



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 579 CULVERT REPLACEMENT AT STA 17+053**

**DISTRICT OF COCHRANE, ONTARIO
MTO ASSIGNMENT NO. 5021-E-0027
G.W.P. 5212-18-00, W.P. 5037-21-01**

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PART A: FACTUAL INFORMATION

1. INTRODUCTION

Thurber Engineering (Thurber) has been retained by McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the replacement of Clute Creek culvert on Highway 579 under Assignment No. 5021-E-0027.

This report presents the results of the foundation investigation carried out for the proposed culvert replacement at STA 17+053 on Highway 579, referred as Culvert 3, in the District of Cochrane, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert site by borehole drilling and laboratory testing and to prepare a borehole location plan, stratigraphic profiles, records of boreholes, laboratory test results, and a description of the subsurface conditions. The results of the foundation investigations at other culvert locations are presented in separate reports.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

The existing culvert is located on Highway 579, approximately 11.4 km north of the intersection with Highway 11 near Cochrane, Ontario. Details of the existing culvert are as follows:

Township and Station	Culvert Size and Type	Length of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Clute and Glackmeyer STA 17+053	3.4 m wide by 2.4 m high Twin-Cell Timber Box Culvert	17.6	247.5 (West)	247.3 (East)

The existing culvert allows flow in a west to east direction under an embankment with approximately 1.2 m of fill above the culvert obvert. The surface of the highway is at approximately Elev. 250.4 m. Locally at the culvert, the embankment slopes have a gradient of about 1.5H:1V.

Based on visual observation, no signs of slope instability were observed near the inlet and outlet of the culvert site; however, erosion of the embankment slope was observed along the north edge of the culvert near the outlet. Both the culvert inlet and outlet were surrounded by grass and other low vegetation. In addition, overhead wires are present along the west side of the highway. Site photographs taken during the foundation investigation are presented in Appendix A.

Highway 579 is comprised of two paved lanes and narrow, partially paved shoulders.

3. INVESTIGATION PROCEDURES

The foundation investigation was carried out between May 4 and May 29, 2023, and consisted of drilling and sampling five boreholes, designated as Boreholes C3-01 to C3-05, to depths of between 9.8 m and 12.8 m (Elev. 240.9 m and 237.2 m). Boreholes C3-02, C3-04, and C3-05 were advanced through the existing highway embankment, while Boreholes C3-01 and C3-03 were advanced near the toe of the embankment near the existing outlet and inlet, respectively.

The Record of Borehole sheets for the boreholes are included in Appendix B.

Utility clearances were obtained prior to mobilization to site. The ground surface elevations at the as-drilled borehole locations were surveyed using a rod and level and is referenced to temporary benchmarks at the top of the culvert inlet and outlet at Elev. 249.3 m and 249.2 m, respectively. The borehole coordinates were based on offset measurements against the highway centerline and existing culvert. The coordinate system MTM NAD 83, Zone 12 was used for the boreholes. The survey was carried out with accuracy consistent with MTO's Guideline for Foundation Engineering Services (version 3.0), date April 2022.

Boreholes C3-02, C3-04, and C3-05 were advanced using a truck-mounted CME 55 drill rig using 205 mm outside diameter hollow stem augers. Boreholes C3-01 and C3-03 were advanced using portable drilling equipment and BW casing employing wash boring technique. Soil samples were obtained at selected intervals using split-spoon samplers in general accordance with ASTM D1586.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff, who logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions observed in open boreholes are not considered stabilized due to the introduction of water throughout the drilling operations. Groundwater level readings observed

upon completion of drilling are shown on the Record of Borehole sheets. The borehole completion details are summarized below.

Borehole	Borehole Depth / Borehole Termination Elevation (m)	Northing and Easting MTM NAD83 Zone 12	Completion Details
C3-01	11.3 / 237.2	N 5 445,067.7 E 299,391.9	Backfilled with bentonite to surface.
C3-02	12.8 / 238.0	N 5,445,050.9 E 299,378.0	Monitoring well decommissioned and borehole backfilled with bentonite and asphalt patch at surface.
C3-03	10.9 / 238.1	N 5,445,041.7 E 299,369.0	Backfilled with bentonite to surface.
C3-04	12.8 / 238.0	N 5,445,043.3 E 299,376.4	Backfilled with bentonite and asphalt patch at surface.
C3-05	9.8 / 240.9	N 5,445,065.4 E 299,380.2	Backfilled with bentonite and asphalt patch surface.

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were subjected to grain size distribution analysis and/or Atterberg Limits testing. The results of this testing program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures in Appendix C.

Testing was carried out on a sample of the native soil to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements of the structures. The results of the analytical testing are summarized in this report and presented in Appendix C.

4. SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Site Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies near a transition between an outwash plain and ground moraine, which are comprised of tills, clays, and sands.

4.2 Subsurface Conditions

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and interpreted stratigraphic profile and section are presented on the

Borehole Locations and Soil Strata Drawings in Appendix D. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following sections. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. Classification and descriptions of coarse- and fine-grained soils are made in accordance with ASTM D2487, and MTO's Soil Classification Manual (as amended), respectively.

The results of in-situ testing (i.e., standard penetration testing) as presented in the record of boreholes and in the following sections are uncorrected. The boundaries between soil deposits on the record of boreholes have been inferred from non-continuous sampling, observation of the progress of drilling, and the results of Standard Penetration Testing. Therefore, the boundaries represent the transitions between soil deposits rather than exact planes of geological change. Variation on the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface conditions encountered consisted of embankment fill comprised of gravel sand to silty sand, underlain by native deposits of organic silt, which in turn is underlain by silty clay, silt, sand to silty sand, and gravel to gravelly sand.

4.3 Asphalt

Boreholes C3-02, C3-04, and C3-05 were advanced through the paved portion of Highway 579, and the thickness of the asphalt was measured to be 25 mm at each borehole location.

4.4 Topsoil

A 65 mm and 25 mm thick layer of topsoil was encountered at ground surface at Borehole C3-01 and Borehole C3-03, respectively. The topsoil thickness may vary in other areas of the site.

4.5 Embankment Fill

Granular embankment fill was encountered below the asphalt in Boreholes C3-02, C3-04, and C3-05 and is comprised of gravelly sand, trace fines, to silty sand, some gravel to gravelly.

The embankment fill ranged in thickness from 2.5 m to 3.0 m and extends to depths of between 2.5 m and 3.0 m (Elev. 248.3 m and 247.8 m).

In general, SPT 'N' values recorded in the embankment fill ranged from 32 blows per 0.3 m penetration to 94 blows per 0.28 m of penetration, indicating a dense to very dense condition.

However, SPT 'N' values between 8 blows and 14 blows per 0.3 m of penetration were also recorded in the fill immediately above the underlying organic silt, indicating the fill is loose to compact in places. The measured moisture contents generally ranged from 3 per cent to 15 per cent.

The results of grain size analyses carried out on selected samples of the embankment fill are shown on the Record of Borehole sheets in Appendix B and presented in Figure C1 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	12 to 27
Sand	60 to 66
Silt	8 to 18
Clay	2 to 4

4.6 Organic Silt

A 1.2 m to 2.4 m thick deposit of organic silt, some sand to sandy containing rootlets and wood fragments was encountered below the topsoil in C3-01 (Elev. 248.4 m) and C3-03 (Elev. 249.0 m), and below the embankment fill in Boreholes C3-02, C3-04, and C3-05 between depths of 2.5 m and 3.0 m (Elev. 248.3 m to 247.8 m).

SPT 'N' values recorded in the organic silt ranged from 2 blows to 20 blows per 0.3 m of penetration, indicating a very loose to compact condition. The measured moisture contents were typically between 28 per cent and 90 per cent, with moisture contents as low as 14 per cent to 20 per cent. Organic contents measured on two samples from this deposit are each about 10 per cent.

The result of grain size analysis carried out on a sample of the organic silt is shown on the Record of Borehole sheets in Appendix B and presented in Figure C2 of Appendix C. The result is summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	19
Silt	56
Clay	25

The result of the Atterberg Limits test carried out on a sample of the organic silt deposit is shown on the Record of Borehole logs in Appendix B and presented in Figure C3 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	52
Plastic Limit	31
Plastic Index	21

The results of the Atterberg Limits testing indicate the material is organic silt of high plasticity (OH).

4.7 Silty Clay

A deposit of silty clay, trace sand was encountered below the organic silt layer in Borehole C3-01 at a depth of 1.2 m (Elev. 247.3 m).

SPT 'N' values recorded in the silty clay ranged from 4 blows to 11 blows per 0.3 m of penetration, indicating a firm to stiff condition. The measured moisture contents were typically between 30 per cent and 35 per cent.

The result of grain size analysis carried out on a sample of the silty clay is shown on the Record of Borehole sheets in Appendix B and presented in Figures C4 of Appendix C. The result is summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	10
Silt	57
Clay	33

The result of the Atterberg Limits test carried out on a sample of the silty clay are shown on the Record of Borehole logs in Appendix B and presented in Figure C5 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	40
Plastic Limit	20
Plastic Index	20

The results of the Atterberg Limits testing indicate the material is silty clay of intermediate plasticity (CI).

4.8 Silt

A 1.8 m to 5.1 m thick deposit of silt, trace sand to sandy, was encountered below the organic silt in Borehole C3-01, C3-02, and C3-05 between depths of 3.0 m and 4.3 m (Elev. 246.7 m to 245.5 m).

SPT 'N' values recorded in the silt ranged from 0 blows (i.e., weight of hammer) to 17 blows per 0.3 m of penetration, indicating a very loose to compact condition. The measured moisture contents generally ranged between 14 per cent and 42 per cent.

The results of grain size analyses carried out on samples of the silt are shown on the Record of Borehole sheets in Appendix B and presented in Figure C6 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	1
Silt	79 to 85
Clay	14 to 20

The results of the Atterberg Limits tests carried out on two samples of the silt are shown on the Record of Borehole logs in Appendix B and presented in Figure C7 of Appendix C. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	22 and 23
Plastic Limit	19 and 21
Plastic Index	2 and 4

The results of the Atterberg Limits testing indicate the material is silt of low plasticity (ML).

4.9 Gravelly Sand to Silty Sand

A deposit of gravelly sand to silty sand, trace gravel to gravelly, was encountered below the silt deposit in Boreholes C3-01, C3-02, and C3-05 between depths of 6.1 m to 9.1 m (Elev. 244.7 m to 241.6 m) and below the organic silt in Borehole C3-03 and C3-04 at depths 2.4 m (Elev. 246.6 m) and 3.7 m (Elev. 247.1 m), respectively.

SPT 'N' values recorded in the gravelly sand to silty sand ranged from 10 blows per 0.3 m penetration to 100 blows per 0.08 m of penetration, indicating a compact to very dense condition. However, SPT 'N' values of 4 blows and 8 blows per 0.3 m of penetration were also recorded in the sand in Borehole C3-04, indicating the deposit is loose in places. The measured moisture contents ranged from 15 per cent to 24 per cent.

The results of grain size analyses carried out on samples of the gravelly sand, and sand to silty sand are shown on the Record of Borehole sheets in Appendix B and presented in Figures C8 and C9 of Appendix C, respectively. The results are summarized as follows:

Soil Particle	Percentage (%) Gravelly Sand	Percentage (%) Sand to Silty Sand
Gravel	21 to 30	0 to 10
Sand	66 to 73	84 to 96
Silt	3 to 5	2 to 13
Clay	0 to 1	1 to 3

4.10 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling are presented on the record of boreholes and summarized below.

Borehole	Date of Measurement	Groundwater Level (m)		Remark
		Depth	Elevation	
C3-01	May 29, 2023	4.0	244.5	Upon completion of drilling. ^{1,2}
C3-02	May 8, 2023	1.6	249.2	Measured from monitoring well.
C3-03	May 28, 2023	3.3	245.7	Upon completion of drilling. ^{1,2}
C3-04	May 7, 2023	1.6	249.2	Upon completion of drilling. ^{1,2}
C3-05	May 4, 2023	6.0	244.7	Upon completion of drilling. ^{1,2}

Notes:

1. Water level measured in casing / hollow stem augers.
2. Introduced water into borehole for drilling with wash boring methods and therefore, measured in casing may not be representative of the natural groundwater level.

The water level in the culvert shown on the General Arrangement Drawing was at Elev. 248.7 m (November 2022), which is about 1.2 m and 1.4 m above the creek bed at the inlet and outlet, respectively. At the time of the investigation (May 2023), the water level in the creek was observed to be at about Elev. 247.6 m.

The water levels measured in the borehole upon completion of drilling, monitoring well, and creek are short-term observations and subject to seasonal fluctuations. In particular, the water levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

5. ANALYTICAL LABORATORY TESTING

One sample of the native sandy organic silt was submitted for analytical testing for corrosivity analysis and sulphide content. The analytical test results for the soil are presented in Appendix C and are summarized below.

Borehole	C3-02
Sample	SS6A
Depth (m)	3.8 – 4.3
Elevation (m)	247.0 – 246.5
Sulphide (Na ₂ CO ₃) %	0.12
Chloride (µg/g)	7.1
Sulphate (µg/g)	180
pH	7.92

Borehole	C3-02
Sample	SS6A
Conductivity ($\mu\text{S/cm}$)	210
Resistivity (Ohm-cm)	4,760

6. MISCELLANEOUS

Downing Drilling Ltd. of Hawkesbury, Ontario, and OGS of Almonte, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the foundation investigation. The investigation was supervised on a full-time basis by Mr. Sergey Gladkiy, B.A.Sc. The overall management of the field program was conducted by Ms. Alysha Kobylinski, P.Eng.

Geotechnical laboratory testing on soil samples was carried out in Thurber's geotechnical laboratory. Organic content testing and corrosivity testing on the organic silt deposit was carried out by SGS Canada Inc., a CALA accredited analytical laboratory in Guelph, Ontario.

Interpretation of the field data and preparation of this report was carried out by Ms. Alysha Kobylinski, P.Eng., and was reviewed by Messrs. Christopher Ng, P.Eng., and Jason Lee, P.Eng.

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PART B: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This report provides an interpretation of the geotechnical data in the foundation investigation report and presents foundation design recommendations for the proposed culvert replacement at STA 17+053 on Highway 579, referred to as Culvert 3, on Highway 579 in the District of Cochrane, Ontario.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, Ontario, and the designer to carry out the culvert replacement and shall not be used or relied upon for any other purposes or by any other parties including the constructor or design-build contractor. The constructor or contractor must make their own interpretation based on the data provided in factual portion of the report (Part A).

Where comments are made on construction, they are provided to highlight those aspects which could affect the design of the project. The constructor or contractor must make their own interpretation of the factual data as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

The highway embankment is up to about 3.0 m high at the existing culvert location (approximately 1.2 m of fill above the culvert obvert) and as such, the proposed replacement box culvert is intended to be installed by open cut methods. It is understood that Highway 579 will be under full closure from traffic during construction and therefore, temporary roadway protection systems will not be required.

The existing structure is a 3.4 m wide by 2.4 m high Twin-Cell Timber Box Culvert, with inlet and outlet inverts at approximate Elev. 247.4 m. The existing highway grade at the culvert is at approximately Elev. 250.4 m. The local creek water level was measured at about Elev. 247.6 m in May 2023.

Based on the General Arrangement (GA) Drawing dated May 2023, it is understood that the existing culvert will be replaced by a concrete box culvert generally along the same alignment. The proposed type, size, length, and invert elevations from the GA Drawing are summarized below.

Culvert Type	Culvert Size (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Precast Concrete Box	4.2 (wide) 3.0 (high) 20.9 (long)	247.0 (West)	246.9 (East)

8. SUB-EXCAVATION, AND BACKFILLING

The very loose to compact organic silt, and firm to stiff silty clay deposit at and immediately below the invert level is not suitable for the support of the proposed culvert. As such, it is recommended that the materials be sub-excavated to Elev. 246.0 m and be replaced by granular backfill. Both the sub-excavation and backfilling operations should be carried out in accordance with OPSS.PROV 902, and in dry conditions.

As a minimum, the base of sub-excavation should extend 0.5 m beyond the edge of the proposed culvert. The base of the sub-excavation should be inspected and approved by qualified geotechnical personnel, and any softened/loosened or poorly performing areas of the subgrade should be removed and replaced with compacted granular fill as directed.

Prior to backfilling, non-woven geotextile meeting the specifications for the OPSS.PROV 1860 Class II and have a maximum fabric opening size (FOS) 75 µm should be placed at the base of the excavation.

The granular backfill meeting the specification of OPSS.PROV 1010 Granular 'A' or 'B' Type II should be placed and compacted in accordance with OPSS.PROV 501 as amended by Special Provision 105S22.

9. TEMPORARY EXCAVATIONS, AND PROTECTION SYSTEMS

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA). The sand to gravelly sand to silty sand embankment fills above the groundwater level are classified as a Type 3. Below the groundwater level, the embankment fills and all native soils (i.e., very loose to compact organic silt, loose to compact silt, and firm to stiff silty clay) are classified as Type 4 soil. For Type 3 soils, temporary cut slopes should have a gradient of 1H:1V or flatter and while Type 4 soils should have a gradient of 3H:1V or flatter. Alternatively, excavations could be supported with temporary protection systems.

Consideration should be given to protecting the temporary cut slopes from precipitation and runoffs during construction to avoid erosion and surficial instability. Stability of the highway embankment and temporary cut slopes are the responsibility of the contractor.

Excavated material must be stockpiled at a distance away from the excavation equal to or greater than the depth of the open cut excavation. The selection and operation of heavy construction equipment near the open cut excavation are the contractor's responsibility. Stockpiling of excavated material and the operation of construction equipment must not destabilize the embankment.

Where required, temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539, as amended by Special Provision 105S09. The lateral movement of the temporary protection systems shall meet Performance Level 2 as specified in OPSS.PROV 539, provided that any existing adjacent utilities (where present) can tolerate the associated magnitude of deformation. The selection, design, installation, and maintenance of protection systems are the responsibility of the contractor.

The soil parameters presented below may apply for the design of temporary roadway protection systems with horizontal backfill.

Stratigraphic Unit	Unit Weight of Material, γ' (kN/m ³)	Angle of Internal Friction, ϕ (kN/m ³)	Coefficient of Static Lateral Earth Pressure	
			Active, K_a	Passive, K_p
Existing Embankment Fill	21	32	0.31	3.3
Organic Silt	16	20	0.49	2.0
Sandy Silt to Silt	19	30	0.33	3.0
Silty Clay	18	28	0.36	2.8
Sand to Silty Sand	19	32	0.31	3.3
Gravelly Sand	19	35	0.27	3.7

Notes:

1. The lateral earth pressure coefficients presented above are based on static loading conditions and level backfill/ground surface behind the protection system. Where there is sloping ground behind the protection system, the coefficient of lateral earth pressure must be adjusted to account for the slope.
2. The total passive resistance below the base of excavation, if required, may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (CHBDC, 2019) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

In accordance with OPSS.PROV 539, should the temporary protection systems be left in place after completion of construction, the top shall be removed to at least 1.2 m below the finished grade or ground level, or at least 0.6 m below the streambed.

10. SUBGRADE PREPARATION, BEDDING, COVER, AND BACKFILL

Upon the completion of the removal of unsuitable foundation soils, the subgrade should be inspected and approved by qualified geotechnical personnel. Protection of the silt and silty clay subgrade should include installation of a non-woven geotextile on the subgrade prior to the placement of bedding material. The geotextile should meet the specifications for the OPSS.PROV 1860 Class II and have a maximum fabric opening size (FOS) of 75 μ m.

The bedding, cover, and backfill should be placed in loose lifts not exceeding 200 mm, and compacted in accordance with OPSS.PROV 501, as amended by Special Provision 105S22. For a precast concrete box culvert, a minimum 75 mm thick uncompacted levelling course should be placed over a 300 mm thick layer of prepared bedding. In accordance with OPSS.PROV 902, backfill should be placed and compacted in simultaneous equal lifts on both sides of the culvert and the top of backfill elevations should be within 500 mm on both sides of the culvert during backfilling. The bedding material should be placed and compacted as soon as practical following inspection and approval of the final subgrade. Construction equipment should not be allowed to travel on the prepared subgrade, which should be protected from disturbance during construction.

The bedding, levelling, cover, and backfill materials should consist of OPSS.PROV 1010 Granular 'A' or 'B' Type II with 100% passing the 26.5 mm sieve.

In accordance with OPSD 3090.100, the depth of frost penetration at this site is approximately 2.5 m.

11. GEOTECHNICAL RESISTANCES

The following geotechnical resistances may be used for the design of the proposed culvert, and have been estimated considering sub excavation and replacement of material with granular to Elev. 246.0 m:

Structure	Founding Condition	Factored Ultimate Geotechnical Resistance (kPa)	Factored Serviceability Geotechnical Resistance for 25 mm of Settlement (kPa)
4.2 m wide Pre-Cast Concrete Box Culvert at STA 17+053	OPSS.PROV 1010 Granular 'A' or 'B' Type II subbase	350	125

The factored geotechnical resistances provided above are based on the following factors from Canadian Highway Bridge Design Code (CHBDC) 2019, Section 6.9:

Factor	Value for Typical Consequence Level and Degree of Understanding
Consequence Factor, Ψ	1.0
Ultimate Geotechnical Resistance Factor, ϕ_{gu}	0.5
Serviceability Geotechnical Resistance Factor, ϕ_{gs}	0.8

It should be noted that the factored ultimate and serviceability geotechnical resistances are dependent on the width of the culvert and the foundation elevation and as such, the geotechnical resistances should be reviewed if the culvert dimensions or founding conditions differ from those specified.

Resistance to lateral loads (i.e., sliding resistance) between the concrete footing and the subgrade should be calculated in accordance with Section 6.10.4 of the CHBDC (2019). The following unfactored coefficient of friction that may be used for design.

Culvert and Subgrade Interface	Coefficient of Friction, $\tan\phi'$
Pre-Cast Concrete Box Culvert on Compacted Granular 'A' Bedding	0.50

The culvert should be designed to resist external loadings including frost forces, lateral earth pressures, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment.

12. CONTROL OF GROUNDWATER AND SURFACE WATER

Observations of water level in the monitoring well indicates the groundwater table will be above the invert of the proposed culvert.

If conditions at the time of construction are similar to those observed during the investigation, pumping from filtered sumps within a temporary cofferdam may be adequate to maintain groundwater from entering the excavations. The dewatering system must be effective to maintain the water level at a minimum of 0.5 m below the base of the excavation to allow for the compaction of backfill, bedding, and cover in dry conditions. In addition, the dewatering system must remain operational until the culvert is installed and backfilled. The design and implementation of the dewatering system is the responsibility of the contractor.

The dewatering system is to be designed in accordance with OPSS.PROV 517, as amended by Special Provision 517F01. Considering the excavation will extend down below the observed groundwater level, a design Engineer and design-checking Engineer with a minimum of 5 years of experience in designing systems of similar nature and scope to the required work is required, and thus Designer Fill-In ***** in Special Provision 517F01 should be "Yes". This recommendation is based on the groundwater conditions observed during the investigation. As noted above, groundwater levels change and should be checked prior to and during the work.

Groundwater taking for construction dewatering is governed by the Ontario Water Resources Act (OWRA), Environmental Protection Act (EPA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

If the water taking rate for this project will be greater than 50,000 L/day and less than 400,000 L/day, registration on the Environmental Activity and Sector Registry (EASR) is required. If the water taking rate will be greater than 400,000 L/day, a Category 3 Permit-To-Take Water (PTTW) is required. The rate of water taking should be assessed by a qualified hydrogeologist once the preferred culvert installation method has been selected.

The groundwater level will fluctuate and the minimum groundwater elevation for the site at the time of the proposed works should be taken as the water level from the design storm period defined by the Contract Documents.

13. STREAM DIVERSION PIPE AND COFFERDAMS

A temporary stream diversion pipe will be required during construction to divert the flow of creek water away from the area of the new culvert to allow for construction in dry conditions. It is anticipated that the invert level of the diversion pipe, will be at or below Elev. 247.3 m.

The temporary diversion pipe should be installed in accordance with OPSD 802.010 and be placed on a minimum 300 mm thick layer of bedding material meeting the specification of OPSS.PROV 1010 Granular 'A' or 'B' Type II in dry conditions. The bedding material should be placed on the prepared subgrade as soon as practical, following inspection and approval by qualified geotechnical personnel. The prepared subgrade should be protected from disturbance during construction.

Due to the required depth of sub-excavation for the replacement of unsuitable foundation soils, interlocking sheet piles cofferdam is likely the preferred option for a temporary cofferdam system. The temporary cofferdams that may be used at the site should be designed and constructed in accordance with OPSS.PROV 539, as amended by Special Provision 105S09. The lateral movement of temporary cofferdam systems should include an evaluation of base stability and hydraulic uplift as defined in the Canadian Foundation Engineering Manual (CFEM, 2006). The contractor is responsible for the design and construction of temporary cofferdam systems.

Refer to Section 0, for engineering parameters that may be used for the design of temporary cofferdams.

14. SCOUR AND EROSION PROTECTION

The contractor shall provide silt fences and erosion control blankets as per OPSS.PROV 805 and OPSD 219.110 throughout the duration of construction to prevent transport of silt/sediment from entering the creek.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the embankment slopes. A vegetation cover shall be established on exposed earth surfaces to protect against surficial erosion in accordance with OPSS.PROV 803.

Scour and erosion control should be provided at the new culvert inlet and outlet areas. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by a specialist experienced in this field. In accordance with OPSS.PROV 511, rock protection should be provided over all surfaces subjected to flowing water.

Treatment at the outlets should be in accordance with OPSD 810.010.

It is recommended that a clay seal or a concrete cut-off wall be used to ensure that water is channelled through the culvert, reducing the potential for piping and erosion around the culvert. The clay seal should be continuous and have a minimum compacted thickness of 500 mm, constructed to approximately 300 mm above the high water level, and extend laterally for the width of the granular backfill. The material used for the clay seal should conform to the requirements stipulated in OPSS 1205. Alternatively, a geosynthetic clay liner could be considered for use as a clay seal.

15. EMBANKMENT REINSTATEMENT

Embankment reinstatement after construction of the proposed culvert should be carried out in accordance with OPSS.PROV 206 with embankment side slope reconstructed to 2H:1V or flatter provided that OPSS.PROV 1010 Granular B Type I or II is used for the reinstatement. The fill placement and compaction should be carried out in accordance with OPSS.PROV 501.

It is understood that the embankment envelope will require a minor re-profiling of the embankment slopes but will remain essentially unchanged (i.e., without the need for grade raise or embankment widening). As a result, foundation settlement is expected to be less than 25 mm.

The magnitude of the embankment self-compression constructed with granular materials is in the order of 0.5% of the newly reconstructed embankment height and is expected to occur predominantly during fill placement.

16. CORROSION POTENTIAL

Based on results of corrosivity testing on a sample of the sandy organic silt, the following statements can be made in reference to the MTO Gravity Pipe Design Guideline. However, it should be noted that effects of road de-icing salts/chemicals should be considered when selecting pipe material and/or corrosion mitigation measures.

- The resistivity of the sandy organic silt was measured to be 4,760 ohm-cm, which indicates the soil has a low corrosion potential ($6,000 \text{ ohm-cm} > R > 4,500 \text{ ohm-cm}$) according to Table 3.2 of the MTO Gravity Pipe Design Guideline.
- The sulphate concentration of the sandy organic silt was measured to be 180 µg/g, which is considered to have a negligible degree of sulphate attack on concrete according to Table 7.2 of the MTO Gravity Pipe Design Guideline.

- The pH level of the sandy organic silt was measured to be 7.92, and according to Section 7.1.1 of the MTO Gravity Pipe Design Guideline, pH levels between 5.5 and 8.5 in soil or water are not considered detrimental to the durability of the culvert.

17. CONSTRUCTION CONCERNS

During construction, qualified geotechnical personnel should be retained to observe activities related to the culvert replacement and advise the Contract Administrator on construction concerns related to performance of the embankment and instability of slopes.

Potential construction concerns include, but are not necessarily limited to:

- The complete removal and replacement of unsuitable foundation soils with compacted granular backfill as outlined in the preceding sections.
- A dewatering system must be implemented to avoid the instability/boiling of the base of the excavation. In addition, the dewatering system must be effective to maintain the water level at a minimum of 0.5 m below the base of the excavation to provide a dry subgrade for the proper compaction of backfill and bedding.
- Disturbance of subgrade soil. Where fine-grained soils are exposed at the culvert subgrade, these areas will become softened and moisture sensitive and may become heavily disturbed when subjected to construction traffic. Construction traffic must not be allowed on the final silt and silty clay subgrade. The final subgrade should be protected with geotextile and granular bedding materials.
- Buried obstructions may be encountered during construction and interfere with excavations, installation of temporary protection systems and cofferdams.

18. CLOSURE

Preparation of the design report and engineering analysis was carried out by Ms. Alysha Kobylinski, P.Eng., and Mr. Christopher Ng, P.Eng., which was reviewed by Mr. Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Alysha Kobylinski, P. Eng.
Geotechnical Engineer



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Associate, Senior Geotechnical Engineer



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Partner, Senior Geotechnical Engineer
Designated MTO Contact

Date: **February 1, 2024**
File: **33730-C3**

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



APPENDIX A SITE PHOTOGRAPHS



Photograph #1 – Highway 579 culvert outlet at the east embankment toe. (May 2023)



Photograph #2 – Highway 579 culvert inlet with debris at the west embankment toe. (May 2023)



Photograph #3 – Highway 579 culvert outlet at the east embankment toe, south cell. (May 2023)



Photograph #4 – Highway 579 culvert outlet at the east embankment toe, north cell. (May 2023)



Photograph #5 – Highway 579 culvert inlet at the west embankment toe, north cell. (May 2023)



Photograph #6 – Highway 579 culvert inlet at the west embankment toe, south cell. (May 2023)



Photograph #7 – Highway 579, approximately 10 m north of the culvert centerline, facing north-northwest. (May 2023)



Photograph #8 – Highway 579, approximately 10 m north of the culvert centerline. Abandoned house located at the center of the photograph. (May 2023)



Photograph #9 – Clute Creek beyond culvert outlet, facing east. (May 2023)



Photograph #10 – West-facing embankment slope from highway grade. Culvert is located at the bottom right corner of the photograph. (May 2023)



Photograph #11 – East-facing embankment slope, facing north-northwest. (May 2023)



Photograph #12 – West-facing embankment slope from highway grade, facing north. Culvert inlet is located near the center of the photograph. (May 2023)



Photograph #13 – Localized erosion at the north edge of the culvert outlet at the east embankment toe. (May 2023)



APPENDIX B
RECORD OF BOREHOLE SHEETS

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS W _L < 50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. (W _L < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W _L < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W _L > 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

RECORD OF BOREHOLE No C3-01

1 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 067.7 E 299 391.9 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE Wash Boring with 'B' Casing COMPILED BY AK
DATUM Geodetic DATE 2023.05.29 - 2023.05.29 LATITUDE 49.143709 LONGITUDE -81.074130 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W P W W L				
								20 40 60 80 100 20 40 60 80 100				20 40 60				
248.5	GROUND SURFACE															
0.9	TOPSOIL: (65 mm)															
	Organic SILT , some sand Very Loose to Loose Dark Brown Moist		1	SS	2		248									
			2	SS	8											
247.3																
1.2	Silty CLAY (CL), trace sand Firm to Stiff Grey Wet		3	SS	11		247									
			4	SS	5											
			5	SS	4		246									
245.5															0 10 57 33	
3.0	SILT , trace sand Loose to Compact Grey Wet		6	SS	4		245									
			7	SS	12											
			8	SS	4		244								0 1 85 14	
							243									
242.4																
6.1	SAND , some gravel, trace fines Compact to Very Dense Grey Wet		9	SS	29/ 0.279		242									
	Flowing sand encountered at a depth of 6.1 m															
			10	SS	100/ 0.127		241									
							240									
			11	SS	19		239								10 84 3 3	

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RECORD OF BOREHOLE No C3-01

2 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 067.7 E 299 391.9 ORIGINATED BY SG
 DIST Cochrane HWY 579 BOREHOLE TYPE Wash Boring with 'B' Casing COMPILED BY AK
 DATUM Geodetic DATE 2023.05.29 - 2023.05.29 LATITUDE 49.143709 LONGITUDE -81.074130 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
237.2	Continued From Previous Page SAND , some gravel, trace fines Compact to Very Dense Grey Wet		12	SS	32		238										
11.3	END OF BOREHOLE AT 11.3 m. NOTES: 1. Water level in casing measured at a depth of 4.0 m below ground surface upon completion of drilling; however, it is not representative of the natural groundwater level due to the introduction of water from wash boring.																

RECORD OF BOREHOLE No C3-02

1 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 050.9 E 299 378.0 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.07 - 2023.05.07 LATITUDE 49.143558 LONGITUDE -81.074321 CHECKED BY CN

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	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
250.8	GROUND SURFACE											
0.0	ASPHALT: (25 mm)		1	SS*	52		250					
	Silty SAND , some gravel Compact to Very Dense Brown Wet (FILL)		2	SS*	32		249					
			3	SS*	68/ 0.279		248					12 66 18 4
	Grey below a depth of 2.3 m		4	SS*	14		247					
247.8	Sandy Organic SILT Compact Dark Brown Moist		5	SS*	13		246					
			6	SS*	20		245					
246.5	Sandy SILT Compact Grey Wet		7	SS*	17		244					
244.7	Silty SAND Compact Grey Wet		8	SS	20		243					0 85 13 2
6.1			9	SS	22		242					
			10	SS	25		241					

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RECORD OF BOREHOLE No C3-02

2 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 050.9 E 299 378.0 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.07 - 2023.05.07 LATITUDE 49.143558 LONGITUDE -81.074321 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W P W W L			
Continued From Previous Page																	
240.6																	
10.2	Gravelly SAND , trace fines Compact Grey Wet		11	SS	20		240						○			21 73 5 1	
							239										
238.0			12	SS	30								○				
12.8	END OF BOREHOLE AT 12.8 m. NOTES: 1. SS* denotes a 63.5 mm inside diameter split-spoon sampler was used for Standard Penetration Testing and the recovery of soil samples. 2. Monitoring well installation consists of 44 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2023.05.08 1.6 249.2						238										

RECORD OF BOREHOLE No C3-03

1 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 041.7 E 299 369.0 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE Continuous sampling; Wash Boring (B-Casing), Coring (A-Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.28 - 2023.05.28 LATITUDE 49.143474 LONGITUDE -81.074445 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
249.0	GROUND SURFACE							20 40 60 80 100		W P W W L			GR SA SI CL	
0.0	TOPSOIL: (25 mm) Organic SILT , some sand Loose Dark Brown Moist		1	SS	4		248							
			2	SS	4		247							
			3	SS	4									0 19 56 25
			4	SS	8									
246.6														
2.4	SAND , trace to some gravel, trace fines Compact Brown Wet		5	SS	12		246							8 89 2 1
			6	SS	10									
			7	SS	13			245						
			8	SS	24			244						10 85 3 2
242.9							243							
6.1	Gravelly SAND , trace to some fines Compact to Very Dense Brown Wet		9	SS	26									
							242							
			10	SS	38		241							
	Coring of gravel from a depth of 9.0 m to 9.1 m No recovery in SS11		11	SS	100/ 0.08		240							

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METRIC

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RECORD OF BOREHOLE No C3-04

1 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 043.3 E 299 376.4 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D. Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.07 - 2023.05.07 LATITUDE 49.143489 LONGITUDE -81.074343 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										WATER CONTENT (%)
250.8	GROUND SURFACE																	
0.8	ASPHALT: (25 mm)		1	SS*	76													
	Gravelly Silty SAND Dense to Very Dense Brown Moist (FILL)		2	SS*	74													27 60 11 2
			3	SS*	36													
248.3			4	SS*	12													OC=10.2%
2.5	Sandy Organic SILT Loose to Compact Dark Brown Moist		5	SS*	5													
247.1			6	SS*	14													
3.7	SAND, trace gravel, trace fines Loose to Compact Brown Wet		7	SS*	8													1 96 2 1
			8	SS	4													
243.6			9	SS	10													30 66 3 1
7.2	Gravelly SAND, trace fines Compact to Dense Grey Wet		10	SS	32													

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15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C3-04

2 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 043.3 E 299 376.4 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D. Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.07 - 2023.05.07 LATITUDE 49.143489 LONGITUDE -81.074343 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa														
								20 40 60 80 100														
	Continued From Previous Page							<div><div></div><div></div></div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>						<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div>W P W W L</div>								
	Gravelly SAND , trace fines Compact to Dense Grey Wet		11	SS	14		240							○					27	69	4	0
							239															
			12	SS	39									○								
238.0							238															
12.8	END OF BOREHOLE AT 12.8 m. NOTES: 1. SS* denotes a 63.5 mm inside diameter split-spoon sampler was used for Standard Penetration Testing and the recovery of soil samples. 2. Water level in casing measured at a depth of 1.6 m below ground surface upon completion of drilling; however, it is not representative of the natural groundwater level due to the introduction of water from wash boring.																					

RECORD OF BOREHOLE No C3-05

1 OF 2

METRIC

WP# 5037-21-01 LOCATION MTM 83-12: N 5 445 065.4 E 299 380.2 ORIGINATED BY SG
DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D. Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.04 - 2023.05.05 LATITUDE 49.143688 LONGITUDE -81.074292 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	W _p	W	W _L							
250.7	GROUND SURFACE						20	40	60	80	100										
0.0	ASPHALT: (25 mm)		1	SS*	73																
	Gravelly SAND, trace fines Loose to Very Dense Brown Moist to Wet (FILL)		2	SS*	47																
	Wet below a depth of 1.5 m		3	SS*	94/ 0.279																
247.9			4	SS*	8																
2.8	Sandy Organic SILT, containing rootlets and wood fragments Loose Dark Brown Moist		5	SS*	6																
246.7			6	SS*	4																
4.0	SILT, trace sand Very Loose to Loose Grey Wet																				
</																					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C3-05

2 OF 2

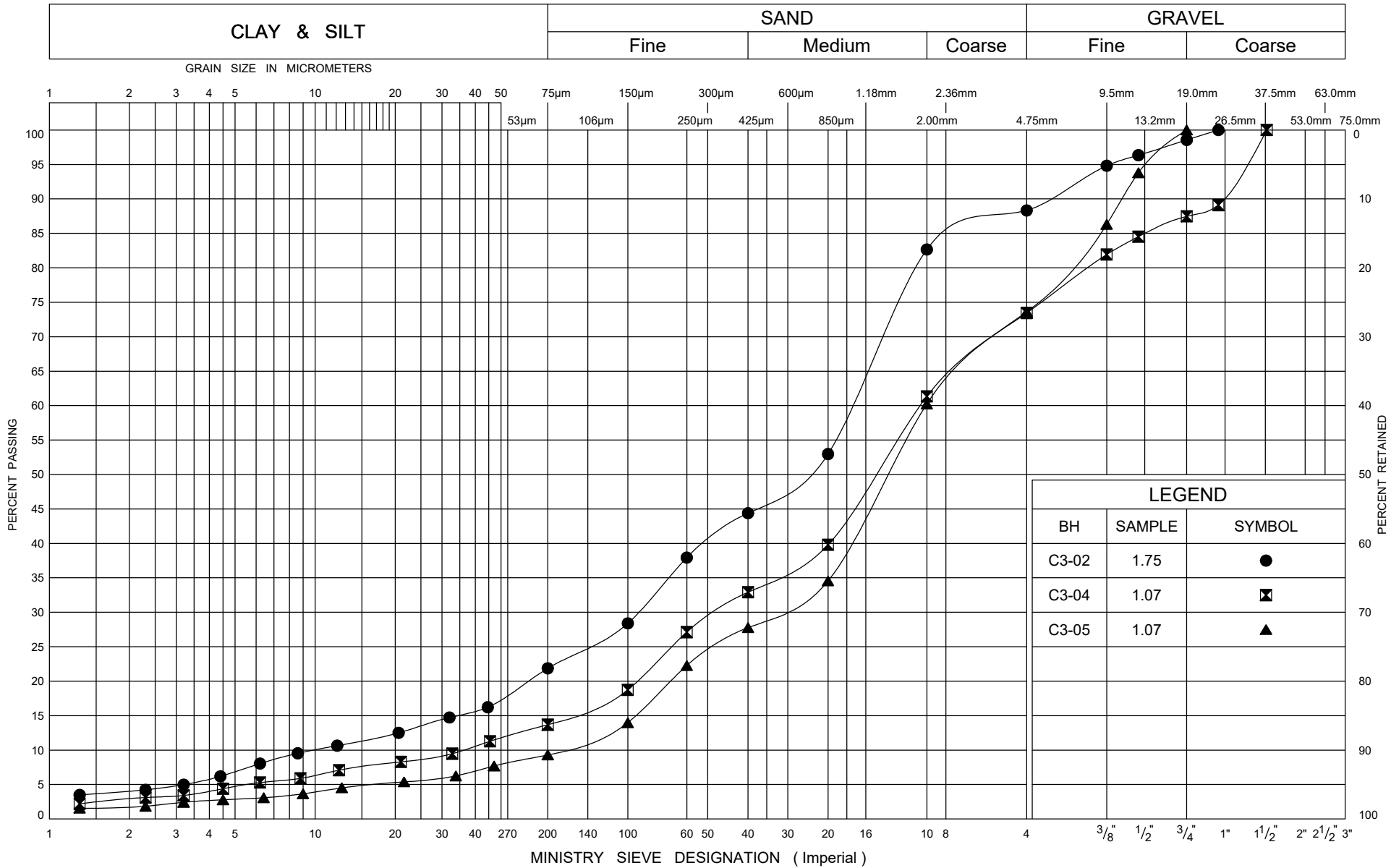
METRIC

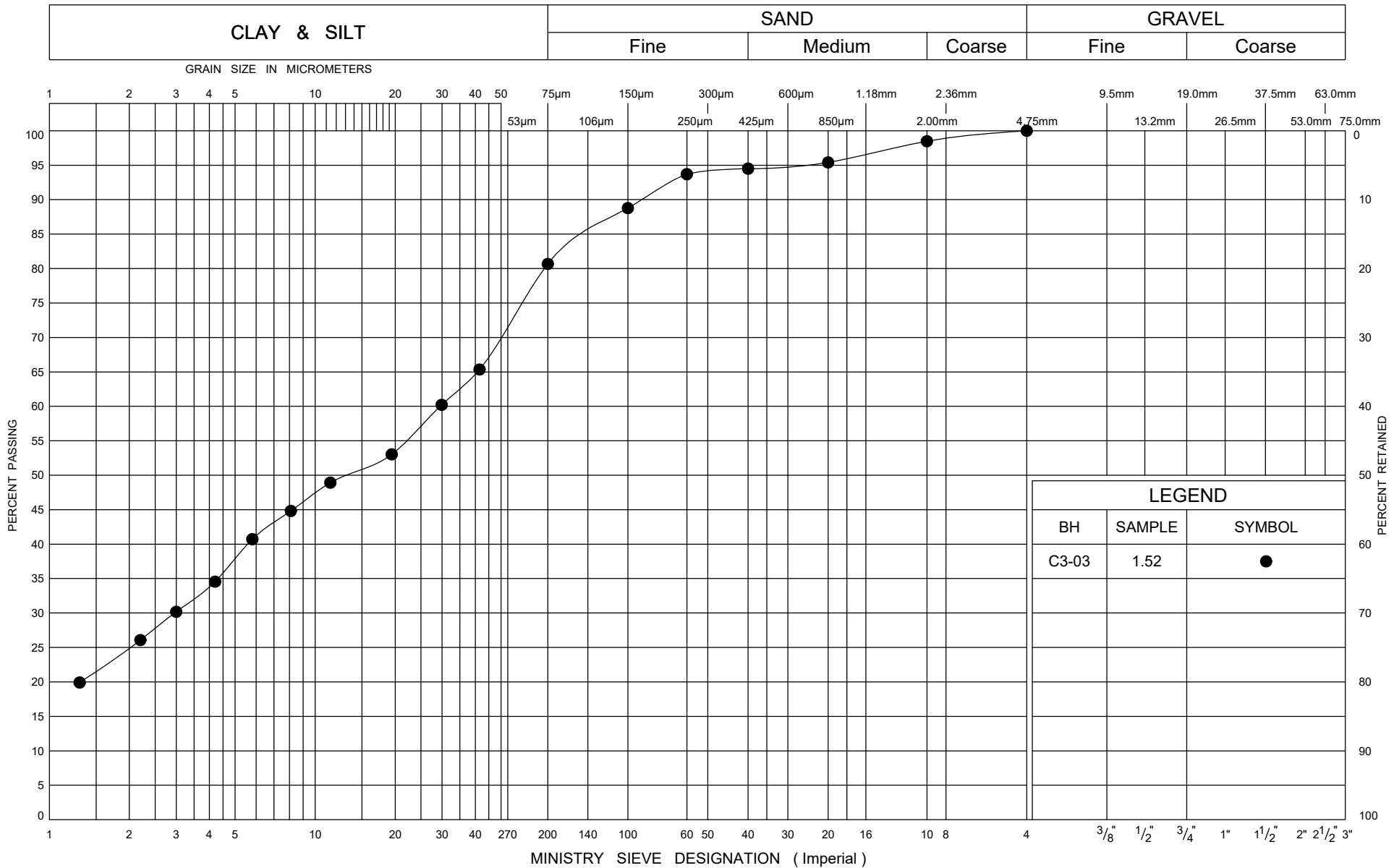
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DIST Cochrane HWY 579 BOREHOLE TYPE 205 mm O.D. Hollow Stem Augers, Wash Boring (N Casing) COMPILED BY AK
DATUM Geodetic DATE 2023.05.04 - 2023.05.05 LATITUDE 49.143688 LONGITUDE -81.074292 CHECKED BY CN

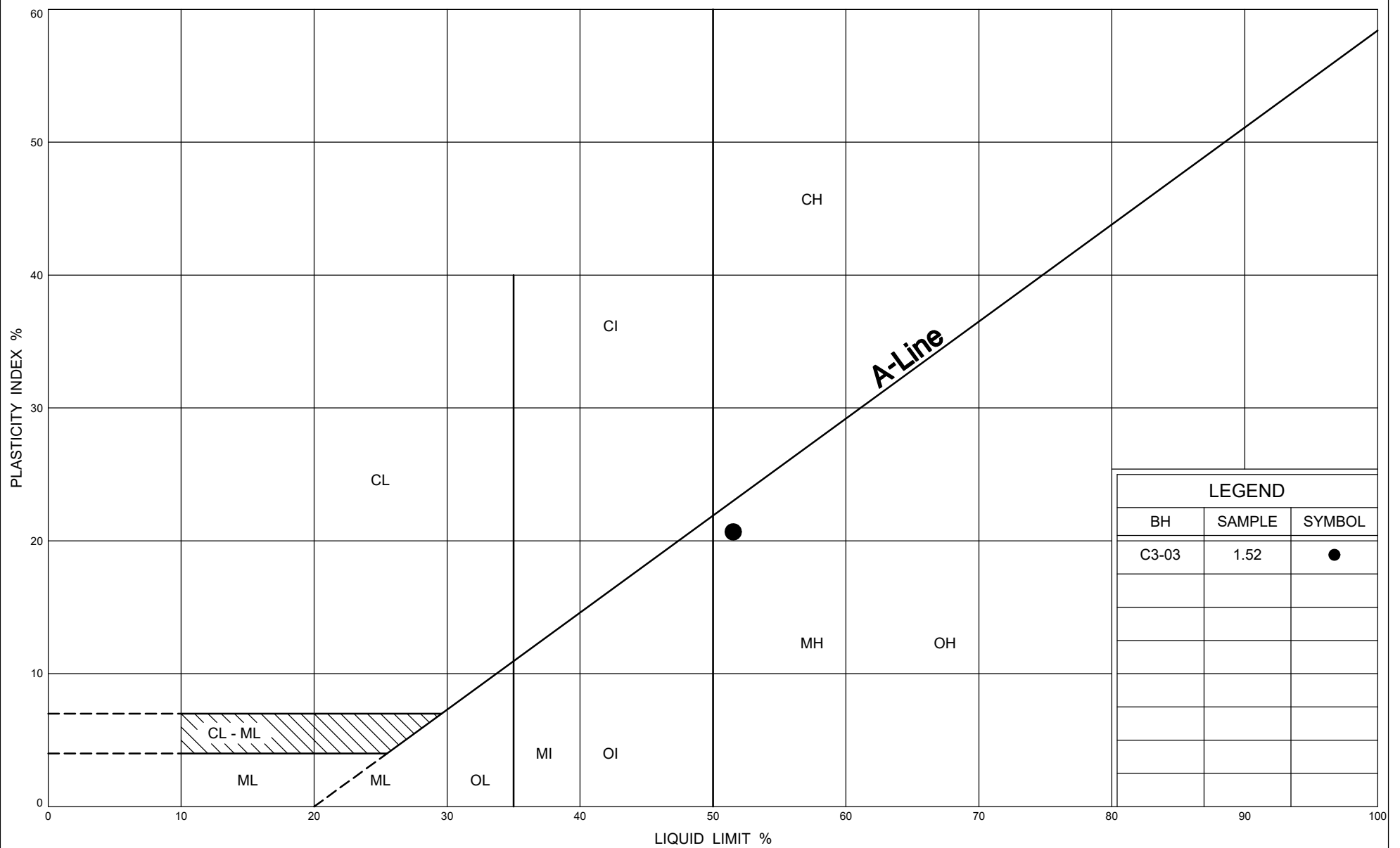
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ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	NOTES: 1. SS* denotes a 63.5 mm inside diameter split-spoon sampler was used for Standard Penetration Testing and the recovery of soil samples. 2. Water level in casing measured at a depth of 6.0 m below ground surface upon completion of drilling; however, it is not representative of the natural groundwater level due to the introduction of water from wash boring.													

APPENDIX C

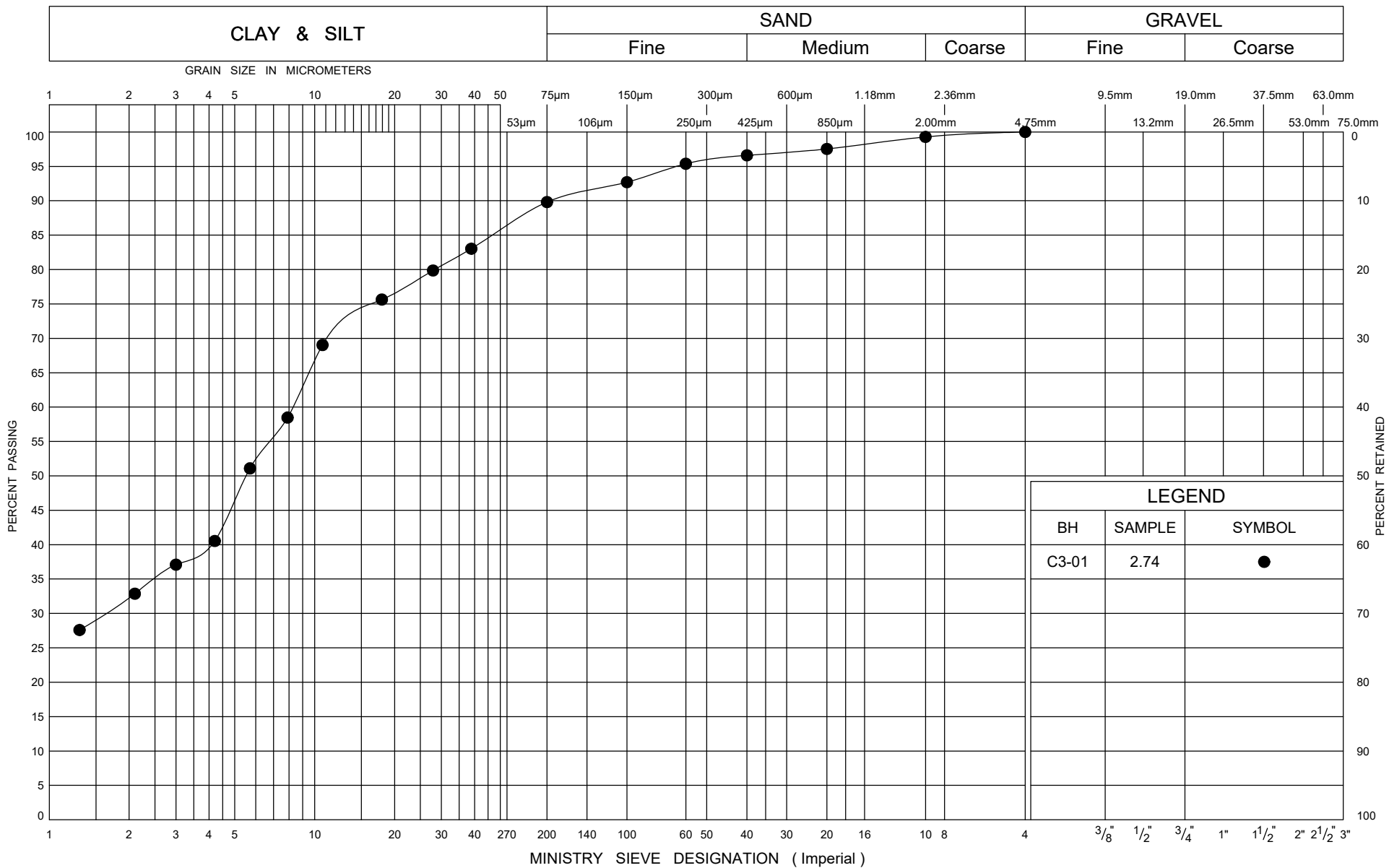
GEOTECHNICAL AND ANALYTICAL LABORATORY TEST RESULTS

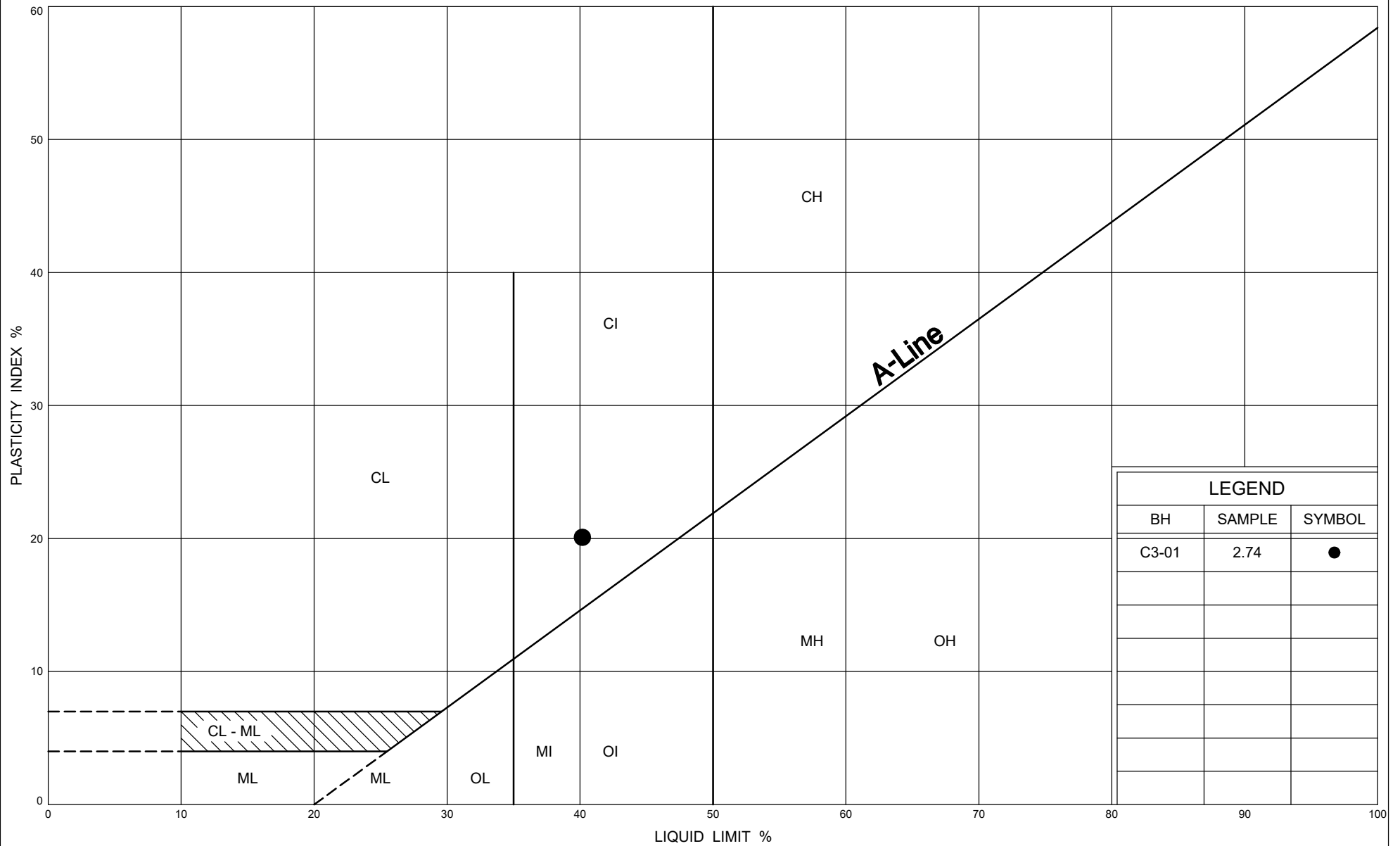


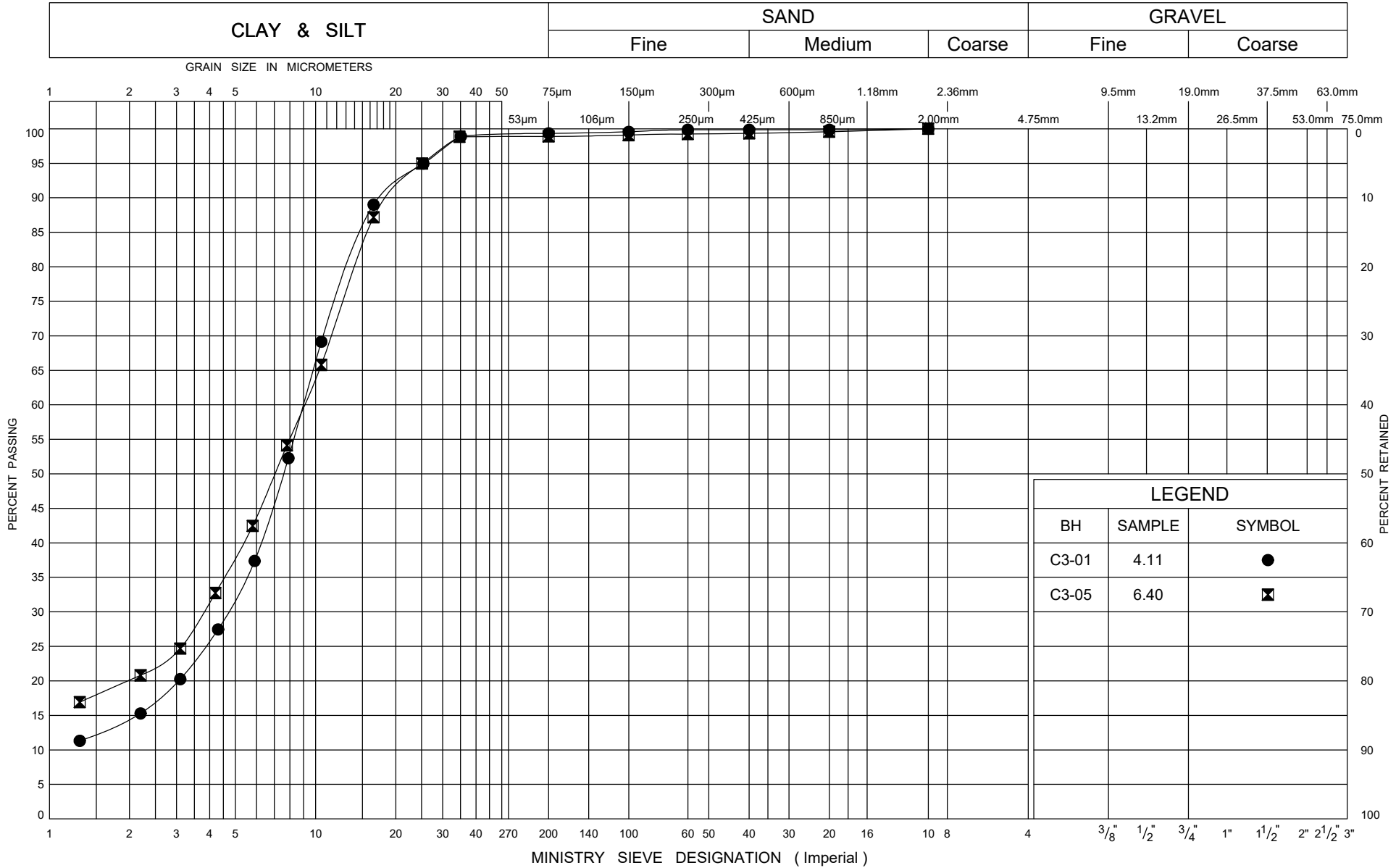


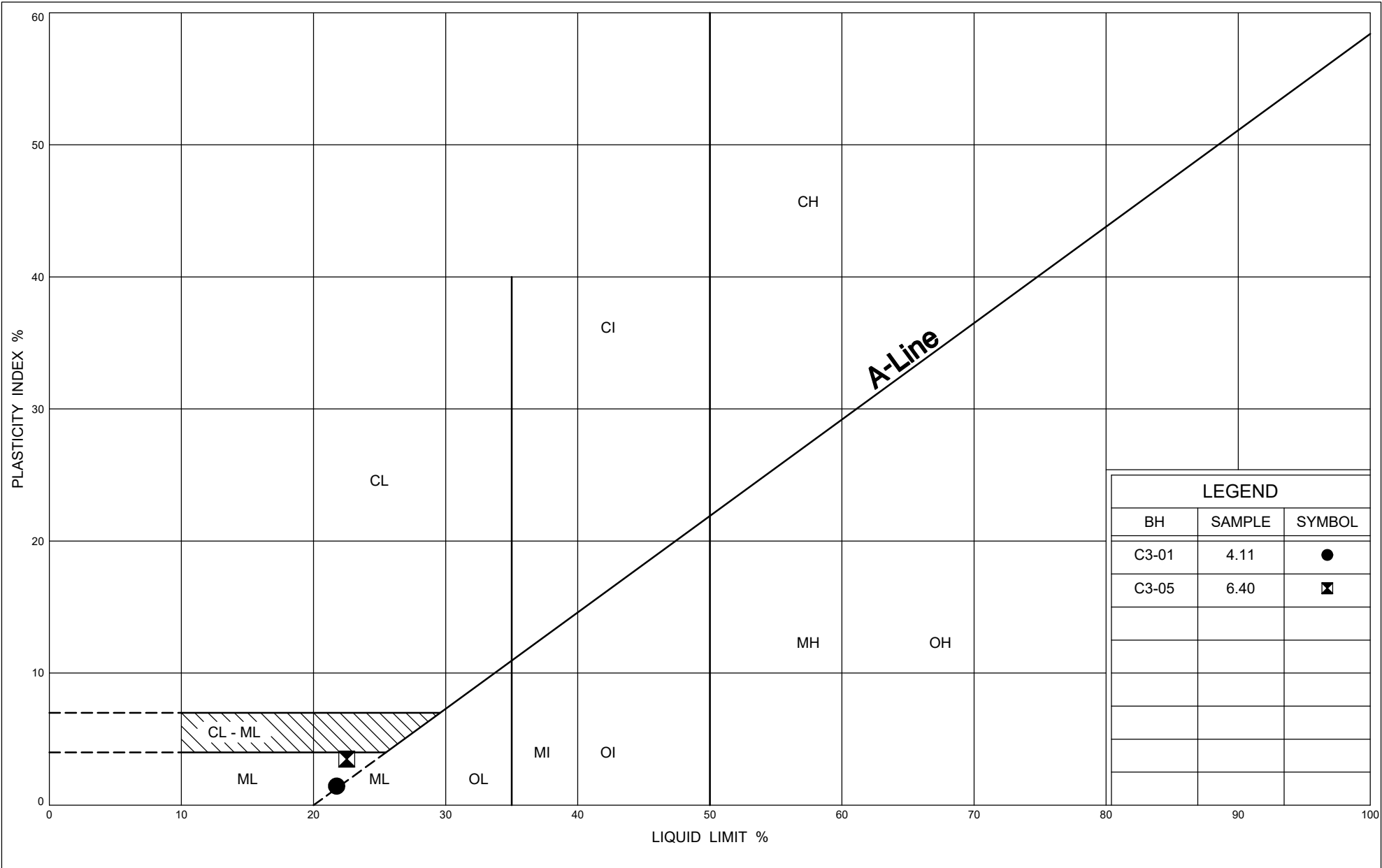


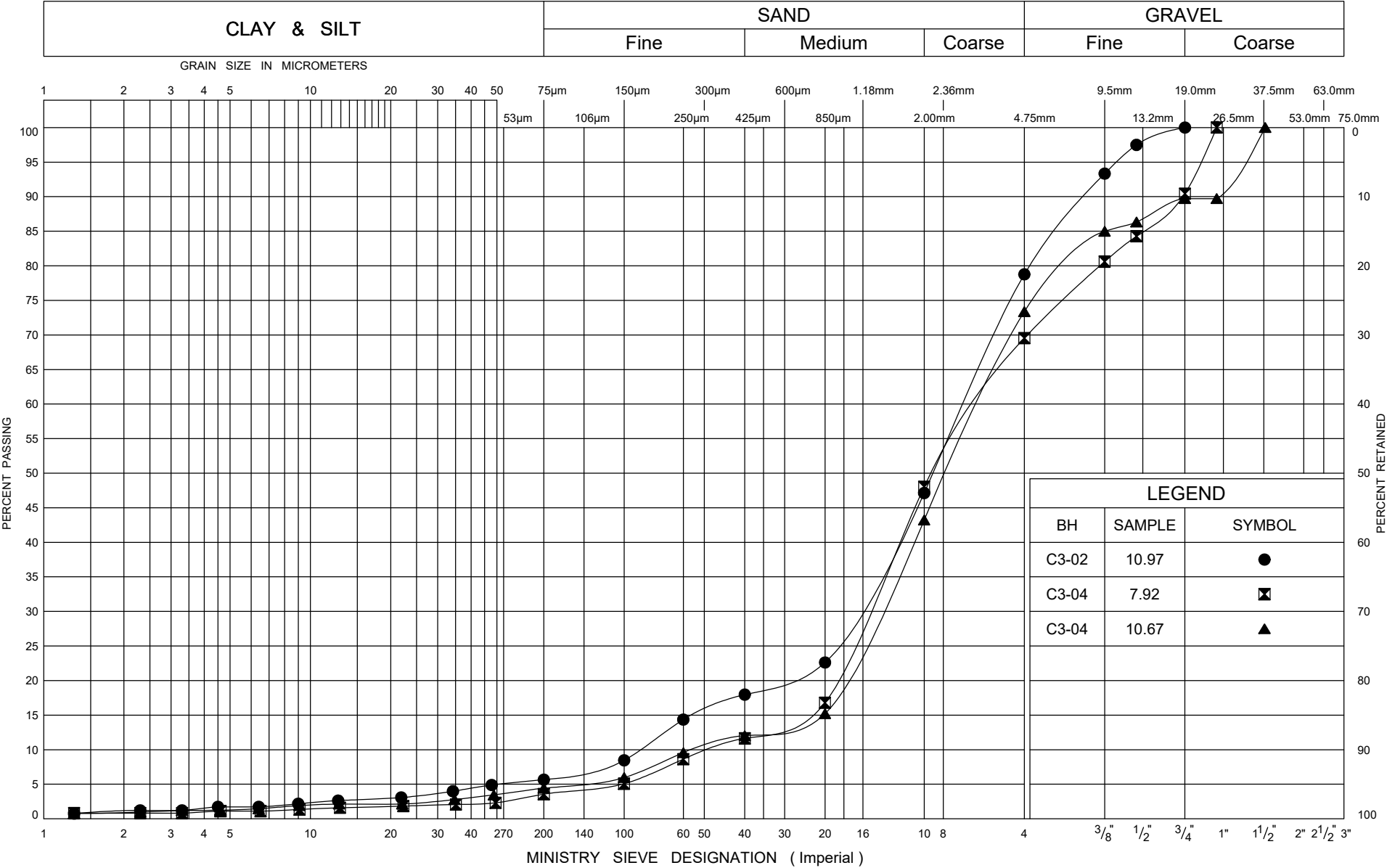
LEGEND		
BH	SAMPLE	SYMBOL
C3-03	1.52	●

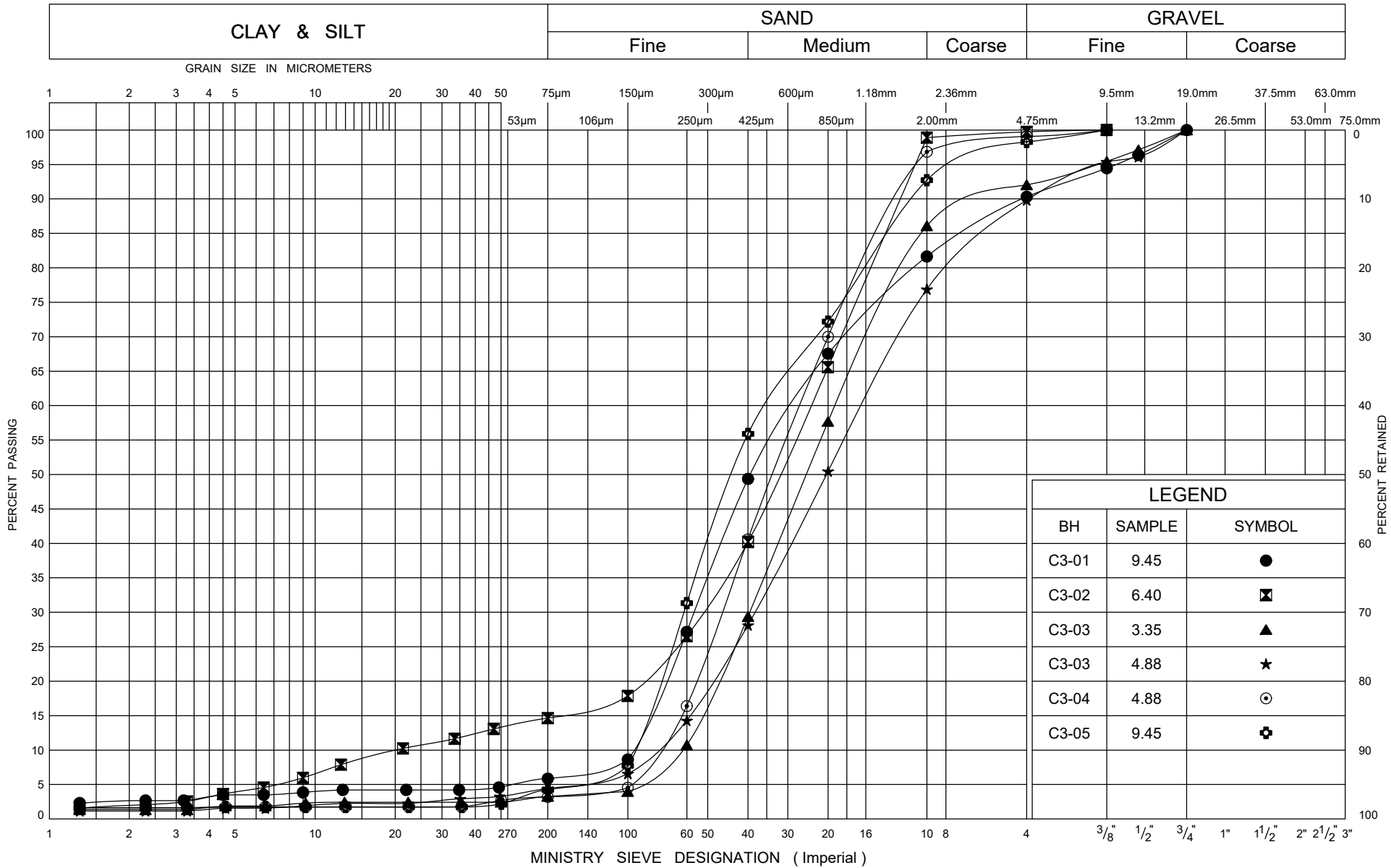














FINAL REPORT

CA40305-MAY23 R1

33730, Highway 579 Culverts

Prepared for

Thurber Engineering Ltd.



FINAL REPORT

CA40305-MAY23 R1

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Maarit Wolfe, Hon.B.Sc
Address	103, 2010 Winston Park Drive	Laboratory	SGS Canada Inc.
	Oakville, ON	Address	185 Concession St., Lakefield ON, K0L 2H0
	L6H 5R7, Canada		
Contact	Ali Rajaei	Telephone	705-652-2000
Telephone		Facsimile	705-652-6365
Facsimile		Email	Maarit.Wolfe@sgs.com
Email	arajaei@thurber.ca; jzoldy@thurber.ca	SGS Reference	CA40305-MAY23
Project	33730, Highway 579 Culverts	Received	05/25/2023
Order Number		Approved	06/05/2023
Samples	Soil (3)	Report Number	CA40305-MAY23 R1
		Date Reported	06/05/2023

COMMENTS
Temperature of Sample upon Receipt: 12 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes
Chain of Custody Number: n/a
Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.


SIGNATORIES
Maarit Wolfe, Hon.B.Sc 



TABLE OF CONTENTS

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Results..... 3

QC Summary..... 4-5

Legend..... 6

Annexes..... 7



FINAL REPORT

CA40305-MAY23 R1

Client: Thurber Engineering Ltd.

Project: 33730, Highway 579 Culverts

Project Manager: Ali Rajaei

Samplers: Ali Rajaei

MATRIX: SOIL

Sample Number	5	6	7
Sample Name	C1-02/SS6	C2-02/SS5	C3-02/SS6A
Sample Matrix	Soil	Soil	Soil
Sample Date	23/05/2023	23/05/2023	23/05/2023

Parameter	Units	RL		Result	Result	Result
Corrosivity Index						
Corrosivity Index	none	1		6	2	4
Soil Redox Potential	mV	no		117	132	155
Sulphide (Na ₂ CO ₃)	%	0.04		0.04	< 0.04	0.12
pH	pH Units	0.05		7.66	7.86	7.92
Resistivity (calculated)	ohms.cm	-9999		4780	4350	4760

General Chemistry

Conductivity	uS/cm	2		209	230	210
--------------	-------	---	--	-----	-----	-----

Metals and Inorganics

Moisture Content	%	0.1		32.8	31.6	13.0
Sulphate	µg/g	0.4		66	21	180

Other (ORP)

Chloride	µg/g	0.4		12	16	7.1
----------	------	-----	--	----	----	-----



FINAL REPORT

CA40305-MAY23 R1

QC SUMMARY

Anions by IC
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0723-MAY23	µg/g	0.4	<0.4	1	35	98	80	120	116	75	125
Sulphate	DIO0723-MAY23	µg/g	0.4	<0.4	1	35	96	80	120	103	75	125

Carbon/Sulphur
Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0068-MAY23	%	0.04	< 0.04	ND	20	113	80	120			

Conductivity
Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0655-MAY23	uS/cm	2	< 2	1	20	101	90	110	NA		



FINAL REPORT

CA40305-MAY23 R1

QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-|ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0655-MAY23	pH Units	0.05	NA	0		100			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

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

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.



LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.

"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

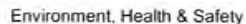
SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

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The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Reproduction of this analytical report in full or in part is prohibited.

This report supersedes all previous versions.

-- End of Analytical Report --



No:

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment

- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: 7/11
Received Date (mm/dd/yy): 05/25/23
Received Time: 13:45

Received By (signature): KMK/KMM
Custody Seal Present: ☒
Custody Seal Intact: ☒

Cooling Agent Present: ☒

Temperature Upon Receipt (°C)

LAB LIMS #: Mani-40305

REPORT INFORMATION

Company:	Thurber Engineering Ltd.
Contact:	Ali Rajaei
Address:	1815 Ironstone Manor Suite 11, Pickering, ON L1W 3W9
Phone:	4165759069
Email:	arajaei@thurber.ca
Email:	akobyilnski@thurber.ca

INVOICE INFORMATION☒ (same as Report Information)

Company: _____
Contact: _____
Address: _____
Phone: _____
Email: _____

PROJECT INFORMATION

Quotation #: _____ P.O. #: 33730
Project #: 33730 Site Location/ID: Highway 579 Culverts

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: _____ Rush Confirmation ID: _____

REGULATIONS

Regulation 153/04:

☐ Table 1 ☐ R/P/I Soil Texture:

☐ Table 2 ☐ I/C/C ☐ Coarse

☐ Table 3 ☐ A/O ☐ Medium

☐ Table ☐ Fine

Other Regulations:

<input type="checkbox"/>	Reg 347/558 (3 Day min TAT)	
<input type="checkbox"/>	PWQO	<input type="checkbox"/> MMR
<input type="checkbox"/>	CCME	<input type="checkbox"/> Other:
<input type="checkbox"/>	MISA	

Sewer By-Law:

☐ Sanitary
☐ Storm

Municipality:

ANALYSIS REQUESTED

[illegible]

COMMENTS:

RECORD OF SITE CONDITION (RSC)	<input type="checkbox"/>	YES	<input checked="" type="checkbox"/>	NO
--------------------------------	--------------------------	-----	-------------------------------------	----

SAMPLE IDENTIFICATION		DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	C1-02/SS6	5/23/23	16:00	1	Soil
2	C2-02/SS5	5/23/23	16:15	1	Soil
3	C3-02/SS6A	5/23/23	16:30	1	Soil
4					
5					
6					
7					
8					
9					
10					
11					
12					

Observations/Comments/Special Instructions
--

Sampled By (NAME): Ali Rajaei

Signature: AR

Date: 05/23/23 (mm/dd/yy)

Pink Copy - Client

Relinquished by (NAME): Charlene Pontejos

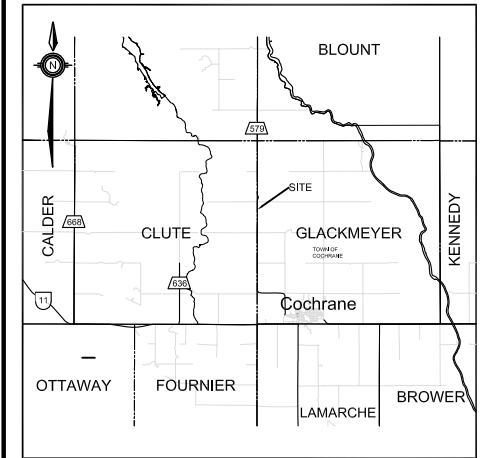
Signature: C. P.

Date: 5/24/23 (mm/dd/yy)






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APPENDIX D
BOREHOLE LOCATION PLAN AND SOIL STRATA DRAWINGS

SHEET



LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

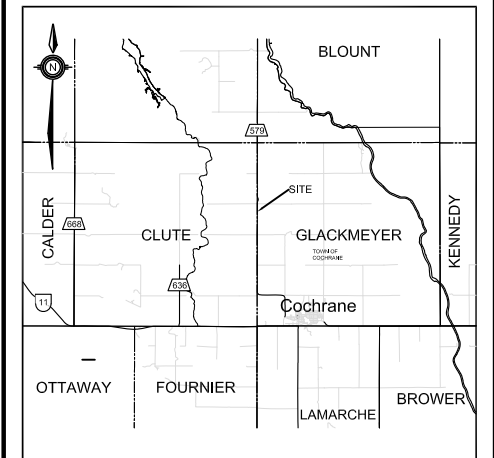
NO	ELEVATION	NORTHING	EASTING
C3-01	248.5	5 445 067.7	299 391.9
C3-02	250.8	5 445 050.9	299 378.0
C3-03	249.0	5 445 041.7	299 369.0
C3-04	250.8	5 445 043.3	299 376.4
C3-05	250.7	5 445 065.4	299 380.2

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 12.








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SHEET



LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

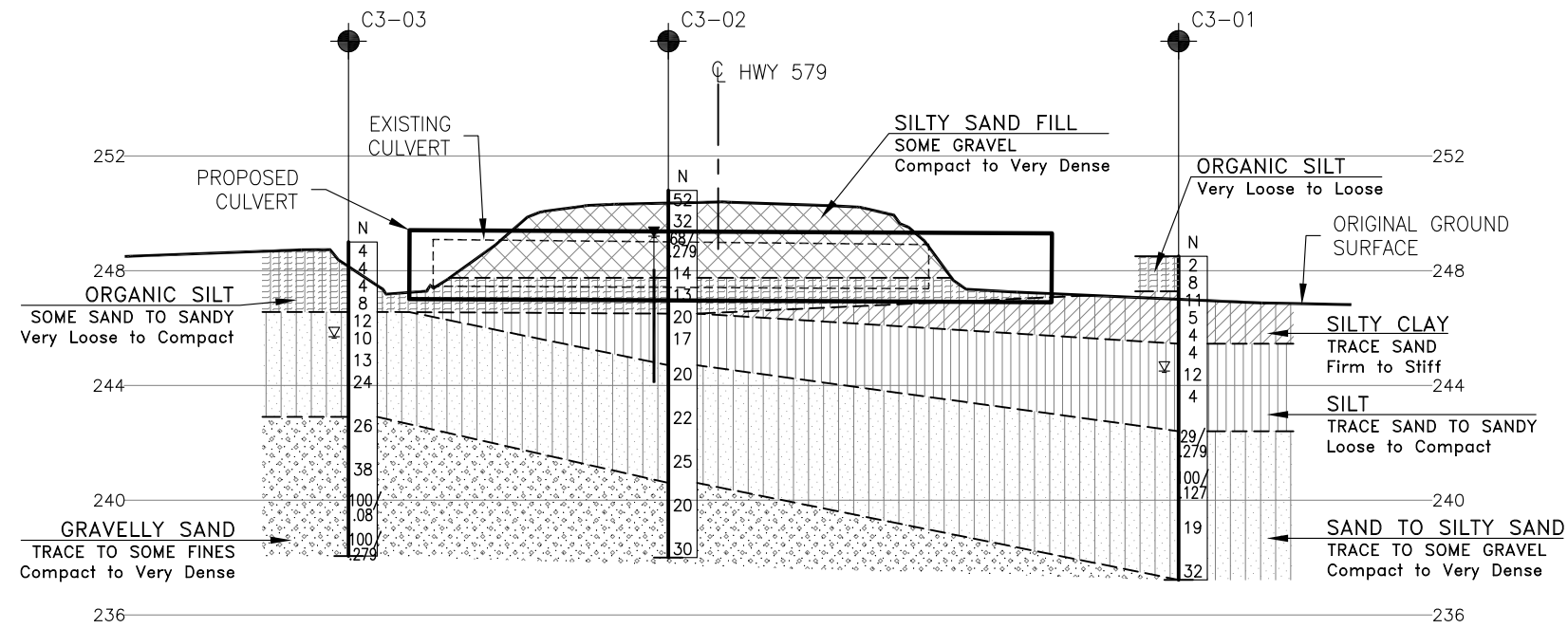
NO	ELEVATION	NORTHING	EASTING
C3-01	248.5	5 445 067.7	299 391.9
C3-02	250.8	5 445 050.9	299 378.0
C3-03	249.0	5 445 041.7	299 369.0
C3-04	250.8	5 445 043.3	299 376.4
C3-05	250.7	5 445 065.4	299 380.2

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 12.

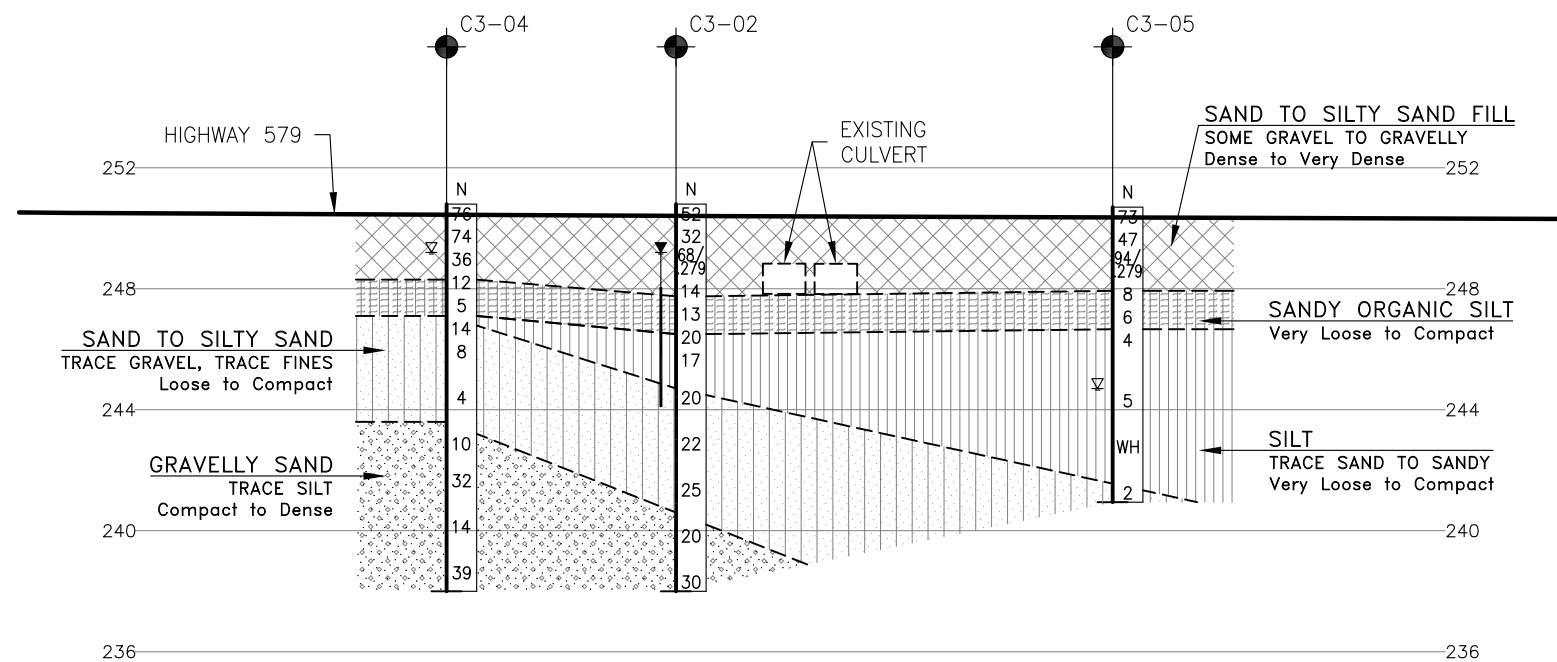


REVISIONS							
	DATE	BY	DESCRIPTION				
DESIGN	AK	CHK	CODE		LOAD	DATE	JAN 2024
DRAWN	AN	CHK	AK	SITE	STRUCT	IDWG	2

PLOTDATE: 1/29/2024 4:44 PM



PROFILE ALONG CULVERT AT STA. 17+053 (A-A')



PROFILE ALONG \mathbb{C} HIGHWAY 579 (B-B')

