6 (El. 251.9 - 247.3) | -- | -- |
| Embankment Fill: Soft Clay and Sand to Sandy Clay, trace gravel | 5.3 - 6.1 (El. 247.1 - 246.3) | 4.6 - 4.9 (El. 247.3 - 247.0) | -- | -- |
| Embankment Fill: Loose Sandy Silt, some Clay | -- | 4.9 - 5.3 (El. 247.0-246.6) | -- | -- |
| Embankment Fill: Firm to Stiff Clay and Silt, included occasional wood chips | -- | 5.3 - 6.9 (El. 246.6 - 245.0) | -- | -- |
| Sand and Silt to Sand/Silty Sand, some Gravel, trace Organics | -- | -- | 0.0 - 0.8 (El. 247.4 - 246.7) | 0.0 - 1.5 (El. 247.2- 245.7) |
| Clay, trace Organics | -- | -- | 0.8 - 1.5 (El. 246.7 - 245.9) | -- |

| Deposit/Layer Description | Depths/Elevations (m) | | | |
|--|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|
| | Borehole No. 1 | Borehole No. 2 | Borehole No. 3 | Borehole No. 4 |
| Soft to firm Varved Silt and Clay with to trace Sand | 6.1 - 8.4 (El. 246.3- 244.0) | 6.9 - 13.7 (El. 245.0- 238.2) | 1.5 - 2.3 (El. 245.9- 245.1) | -- |
| Very Loose to Very dense Silt, some Clay, trace Sand | 8.4 - 16.6 (El. 244.0- 235.8) | 13.7 - 16.6 (El. 238.2- 235.3) | 2.3 - 6.7 (El. 245.1- 240.7) | 1.5 - 7.0 (El. 245.7- 240.2) |

5.1 Asphalt

A thin layer of approximate 60 to 70 mm asphalt was observed in both BH Nos. 2 and 1, respectively, which were drilled on the shoulders through the embankment.

5.2 Embankment Fill

The encountered embankment fill materials underlying the asphalt layer extended down to 6.1 mbgs (El. 246.3 m) in BH No.1 and 6.9 mbgs (El. 245.0 m) in BH No 2. The embankment fill materials varied in composition with depth. A layer of sand fill (4.5 to 5.2 m thick) was encountered below pavement structure extending down to El. 247.1 m in BH No. 1 and El. 247.3 m in BH No 2. In BH No. 1, the sand fill is followed by clay and sand fill which was observed to be 0.8 m thick and extended between El. 247.1 m and 246.3 m. In BH. No. 2, the sand fill is followed by a sandy clay fill which was observed to be 0.3 m thick and extended between El. 247.3 m and 247.0 m. Underlying the sandy clay fill in BH No. 2, a layer of sandy silt fill was observed to be 0.4 m thick and extended between El. 247.0 m and 246.6 m, followed by a layer of clay and silt fill of 1.6 m thick and extended between El. 246.6 m and 245.0 m.

The embankment fill, immediately below the asphalt layer, is mainly composed of brown sand with different portions of silt and clay. The sand fill layer extended to approximately 4.6 to 5.3 m depth. This sand fill layer was almost dry with approximate moisture content of 7 to 15% measured in the geotechnical laboratory. The results for grain size analyses of representative samples comprising the sand fill layer are summarized in Table 3 and presented on Figure No. L-1, 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-3 | 1.6 (250.8) | 3 | 60 | 37 | | SM |
| BH No. 1 / SS-6 | 3.9 (248.5) | 9 | 69 | 22 | | SM |
| BH No. 2 / SS-2 | 0.9 (251.0) | 5 | 79 | 16 | | SM |
| BH No. 2 / SS-5 | 3.1 (248.8) | 15 | 69 | 16 | | SM |

The sand fill layer was generally loose to compact, based on recorded SPT 'N' values ranging from 4 to 24 blows/300 mm.

The clay and sand to sandy clay fill was observed to be brown and moist, and was generally soft on recorded SPT 'N' value of 1 blow/300 mm.

The silt and clay fill deposit included occasional wood chips and was observed to be brown to grey and moist with an approximate moisture content of 34% measured in the geotechnical laboratory.

A representative soil sample from this silt and clay fill layer was subjected to grain size analysis and Atterberg's Limits, the results are summarized in Table 4 and provided in Figure Nos. L-3 and L-5, Appendix C.

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

| Sample Tested | Sample Depth / Elev. (m) | Grain Size Analysis (%) | | | | Atterberg Limits (%) | | | Soil Classification |
|-----------------|--------------------------|-------------------------|------|------|------|----------------------|----|----|---------------------|
| | | Gravel | Sand | Silt | Clay | LL | PL | PI | |
| BH No. 2 / SS-9 | 6.4 (245.5) | 0 | 6 | 49 | 45 | 49 | 22 | 27 | CL |

The silt and clay fill layer was generally firm to stiff on recorded SPT 'N' values ranging from 6 to 11 blows/300 mm.

The sandy silt fill deposit was observed to be brown and moist, and was generally very loose on recorded SPT 'N' value of 1 blow/300 mm. A representative soil sample from this sandy silt fill layer was subjected to grain size analysis and the results are summarized in Table 5 and provided in Figure No. L-1, Appendix C.

Table 5 Particle Size Distribution Results of the Sandy Silt Fill

| Sample Tested | Sample Depth / Elev. (m) | Grain Size Analysis (%) | | | | Soil Classification |
|------------------|--------------------------|-------------------------|------|------|------|---------------------|
| | | Gravel | Sand | Silt | Clay | |
| BH No. 2 / SS-7B | 5.1 (246.8) | 5 | 38 | 44 | 12 | ML |

5.3 Sand/Sand & Silt

The sand/sand and silt layer was observed at surface in BH Nos. 3 and 4 and extended to El. 246.7 m in BH No. 3 (approximately 0.8 m thick) and to El. 245.7 m in BH No. 4 (approximately 1.5 m thick).

This deposit mainly consisted of sand and silt with different portions of gravel and clay. The layer was observed to be brown in general and contained trace organics.

The natural moisture contents measured on a sample recovered from this deposit is 48%. One gradation (hydrometer) analysis was carried out on a sample from this deposit, and the results is summarized in Table 6 and provided in Figure No. L-4, Appendix C.

Table 6 Particle Size Distribution and Atterberg Limits Results of the Native Sand/Sand and Silt

| Sample Tested | Sample Depth / Elev. (m) | Grain Size Analysis (%) | | | | Water Content (%) | Soil Classification |
|---------------|--------------------------|-------------------------|------|------|------|-------------------|---------------------|
| | | Gravel | Sand | Silt | Clay | | |
| BH No. 4/SS-2 | 1.1 (246.1) | 4 | 44 | 37 | 14 | 48 | ML |

5.4 Clay

Below the sand and silt layer in BH Nos. 3, a native deposit of brown to grey clay was encountered and extended to El. 245.9 m (approximately 0.7 m thick). The clay layer contained trace organics (3.8 %).

5.5 Varved Silt and Clay

Below the embankment fill in BH Nos. 1 and 2 and below the native clay in BH No. 3, a native deposit of brown to grey silty clay/silt and clay was encountered. The silty clay/silt and clay was observed between El. 246.3 m to El. 244.0 m in BH No. 1 (approximately 2.3 m thick). The silty clay/silt and clay was observed between El. 245.0 m to El. 238.2 m in BH No. 2 (approximately 6.8 m thick). The silty

clay/silt and clay was observed between El. 245.9 m to El. 245.1 m in BH No. 3 (approximately 0.8 m thick). The silty clay/silt and clay layer was observed to be soft to firm based on vane shear strength values ranging from 23 to 47 kPa.

The natural moisture content of the Silty clay/silt and clay ranged from 33 to 45%. Gradation analyses were carried out on three (3) samples from this deposit, and the results are summarized in Table 7 and provided in Figure Nos. L-3 and L-5, Appendix C.

Table 7 Particle Size Distribution Results of the Native Silty Clay/Silt and Clay

| Sample Tested | Sample Depth / Elev. (m) | Grain Size Analysis (%) | | | | Atterberg Limits (%) | | | Soil Classification |
|----------------|--------------------------|-------------------------|------|------|------|----------------------|----|----|---------------------|
| | | Gravel | Sand | Silt | Clay | LL | PL | PI | |
| BH No. 1/SS-10 | 7.5 (244.9) | 4 | 26 | 31 | 40 | 41 | 16 | 25 | CL |
| BH No. 2/SS-12 | 9.4 (242.5) | 0 | 14 | 42 | 44 | 49 | 23 | 26 | CL |
| BH No. 3/SS-3 | 1.7 (245.7) | 0 | 8 | 44 | 48 | 45 | 25 | 20 | CL |

5.6 Silt

Below the native silty clay/silt and clay layer in BH Nos. 1 to 3, and below the native sand/sand and silt in BH No. 4, a silt deposit was encountered up to the termination depth of the boreholes. The silt was encountered between El. 245.7 m to the maximum depth of El. 235.3 m.

The layer consisted mainly of silt with different portions of sand, clay, and gravel. This silt layer was observed to be very loose to very dense based on SPT 'N' values ranging from 0 (manual pressure/weight of the hammer) to 102 blows/300 mm. High blow counts can be inferred to occur due to cobbles and/or boulders.

The natural moisture contents measured on samples recovered from the deposit ranged from 21 to 43%. Gradation analyses and Atterberg's Limits were carried out on six (6) samples of this deposit, and the results are summarized in Table 8 and provided in Figure Nos. L-2 and L-5, Appendix C.

Table 8 Particle Size Distribution Results of the Native Silt/Clayey Silt

| Sample Tested | Sample Depth / Elev. (m) | Grain Size Analysis (%) | | | | Atterberg Limits (%) | | | Soil Classification |
|------------------|--------------------------|-------------------------|------|------|------|----------------------|----|----|---------------------|
| | | Gravel | Sand | Silt | Clay | LL | PL | PI | |
| BH No. 1 / SS-12 | 8.7 (243.7) | 0 | 4 | 82 | 14 | 26 | 18 | 8 | CL-ML |
| BH No. 1 / SS-14 | 12.5 (239.9) | 1 | 6 | 85 | 9 | 23 | 16 | 7 | CL-ML |
| BH No. 2 / SS-15 | 13.8 (238.1) | 0 | 0 | 86 | 13 | 23 | 15 | 8 | CL-ML |
| BH No. 3 / SS-8 | 5.6 (241.8) | 0 | 0 | 91 | 9 | - | - | - | CL-ML |
| BH No. 4 / SS-5 | 3.2 (244.0) | 0 | 1 | 77 | 22 | 29 | 25 | 4 | CL-ML |
| BH No. 4 / SS-8 | 6.7 (240.5) | 0 | 1 | 87 | 12 | 24 | 21 | 3 | ML |

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 9.

Table 9 Groundwater Levels

| BH No. | Drilling Date | Ground Surface Elev. (m) | Borehole Bottom | | Monitoring Date | GW in borehole | | Monitoring Date | GW in Well | |
|----------|---------------|--------------------------|-----------------|-----------|-----------------|----------------|-----------|-----------------|------------|-----------|
| | | | Depth (m) | Elev. (m) | | Depth (m) | Elev. (m) | | Depth (m) | Elev. (m) |
| BH No. 1 | May 09, 2022 | 252.4 | 16.6 | 235.8 | May 09, 2022 | 10.2 | 242.2 | -- | -- | -- |
| BH No. 2 | May 10, 2022 | 251.9 | 16.6 | 235.3 | May 10, 2022 | 9.2 | 242.7 | -- | -- | -- |
| BH No. 3 | May 04, 2022 | 247.4 | 6.7 | 240.7 | May 04, 2022 | 0.4 | 247.0 | July 21, 2022 | 0.2 | 247.2 |
| BH No. 4 | May 05, 2022 | 247.2 | 7.0 | 240.2 | May 05, 2022 | 4.2 | 243.0 | July 21, 2022 | 0.5 | 246.7 |

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 246.2 m. The water level in the creek was measured in July 14, 2022 and was at EL. 246.8 m adjacent to BH No. 3 and EL. 246.9 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 10.

Table 10 Soil Corrosivity Chemical Analysis Results

| BH No. | Sample | Depth (Elev.) (m) | pH | Sulphate (%) | Chloride (%) | Resistivity (Ohm-cm) |
|----------|--------|-------------------|------|--------------|--------------|----------------------|
| BH No. 1 | SS-9 | 6.3 (246.1) | 7.69 | 0.15 | <0.0020 | 740 |



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

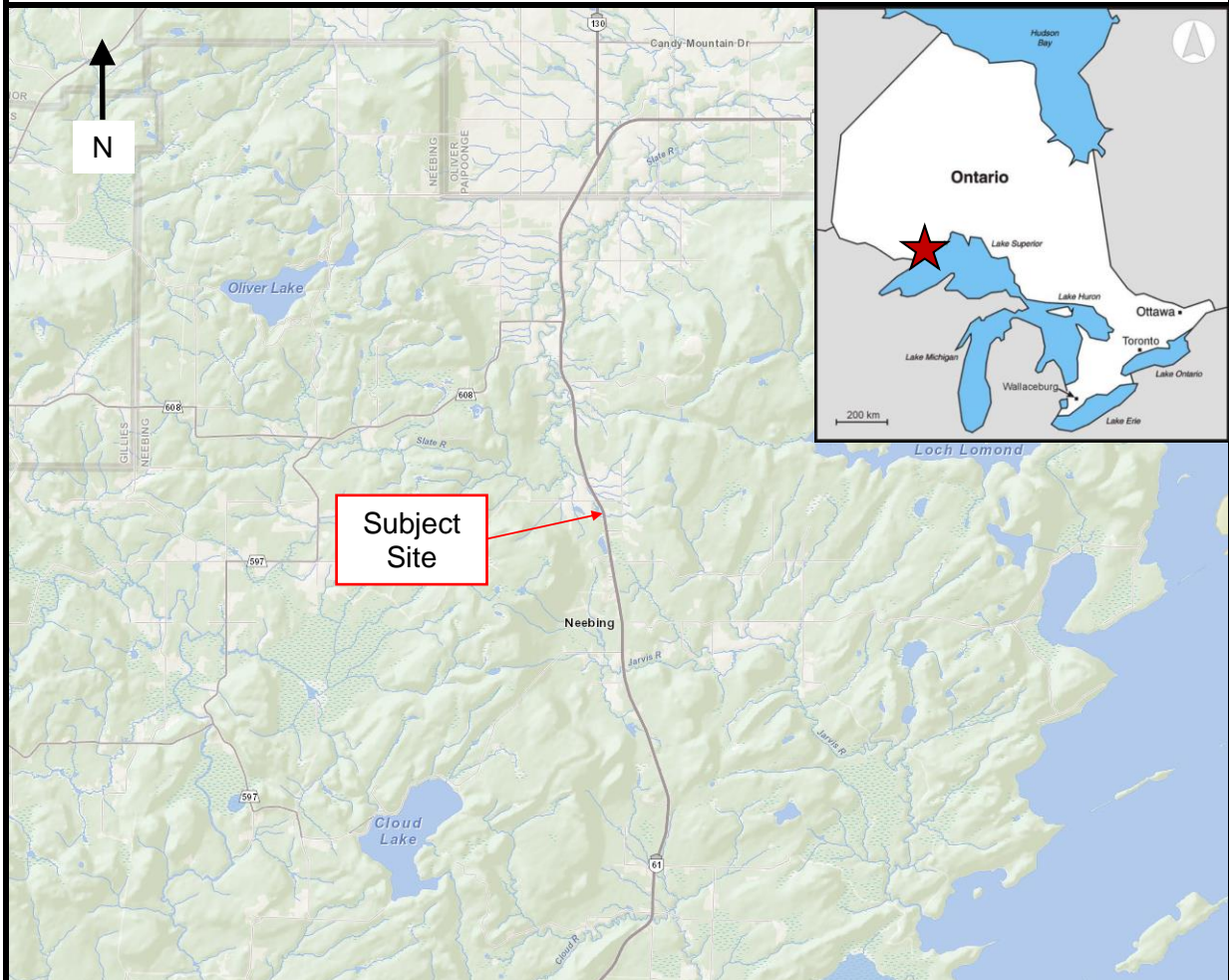


ENGLOBE

KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL FOUNDATION INVESTIGATION REPORT

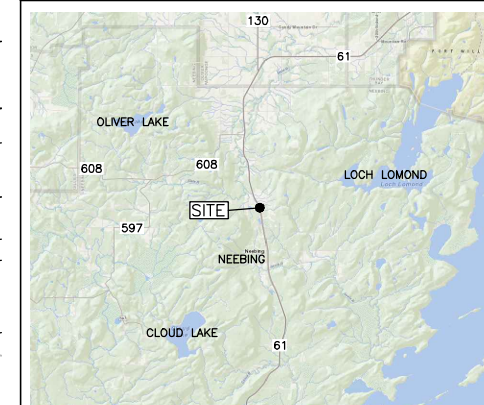
Station 16+215 Culvert
Culvert Replacement
Highway No. 61, Twp. of Blake Assignment
Number 6020-E-0021
GWP 6176-15-00




Reference No: 02109931

July 2022



2



| | |
|--|--|
|  | Borehole |
| N | Blows/0.3 m (Std Pen Test, 475 J/blow) |
| DCPT | Blows/0.3 m (60° Cone, 475 J/blow) |
|  | Water Level at Time of Investigation |
| A/R | Auger Refusal at Elevation |
| E/S | End of Sampling |
|  | Piezometer |

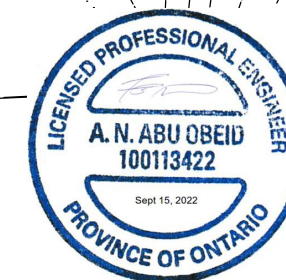
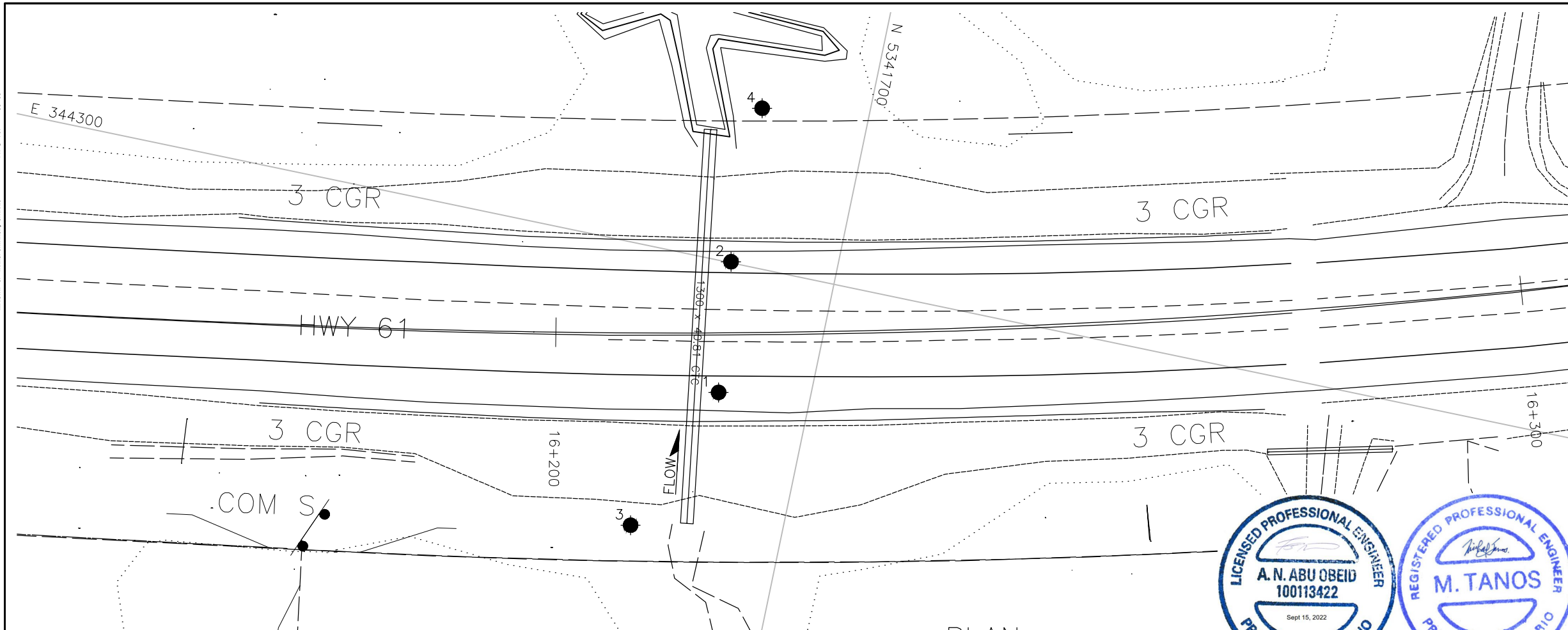
| BOREHOLE No. | ELEVATION | O/S | NORTHING | EASTING |
|-----------------|-----------|-----------|-----------|---------|
| 1 | 252.4 | 5.5 m Rt | 5341690.6 | 344313. |
| 2 | 251.9 | 7.0 m Lt | 5341689.1 | 344299. |
| 3 | 247.4 | 19.8 m Rt | 5341684.5 | 344328. |
| 4 | 247.2 | 21.1 m Lt | 5341689.0 | 344283. |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

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.

Coordinates based on MTM Zone 15 NAD83 CSR

GEOCRES No. 52A-267

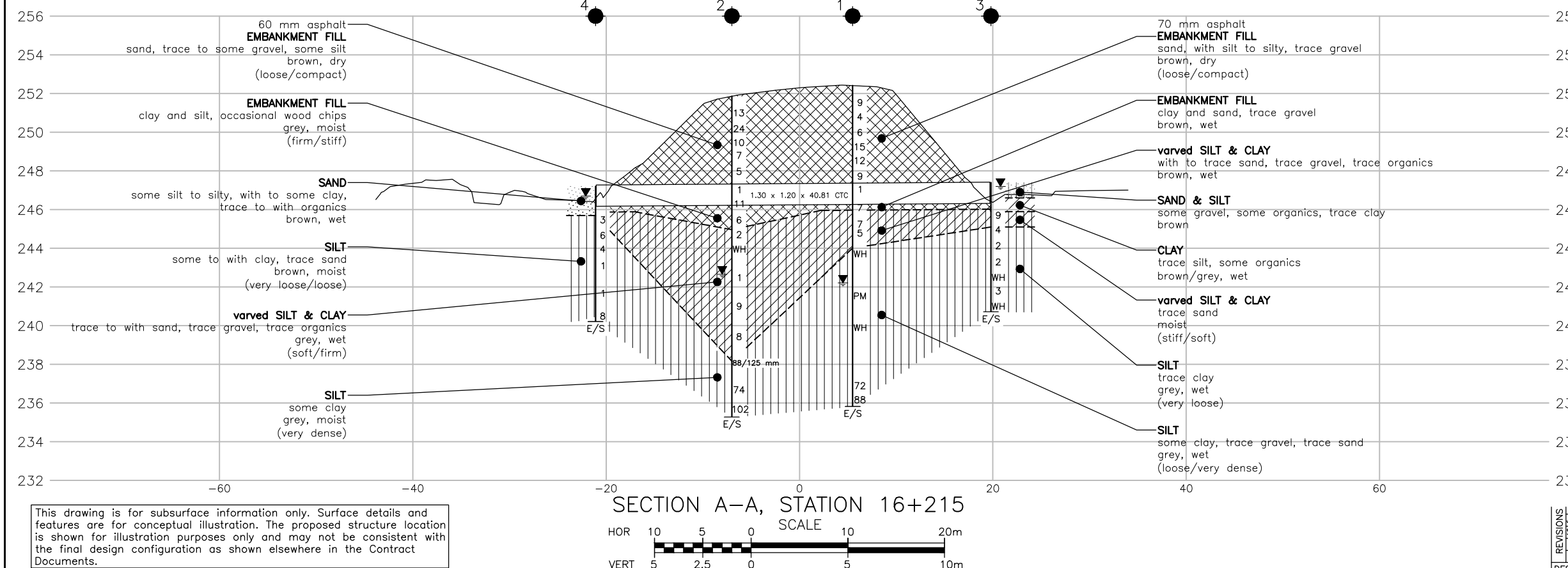
| | | | | | | | | |
|-------------|--------|-----|----|-------|--------|--------|-----|-----------|
| REVISIONS | JUL/22 | | DM | DRAFT | | | | |
| | SEP/22 | | DM | FINAL | | | | |
| | | | | | | | | |
| | | | | | | | | |
| DESCRIPTION | | | | | | | | |
| DESIGN | | CHK | | CODE | | LOAD | | DATE SEP. |
| DRAWN | DM | CHK | AO | SITE | STRUCT | SCHEMF | DWG | |



2022-09-15



2022-09-15



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.

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 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 _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 |
| | | | | | | | | 20 | 40 | 60 | 80 | | | | | 100 | W _p | W | W _L | | | | |
| 252.4 | | | | | | | | | | | | | | | | | | | | | | | |
| 0.1 | ASPHALT - 70 mm | | 1 | AS | | | 252 | | | | | | | | | | | | | | | | |
| | - trace clay, moist | | | | | 2 | SS | 9 | | | | | | | | | | | | | | | |
| | | | | | | 3 | SS | 4 | | | | | | | | | | | | | | | |
| | | | | | | 4 | SS | 6 | | | | | | | | | | | | | | | |
| | | | | | | 5 | SS | 15 | | | | | | | | | | | | | | | |
| | | | | | | 6 | SS | 12 | | | | | | | | | | | | | | | |
| | | | | | | 7 | SS | 9 | | | | | | | | | | | | | | | |
| | | | | | | 8 | SS | 1 | | | | | | | | | | | | | | | |
| | | | | | | 9 | SS | 7 | | | | | | | | | | | | | | | |
| | | | | | | 10 | SS | 7 | | | | | | | | | | | | | | | |
| 247.1 | EMBANKMENT FILL - CLAY & SAND - trace gravel, brown, wet | | 11 | SS | 5 | | 245 | | | | | | | | | | | | | | | | |
| 246.3 | VARVED SILT & CLAY - with sand to trace sand, trace gravel, trace organics, brown, wet | | 12 | SS | WH | | 244 | | | | | | | | | | | | | | | | |
| 6.1 | - brown/grey, moist | | | | | 13 | SS | 7 | | | | | | | | | | | | | | | |
| | - wet | | | | | 14 | SS | 5 | | | | | | | | | | | | | | | |
| | | | | | | 15 | SS | 5 | | | | | | | | | | | | | | | |
| 244.0 | SILT - some clay, trace sand, grey, wet, loose to very dense | | 16 | SS | WH | | 243 | | | | | | | | | | | | | | | | |
| 8.4 | | | 17 | SH | | | 242 | | | | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: 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

METRIC

| SOIL PROFILE | | | | | |
|---------------|-------------------------------|------------|-----------------|----------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES | GROUND WATER CONDITIONS | ELEVATION SCALE |
| | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT <div><div></div><div>20406080100</div></div> |
| | | | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE |
| | | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p ww _L WATER CONTENT (%) |
| | | | | | UNIT WEIGHT γ kN/m³ |
| | | | | | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| 235.8 16.6 | - trace sand, gravel | | 13 SS PM | | 242 |
| | | | | | 241 |
| | | | 14 SS WH | | 240 |
| | | | | | 239 |
| | | | NR 50/ 25 mm | | 238 |
| | | | | | 237 |
| | | | 15 SS 72 | | 236 |
| | | | 16 SS 88 | | |
| | 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

+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 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 | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|--------|------------|----------------------------|-----------------|--|----|-----|-----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 251.9 | | | | | | | | SHEAR STRENGTH kPa | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | |
| | | | | | | | | WATER CONTENT (%) | | | | | | |
| | | | | | | | | 40 | 80 | 120 | 160 | 200 | | |
| | | | | | | | | | | | | | | |
| 0.1 | ASPHALT - 60 mm | | | | | | | | | | | | | |
| | EMBANKMENT FILL - SAND - fine grained, some silt, trace to some gravel, brown, dry, loose to compact | | 1 | AS | | | | | | | | | | |
| | | | 2 | SS | 13 | | 251 | | | | | | ○ | 5 79 (16) |
| | | | 3 | SS | 24 | | 250 | | | | | | | |
| | | | 4 | SS | 10 | | 249 | | | | | | ○ | 15 69 (16) |
| | | | 5 | SS | 7 | | 248 | | | | | | | |
| | | | 6 | SS | 5 | | 247 | | | | | | | |
| 247.3 | EMBANKMENT FILL - SANDY CLAY - brown, moist | | 7A | SS | 1 | | 246 | | | | | | | |
| 247.0 | EMBANKMENT FILL - SANDY SILT - some clay, trace gravel, grey, wet, loose | | 7B | | | | 245 | | | | | | ○ | 5 38 44 12 |
| 246.6 | EMBANKMENT FILL - CLAY & SILT - occasional wood chips, grey, moist, firm to stiff | | 8 | SS | 11 | | 244 | | | | | | | |
| 5.3 | - trace sand | | 9 | SS | 6 | | 243 | | | | | | ○ | 0 6 49 45 |
| 245.0 | VARVED SILT & CLAY - trace to with sand, trace gravel, organics, grey, wet, soft to firm | | 10 | SS | 2 | | 242 | | | | | | | |
| 6.9 | | | 11 | SS | WH | | | | | | | | | |
| | | | | SHELBY | | | | | | | | | | |
| | | | 12 | SS | 1 | | | | | | | | ○ | 0 14 42 44 |
| | | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: 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 |
|-------|----------|------|-------------------------|----------|-----------|-----------|------------|------------|----|

| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|----------------|-------------|-------------|--------|------|------------|----------------------------|-----------------|---|------------------|--|---|
| | | | | | | | | PLASTIC LIMIT | MOISTURE CONTENT | | |
| | | | | | | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 40 80 120 160 200 | | | |
| | | | | | | | | WATER CONTENT (%) 20 40 60 | | | |

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

+³, ×³: Numbers refer to Sensitivity ○^{3%} 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 _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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 247.4 | | | | | | | | | | | | | | | | | |
| 0.0 | SAND & SILT - some gravel, organics, trace clay, brown | | 1 | AS | | | 247 | | | | | | | | | | |
| 246.7 | | | | | | | | | | | | | | | | | |
| 0.8 | CLAY - some organics, silt, brown/grey, wet | | 2 | AS | | | | | | | | | | | | | Organic Content 3.8 % |
| 245.9 | | | | | | | 246 | | | | | | | | | | |
| 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 | | 245 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 2 | | 244 | | | | | | | | | | Organic Content 1.4 % |
| | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 2 | | 243 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | WH | | 242 | | | | | | | | | | 0 0 91 9 Organic Content 1.3 % |
| | | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 3 | | 241 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 9 | SS | WH | | | | | | | | | | | | |
| 240.7 | | | | | | | | | | | | | | | | | |
| 6.7 | End of Borehole at 6.7 m bgs | | | | | | | | | | | | | | | | |

+ 3, X 3: 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 _P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|--|--|---------|------|------------|--|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) |
| 247.2 | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| 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 | | | | | | | | | | | |
| 245.7 | | | | | | | | | | | | | | | | | | |
| 1.5 | SILT - some clay, trace sand, brown, moist, very loose to loose |  | 3 | SS | 3 |  | 245 | | | | | | | | | | | |
| | - trace sand, gravel, moist | | | | | | | | | | | | | | | | | |
| | - trace sand, grey | | 4 | SS | 6 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | - trace sand, grey | | 5 | SS | 4 | | | 244 | | | | | | | H | o | | 0 1 77 22 |
| | | | | | | | | | | | | | | | | | | |
| | - wet | | 6 | SS | 1 | | | 243 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
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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: Fill: Sand to Sandy Silt Grain Size Distribution Curve

Figure No. L-2: Silt Grain Size Distribution Curve

Figure No. L-3: Silty Clay to Clay & Silt Grain Size Distribution Curve

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

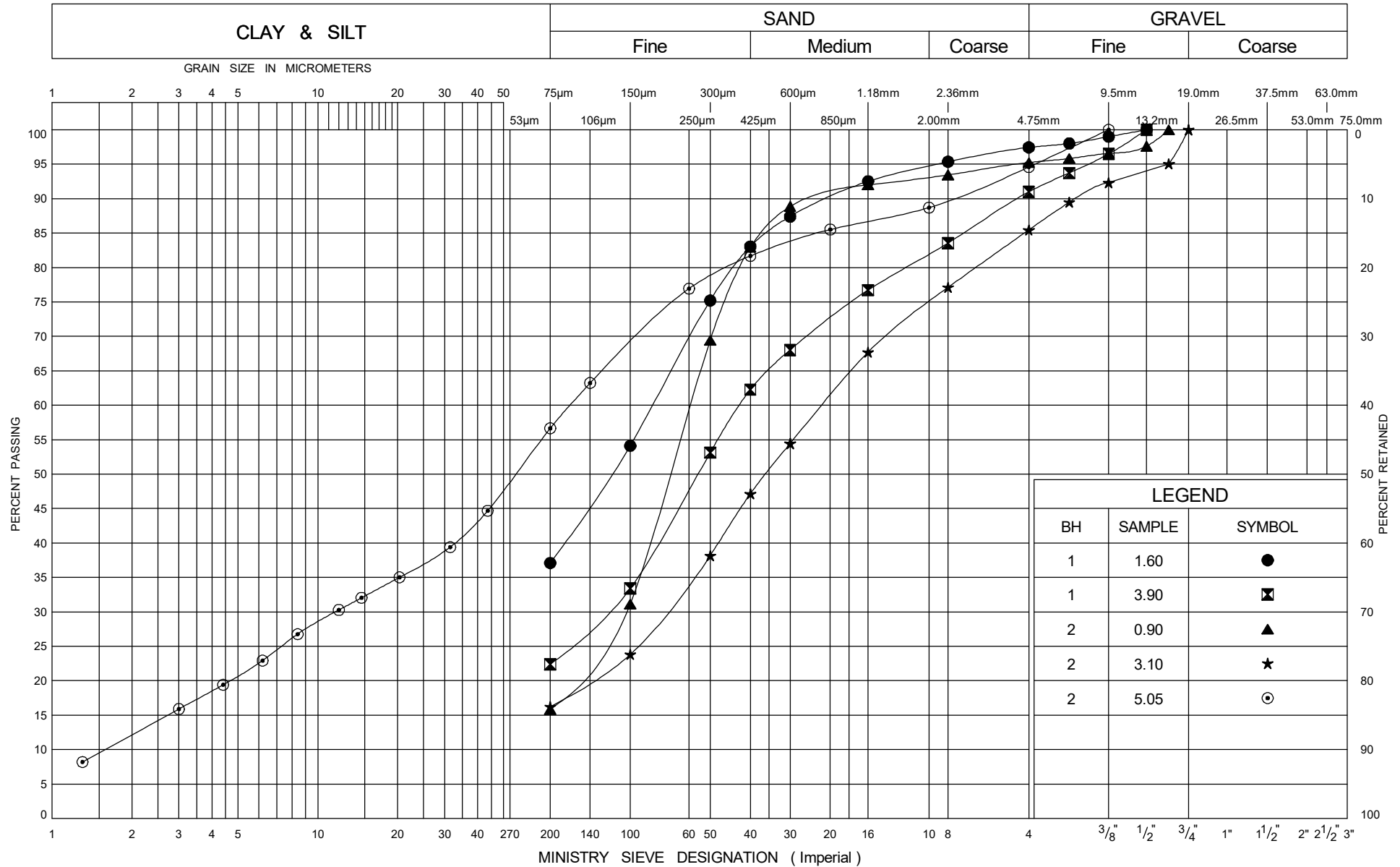
Figure No. L-5: Atterberg Limits Summary

Chemical Test Results



ENGLOBE

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

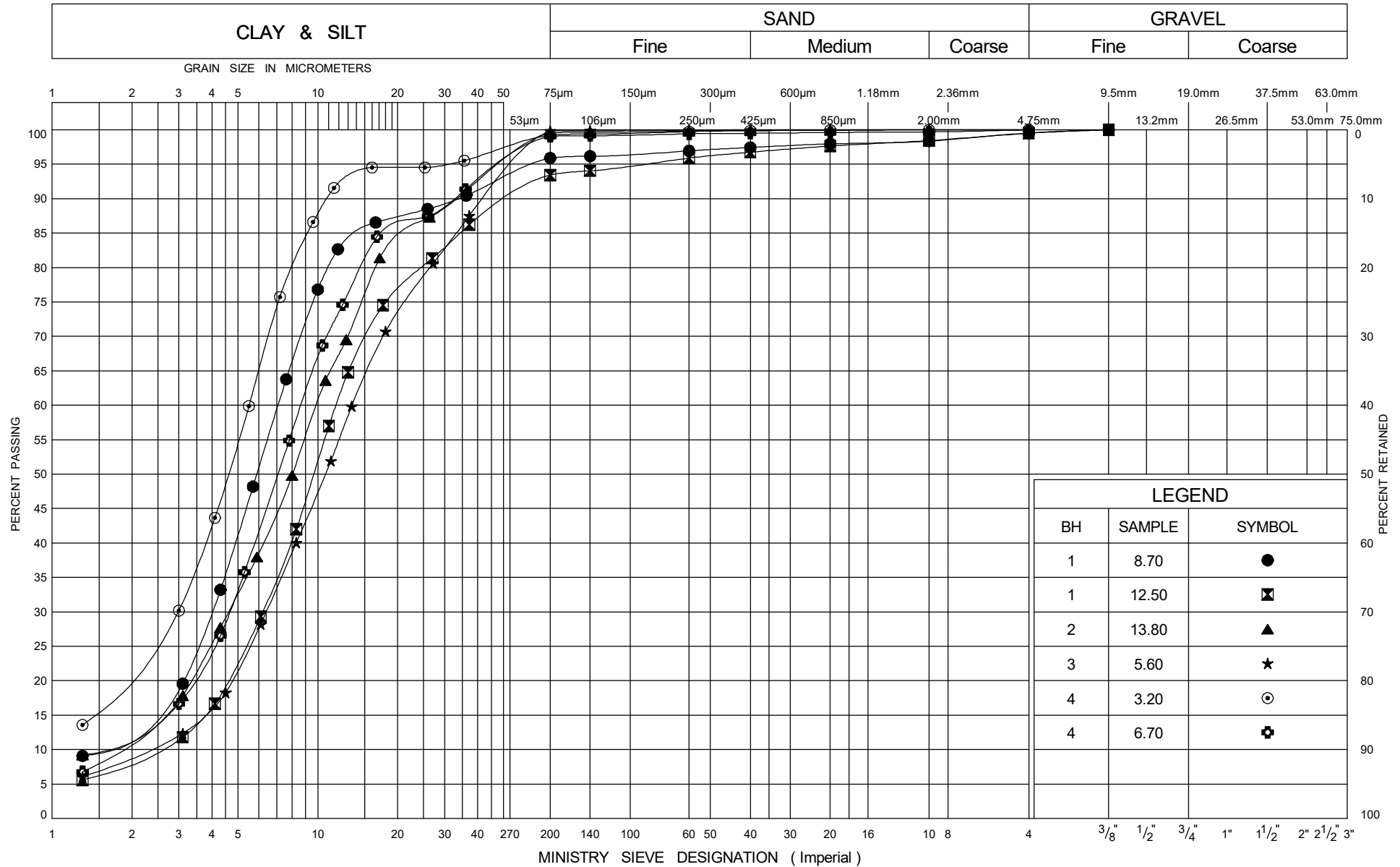
FILL - SAND to SANDY SILT

Figure No. L-1

GWP 6176-15-00

Highway 61, GWP

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

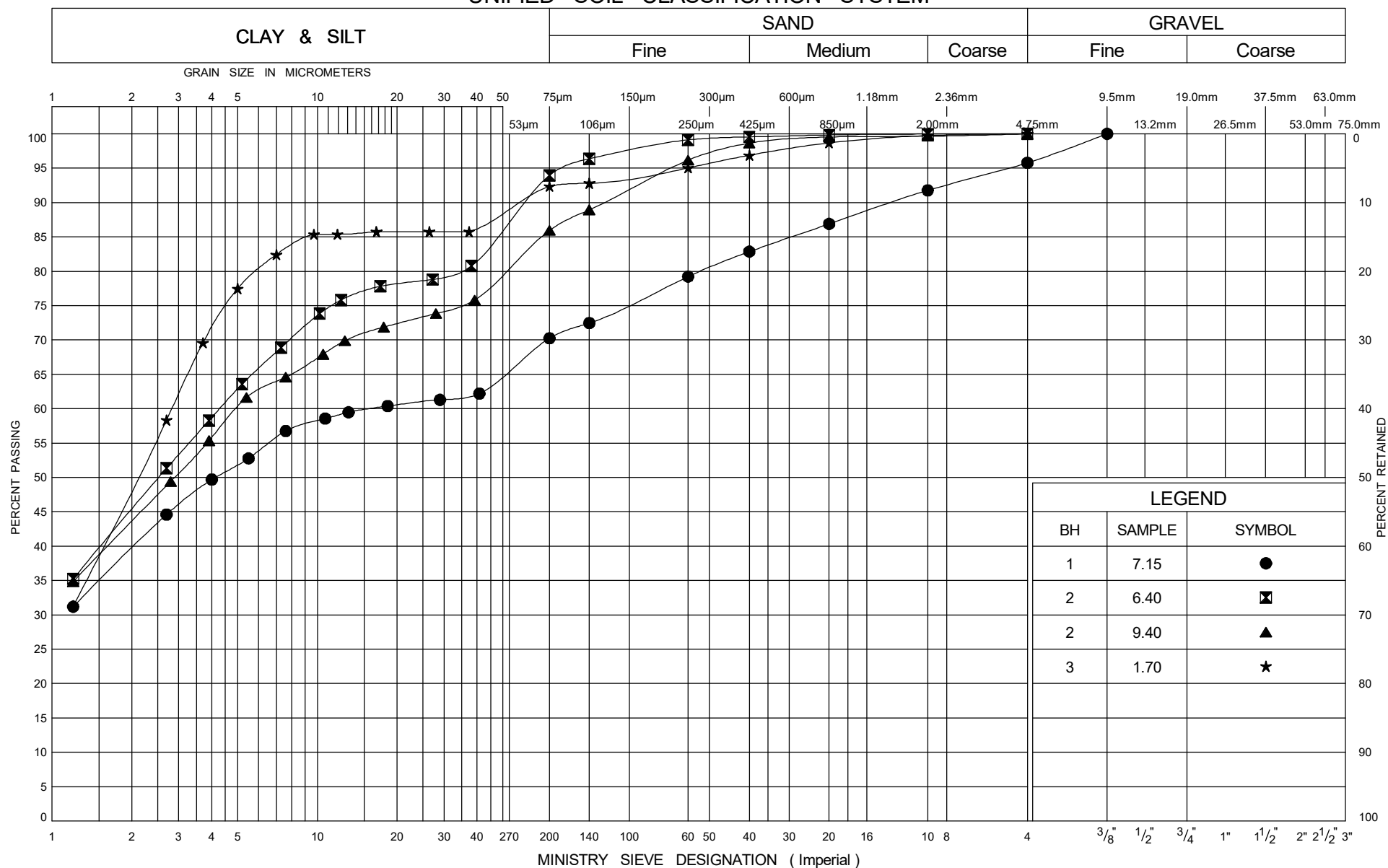
SILT

Figure No. L-2

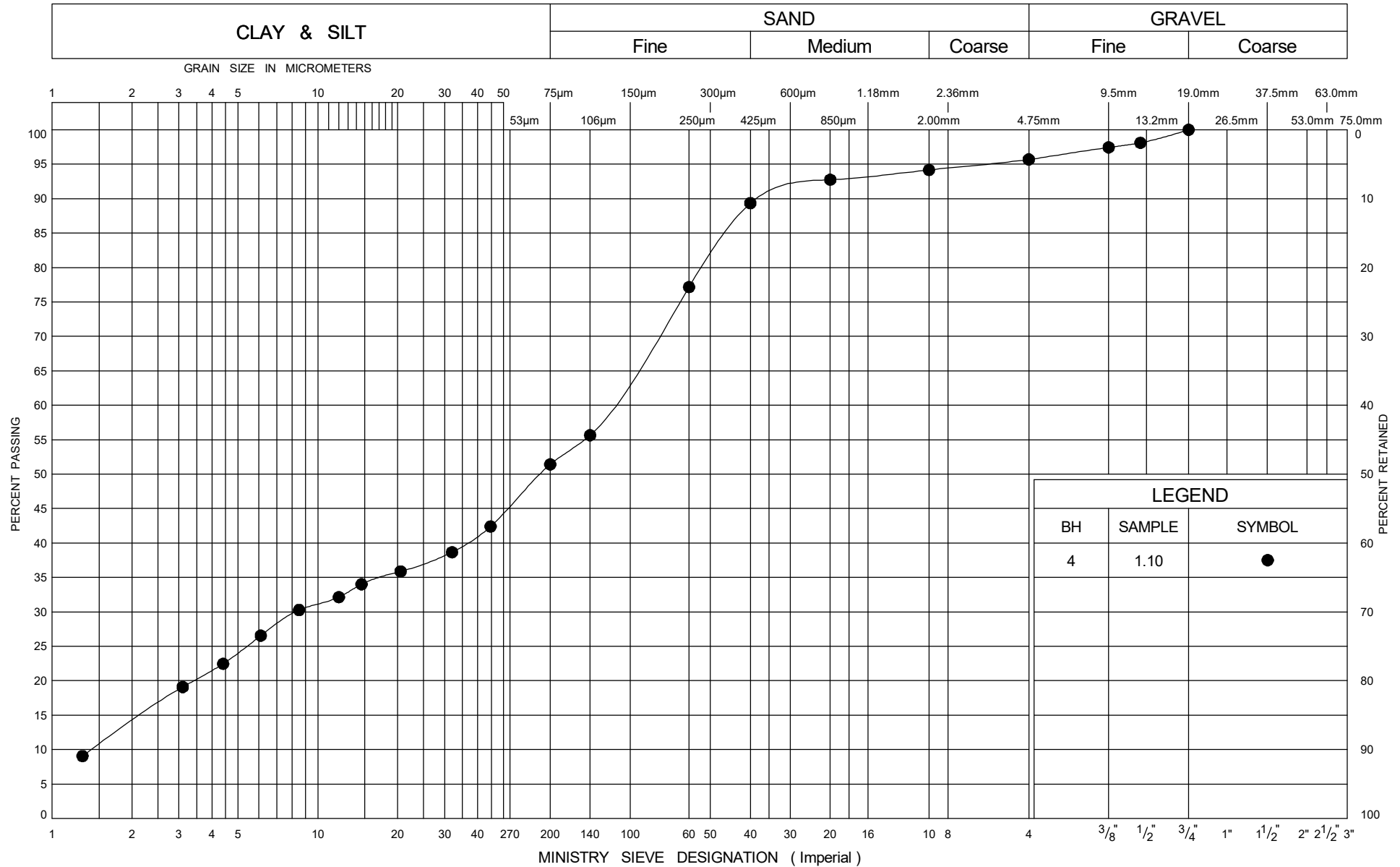
GWP #6176-15-00

Highway 61, NWR

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



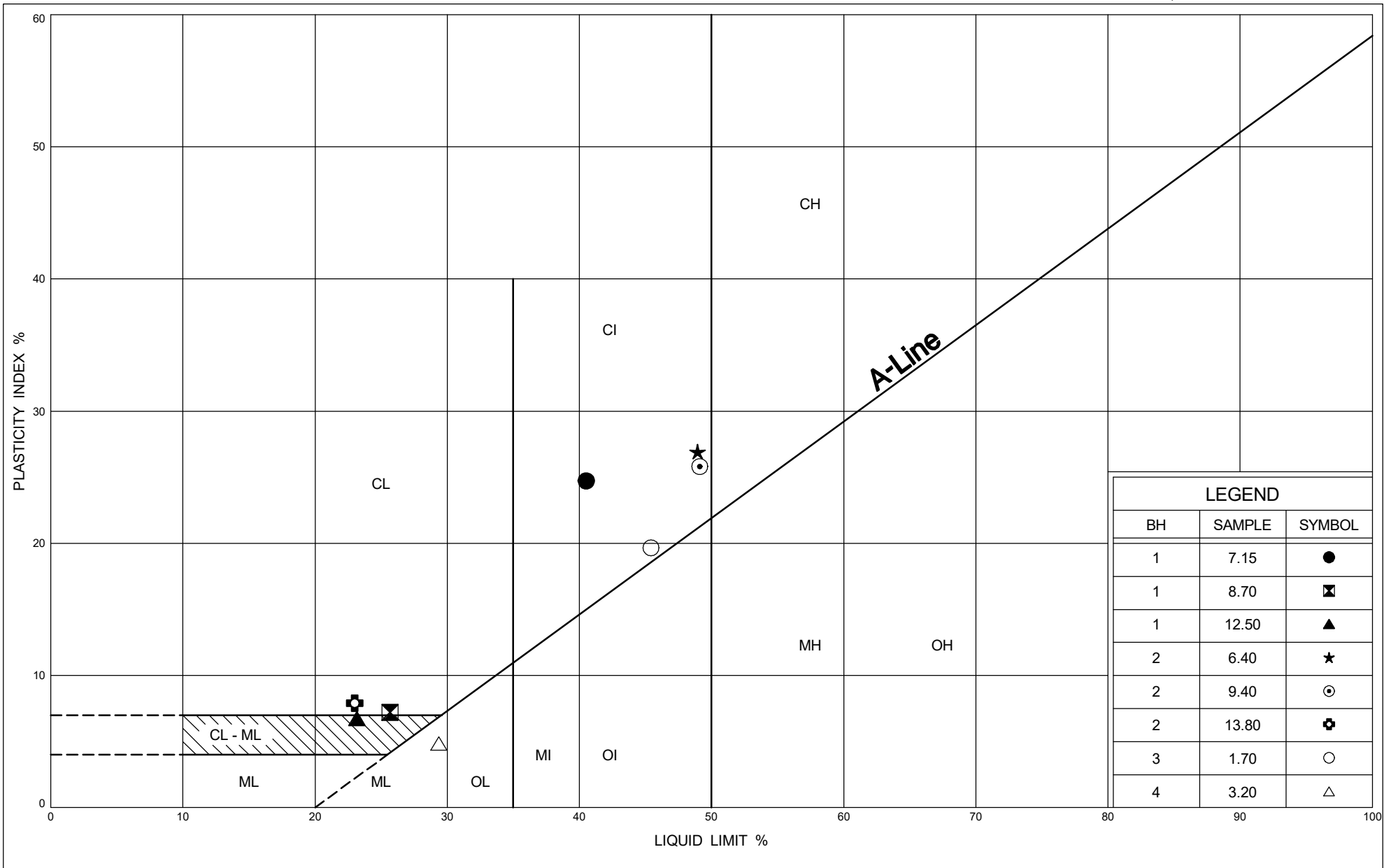
GRAIN SIZE DISTRIBUTION

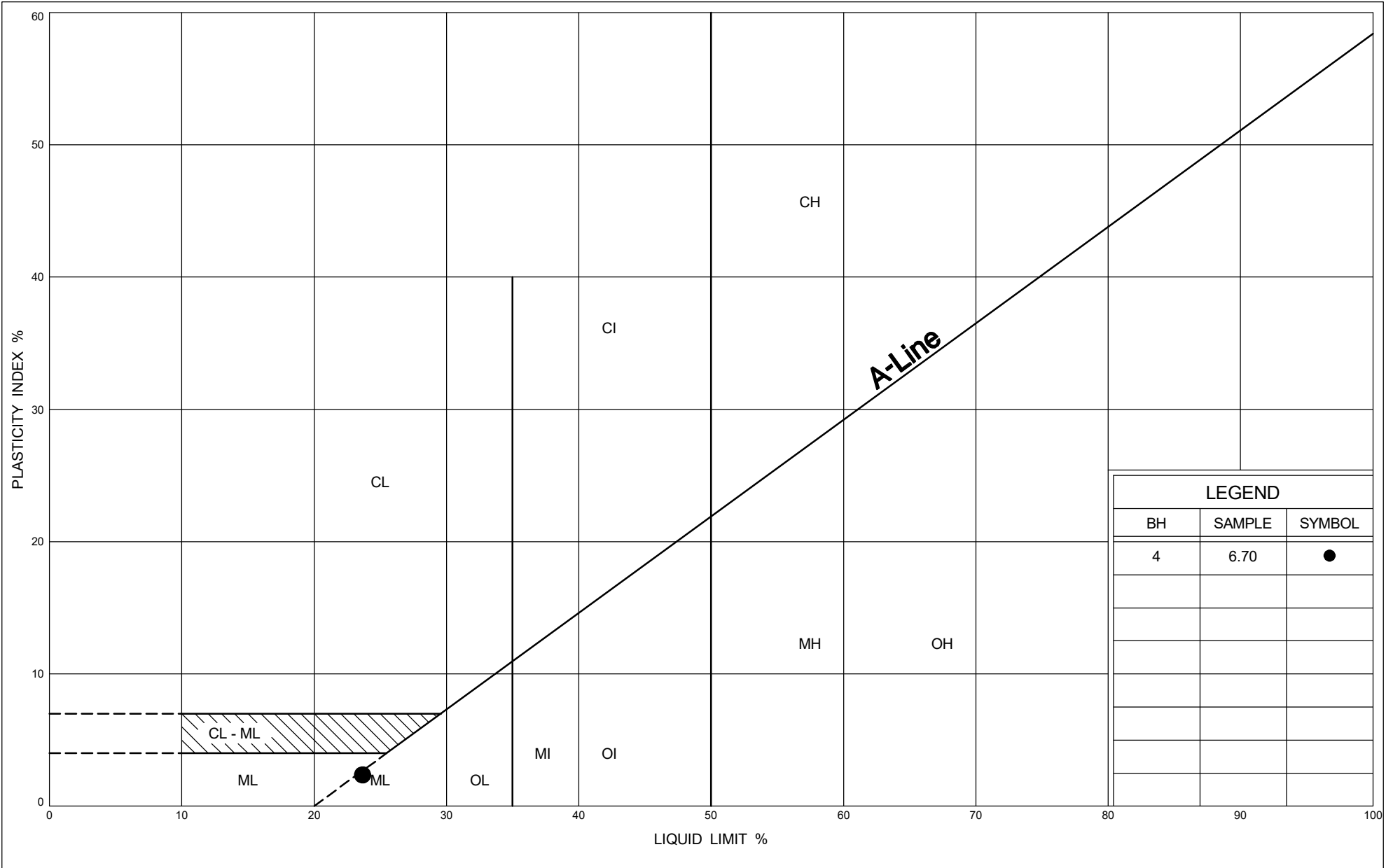
SILTY SAND

Figure No. L-4

GWP 6176-15-00

Highway 61, NWR





| LEGEND | | |
|--------|--------|--------|
| BH | SAMPLE | SYMBOL |
| 4 | 6.70 | ● |
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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

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

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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For Service Group specific validation please refer to the Validation Signature Page.



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 | | |
| | UNITS | 16+215 | RDL | QC Batch | 19+250 | RDL | QC Batch | 20+200 | RDL | QC Batch |

Calculated Parameters

| | | | | | | | | | | |
|-------------|--------|-----|--|---------|-----|--|---------|------|--|---------|
| Resistivity | ohm-cm | 740 | | 8123845 | 530 | | 8123845 | 3200 | | 8123845 |
|-------------|--------|-----|--|---------|-----|--|---------|------|--|---------|

Inorganics

| | | | | | | | | | | |
|-------------------------------|-------|------|-------|---------|------|-------|---------|------|-------|---------|
| 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 CaCl ₂ 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 CaCl ₂ 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 CaCl ₂ 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

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 |
|-----------|--------|

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 ⁻) | 2022/07/26 | 116 | 70 - 130 | 102 | 70 - 130 | <20 | ug/g | NC | 35 |
| 8130435 | Soluble (20:1) Sulphate (SO ₄) | 2022/07/26 | 127 | 70 - 130 | 107 | 70 - 130 | <20 | ug/g | NC | 35 |
| 8130626 | Available (CaCl ₂) 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 <= 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

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 | C22 | Chainage | 16+215 |
| UTM Easting | 344306.4362 | UTM Northing | 5341686.9665 |
| Description | South of the Valley Road West & Highway 61 intersection | | |

C. STRUCTURE DETAILS

Material – CSP through CTC

Dimensions – 1200 x 1200 US / 1200 x 1200 DS

Clearance (soffit to normal water level) – 500mm US and DS

High Water Mark (on structure) – Obv.

Structures (U/S / D/S of Crossing) – 1600mm DS

Debris – N/A

D. ENVIRONMENTAL CONDITIONS

Watercourse Type and Creek Material – Wetland / muck

Bank Conditions (stability) – Erosion and scour holes on both ends

Channel Dimensions (width and depth) – 3m, 3:1, 600mm deep US and DS

Observed Flow Conditions (ephemeral/permanent) – Permanent

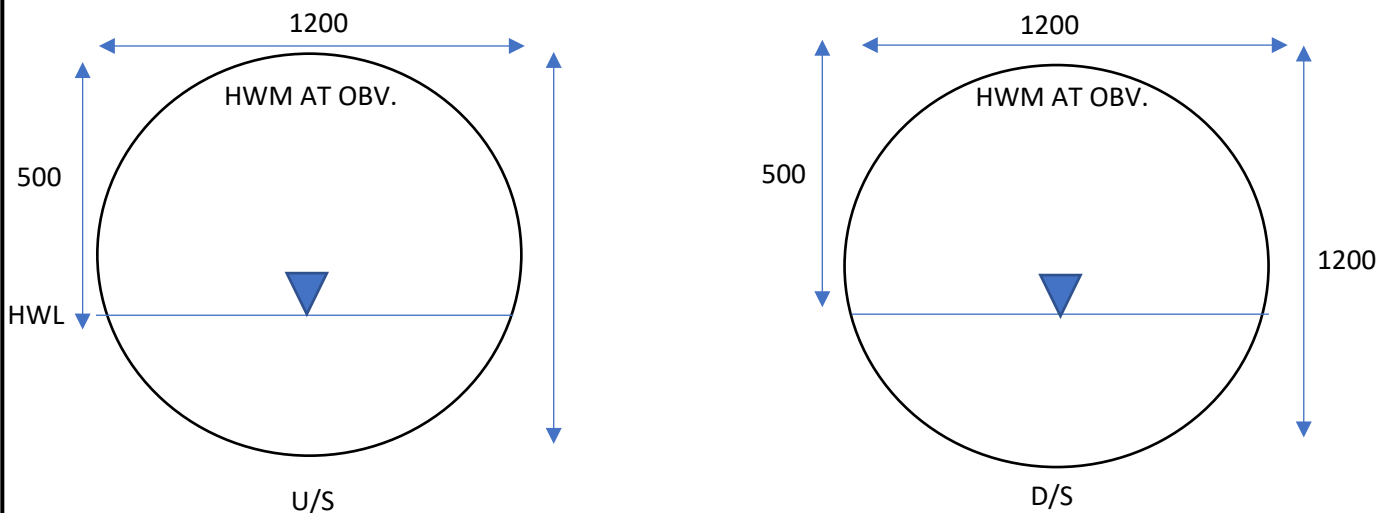
E. SITE CONDITIONS

Road Condition (sag, settlement, etc.) – OK

Physical Culvert Condition (rust, damage, etc.) – Damaged, rust and sagging

Culvert Appearance (general comments) – Replace

Site Sketch –



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

