THURBER ENGINEERING LTD.

DETAILED FOUNDATION INVESTIGATION AND DESIGN REPORT
CAMERON CREEK CULVERT REPLACEMENT
HIGHWAY 11, DISTRICT OF RAINY RIVER, ONTARIO
AGREEMENT 6019-E-0009, WORK ORDER 35
G.W.P. 6120-17-00, SITE NO. 45X-0160/C0

LATITUDE: 48.678411°, LONGITUDE: -94.140064°

GEOCRES No.: 52D-37

Report

to

HATCH

Date: January 18, 2023
File: 33309

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. for the design of the proposed Cameron Creek Culvert replacement. The Cameron Creek Culvert is located on Highway 11, within the Morley Township, District of Rainy River, Ontario. The site is approximately 1.7 km east of Highway 617 in Stratton, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert location and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to Hatch, under the Ministry of Transportation Ontario (MTO) Retainer Agreement Number 6019-E-0009, Work Order 35.

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 Cameron Creek Culvert is located on Highway 11, between Sharp Road and Oster Road, near Stratton, Ontario. The existing culvert allows Cameron Creek to flow in a north to south direction under Highway 11. Highway 11 generally runs in an east-west direction at the culvert site.

The General Arrangement drawings provided by Hatch indicate that the existing structure is a closed bottom, concrete box culvert, with a span of 6.1 m, opening height of 1.8 m, and length 19.7 m. The estimated culvert invert (bottom of pipe) is at approximate Elev. 334.8 m at the inlet (north) and 334.7 m at the outlet (south). The existing road grade at the culvert location is at approximate Elev. 338.31 m, which indicates approximately 1.3 m of fill above the top slab of the culvert. The local creek water level was reportedly measured at Elev. 334.9 m on July 17, 2018.

The site topography near the culvert area is generally flat along Highway 11 on both sides of Cameron Creek. The existing highway embankment side slopes are inclined at approximately 1H:1V or steeper at the ends of the culvert, and 2H:1V or flatter beyond the culvert.

The lands surrounding the site predominantly consist of agricultural areas with some residences near Highway 11 with localized, partially forested terrain along the creek. A railway corridor running in a general east-west direction exists approximately 130 m north of the culvert site. Photographs in Appendix C show the general nature of the site and the existing culvert.

Based on published geological information, the culvert lies within an area consisting of Glaciolacustrine deposits of silt and clay with minor sand, overlying Precambrian bedrock. Based on the OGS Map MRD126-REV1 titled “Bedrock Geology of Ontario”, dated 2011, the bedrock at site is identified as a metamorphosed tonalite to granodiorite, and mafic to intermediate metavolcanic rocks.

3. INVESTIGATION PROCEDURES

The site investigation and field-testing program for this project was carried out in two phases, from May 3 to 5, 2022 and from August 26 to 28, 2022. The investigation consisted of drilling and sampling five (5) boreholes (22-01 to 22-05) to depths of 12.8 to 16.3 m below ground surface (Elev. 321.9 m to 323.9 m). Boreholes 22-03 to 22-05 were drilled through the paved portion of Highway 11. Boreholes 22-01 and 22-02 were drilled off road, near the culvert inlet and outlet.

The Record of Borehole sheets are included in Appendix A. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were estimated from field measurements relative to existing site features and the topographic drawings provided to Thurber by Hatch. The coordinate system MTM NAD 83, Zone 16 was used for the boreholes.

Boreholes 22-01 and 22-02 were advanced using a Simco Track mounted, limited access drill rig, using solid stem augers. Boreholes 22-03 to 22-05 were advanced using a rubber-tired CME 750 drill rig, using solid stem augers and NW casing / Tricone with wash boring techniques. Soil samples were obtained in all boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Field vane shear testing, typically using an MTO “N” sized shear vane was carried out in the cohesive soils.

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

A monitoring well was installed in Borehole 22-01. The well consisted of 50 mm Schedule 40 PVC pipe with a 3.0 m long slotted screen, enclosed in a column of filter sand to permit groundwater level monitoring. Well installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets.

A sample of the groundwater was obtained from the well during the field investigation and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of water quality parameters. A single well response test (“slug test”) was also carried out in the well. Upon collection of the final water level readings on August 28, 2022, the well was decommissioned in general accordance with MECP O.Reg. 903.

Details of the drilling program, including drilling depths, monitoring well installation and completion details are summarized in Table 3.1 below.

Table 3.1: Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
22-01	12.8 / 323.5	12.0 / 324.2	50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen monitoring well installed at 12.0 m depth. Filter sand from 12.8 m to 7.8 m, bentonite to surface with 0.17 m stick up. Monitoring well removed August 28, 2022, borehole backfilled with bentonite to surface.
22-02	12.8 / 323.9	None installed	Borehole was backfilled with bentonite holeplug from 12.8 m to surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
22-03	16.3 / 322.0	None installed	Borehole backfilled with bentonite holeplug from 16.3 to 1.2 m, concrete from 1.2 m to 0.2 m, and asphalt to surface.
22-04	16.3 / 321.9	None installed	Borehole backfilled with bentonite holeplug from 16.3 to 1.2 m, concrete from 1.2 m to 0.2 m, and asphalt to surface.
22-05	15.8 / 322.5	None installed	Borehole backfilled with bentonite holeplug from 15.8 to 1.2 m, concrete from 1.2 m to 0.2 m, and asphalt to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and hydrometer) for 25% of the collected samples. The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and are shown on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, two (2) samples of the soil and one sample of surface water were collected during the investigation and submitted to SGS, a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of soil corrosivity parameters. In order to assess the quality of the groundwater for disposal purposes, a groundwater sample from Borehole 22-01 and a surface water sample from the creek were collected. The results of the analytical testing are summarized in this report and presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and 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 paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface stratigraphy below the asphalt typically consists of gravelly sand to gravel and sand fill, overlying silty clay fill. The fill is underlain by native sandy, silty clay. More detailed descriptions of individual strata are presented below.

5.1 Asphalt

Boreholes 22-03, 22-04, and 22-05 were drilled through the paved portion of Highway 11. The asphalt thickness was 150 mm in all three boreholes.

5.2 Granular Fill

Granular embankment fill was encountered below the pavement in Boreholes 22-03, 22-04, and 22-05. The fill was described as brown and ranged in composition from gravelly sand to sand and gravel with some silt. The granular fill was encountered from the bottom of asphalt at 0.15 m depth and extended to depths ranging from 1.8 to 3.2 m (Elev. 336.5 to 335.1 m) across all road boreholes. The approximate thickness of the granular fill ranged from 1.6 to 3.0 m.

SPT ‘N’ values in the granular fill ranged from 8 to 88 blows per 0.3 m of penetration, indicating a loose to very dense relative density; typically compact to very dense. The measured moisture content for the granular fill ranged from 2 to 15%.

The results of grain size analyses conducted on three selected samples of the granular fill are provided on the Record of Borehole sheets in Appendix A and plotted in Figure B1 of Appendix B. The results are summarized in Table 3.1 below.

Table 5.1: Granular Fill Grain Size Analysis

Soil Particle	Percentage (%)
Gravel	27 to 42
Sand	44 to 61
Silt and Clay	12 to 15

5.3 **Silty Clay Fill**

Silty clay fill was encountered below the granular fill in Boreholes 22-03 and 22-05 at depths of 3.2 and 1.8 m (Elev. 335.1 and 336.5 m) respectively. The silty clay fill extended to depths of 4.1 m in both boreholes (Elev. 334.2 m). The thickness of the silty clay fill ranged from 0.9 to 2.3 m. The silty clay was described as grey and contained trace sand and gravel.

SPT ‘N’ values in the silty clay fill ranged from 4 to 11 blows per 0.3 m of penetration, indicating a soft to stiff relative density. Measured moisture contents ranged from 28 to 50%.

One grain size analysis and one Atterberg limit test was conducted the silty clay fill. The results of the grain size analysis indicate the soil was composed of 0% gravel, 1% sand, 34% silt, and 65% clay sized particles. The results of the Atterberg Limits test indicates the Liquid Limit is 80%, the Plastic Limit is 28%, and the Plastic Index is 52%, indicating a soil type of high plasticity (CH). The results of the grain size analysis and the Atterberg Limit analysis are provided on the Record of Borehole sheets in Appendix A and plotted in Figure B2 and B5 of Appendix B, respectively.

5.4 **Topsoil**

Topsoil was observed at the ground surface in Boreholes 22-01 and 22-02. Topsoil thicknesses were 225 mm and 50 mm respectively. The soil was described as black and moist. The topsoil thickness may vary in other areas of the site.

5.5 **Silty Clay**

Silty clay was encountered below the fill or topsoil in all boreholes. The silty clay was encountered below the topsoil at the off-road boreholes (22-01 and 22-02) at depths from 0.05 to 0.2 m (Elev. 336.7 to 336.1 m). In the on-road boreholes (22-03, 22-04, and 22-05) the silty clay was encountered below the granular or silty clay fill at depths ranging from 3.0 to 4.1 m (Elev. 335.2 to 334.2 m). All boreholes were terminated within the silty clay. The termination depths ranged from 12.8 m to 16.3 m (Elevation 323.9 to 321.9 m)

The silty clay was generally sandy, contained trace gravel and ranged in colour from brown to grey. In Borehole 22-01, the upper 0.5 m of the silty clay was observed to include occasional organics. SPT ‘N’ Values in the silty clay ranged from 3 to 21 per 0.3 m penetration, and field vane shear tests measured undrained shear strengths ranging from 64 to 105 kPa. The SPT ‘N’ values and undrained shear strength values indicate that the clay has a soft to very stiff consistency (typically stiff to very stiff).

Recorded moisture contents in the silty clay typically ranged from 18 to 32%, with localized moisture content measurements ranging from 12% to 48% in Borehole 22-04. The results of grain size analyses conducted on 11 samples of the silty clay deposit are provided on the Record of Borehole sheets in Appendix A and plotted in Figures B3 and B4 of Appendix B. The results are summarized in Table 5.2 below.

Table 5.2: Silty Clay Grain Size Analysis

Soil Particle	Percentage (%)
Gravel	0 to 6
Sand	15 to 33
Silt	34 to 45
Clay	24 to 51

The results of Atterberg Limits tests conducted on nine samples of the silty clay deposit are provided on the Record of Borehole sheets in Appendix A and plotted in Figures B6 and B7 of Appendix B. the results are summarized in Table 5.3 below.

Table 5.3: Silty Clay Atterberg Limits Test Results

Parameter	Result
Liquid Limit	26 to 48
Plastic Limit	13 to 18
Plasticity Index	13 to 30

The results indicate that the silty clay has low to intermediate plasticity, with group symbols of CL to CI.

5.6 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling, and in the monitoring well installed in Borehole 22-01. The measured groundwater levels are summarized in Table 5.4 below. The monitoring well was decommissioned on August 28, 2022 following final water level readings and slug testing.

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Table 5.4: Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
22-01	August 27, 2022 August 27, 2022 August 27, 2022 August 28, 2022	11.6 11.3 11.1 10.7	324.7 324.9 325.2 325.6	In monitoring well.
22-02	August 28, 2022	11.0	325.7	Open borehole.
22-03	May 3, 2022	5.1	333.2	Open borehole.
22-04	May 4, 2022	1.8	336.4	Open borehole (inside drill casing).
22-05	May 4, 2022	1.7	336.6	Open borehole (inside drill casing).

Due to the short duration of the field investigation, it is anticipated that sufficient time was not available for infiltration of groundwater into the open boreholes and monitoring well, given the presence of relatively low permeability silty clay subsurface soils. Therefore, the water level measurements recorded may not represent the stabilized groundwater level.

The groundwater level is likely to reflect the local river water level. The surface water level of Cameron Creek was reportedly measured at Elev. 334.9 m in July 2018.

It should also be noted that groundwater levels are short term observations and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Samples of the native silty clay and the gravelly sand fill from Boreholes 22-02 and 22-03 and a sample of surface water taken from the Cameron Creek were submitted for analytical testing of corrosivity parameters and sulphate. The laboratory certificates of analysis for the current investigation are presented in Appendix B. The results of the analytical tests are summarized below in Table 6.1.

Table 6.1: Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results		
			22-02 SS1 (0' – 2')	22-03 SS4 (7'6" – 9'6")	Cameron Creek
			Native Silty Clay	Gravelly Sand Fill	Surface Water
Redox Potential	mV	mV	279	230	214
Sulphide	%	N/A	< 0.04	< 0.04	---
pH	-	-	8.28	8.88	7.98
Chloride	µg/g	mg/L	< 10↑	99	2.0
Sulphate	µg/g	mg/L	30	24	1.3
Conductivity	µS/cm	µS/cm	150	278	433
Resistivity	ohm-cm	ohm-cm	6670	3600	2309*

↑ *Indicates that standard reporting limit was raised by laboratory*

* *Calculated by Thurber based on conductivity result*

7. WATER QUALITY

For assessment of the general groundwater quality at the site, a sample of the groundwater from the monitoring well at Borehole 22-01, and a surface water sample from the creek were collected on August 28, 2022. The water samples were analyzed for selected inorganic parameters included in the Ontario Provincial Water Quality Objectives (PWQO), as well as Total Suspended Solids. Filtered sub-samples of the groundwater and surface water were also tested for dissolved metal parameters for comparison purposes. The analytical test results are presented in Appendix B.

The analytical results of the water testing were compared to limits for the PWQO for surface water discharge. The concentrations of all parameters tested that did not meet the criteria established in the PWQO are listed below in Table 7.1. All parameters shown in Table 7.1 are from the unfiltered sample, representing total concentrations. No dissolved parameter concentrations (filtered sub-samples) exceeded the PWQO criteria. The Total Suspended Solids concentration for surface water was 4 mg/L and was 23,100 mg/L for the unfiltered water taken from the monitoring well at 22-01 (no assigned PWQO criteria).

Table 7.1 – Water Parameters Exceeding PWQO Criteria

Sample ID	Parameter	Criteria	Parameter Limit (mg/L)	Result (mg/L)
22-01 (Groundwater)	Mercury (total)	PWQO	0.0002	0.00108
	Arsenic (total)	Interim PWQO PWQO	0.005 0.100	0.0264
	Boron (total)	Interim PWQO	0.0002	0.434
	Cadmium (total)	Interim PWQO[1] PWQO	0.0005 0.0002	0.00731
	Cobalt (total)	Interim PWQO	0.0009	0.0733
	Iron (total)	PWQO	0.3	6.68
	Nickel (total)	PWQO	0.025	0.141
	Phosphorus (total)	Interim PWQO[2]	0.01	3.11
	Thallium (total)	Interim PWQO	0.0003	0.000380
	Zinc (total)	Interim PWQO PWQO	0.02 0.03	0.175
Cameron Creek (Surface Water)	Cobalt (total)	PWQO	0.0009	0.00102
	Iron (total)	PWQO	0.3	0.556
	Phosphorus (total)	Interim PWQO[2]	0.01	0.059

[1] Cadmium interim PWQO follows a scale based on measured hardness as $CaCO_3$. The interim PWQO of 0.0001 mg/L is set for water with less than 100 mg/L hardness as $CaCO_3$, The interim PWQO of 0.0005 mg/L is set for water with greater than 100 mg/L hardness as $CaCO_3$. All water samples taken have measured hardness as $CaCO_3$ greater than 100 mg/L. See Appendix B for testing results.

[2] Total Phosphorous Interim PWQO follows site specific guidelines. The interim PWQO of 0.01 mg/L is set as a high level of protection against aesthetic deterioration, the interim PWQO of 0.02 mg/L to avoid nuisance concentrations of algae in lakes, and the interim PWQO of 0.03 mg/L to avoid excessive plant growth in rivers and streams

8. SINGLE WELL RESPONSE TEST RESULTS

8.1 Test Procedure

A Single Well Response Test (SWRT), or “slug” test, was carried out in the 50-mm diameter well installed in Borehole 22-01. The well was screened across silty clay. The test was completed using the following method:

- Following installation of the monitoring well, the well was initially dry.
- A datalogger was inserted into the well after installation to monitor the initial water level recovery in the well. The datalogger was set to record water levels every 10 seconds, based on the anticipated rate of recovery of the well.

- Manual and electronic measurements were recorded until the water level in the well recovered sufficiently.
- Manual measurements were compared to electronic measurements for quality control of the data.

8.2 Hydraulic Conductivity

The slug test was analyzed using the Hvorslev method. The plot of the slug test result is included in Appendix B. The hydraulic conductivity value calculated from the in-situ slug test is summarized in Table 8.1 below.

Table 8.1: Single Well Response Test Result

Monitoring Well	Hydraulic Conductivity (m/s)	Screened Formation
22-01	1.6×10^{-8}	Silty Clay

9. MISCELLANEOUS

Thurber obtained utility clearances for the borehole locations prior to drilling. Borehole locations were selected and established in the field by Thurber Engineering Ltd.

RPM Drilling of Thunder Bay, Ontario supplied a rubber-tired CME 750 drill rig and a Simco Limited Access drill rig, and conducted the drilling, sampling and in-situ testing operations for the boreholes. Traffic control services were provided by ML Judson Trucking Ltd. of Emo, Ontario.

Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory. Analytical testing was carried out by SGS.

The field investigation was supervised on a full-time basis by Mr. Gregory Stanhope and Mr. Matthew MacAskill of Thurber. The overall supervision of the field program was conducted by Ms. Rachel Bourassa, EIT and Mr. Mark Farrant, P.Eng. of Thurber.

Interpretation of the field data and preparation of this report was carried out by Ms. Rachel Bourassa, E.I.T. and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

10. GENERAL

This report provides an interpretation of the factual data from Part 1 of the report and presents geotechnical recommendations for the proposed replacement of the existing Cameron Creek culvert crossing Highway 11. The discussion and recommendations presented in this report are based on the information provided by Hatch and on the factual data obtained during the course of the investigation.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The General Arrangement drawings provided by Hatch indicate that the existing structure is a closed bottom, concrete box culvert, with a span of 6.1 m, opening height of 1.8 m, and a length of 19.7 m. The estimated culvert invert (bottom of culvert) is at approximate Elev. 334.8 m at the inlet (north) and 334.7 m at the outlet (south). The existing road grade at the culvert location is at approximate Elev. 338.31 m, which indicates approximately 1.3 m of fill above the top slab of the culvert. The local creek water level was reportedly measured at Elev. 334.9 m on July 17, 2018.

The site topography near the culvert area is generally flat along Highway 11 on both sides of Cameron Creek. The existing highway embankment side slopes are inclined at approximately 1H:1V or steeper at the ends of the culvert, and 2H:1V or flatter beyond the culvert.

This report refers to the following applicable codes:

- Canadian Highway Bridge Design Code (CHBDC), 2019
- National Building Code of Canada (NBCC), 2015

11. CULVERT DESIGN

11.1 Culvert Alternatives

This section presents discussions on various options for rehabilitation or replacement of the existing culvert. Foundation recommendations for the preferred culvert types are provided.

Several culvert options being considered for this site are listed below:

- Rehabilitation of existing box culvert with new concrete box culvert extensions
- Replacement with corrugated steel pipe (CSP), structural plate corrugated steel pipe (SPCSP) or twin pipes
- Replacement with concrete box (closed) culvert composed of pre-cast segments

A comparison of the culvert types and foundation alternatives based on their respective advantages and disadvantages is included in Appendix E.

Preliminary draft General Arrangement (GA) drawings were provided by Hatch for each of the above culvert options. Each of these options includes lengthening of the culvert and widening of the embankment with additional fill at each end. Recommendations for the design and installation of these culvert options are presented below.

11.2 Summary of Subsurface Conditions

In general, the subsurface stratigraphy encountered in the boreholes consisted of asphalt and gravelly sand to gravel and sand fill and silty clay fill, underlain by native sandy, silty clay.

The unstabilized groundwater level in the open boreholes and monitoring well ranged from approximate Elevation 325.6 to 336.6 m. The local creek water level was reportedly measured at Elev. 334.9 m on July 17, 2018.

11.3 Foundation Design for Culverts

The invert level of the existing culvert (bottom of culvert) is at approximate Elevation 334.8 m at the inlet (north) and 334.7 m at the outlet (south).

Foundation design aspects for the replacement culvert include subgrade conditions and preparation, geotechnical capacities, settlement of foundation soils, lateral earth pressures, groundwater control, cofferdams, temporary stream diversion pipes, temporary roadway protection system design and restoration of the roadway embankment.

11.3.1 CSP or Structural Plate CSP (SPSCP) Replacement

Replacement of the culvert with a single or multiple CSPs or SPCSPs along the same alignment may be considered for this site. It is anticipated that the subgrade soils within the culvert footprint will not be subjected to any significant additional loading due to the culvert replacement, except where the culvert is to be lengthened beyond the existing culvert. The GA drawing (Option 2) provided by Hatch shows a design including twin 3.05 m diameter SPCSPs, with an invert level (bottom of pipe) at approximate Elev. 334 m.

If this alternative is selected, the pipes should be placed on a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements as per OPSD 802.010. The bedding material should be placed on the prepared subgrade as soon as practical, following its inspection and approval. The underside of the bedding layer should be placed at or below Elev. 333.7 m on the firm to stiff native sandy, silty clay. Any buried topsoil, excessively soft soil, large cobbles and boulders, and any soft, very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition. The subgrade preparation, placement and compaction of bedding should be carried out in the dry. Adequate preparation of the subgrade will be essential for good performance of the culvert. Construction equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction. A separation layer consisting of a non-woven geotextile should be placed between the subgrade soils and the bedding material. The geotextile should meet the specifications for the OPSS Class II (OPSS 1860) and have a fabric opening size (FOS) not greater than 212 μm.

11.3.2 Concrete Box Culvert Replacement or Box Culvert Extensions

Replacement of the culvert with a new concrete box culvert on the same alignment, or rehabilitation of the existing box culvert with new concrete box culvert extensions are also both viable alternatives for this site. It is anticipated that the subgrade soils within the culvert footprint will not be subjected to any significant additional loading due to these options, except where the replacement culvert or extensions are longer than the existing culvert. The GA drawings provided by Hatch show an extension design (Option 1) including 3.87 to 4.96 m long concrete box extensions, and a replacement design (Option 3) including a 33.9 m long concrete box culvert. The box culvert extensions for Option 1 have an opening size of 6.1 m wide by 1.8 m high, with invert levels (bottom of culvert) at approximately Elev. 334.5 m. For Option 3, the replacement box culvert has an opening size of is 6.0 m wide by 2.8 m high, with an invert level (bottom of culvert) at approximate Elev. 333.4 m.

In order to provide a uniform foundation subgrade, a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements should be provided under the base of the box culvert or extensions, similar to as shown on OPSD 803.010. The bedding material should be placed on the prepared subgrade as soon as practicable following its inspection and approval. The underside of the bedding layer should be placed on the firm to stiff native sandy, silty clay at or below Elev. 334.2 m for the box extensions or Elev. 333.1 m for the replacement culvert. Any buried topsoil, excessively soft soil, large cobbles and boulders, and any soft, very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition. The subgrade preparation and placement and compaction of the bedding material should be carried out in the dry. Adequate preparation of the subgrade will be essential for performance of the culvert. A separation layer consisting of a non-woven geotextile should be placed between the subgrade soils and the bedding material. The geotextile should meet the specifications for the OPSS Class II, and have a fabric opening size (FOS) not greater than 212 µm. The subgrade surface prepared to support the box units should have a 75 mm minimum thick top levelling course consisting of uncompacted Granular A as per OPSS 422. Construction equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction.

The following geotechnical resistances are recommended for the design of a box culvert or box culvert extensions with approximately 6 to 7 m bearing width founded at or below Elevation 334.2 m on the native firm to stiff sandy, silty clay:

Geotechnical Resistance	Approx. 6 to 7 m Wide Culvert
Factored Geotechnical Resistance at ULS	180 kPa
Geotechnical Resistance at SLS (for up to 25 mm settlement)	120 kPa

A consequence factor of 1.0 was utilized in this design adopting the typical consequence level. The geotechnical resistance factor of 0.5 for bearing and 0.8 for settlement, both adopted for typical degree of understanding, were used to obtain the above values, as per Canadian Highway

Bridge Design Code (CHBDC) 2019, Section 6.9.

The factored ultimate resistance and settlement are dependent on the culvert size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the culvert width or founding/invert elevation differs significantly from that given above.

The above geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance values used in design must be reduced in accordance with CHBDC 2019, Clause 6.10.5.3.

Resistance to sliding should be calculated assuming ultimate coefficients of friction of 0.45 between the concrete and the underlying Granular A or B Type II bedding material, and 0.35 between the bedding material and the native sandy, silty clay.

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.

11.3.3 Frost Cover

The depth of frost penetration at this site is approximately 2.3 m based on OPSD 3090.100. The base of any concrete footings if employed should be provided with a minimum of 2.3 m of earth cover as protection against frost action. The frost cover requirement does not apply to the pipe and box culvert options.

Frost treatment / tapers should be in accordance with OPSD 803.031 for a pipe culvert replacement or 803.010 for a box culvert replacement. As the depth of the existing granular material ranges from 1.8 to 3.2 m, new frost tapers are not required for open-cut construction.

11.3.4 Subgrade Preparation

Performance of the replacement culvert or culvert extensions will depend on the preparation of the subgrade.

Any buried topsoil, excessively soft soil, large cobbles and boulders, and any soft, very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition.

In the event that subgrade preparation is required, the width of sub-excavation should be defined by a line extending from 0.3 m beyond the outside edge of the proposed culvert, outward and downward at 1H:1V. The sub-excavated area should then be backfilled with granular material meeting OPSS.PROV 1010 Granular A or Granular B Type II requirements and be compacted as per OPSS.PROV 501. The subgrade preparation and placement and compaction of the bedding material must be carried out in the dry.

Construction equipment should not be allowed to travel on the prepared subgrade, which must be protected from disturbance during construction. Suggested wording for an Operational Constraint on Subgrade Preparation is included in Appendix F.

11.3.5 Settlement

The replacement culvert options are proposed to be constructed approximately on the same alignment and with a similar or larger opening size as the existing culvert with no grade raise on the overlying embankment. As the replacement or rehabilitated culvert will be longer than the existing culvert, some placement of additional fill will be required to widen the embankment slopes. The anticipated additional fill height is up to approximately 1 m at the inlet and up to approximately 2 m at the outlet. The fill height decreases to the east and west of the culvert, to transition to the existing embankment footprint. Foundation settlement of the native firm to stiff sandy silty clay of up to 25 mm is anticipated under the fill where placed beyond the existing embankment. Each of the culvert options will need to be designed to accommodate differential settlement between the widened highway and the existing embankment.

11.3.6 Recommended Approach for Culvert Replacement

From a foundation engineering perspective, replacement with twin SPCSP pipes or a concrete box culvert, or rehabilitation of the existing culvert including new box culvert extensions are all considered to be feasible culvert replacement options.

12. EXCAVATION AND GROUNDWATER CONTROL

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the granular and silty clay fills at this site are classified as a Type 3 soil above the water table. Below the water table (i.e., if the groundwater flow is not controlled), the fill soils would be classified as Type 4 soils. The native sandy silty clay is classified as Type 3 soil, however the stability analyses for temporary excavations (see Section 20) indicate that 1H:1V temporary excavations are not recommended.

Excavation and backfilling for culvert construction should be carried out in accordance with OPSS.PROV 902. Excavations for culvert replacement or extensions will be carried out through the existing fill and into the native sandy silty clay.

Installation of the culvert should be carried out in the dry. It is anticipated that excavation for the culvert replacement or extensions will be carried out below the creek water level, and diversion of the surface water flow will be required. Furthermore, surface runoff and groundwater seepage from the embankment fill should be anticipated and will accumulate in the excavations if not controlled. A combination of cofferdam enclosures and stream diversion along with pumping from properly filtered sumps within an enclosure will be required to maintain dry excavations during the course of staged construction.

The design of any dewatering systems is the responsibility of the Contractor. The Contract Documents must alert the Contractor to this responsibility and to design the system in accordance with SP FOUN0003 and OPSS.PROV 517. A preconstruction survey is not required at this site, thus Designer Fill-In ** in SP FOUN0003 should be “N/A”.

The groundwater level will fluctuate and the minimum groundwater elevation at the time of the proposed work should be taken as the creek water level or the design storm return period defined by the contract documents for the temporary dewatering system.

13. STREAM DIVERSION PIPE

A temporary stream diversion pipe may be required to divert creek water flow during construction of the replacement culvert or extensions. As shown on the draft GA drawings, it is anticipated that the invert level of the diversion pipe will be at or below Elevation 334.5 m, which corresponds to the silty clay fill or native sandy silty clay.

The temporary diversion pipe should be placed on a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements as per OPSD 802.010. The bedding material should be placed on the prepared subgrade as soon as practical, following its inspection and approval. The subgrade preparation should be carried out in the dry. The prepared subgrade should be protected from disturbance during construction.

The stream diversion pipe could be installed within the temporary open cut excavations, or within a shored excavation using a trench box.

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14. DEWATERING ASSESSMENT

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 will be greater than 50,000 L/day and less than 400,000 L/day then registration on the Environmental Activity and Sector Registry (EASR) will be required. If the water taking rate will be greater than 400,000 L/day, then a Category 3 Permit To Take Water (PTTW) will be required. On July 1, 2021, changes to EASR registrations came into effect, and storm water values no longer contribute to EASR maximum water taking rates. They are still, however, applicable to maximum water taking rates for PTTWs. A preliminary assessment of the need for water taking permitting is provided herein; however, additional analysis will be required to confirm this.

Three options were considering for the preliminary dewatering assessment at this site. Option 1 includes box culvert extensions of the existing culvert; Option 2 is replacement of the existing culvert with twin SPCSP culverts, and Option 3 is replacement of the existing culvert with a precast box culvert. In addition, a temporary diversion pipe will be installed adjacent to the culvert during construction to redirect the creek flow around the work area. Based on the draft GA drawings, the dimensions and conditions that were assumed for the preliminary dewatering assessment are provided in Table 14.1 below. For full dewatering to the base of the temporary excavation, the geologic unit that will need to be dewatered is silty clay.

Table 14.1: Assumed Excavation Dimensions and Ground Conditions

Structure	Assumed Excavation Footprint (m)	Lowest Assumed Elevation of Excavation (m)	Assumed Groundwater Elevation (m)	Geologic Unit(s) to Dewater
Option 1 – Extension Culvert – One Extension	20 x 5	334.0	337.0	Silty Clay
Option 2 – One Half of Twin SPCSP Replacement Culvert	28 x 17	333.5	337.0	Silty Clay
Option 3 – One Half Precast Box Replacement Culvert	28 x 17	333.0	337.0	Silty Clay
Diversion Pipe	25 x 8	333.5	337.0	Silty Clay

For the purpose of estimating water taking flow rates, it was assumed that surface water flow would be directed around the excavation such that surface water will not enter the excavation at a significant rate.

The water taking will be temporary in nature for the purpose of construction dewatering for installation of the culvert. The hydraulic conductivity of the silty clay was assumed based on the results of the in-situ slug test described in Section 8, which was within the range of estimates based on grain-size using the Puckett correlation. Dewatering rates were estimated using the Dupuit analytical solution. The radius of influence was calculated using the Sichardt equation. It is assumed the water level will be lowered to about 1 m below the proposed excavation in order to facilitate a dry, stable work area.

A maximum water level elevation of 337.0 m was assumed for all dewatering calculations based on the high-water level (25-year design flow returns) as indicated on the Cameron Creek Culvert GA Drawing Option 2, dated Oct. 26, 2022 provided by Hatch. It is noted that a stabilized water level was not recorded during the investigation and therefore Elev. 337.0 m was selected as a conservative (relatively high) water level.

It is assumed that one extension will be constructed at a time for Option 1. For Options 2 and 3, it is assumed that one half of the culvert will be constructed at a time to allow for one lane of traffic to remain open during construction. It is assumed that the full length of the diversion pipe may be constructed in a single operation, which would not be carried out concurrently with the excavation for the culvert construction.

The preliminary peak water taking rates for Options 1 to 3 and the diversion pipe were estimated to range from approximately 15,000 to 30,000 L/day, including a safety factor and 50-mm rainfall allowance. The majority of the peak water taking rate is due to the rainfall allowance. The anticipated rate of groundwater flow through the silty clay is very small. The preliminary radius of influence was estimated to be approximately less than 10 m from the edge of the excavation for each of the respective options.

Considering the estimated peak water taking rate is less than 50,000 L/day, an EASR registration will not be required.

Some perched water may exist in the gravelly sand to sand and gravel fill that may need to be temporarily managed. It is anticipated the fill will not be a source of continuous groundwater flow into the excavation; however, dewatering flow rates may be temporarily higher than the budgeted dewatering rate initially. If higher flow rates are initially encountered, the contractor must not dewater more than 50,000 L/day in order to remain below the minimum water taking rate for EASR registration.

15. WATER QUALITY

For assessment of the general groundwater quality at the site, a sample of the groundwater from the monitoring well at Borehole 22-01, and a surface water sample from the creek were collected on. As noted in Section 7, the water samples were tested and the results were compared to the Ontario Provincial Water Quality Objectives (PWQO). Filtered sub-samples of the groundwater and surface water were also tested for dissolved metal parameters for comparison purposes. The water sample test results are summarized in Table 7.1, and the full analytical test results are presented in Appendix B.

The test results indicate that ten metals parameters tested from the groundwater sample and three of the metals parameters tested from the surface water sample exceeded the PWQO criteria for total (unfiltered) concentrations. However, testing of filtered samples to remove the high Total Suspended Solids, indicated considerably reduced metals concentrations, with no dissolved metals concentrations exceeding the PWQO criteria. If dewatering is used at this site, it is likely that treatment of the discharge water through the use of filtering, settling tanks or other methods may be required to reduce the amount of suspended solids and the metals concentrations prior to discharge into local surface water bodies such as creeks.

16. CULVERT BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the culvert should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 802.010 or 803.010, as appropriate. Backfilling for the culvert should be in accordance with OPSS.PROV 401 for a CSP and OPSS.PROV 902 for a box culvert. All fills should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501. The backfill should be placed and compacted in simultaneous lifts on both sides of the culvert, and the top of backfill elevation should not differ more than 500 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and on the roof of the culvert. Compaction equipment to be used adjacent to the culvert should be restricted in accordance with OPSS.PROV 501.

Lateral earth pressures acting on the culvert walls may be assumed to be a triangular distribution. For a fully drained backfill, the pressures should be computed in accordance with the CHBDC 2019, but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where p_h = horizontal pressure on the wall at depth h (kPa)
K = earth pressure coefficient (see table below)
γ = bulk unit weight of retained soil (see table below)
h = depth below top of fill where pressure is computed (m)
q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the culvert walls are dependent on the material used as backfill. Recommended unfactored values are shown in Table 16.1 below.

Table 16.1 – Lateral Earth Pressure Coefficients (K)

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35°$; $\gamma = 22.8$ kN/m^3		OPSS Granular B Type I (modified) or Type III $\phi = 32°$; $\gamma = 21.2$ kN/m^3	
	Horizontal Backfill	**Sloping Backfill (2H:1V)**	**Horizontal Backfill**	**Sloping Backfill (2H:1V)**
Active (Unrestrained Wall)	0.27	0.40	0.31	0.48
At-rest (Restrained Wall)	0.43	0.62	0.47	0.70
Passive	3.7	-	3.2	-

Note: Submerged unit weight should be used below the groundwater level/high creek level.

For rigid structures such as concrete box culverts, at-rest horizontal earth pressures should be used for design. Active earth pressures should be used for any unrestrained wall.

The use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) is preferred as it results in lower earth pressures acting on the culvert.

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added. The magnitude of the surcharge should be 12 kPa at the top of fill and decrease to 0 kPa at a depth of 1.7 m for Granular B Type I, or at a depth of 2.0 m for Granular A or B Type II.

17. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site classification is based on the soil conditions encountered in the upper 30 m of the stratigraphy. Based on the presence of generally stiff sandy silt clay native soil, the site is classified as Seismic Site Class D in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC. The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.037 g as per the National Building Code of Canada (NBCC).

In accordance with Section 6.14.7 of the CHBDC 2019, the culvert walls should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in Table 17.1 may be used:

Table 17.1 – Earth Pressure Coefficients for Earthquake Loading

Condition	Earth Pressure Coefficient (K)		
	OPSS Granular A or Granular B Type II $\phi = 35°, \gamma = 22.8$ **kN/m³**	**Existing Granular Fill or OPSS Granular B Type I (modified) or Type III** $\phi = 32°, \gamma = 21.2$ **kN/m³**	**Existing Fill or Native Silty Clay** $\phi = 25°, \gamma = 18$ **kN/m³**
Active (K_{AE})[1]	0.29	0.33	0.43
Passive (K_{PE})[2]	3.6	3.2	2.4
At Rest (K_{OE})[3]	0.49	0.53	0.64

Note 1: Mononobe and Okabe, 1929, World Engineering Congress 9: 179-187

Note 2: Passive case assumes a horizontal surface in front of the wall.

Note 3: Wood, J. H. 1973, earthquake induced soil pressures on structures, PhD Thesis, California Institute of Technology, Pasadena, CA.

In view of the low potential for seismic activity in the area, liquefaction is not considered to be a concern at this site.

18. COFFERDAMS

Construction of cofferdams will be required for stream diversion and constructing the culvert replacement in the dry. Options for cofferdams include interlocking sheet piles or sandbags. Sheet pile cofferdams are anticipated to be feasible at this site as they can be driven into the native sandy silty clay. The recommendations provided in Section 19 below for Temporary Protection Systems are also applicable to sheet pile cofferdams.

19. TEMPORARY PROTECTION SYSTEM

A temporary roadway protection system, if utilized, should be implemented in accordance with OPSS.PROV 539 and designed for Performance Level 2. Options for roadway protection are a soldier pile and lagging system or interlocking sheet piles. Sheet piles are anticipated to be feasible at this site as they can be driven into the native sandy silty clay. The soil parameters in

Table 19.1 may apply for the design of the temporary roadway protection system with horizontal backfill.

Table 19.1 – Soil Parameters for Temporary Protection System Design

Soil Parameter	Existing Granular Fill	Native or Fill Silty Clay
Φ (angle of internal friction)	32˚	25˚
γ (total unit weight)	21 kN/m³	18 kN/m³
γ_w (submerged unit weight)	11 kN/m³	10 kN/m³
K_a	0.31	0.41
K_p	3.3	2.5

Full hydrostatic pressure should be considered assuming a water level at least equal to the design creek water level.

The temporary protection system may be removed or partially removed upon completion of the work. Care must be taken when removing the piles as to not incur damage to the subgrade of the newly installed culvert.

The design of the temporary protection system is the responsibility of the Contractor. The actual pressure distribution acting on the protection/shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors have to be considered when designing the shoring system. All protection systems should be designed by a Professional Engineer experienced in such designs, who will determine an appropriate support system.

20. SLOPE STABILITY

20.1 Permanent Slopes

As the replacement culvert will be longer than the existing culvert, placement of additional fill, up to approximately 1 to 2 m in height, will be required to widen and flatten the embankment side slopes, and transition to the existing embankment footprint beyond the culvert.

Slope stability analyses were conducted for the widened embankment side slopes of Highway 11 for both the culvert extension and replacement options. The stability assessments assume the embankment fill will consist of Granular B Type II, constructed at a 2H:1V slope. Based on discussions with Hatch, it is understood that property constraints and the proximity to existing utilities on the south side of Highway 11 limit the space available for the widened embankment. Therefore, the stability assessments also considered utilizing rock fill to allow a steeper 1.5H:1V slope to be constructed. The results of the slope stability analyses are included in Appendix G.

Figures 1 and 2 show the existing embankment slope with a Factor of Safety of 1.05 against shallow failure (Figure 1) and 1.44 for deep seated failure (Figure 2). Both analyses are for the steeper south embankment slope. Figures 3 and 4 show the rehabilitation option with the existing granular fill embankment and a benched-in rock fill slope inclined at 1.5H:1V to widen the embankment. With a minimum 1 m thick rock fill treatment at the narrowest point, the Factor of Safety against slope failure is 1.56 for the short-term (undrained) and 1.55 for the long-term (drained) conditions. Figure 5 shows a Factor of Safety of 1.6 for a deep-seated failure condition. Therefore, widening the existing embankment using 1.5H:1V rock fill slopes is considered to be acceptable. Construction of the rock fill benching is discussed in Section 21.

For both the SPCSP or concrete box culvert replacement options, Figures 6 and 7 show that 1.5H:1V slopes for a full rock fill embankment would be stable, with a Factor of Safety against slope failure of 1.55 for both the short-term (undrained) and long-term (drained) conditions. Figures 8 and 9 (Factor of Safety of 1.54) show that a Granular B Type II embankment with 2H:1V side slopes would also be stable for the short and long-term conditions.

20.2 Temporary Excavation Slopes

Assessment of the stability of temporary excavation slopes for installing the new culvert was also carried out. Figure 10 shows that temporary excavation slopes of 3H:1V below the groundwater table and 1H:1V above the groundwater table have a Factor of Safety against slope failure of 1.0, and therefore are not acceptable. In order to achieve a minimum Factor of Safety of 1.3 for stability of the temporary excavation slopes, above the groundwater level the slopes should be inclined at no steeper than 1.5H:1V. Figure 11 shows a Factor of Safety of 1.3 for 1.5H:1V temporary slopes above the groundwater level.

Suggested wording for an Operational Constraint on Temporary Excavation Slopes is included in Appendix F.

21. EMBANKMENT RESTORATION

Embankment restoration after completion of the culvert replacement should be carried out in accordance with OPSS.PROV 206. The embankment reconstruction material should consist of imported Granular B Type II and a cover of Rock Fill material. The restored embankment beyond the culvert should be reinstated at the existing slope inclination, but no steeper than 2H:1V if constructed with granular fill or 1.5H:1V if constructed with rock fill. Soils generated from the culvert excavation should not be used for reinstatement of the embankment.

In general, surface vegetation, peat, topsoil, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the areas around the culvert inlets and outlets, and within the embankment footprints. Inspection and approval of the foundation surfaces by qualified geotechnical personnel should be conducted.

Widening the existing slopes for the rehabilitation option will require the rock fill to be benched into the existing granular fill embankment. The rock fill slope surface should be a minimum of 1 m thick, with minimum 1.5 m wide horizontal benches excavated into the existing embankment slope. To maintain stability of the existing slope during construction, the benches should be constructed one at a time, starting with the bottom bench, and limited to 5 m long sections. The rock fill should be immediately placed along the 5 m long portion of the first bench excavated, and not placed by end-dumping.

Once the entire bottom bench has been constructed, the next bench up should be excavated and immediately backfilled with rock fill in 5 m long sections in the same manner. The final granular fill for the highway pavement should not be placed until all rock fill benches are complete.

If any slope instability is observed during the work (e.g. signs of sloughing, seepage, cracking or movement), remedial actions (e.g. slope flattening or backfilling the excavation) must be taken immediately to ensure the stability of the excavation and the safety of workers.

22. SCOUR AND EROSION PROTECTION

Erosion protection should be provided at the culvert inlet and outlet. Design of the erosion protection measures should consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field in accordance with OPSD 810.010, OPSS 511 and OPSS.PROV 1004.

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

A concrete cut-off wall (for box culvert options only) and a clay seal (only at the inlet) should be used to minimize the potential for erosion or piping around the culvert. The clay seal should extend to approximately 0.3 m above the high-water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS.PROV 1205. A geosynthetic clay liner may be used in place of a compacted clay seal.

Selection of streambed material should be in accordance with OPSS 1005.

23. CORROSION AND SULPHATE ATTACK POTENTIAL

The results of the corrosivity and sulphate content analytical tests conducted on the soil and surface water samples indicate the following conditions at the locations tested:

- The potential for corrosion on metal or concrete foundations from the surrounding native silty clay or surface water is considered to be mild, due to the low chloride and sulphate concentrations in the samples tested.
- The potential for corrosion on metal and concrete from the surrounding granular fill is considered to be moderate, due to the relatively lower resistivity for the fill, compared to the native soil. The effect of road deicing salt should be considering while selecting the class of concrete.
- The potential for sulphate attack on concrete from the surrounding soil or surface water is considered to be negligible due to the low sulphate concentration in the samples tested.
- Appropriate protection measures are recommended for metal or concrete structural elements. The effect of road deicing salt should be considered while selecting the corrosion protection measures.

24. CONSTRUCTION CONCERNS

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

- If the box culvert extension option is selected, the connections between the existing culvert and the extensions must be capable of tolerating the differential settlement between the existing and new fill for the widened embankment.
- Full dewatering to below the base of the culvert excavation will be required to maintain dry excavations for construction.
- The water level in the creek may fluctuate and be at a higher elevation at the time of construction than indicated in the report.

25. CLOSURE

Preparation of the design report was carried out by Mr. Mark Farrant, P.Eng. Engineering analysis was carried out by Mr. Mark Farrant, P.Eng. and Mr. Keli Shi, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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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.

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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

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

C_{pen} 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			

Ministry of Transportation Ontario

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RECORD OF BOREHOLE No 22-01

METRIC

GWP# 6120-17-00 | LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 966.3 E 220 848.6 | ORIGINATED BY GS

DIST Rainy River HWY 11 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY MC

DATUM Geodetic | DATE 2022.08.26 - 2022.08.27 LATITUDE 48.678533 LONGITUDE -94.140124 | CHECKED BY RB

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.3	GROUND SURFACE					
0.0	**TOPSOIL** Black Moist					
0.2	Silty **CLAY**, occasional organics Brown Moist	1	SS	6	336	
335.6 0.7	Silty **CLAY**, sandy, trace gravel Firm Grey Moist (CL)	2	SS	5	335	6 26 44 24
		3	SS	6	334	
		1	TW		333	
	Becoming Very Stiff	4	SS	5	332	2 29 43 26
		5	SS	15	331 / 330	
		6	SS	17	329 / 328	
		7	SS	20	327	1 30 40 29

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 22-01

METRIC

GWP# 6120-17-00	LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 966.3 E 220 848.6		ORIGINATED BY GS
DIST Rainy River HWY 11	BOREHOLE TYPE Solid Stem Augers		COMPILED BY MC
DATUM Geodetic	DATE 2022.08.26 - 2022.08.27	LATITUDE 48.678533 LONGITUDE -94.140124	CHECKED BY RB

SOIL PROFILE — Continued From Previous Page

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)
	Silty **CLAY**, sandy, trace gravel Very Stiff Grey Wet (CL)	8	SS	20	326	
					325	
		9	SS	21	324	
323.5 12.8		10	SS	19		

Column headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL; STRAT PLOT; GROUND WATER CONDITIONS.

END OF BOREHOLE AT 12.8m.
Monitoring Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2022.08.27	11.1	325.2
2022.08.28	10.7	325.6

Water level taken on August 28, 2022, was unstabilized.

+ ³, × ³ : Numbers refer to Sensitivity

20 / 15 / 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 22-02

METRIC

GWP# 6120-17-00	LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 935.9 E 220 850.1		ORIGINATED BY GS
DIST Rainy River HWY 11	BOREHOLE TYPE Solid Stem Augers		COMPILED BY MC
DATUM Geodetic	DATE 2022.08.27 - 2022.08.28	LATITUDE 48.678260 LONGITUDE -94.140098	CHECKED BY RB

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
336.7	GROUND SURFACE
0.0	**TOPSOIL** Black Moist
	Silty **CLAY**, some sand, trace gravel Stiff to Very Stiff Grey Moist to Wet (CI-CL)
	Becoming sandy

Continued Next Page

SAMPLES

NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
1	SS	20				
2	SS	12	0	15	34	51
3	SS	12				
4	SS	11				
5	SS	8	1	33	40	26
1	TW					
6	SS	14				
7	SS	12				

GROUND WATER CONDITIONS

ELEVATION SCALE: 336, 335, 334, 333, 332, 331, 330, 329, 328, 327

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20, 40, 60, 80, 100

SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE: 20, 40, 60, 80, 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 20, 40, 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

+ 3, × 3: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 22-02

METRIC

GWP# 6120-17-00	LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 935.9 E 220 850.1		ORIGINATED BY GS
DIST Rainy River HWY 11	BOREHOLE TYPE Solid Stem Augers		COMPILED BY MC
DATUM Geodetic	DATE 2022.08.27 - 2022.08.28	LATITUDE 48.678260 LONGITUDE -94.140098	CHECKED BY RB

Column headings: SOIL PROFILE (ELEV / DEPTH; DESCRIPTION; STRAT PLOT); SAMPLES (NUMBER; TYPE; "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) (GR, SA, SI, CL)

Continued From Previous Page

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER	ELEVATION SCALE	GR	SA	SI	CL
	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Grey Wet (CI-CL)	8	SS	15			2	28	40	30
					▽	326				
		9	SS	17		325				
		10	SS	11						
323.9						324				
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.0m AND WATER LEVEL AT 11.0m* IN OPEN HOLE UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE. * UNSTABILIZED WATER LEVEL									

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+³, ×³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

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RECORD OF BOREHOLE No 22-03

METRIC

GWP# 6120-17-00	LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 954.9 E 220 859.1		ORIGINATED BY MM
DIST Rainy River HWY 11	BOREHOLE TYPE Solid Stem Augers/Wash Boring		COMPILED BY AA
DATUM Geodetic	DATE 2022.03.05 - 2022.03.05	LATITUDE 48.678432 LONGITUDE -94.139979	CHECKED BY RB

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.3	GROUND SURFACE						
0.0	**ASPHALT:** (150mm)						
0.2	Gravelly **SAND**, some silt Very Dense to Compact Brown Moist (FILL)		1	SS	49		27 61 12 (SI+CL)
			2	SS	30		
			3	SS	18		
			4	SS	88		
335.1 / 3.2	Silty **CLAY**, trace sand, trace gravel Stiff Grey Wet (FILL)		5	SS	11		
334.2 / 4.1	Silty **CLAY**, sandy, trace gravel Soft Grey Wet (CL)		6	SS	3	∇	1 24 45 30
	Becoming Stiff						
			7	SS	6		
			1	ST			
			8	SS	7		

ELEVATION SCALE: 338, 337, 336, 335, 334, 333, 332, 331, 330, 329

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

Field vane sensitivity values: 1.4, 1.3, 1.6

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 22-03

METRIC

GWP# 6120-17-00	LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 954.9 E 220 859.1		ORIGINATED BY MM
DIST Rainy River HWY 11	BOREHOLE TYPE Solid Stem Augers/Wash Boring		COMPILED BY AA
DATUM Geodetic	DATE 2022.03.05 - 2022.03.05	LATITUDE 48.678432 LONGITUDE -94.139979	CHECKED BY RB

ELEV / DEPTH	DESCRIPTION (Continued From Previous Page)	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	FIELD VANE (sensitivity)	WATER CONTENT	GR	SA	SI	CL
	Silty **CLAY**, sandy, trace gravel Stiff Grey Wet (CL)				328	1.6					
		9	SS	8	327		○				
						1.4					
		10	SS	9	326		○				
					325	1.4					
		2	ST		324						
						1.5					
		11	SS	11	323		⊢○⊣	1	31	41	27
322.0 / 16.3	END OF BOREHOLE AT 16.3m. BOREHOLE OPEN TO 16.3m AND WATER LEVEL AT 5.1m* IN OPEN HOLE UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CONCRETE TO 0.2m, AND ASPHALT TO SURFACE. * UNSTABILIZED WATER LEVEL				322	1.4					

Legend: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+ 3, × 3: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No 22-04

METRIC

GWP# 6120-17-00 | LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 949.6 E 220 838.2 | ORIGINATED BY MM

DIST Rainy River HWY 11 | BOREHOLE TYPE Solid Stem Augers/Wash Boring | COMPILED BY AA

DATUM Geodetic | DATE 2022.03.05 - 2022.03.05 | LATITUDE 48.678381 | LONGITUDE -94.140262 | CHECKED BY RB

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.2	GROUND SURFACE									
0.0	**ASPHALT:** (150mm)					338				
0.2	Gravelly **SAND**, some silt Very Dense to Loose Brown Dry to Moist (FILL)	1	SS	62				○		
		2	SS	18		337		○		29 56 15 (SI+CL)
		3	SS	32	▽	336		○		
		4	SS	8				○		
335.2 3.0	Silty **CLAY**, sandy, trace gravel Firm Grey Wet (CL-CI)	5	SS	5		335		○		
						334				
		6	SS	5		333		○		
	Becoming Stiff to Very Stiff						+ 2.0			
		7	SS	6		332		○		
						331	+ 2.0			
		8	SS	12		330		├○──┤		1 31 39 29
		9	SS	17		329		○		

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Legend: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No 22-04

METRIC

GWP# 6120-17-00 | LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 949.6 E 220 838.2 | ORIGINATED BY MM

DIST Rainy River HWY 11 | BOREHOLE TYPE Solid Stem Augers/Wash Boring | COMPILED BY AA

DATUM Geodetic | DATE 2022.03.05 - 2022.03.05 | LATITUDE 48.678381 | LONGITUDE -94.140262 | CHECKED BY RB

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT / REMARKS	GR	SA	SI	CL
	Continued From Previous Page									
	Silty **CLAY**, sandy, trace gravel Very Stiff to Stiff Grey Wet (CL-CI)				328					
		10	SS	15	327					
		11	SS	12	326		1	28	43	28
		12	SS	13	325 / 324					
		1	ST		323 / 322	1.4				
321.9 16.3	END OF BOREHOLE AT 16.3m BOREHOLE OPEN TO 16.3m AND WATER LEVEL AT 1.8m* (INSIDE CASING) COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CONCRETE TO 0.2m, AND ASPHALT TO SURFACE. * UNSTABILIZED WATER LEVEL									

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE, 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+³, ×³: Numbers refer to Sensitivity   20 / 15 / 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No 22-05

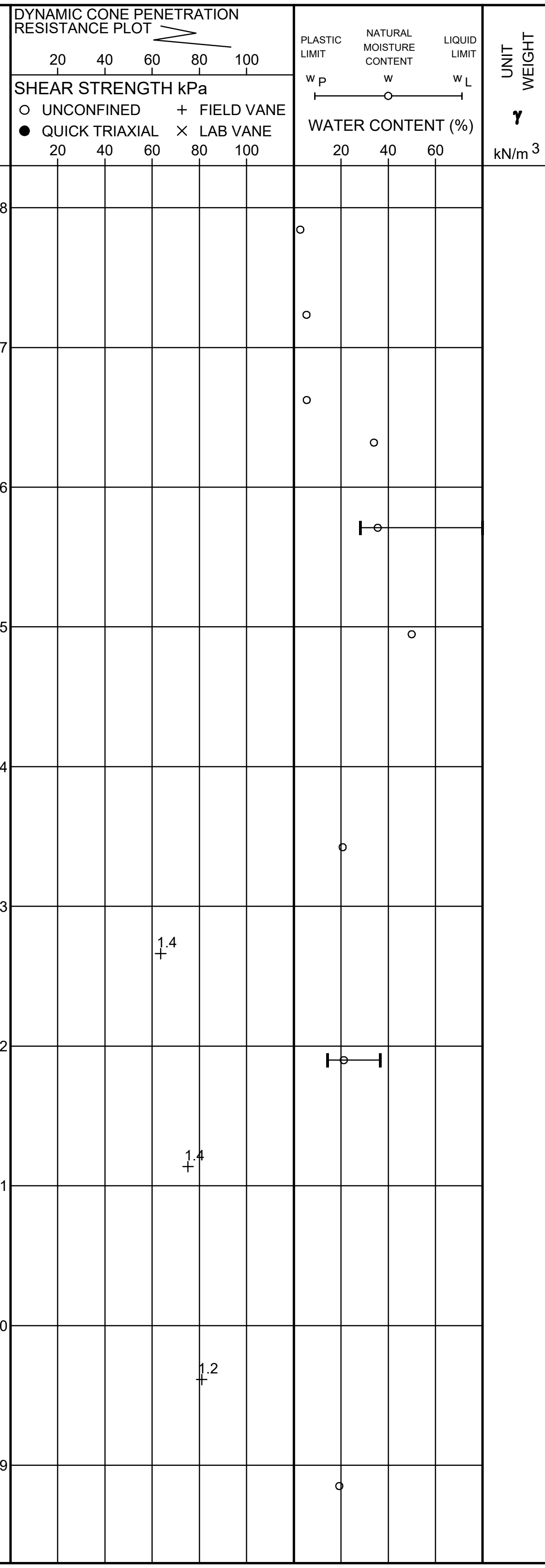
METRIC

GWP# 6120-17-00 | LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 949.2 E 220 864.8 | ORIGINATED BY MM

DIST Rainy River HWY 11 | BOREHOLE TYPE Solid Stem Augers/Wash Boring | COMPILED BY AA

DATUM Geodetic | DATE 2022.04.05 - 2022.04.05 LATITUDE 48.678381 LONGITUDE -94.139901 | CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.3	GROUND SURFACE					
0.0	**ASPHALT:** (150mm)					
0.2	**SAND** and **GRAVEL**, some silt Very Dense to Compact Brown Dry to Moist (FILL)	1	SS	66		
		2	SS	11		42 44 14 (SI+CL)
336.5 / 1.8	Silty **CLAY**, trace sand, trace gravel Firm Brown Wet (FILL-CH)	3	SS	7	∇ (water level)	
		4	SS	5		0 1 34 65
		5	SS	4		
334.2 / 4.1	Silty **CLAY**, sandy, trace gravel Soft Grey Wet (CI)	6	SS	3		
	Becoming Stiff					
		7	SS	6		0 29 40 31
		1	ST			
		8	SS	9		



Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity; 20 / 15 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 22-05

METRIC

GWP# 6120-17-00 | LOCATION Cameron Creek Culvert; MTM NAD 83-16: N 5 393 949.2 E 220 864.8 | ORIGINATED BY MM

DIST Rainy River HWY 11 | BOREHOLE TYPE Solid Stem Augers/Wash Boring | COMPILED BY AA

DATUM Geodetic | DATE 2022.04.05 - 2022.04.05 | LATITUDE 48.678381 | LONGITUDE -94.139901 | CHECKED BY RB

Continued From Previous Page

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (FIELD VANE, kPa) / SENSITIVITY	WATER CONTENT (%)
	Silty **CLAY**, sandy, trace gravel Stiff Grey Wet (CI)					+ ~80 (1.6)	
					328		
		9	SS	9			~20
					327		
						+ ~80 (1.3)	
					326		
		10	SS	11			~18
						+ ~85 (1.5)	
					325		
		11	SS	9			~20
					324		
						+ ~80 (1.4)	
					323		
		12	SS	13			~20
322.5 15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 1.7m* (INSIDE CASING) COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CONCRETE TO 0.2m, AND ASPHALT TO SURFACE. * UNSTABILIZED WATER LEVEL						

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20 40 60); UNIT WEIGHT γ kN/m^3; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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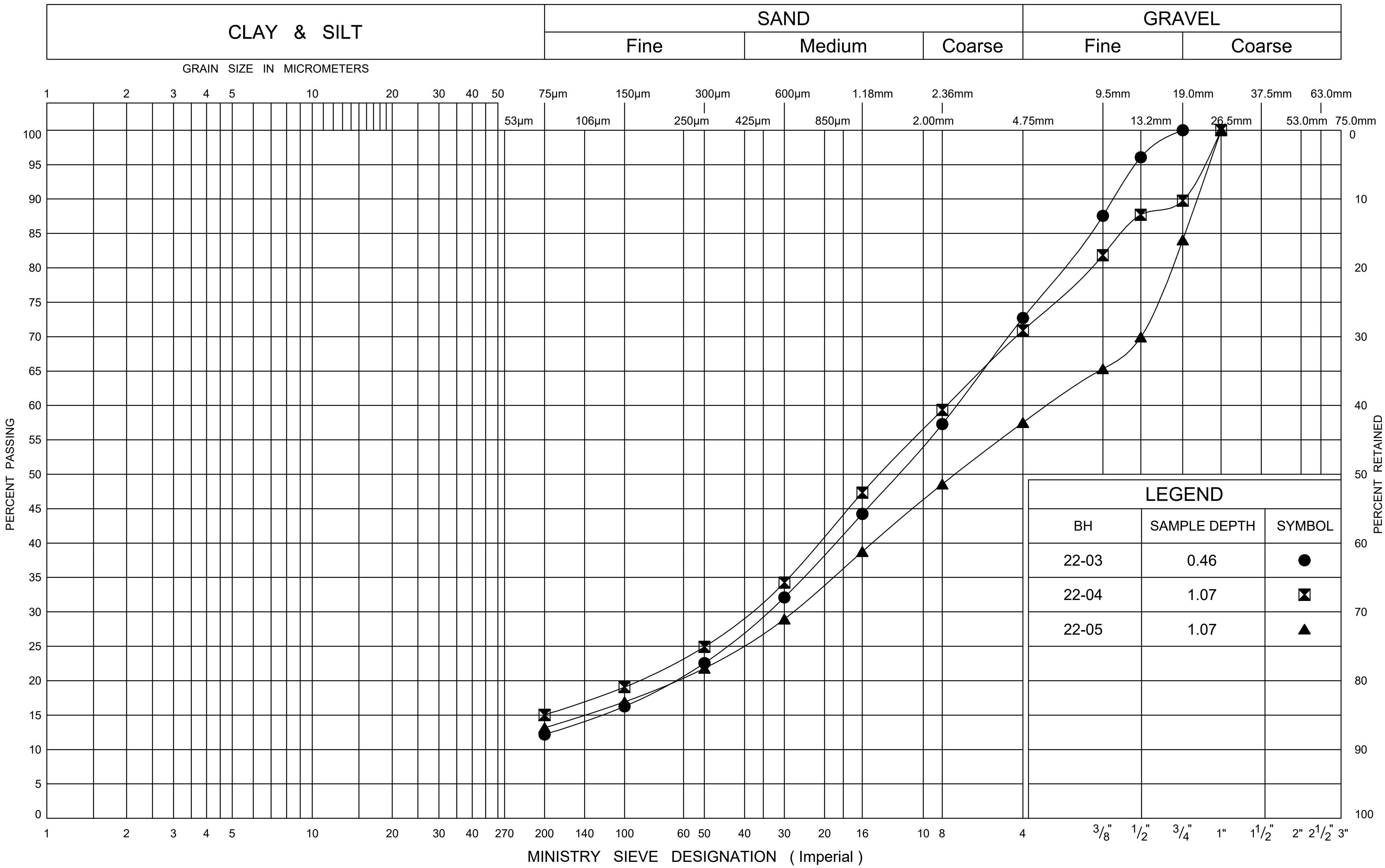
Appendix B

Laboratory and Well Test Results



LEGEND

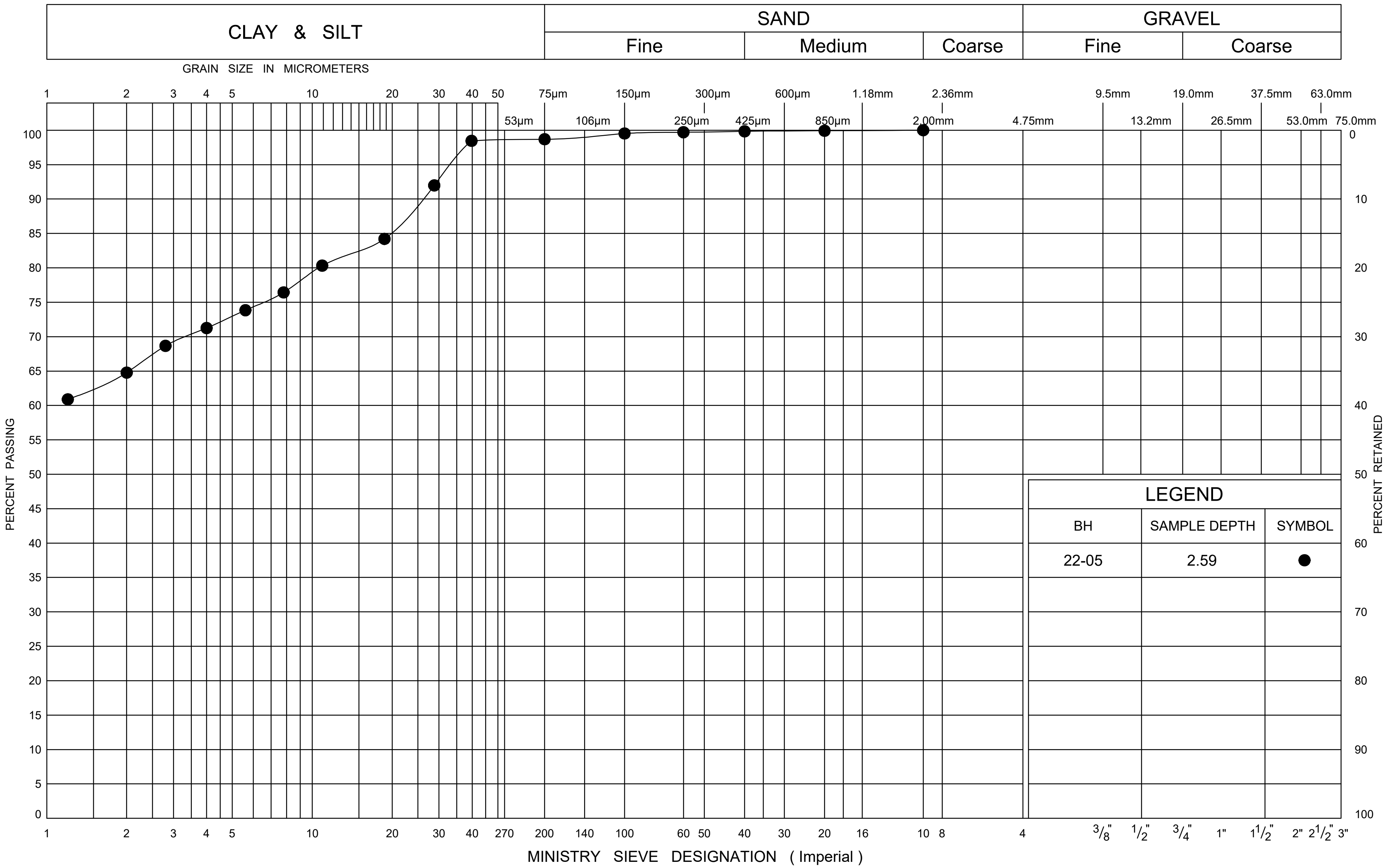
BH	SAMPLE DEPTH	SYMBOL
22-03	0.46	●
22-04	1.07	⊠
22-05	1.07	▲

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
GRANULAR FILL

FIG No B1
W.P.
Cameron Creek Culvert

78 12 M



BH	SAMPLE DEPTH	SYMBOL
22-05	2.59	●

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

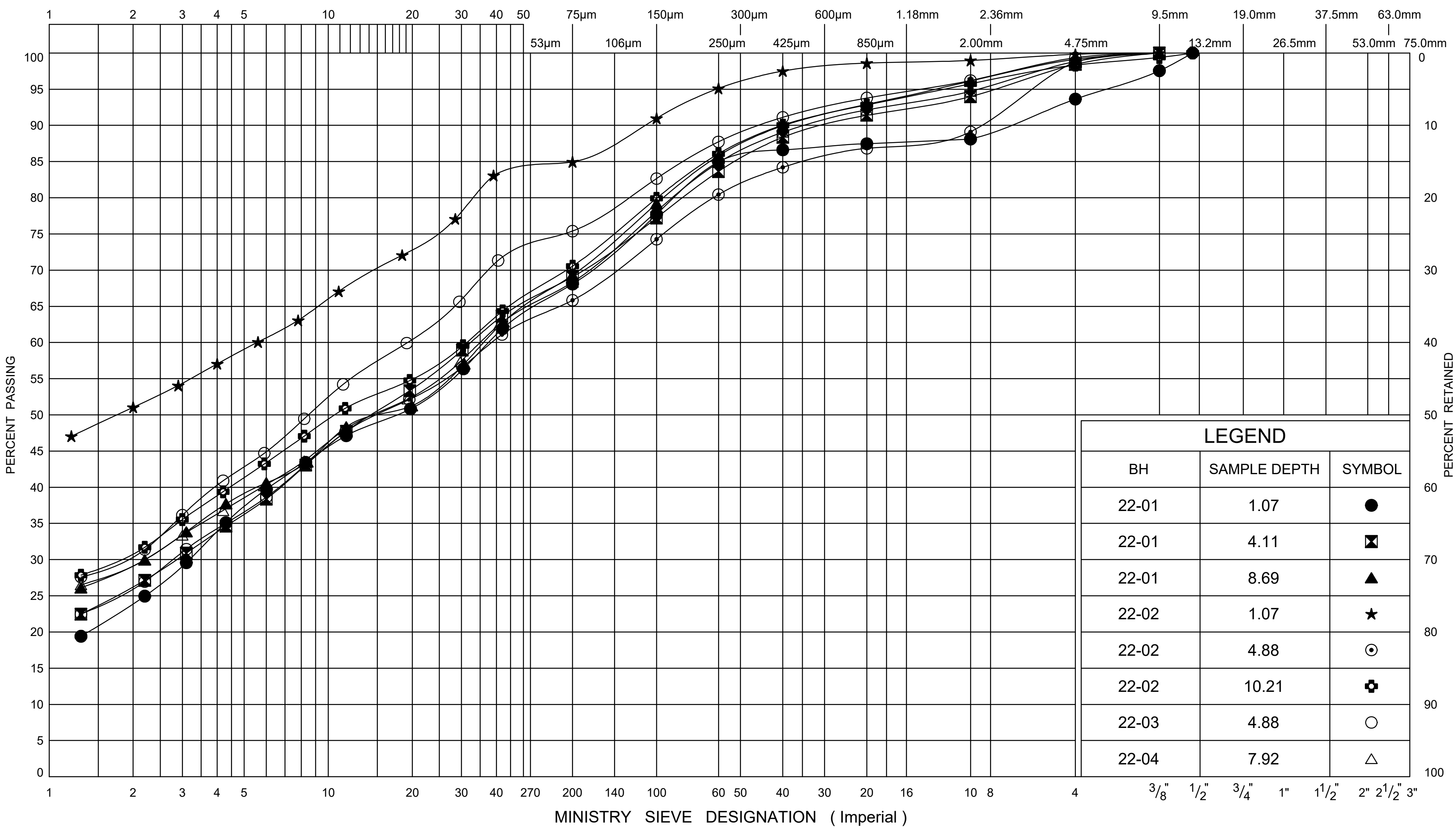
Silty CLAY FILL

FIG No B2

W.P.

Cameron Creek Culvert

ONTARIO MOT GRAIN SIZE 3 MTO-33309.GPJ ONTARIO MOT.GDT 11/8/22



LEGEND

BH	SAMPLE DEPTH	SYMBOL
22-01	1.07	●
22-01	4.11	⧗
22-01	8.69	▲
22-02	1.07	★
22-02	4.88	⊙
22-02	10.21	✚
22-03	4.88	○
22-04	7.92	△

Ministry of Transportation
Ontario

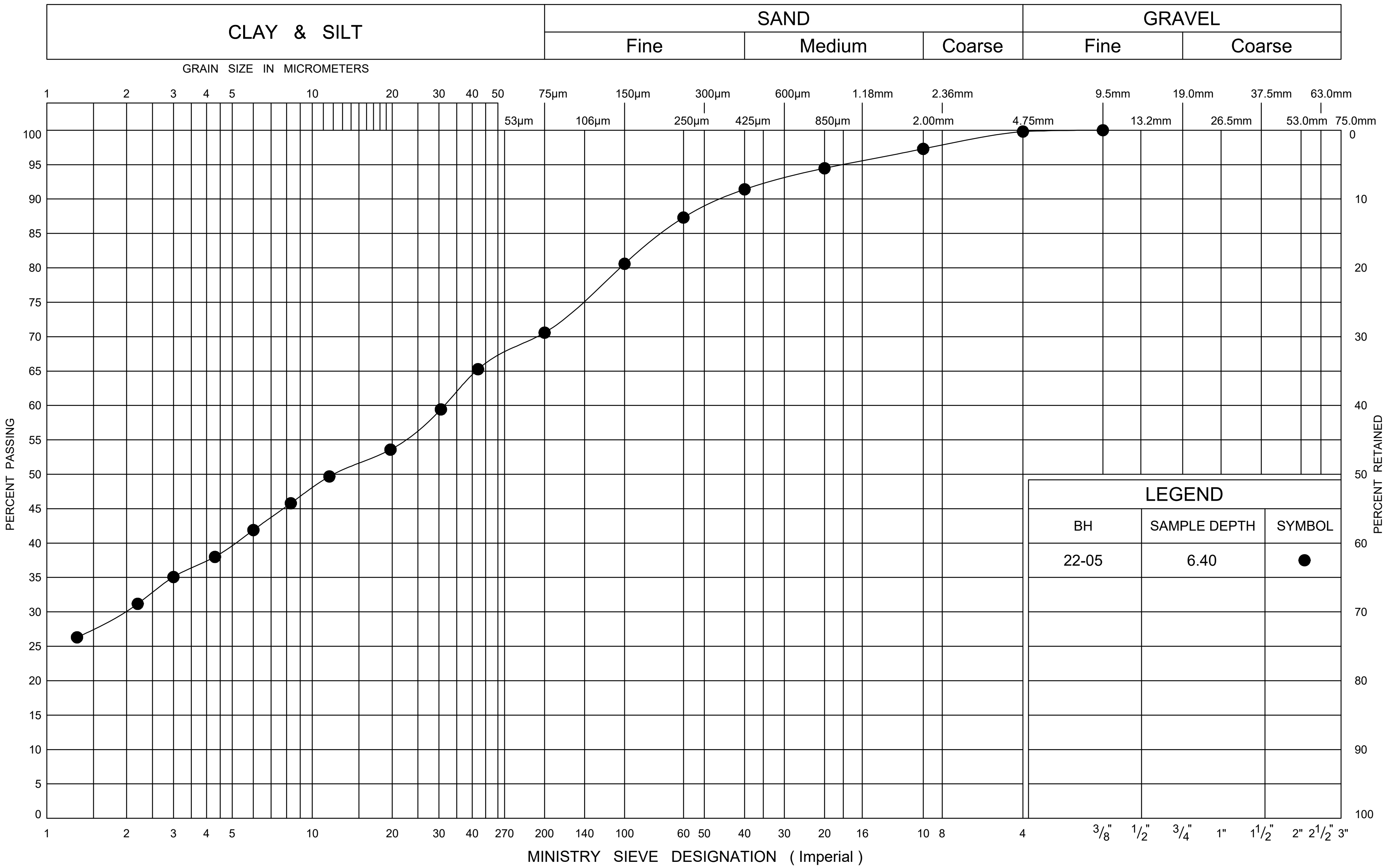
GRAIN SIZE DISTRIBUTION

Sandy Silty CLAY

FIG No B3

W.P.

Cameron Creek Culvert



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
22-05	6.40	●

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

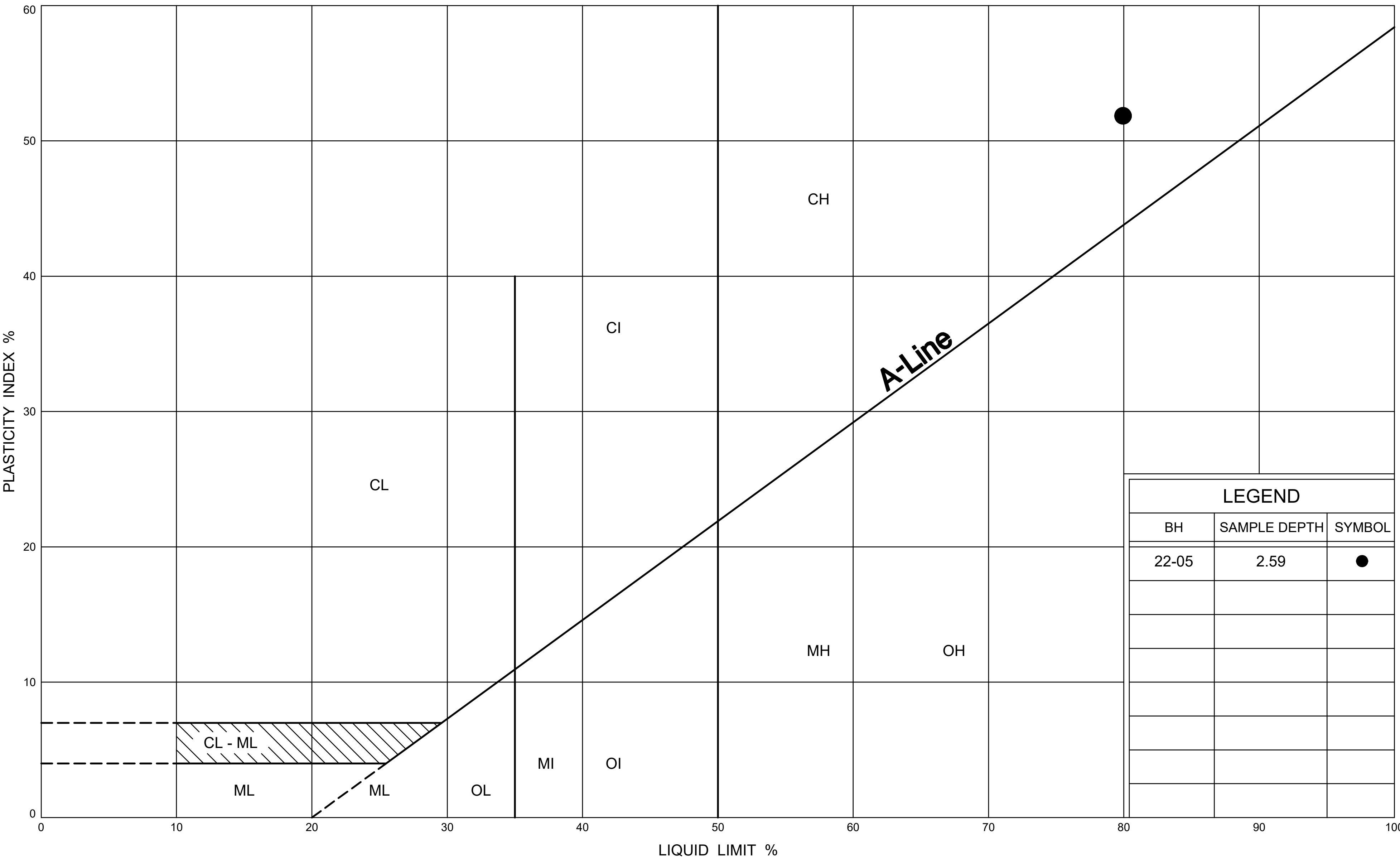
Sandy Silty CLAY

FIG No B4

W.P.

Cameron Creek Culvert

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
22-05	2.59	●

Ministry of Transportation
Ontario

PLASTICITY CHART

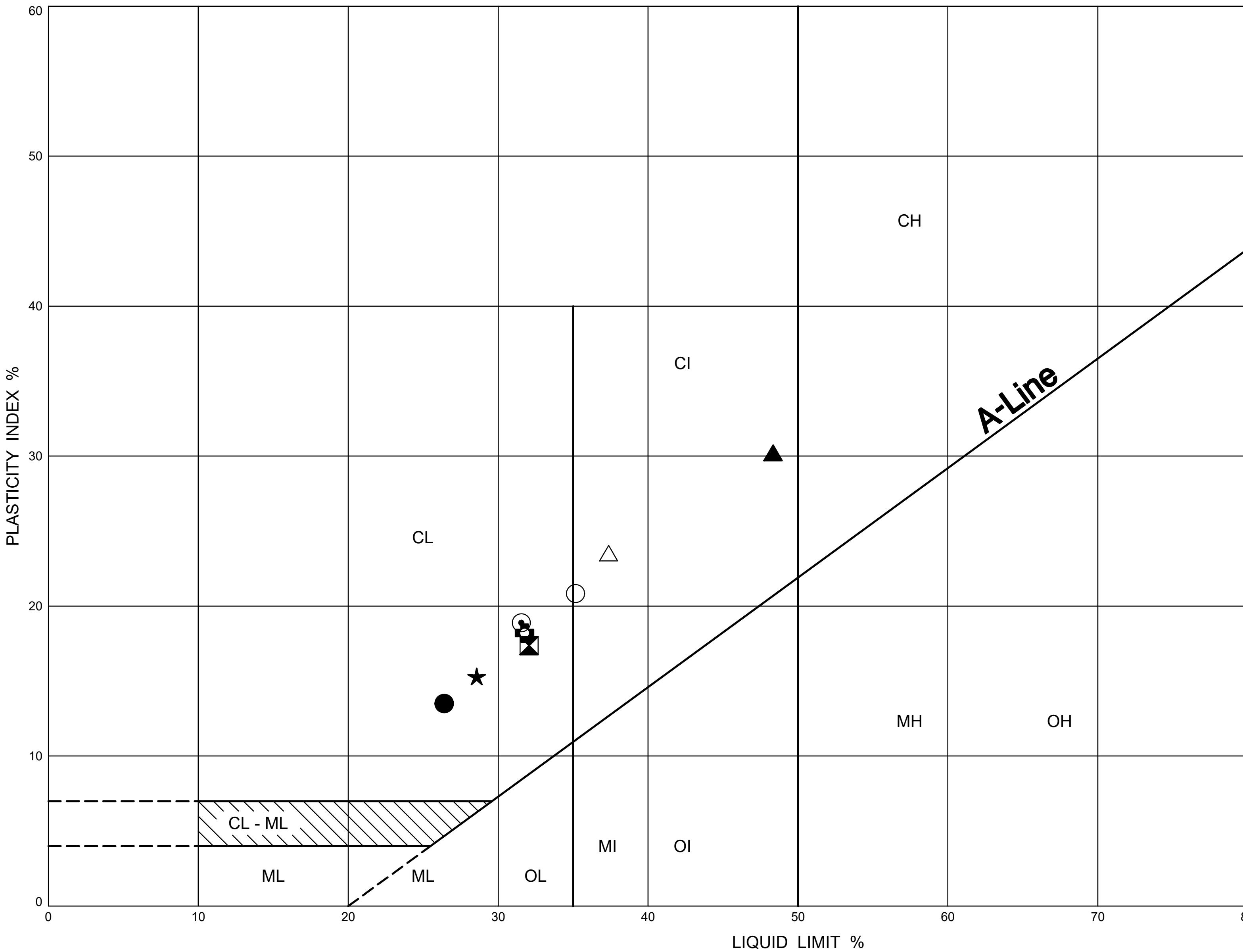
Silty CLAY FILL

FIG No B5

W.P.

Cameron Creek Culvert

Oct 75, FF - S - 21



LEGEND

BH	SAMPLE DEPTH	SYMBOL
22-01	4.11	●
22-01	8.69	⧗
22-02	1.07	▲
22-02	4.88	★
22-03	4.88	⊙
22-03	15.54	✿
22-04	7.92	○
22-04	12.50	△

Ministry of Transportation
Ontario

PLASTICITY CHART

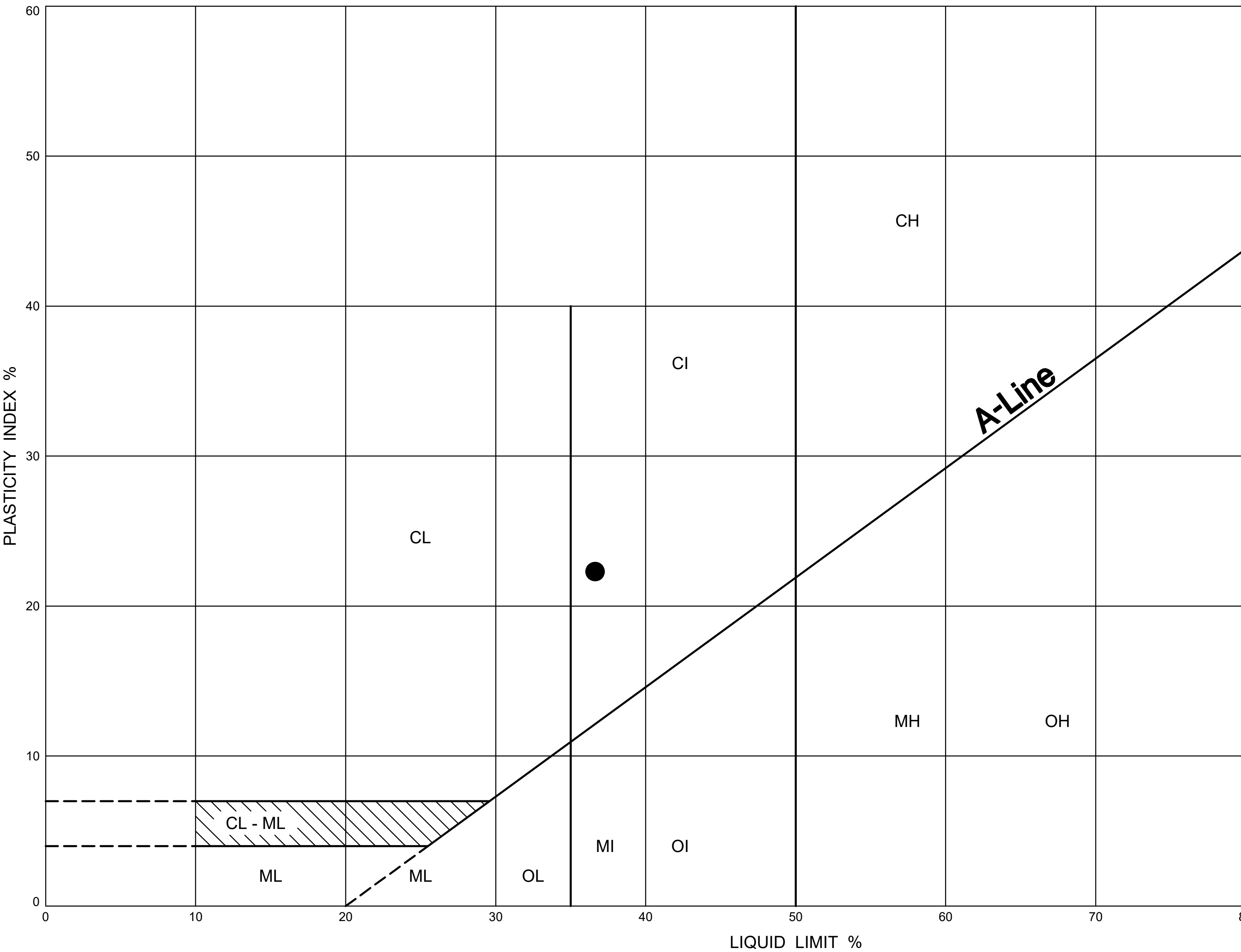
Sandy Silty CLAY

FIG No B6

W.P.

Cameron Creek Culvert

Oct 75, FF - S - 21



LEGEND

BH	SAMPLE DEPTH	SYMBOL
22-05	6.40	●

ONTARIO MOT PLASTICITY CHART 2 MTO-33309.GPJ ONTARIO MOT.GDT 11/8/22

Ministry of Transportation
Ontario

PLASTICITY CHART

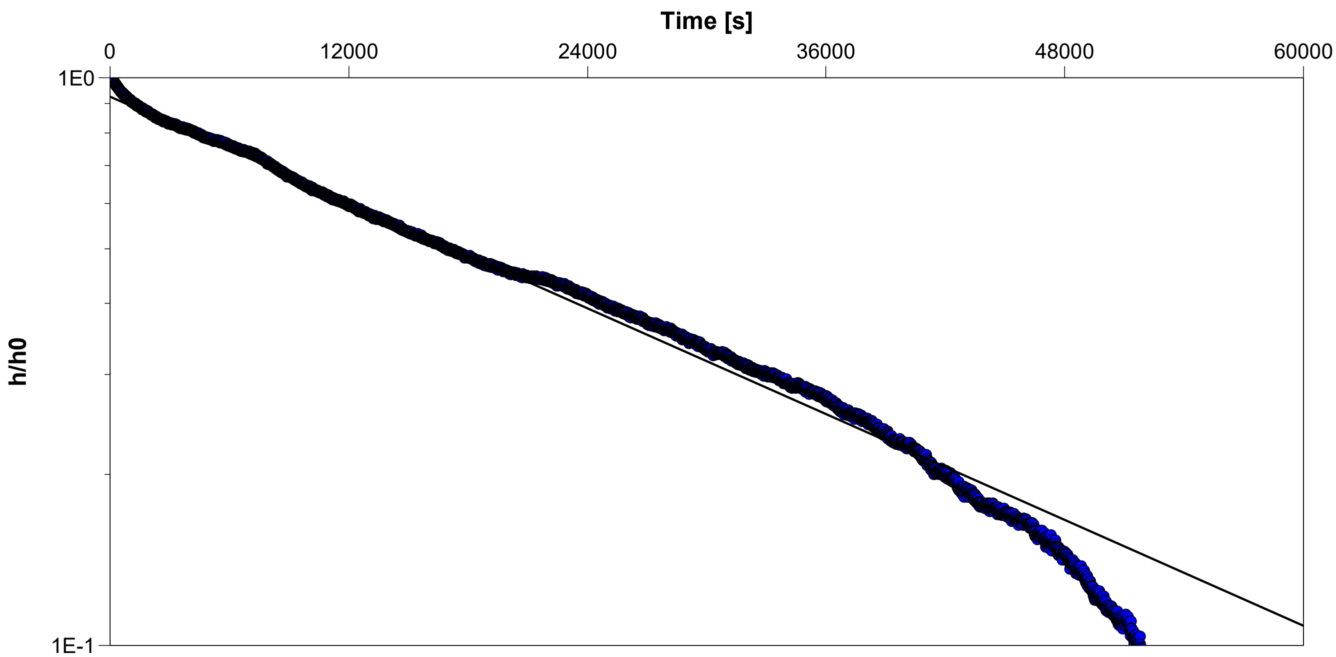
Sandy Silty CLAY

FIG No B7

W.P.

Cameron Creek Culvert

THURBER ENGINEERING LTD.	**Slug Test Analysis Report**	
	Project: Cameron Creek Culvert Replacement	
	Number: 33309	
	Client: MTO	
Location: District of Rainey River	Slug Test: 22-01	Test Well: 22-01
Test Conducted by: GS		Test Date: 2022-08-27
Analysis Performed by: JR	22-01 SWRT Analysis	Analysis Date: 2022-10-27
Aquifer Thickness:		
	Checked by: PC	



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
22-01	1.6×10^{-8}	

FINAL REPORT

CA40191-OCT22 R1

33309, C.ameron and Lyon Creek Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA40191-OCT22
Project	33309, C.ameron and Lyon Creek Culvert	Received	10/26/2022
Order Number		Approved	11/04/2022
Samples	Soil (1)	Report Number	CA40191-OCT22 R1
		Date Reported	11/08/2022

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes

Chain of Custody Number: No.1

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

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

FINAL REPORT

CA40191-OCT22 R1

Client: Thurber Engineering Ltd.

Project: 33309, C.ameron and Lyon Creek Culvert

Project Manager: Rachel Bourassa

Samplers: Rachel Bourassa

MATRIX: SOIL

Sample Number 6

Sample Name 22-02 SS1 (0'-2')

Sample Matrix Soil

Sample Date 27/10/2022

Parameter	Units	RL		Result
Corrosivity Index				
Corrosivity Index	none	1		1
Soil Redox Potential	mV	no		279
Sulphide (Na2CO3)	%	0.04		< 0.04
pH	pH Units	0.05		8.28
Resistivity (calculated)	ohms.cm	-9999		6670
General Chemistry				
Conductivity	uS/cm	2		150
Metals and Inorganics				
Moisture Content	%	0.1		18.5
Sulphate	µg/g	0.4		30
Other (ORP)				
Chloride	µg/g	0.4		< 10↑

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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	DIO0587-OCT22	µg/g	0.4	<0.4	1	35	98	80	120	92	75	125
Sulphate	DIO0587-OCT22	µg/g	0.4	<0.4	3	35	99	80	120	107	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-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)	ECS0088-OCT22	%	0.04	< 0.04	ND	20	117	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-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	EWL0670-OCT22	uS/cm	2	< 2	0	20	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-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	EWL0670-OCT22	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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS

Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

- 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

No: 1

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: ED
Received Date (mm/dd/yy): 10-26-22
Received Time: 1140
Received By (signature): [signature]
Custody Seal Present: ✓
Custody Seal Intact: ✓
Cooling Agent Present: ✓
Temperature Upon Receipt (°C): 9X3
LAB LIMS #: Oct 26th CA40191

REPORT INFORMATION

Company: Thurber Engineering Ltd.
Contact: Rachel Bourassa
Address: 103-2010 Winston Park Drive, Oakville, Ontario
Phone: 416-523-1015
Email: rbourassa@thurber.ca
Email:

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #:
P.O. #:
Project #: 33309
Site Location/ID: Cameron and Lyon Creek Culvert

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:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ___ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ CCME ☐ MISA ☐ MMER ☑ Other:

Sewer By-Law: ☐ Sanitary ☐ Storm
Municipality:

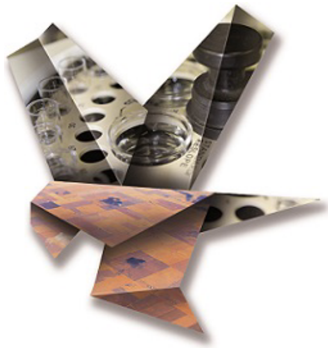
RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH☐ ABN☐ SVOC(all)☐	PCB Total ☐ Aroclor ☐	PHC F1-F4☑ VOC☐ BTEX☑ BTEX/F1☐ F2-F4☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC☐ OP☐	TCLP M&I☐ VOC☐ PCB☐ B(a)P☐ ABN☐ Ignit.☐	Water Pkg Gen.☐ Ext.☐	Sewer Use:	Corrosivity/Resistivity					COMMENTS:
1	22-07 SS3B (8'6" - 9'6")	8/23/22	–	1	Soil		☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
2	22-02 SS1 (0'-2')	8/27/22	–	1	Soil		☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
3							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
4							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
5							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
11							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
12							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Observations/Comments/Special Instructions: *Corrosivity should include Sulphate

Sampled By (NAME): Rachel Bourassa / GS	Signature: [signature]	Date: 8/27/22	(mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	Signature: [signature]	Date: 10/26/22	(mm/dd/yy)	Yellow & White Copy - SGS



FINAL REPORT

CA40152-JUN22 R1

33309, C.ameron and Lyon Creek Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA40152-JUN22
Project	33309, C.ameron and Lyon Creek Culvert	Received	06/09/2022
Order Number		Approved	06/26/2022
Samples	Soil (1)	Report Number	CA40152-JUN22 R1
		Date Reported	11/08/2022

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes

Chain of Custody Number:1

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

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

FINAL REPORT

Client: Thurber Engineering Ltd.

Project: 33309, C.ameron and Lyon Creek Culvert

Project Manager: Rachel Bourassa

Samplers: Rachel Bourassa

MATRIX: SOIL

Sample Number	5
Sample Name	22-03 SS4 (7'6"-9'6")
Sample Matrix	Soil
Sample Date	03/05/2022

Parameter	Units	RL		Result
Corrosivity Index				
Corrosivity Index	none	1		4
Soil Redox Potential	mV	no		230
Sulphide (Na2CO3)	%	0.04		< 0.04
pH	pH Units	0.05		8.88
Resistivity (calculated)	ohms.cm	-9999		3600
General Chemistry				
Conductivity	uS/cm	2		278
Metals and Inorganics				
Moisture Content	%	0.1		13.9
Sulphate	µg/g	0.4		24
Other (ORP)				
Chloride	µg/g	0.4		99

FINAL REPORT

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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	DIO0242-JUN22	µg/g	0.4	<0.4	3	35	97	80	120	99	75	125
Sulphate	DIO0242-JUN22	µg/g	0.4	<0.4	5	35	96	80	120	96	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-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)	ECS0029-JUN22	%	0.04	< 0.04								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-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	EWL0245-JUN22	uS/cm	2	2	0	20	101	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-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	EWL0245-JUN22	pH Units	0.05	NA	0		99			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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

- 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

No: 1

Laboratory Information Section - Lab use only

Received By: Nicole Brigant
Received Date (mm/dd/yy): June 9/22
Received Time: 10:00
Received By (signature): [signature]
Custody Seal Present: ☑
Custody Seal Intact: ☐
Cooling Agent Present: ☑ Ice
Temperature Upon Receipt (°C): 8°C x3
LAB LIMS #: CA40523-JUN22

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering Ltd.	☑ (same as Report Information)
Contact: Rachel Bourassa	Company:
Address: 103-2010 Winston Park Drive, Oakville, Ontario	Contact:
	Address:
Phone: 416-523-1015	Phone:
Email: rbourassa@thurber.ca	Email:
Email:	

PROJECT INFORMATION

Quotation #: ______ P.O. #: ______
Project #: 33309 Site Location/ID: Cameron and Lyon Creek Culvert

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:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ CCME ☐ MISA ☐ MMER ☑ Other:

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

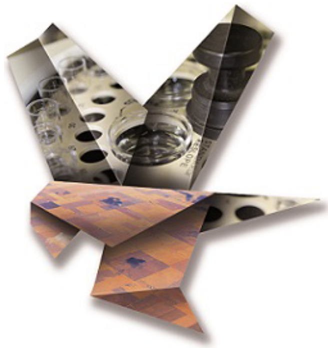
ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH☐ ABN☐ SVOC(all)☐	PCB Total ☐ Aroclor ☐	PHC F1-F4☑ VOC☐ BTEX☑ BTEX/F1☐ F2-F4☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC☐ OP☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.☐	Water Pkg Gen.☐ Ext.☐	Sewer Use:	Corrosivity/Resistivity					COMMENTS:
1	22-03 SS4(7'6" - 9'6")	5/3/22	9:00 A.M.	1	SOIL		☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
2	22-08 SS3(5' - 7')	05/02/22	11:00 A.M.	1	SOIL		☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	
3							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
4							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
5							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
11							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
12							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Observations/Comments/Special Instructions
*Jars from a different Lab were used

Sampled By (NAME):	Rachel Bourassa	Signature: Rachel Bourassa	Date: 05/03/22	(mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME):	Rachel Bourassa	Signature: Rachel Bourassa	Date: 06/07/22	(mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018



FINAL REPORT

CA40016-SEP22 R

33309, Emo, ON

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Brad Moore Hon. B.Sc
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	705-652-2143
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	brad.moore@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA40016-SEP22
Project	33309, Emo, ON	Received	09/01/2022
Order Number		Approved	09/07/2022
Samples	Surface Water (1)	Report Number	CA40016-SEP22 R
		Date Reported	09/07/2022

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes

Chain of Custody Number: 010115

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

FINAL REPORT

CA40016-SEP22 R

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

Sample Number	6
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Parameter	Units	RL	L1	Result
General Chemistry				
Conductivity	uS/cm	2		433
Redox Potential	mV	no		214
Metals and Inorganics				
Sulphate	mg/L	0.04		1.3
Other (ORP)				
pH	No unit	0.05	8.6	7.98
Chloride	mg/L	0.04		2.0

EXCEEDANCE SUMMARY

No exceedances are present above the regulatory limit(s) indicated

FINAL REPORT

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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	DIO0073-SEP22	mg/L	0.04	<0.04	4	20	97	90	110	96	75	125
Sulphate	DIO0115-SEP22	mg/L	0.04	<0.04	0	20	97	90	110	94	75	125

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-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	EWL0055-SEP22	uS/cm	2	< 2	0	20	99	90	110	NA		

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-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
pH	EWL0055-SEP22	No unit	0.05	NA	1		100			NA		

QC SUMMARY

Redox Potential

Method: SM 2580 I

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
Redox Potential	EWL0057-SEP22	mV	no	NA	0	20	103	80	120	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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

- 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

No: 010115

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: Scott R
Received By (signature): S
Received Date (mm/dd/yyyy): 09 / 01 / 2022 (mm\dd\yy)
Custody Seal Present: ☐
Cooling Agent Present: ☐ Ice
Received Time: 11 : 30
Custody Seal Intact: ☐
Temperature Upon Receipt (°C): 9 & 3
LAB LIMS #: SRPT-40015-16

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Eng LTD	☑ (same as Report Information)
Contact: Rachel Bourassa	Company:
Address: 2010 Winston Park Dr #103 Oakville ON L6M 5R7	Contact:
Phone: 416 523 1015	Address:
Email: rbourassa@thurber.ca	Phone:
Email:	Email:

PROJECT INFORMATION

Quotation #: P.O. #:
Project #: 33309 Site Location/ID: EMO, ON

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:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ___ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☑ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH☐ ABN☐ SVOC(all)☐	PCB Total ☐ Aroclor ☐	PHC F1-F4☐ VOC☐ BTEX☐ BTEX/F1☐ F2-F4☐	VOC☐ BTEX☐ THM☐	Pesticides OC☐ OP☐	TCLP M&I ☐ VOC ☐ PCB☐ B(a)P ☐ ABN ☐ Ignit.☐	Water Pkg Gen. ☐ Ext.☐	Sewer Use:	TSS	Lab Filtered Metals	Corrosivity	General Water Characterization Package	COMMENTS:
1	Cameron Creek SW	Aug 28/22		15	Water											✓	✓	✓	✓	
2	22-01	Aug 28/22		14	Water											✓	✓		✓	
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

Observations/Comments/Special Instructions: Corrosivity Includes PH, Soluable Sulphate, Chloride, Resistivity, Electrical Conductivity

Sampled By (NAME): Greg Stanhope	Signature: GS	Date: Aug / 28 / 2022	(mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	Signature: Rachel Bourassa	Date: Aug / 31 / 2022	(mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

FINAL REPORT

CA40015-SEP22 R1

33309, Emo, ON.

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA40015-SEP22
Project	33309, Emo, ON.	Received	09/01/2022
Order Number		Approved	09/14/2022
Samples	Ground Water (1)	Report Number	CA40015-SEP22 R1
		Date Reported	11/11/2022

COMMENTS

MAC - Maximum Acceptable Concentration
AO/OG - Aesthetic Objective / Operational Guideline
NR - Not reportable under applicable Provincial drinking water regulations as per client.

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody Number:010115

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

Jill Campbell

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FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.
Project: 33309, Emo, ON.
Project Manager: Rachel Bourassa
Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	8
Sample Name	22-01
Sample Matrix	Ground Water
Sample Date	28/08/2022

General Chemistry

Parameter	Units	RL	L1	Result
Total Suspended Solids	mg/L	2		23100
Alkalinity	mg/L as CaCO3	2		407
Bicarbonate	mg/L as CaCO3	2		407
Carbonate	mg/L as CaCO3	2		< 2
OH	mg/L as CaCO3	2		< 2
Colour	TCU	3		17
Conductivity	uS/cm	2		1030
Turbidity	NTU	0.10		>4000
Ammonia+Ammonium (N)	as N mg/L	0.1		0.9
Phosphorus (total reactive)	mg/L	0.03		0.19
Total Organic Carbon	mg/L	1		8
Ion Ratio	-	-9999		28.04
Total Dissolved Solids (calculated)	mg/L	-9999		6469
Conductivity (calculated)	uS/cm	-9999		17434
Langeliers Index 4° C	@ 4° C	-9999		2.22
Saturation pH 4°C	pHs @ 4°C	-9999		5.79

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON.

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	8
Sample Name	22-01
Sample Matrix	Ground Water
Sample Date	28/08/2022

Metals and Inorganics

Parameter	Units	RL	L1	Result
Fluoride	mg/L	0.06		0.35
Bromide	mg/L	0.3		< 0.3
Nitrite (as N)	as N mg/L	0.03		0.24
Nitrate (as N)	as N mg/L	0.06		0.43
Sulphate	mg/L	0.2		140
Hardness (dissolved)	mg/L as CaCO3	0.05		424
Aluminum (dissolved)	mg/L	0.001	0.075	0.069
Aluminum (0.2µm)	mg/L	0.001	0.075	0.006
Arsenic (dissolved)	mg/L	0.0002		0.0027
Boron (dissolved)	mg/L	0.002		0.179
Barium (dissolved)	mg/L	0.00008		0.0493
Beryllium (dissolved)	mg/L	0.000007		0.000013
Cobalt (dissolved)	mg/L	0.000004		0.00491
Calcium (dissolved)	mg/L	0.01		95.3
Cadmium (dissolved)	mg/L	0.000003		0.000342
Copper (dissolved)	mg/L	0.0002		0.0084
Chromium (dissolved)	mg/L	0.00008		< 0.00008
Iron (dissolved)	mg/L	0.007		0.050
Potassium (dissolved)	mg/L	0.009		7.20
Magnesium (dissolved)	mg/L	0.001		45.3
Manganese (dissolved)	mg/L	0.00001		0.0961
Molybdenum (dissolved)	mg/L	0.00004		0.03848

SGS

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON.

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	8
			Sample Name	22-01
			Sample Matrix	Ground Water
			Sample Date	28/08/2022
Parameter	**Units**	**RL**	**L1**	**Result**
Metals and Inorganics (continued)				
Nickel (dissolved)	mg/L	0.0001		0.0041
Sodium (dissolved)	mg/L	0.01		55.9
Phosphorus (dissolved)	mg/L	0.003		0.032
Lead (dissolved)	mg/L	0.00009		0.00107
Silicon (dissolved)	mg/L	0.02		5.84
Silver (dissolved)	mg/L	0.00005		< 0.00005
Strontium (dissolved)	mg/L	0.00008		0.448
Thallium (dissolved)	mg/L	0.000005		0.000035
Tin (dissolved)	mg/L	0.00006		0.00026
Titanium (dissolved)	mg/L	0.00005		0.00506
Antimony (dissolved)	mg/L	0.0009		0.0013
Selenium (dissolved)	mg/L	0.00004		0.00213
Uranium (dissolved)	mg/L	0.000002		0.0199
Vanadium (dissolved)	mg/L	0.00001		0.00234
Zinc (dissolved)	mg/L	0.002		0.055
Hardness	mg/L as CaCO3	0.05		16500
Aluminum (total)	mg/L	0.001		0.333
Arsenic (total)	mg/L	0.0002	0.005	0.0264
Boron (total)	mg/L	0.002	0.2	0.434
Barium (total)	mg/L	0.00008		1.48
Beryllium (total)	mg/L	0.000007	1.1	0.000220
Cobalt (total)	mg/L	0.000004	0.0009	0.0733

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.
Project: 33309, Emo, ON.
Project Manager: Rachel Bourassa
Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	8
			Sample Name	22-01
			Sample Matrix	Ground Water
			Sample Date	28/08/2022
Parameter	**Units**	**RL**	**L1**	**Result**
Metals and Inorganics (continued)				
Calcium (total)	mg/L	0.01		4910
Cadmium (total)	mg/L	0.000003	0.0005	0.00731
Copper (total)	mg/L	0.0002	0.005	0.0022
Chromium (total)	mg/L	0.00008	0.1	< 0.00008
Iron (total)	mg/L	0.007	0.3	6.68
Potassium (total)	mg/L	0.009		30.5
Magnesium (total)	mg/L	0.001		1040
Manganese (total)	mg/L	0.00001		23.6
Molybdenum (total)	mg/L	0.00004	0.04	0.0278
Nickel (total)	mg/L	0.0001	0.025	0.141
Sodium (total)	mg/L	0.01		66.1
Phosphorus (total)	mg/L	0.003	0.01	3.11
Lead (total)	mg/L	0.00009	0.025	< 0.00009
Silicon (total)	mg/L	0.02		24.8
Silver (total)	mg/L	0.00005	0.0001	< 0.00005
Strontium (total)	mg/L	0.00008		4.72
Thallium (total)	mg/L	0.000005	0.0003	0.000380
Tin (total)	mg/L	0.00006		< 0.00006
Titanium (total)	mg/L	0.00005		0.00054
Antimony (total)	mg/L	0.0009	0.02	< 0.0009
Selenium (total)	mg/L	0.00004	0.1	0.00101
Uranium (total)	mg/L	0.000002	0.005	0.000080

SGS

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON.

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	8
			Sample Name	22-01
			Sample Matrix	Ground Water
			Sample Date	28/08/2022
Parameter	**Units**	**RL**	**L1**	**Result**
Metals and Inorganics (continued)				
Vanadium (total)	mg/L	0.00001	0.006	0.00445
Zinc (total)	mg/L	0.002	0.02	0.175
Cation sum	meq/L	-9999		336.68
Anion Sum	meq/L	-9999		12.01
Anion-Cation Balance	% difference	-9999		93.11
Other (ORP)				
pH	No unit	0.05	8.6	8.01
Chloride	mg/L	0.2		30
Mercury (total)	mg/L	0.00001	0.0002	0.00108
Mercury (dissolved)	mg/L	0.00001	0.0002	0.00007

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
22-01				
Mercury	EPA 7471A/SM 3112B	mg/L	0.00108	0.0002
Arsenic	SM 3030/EPA 200.8	mg/L	0.0264	0.005
Boron	SM 3030/EPA 200.8	mg/L	0.434	0.2
Cadmium	SM 3030/EPA 200.8	mg/L	0.00731	0.0005
Cobalt	SM 3030/EPA 200.8	mg/L	0.0733	0.0009
Iron	SM 3030/EPA 200.8	mg/L	6.68	0.3
Nickel	SM 3030/EPA 200.8	mg/L	0.141	0.025
Phosphorus	SM 3030/EPA 200.8	mg/L	3.11	0.01
Thallium	SM 3030/EPA 200.8	mg/L	0.000380	0.0003
Zinc	SM 3030/EPA 200.8	mg/L	0.175	0.02

QC SUMMARY

Alkalinity

Method: SM 2320 | Internal ref.: ME-CA-[ENV]EWL-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
Alkalinity	EWL0055-SEP22	mg/L as CaCO3	2	< 2	0	20	100	80	120	NA		

Ammonia by SFA

Method: SM 4500 | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-007

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
Ammonia+Ammonium (N)	SKA0060-SEP22	as N mg/L	0.1	<0.1	ND	10	101	90	110	102	75	125
Ammonia+Ammonium (N)	SKA0069-SEP22	as N mg/L	0.1	<0.1	2	10	102	90	110	99	75	125

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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
Bromide	DIO0070-SEP22	mg/L	0.3	<0.3	ND	20	99	90	110	102	75	125
Nitrite (as N)	DIO0070-SEP22	mg/L	0.03	<0.03	ND	20	99	90	110	102	75	125
Nitrate (as N)	DIO0070-SEP22	mg/L	0.06	<0.06	ND	20	100	90	110	103	75	125
Chloride	DIO0136-SEP22	mg/L	0.2	<0.2	2	20	100	90	110	100	75	125
Sulphate	DIO0136-SEP22	mg/L	0.2	<0.2	2	20	100	90	110	97	75	125
Chloride	DIO0178-SEP22	mg/L	0.2	<0.2	16	20	103	90	110	106	75	125
Sulphate	DIO0178-SEP22	mg/L	0.2	<0.2	2	20	97	90	110	NV	75	125

Carbon by SFA

Method: SM 5310 | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-009

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
Total Organic Carbon	SKA5019-SEP22	mg/L	1	<1	0	20	100	90	110	96	75	125

QC SUMMARY

Carbonate/Bicarbonate

Method: SM 2320 | Internal ref.: ME-CA-[ENV]EWL-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
Carbonate	EWL0055-SEP22	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		
Bicarbonate	EWL0055-SEP22	mg/L as CaCO3	2	< 2	0	10	NA	90	110	NA		
OH	EWL0055-SEP22	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		

Colour

Method: SM 2120 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-002

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
Colour	EWL0075-SEP22	TCU	3	< 3	ND	10	100	80	120	NA		

QC SUMMARY

Conductivity

Method: SM 2510 I Internal ref.: ME-CA-[ENV]EWL-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	EWL0055-SEP22	uS/cm	2	< 2	0	20	99	90	110	NA		

Fluoride by Specific Ion Electrode

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-014

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
Fluoride	EWL0070-SEP22	mg/L	0.06	<0.06	ND	10	103	90	110	97	75	125
Fluoride	EWL0083-SEP22	mg/L	0.06	<0.06	0	10	102	90	110	99	75	125

Mercury by CVAAS

Method: EPA 7471A/SM 3112B I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

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
Mercury (total)	EHG0005-SEP22	mg/L	0.00001	< 0.00001	18	20	105	80	120	101	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-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
Silver (total)	EMS0061-SEP22	mg/L	0.00005	<0.00005	ND	20	107	90	110	99	70	130
Aluminum (total)	EMS0061-SEP22	mg/L	0.001	<0.001	3	20	100	90	110	99	70	130
Aluminum (0.2µm)	EMS0061-SEP22	mg/L	0.001	<0.001	3	20	100	90	110	99	70	130
Arsenic (total)	EMS0061-SEP22	mg/L	0.0002	<0.0002	2	20	102	90	110	91	70	130
Barium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00002	10	20	106	90	110	108	70	130
Beryllium (total)	EMS0061-SEP22	mg/L	0.000007	<0.000007	ND	20	96	90	110	88	70	130
Boron (total)	EMS0061-SEP22	mg/L	0.002	<0.002	12	20	101	90	110	99	70	130
Calcium (total)	EMS0061-SEP22	mg/L	0.01	<0.01	3	20	101	90	110	102	70	130
Cadmium (total)	EMS0061-SEP22	mg/L	0.000003	<0.000003	ND	20	104	90	110	104	70	130
Cobalt (total)	EMS0061-SEP22	mg/L	0.000004	<0.000004	10	20	105	90	110	107	70	130
Chromium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00008	1	20	99	90	110	92	70	130
Copper (total)	EMS0061-SEP22	mg/L	0.0002	<0.0002	ND	20	103	90	110	119	70	130
Iron (total)	EMS0061-SEP22	mg/L	0.007	<0.007	ND	20	97	90	110	125	70	130
Potassium (total)	EMS0061-SEP22	mg/L	0.009	<0.009	1	20	96	90	110	114	70	130
Magnesium (total)	EMS0061-SEP22	mg/L	0.001	<0.001	0	20	95	90	110	109	70	130
Manganese (total)	EMS0061-SEP22	mg/L	0.00001	<0.00001	9	20	101	90	110	91	70	130
Molybdenum (total)	EMS0061-SEP22	mg/L	0.00004	<0.00004	3	20	102	90	110	108	70	130
Sodium (total)	EMS0061-SEP22	mg/L	0.01	<0.01	3	20	98	90	110	110	70	130
Nickel (total)	EMS0061-SEP22	mg/L	0.0001	<0.0001	4	20	99	90	110	104	70	130
Lead (total)	EMS0061-SEP22	mg/L	0.00009	<0.00001	0	20	106	90	110	111	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Phosphorus (total)	EMS0061-SEP22	mg/L	0.003	<0.003	13	20	96	90	110	NV	70	130
Antimony (total)	EMS0061-SEP22	mg/L	0.0009	<0.0009	ND	20	98	90	110	128	70	130
Selenium (total)	EMS0061-SEP22	mg/L	0.00004	<0.00004	ND	20	102	90	110	89	70	130
Silicon (total)	EMS0061-SEP22	mg/L	0.02	<0.02	13	20	93	90	110	NV	70	130
Tin (total)	EMS0061-SEP22	mg/L	0.00006	<0.00006	ND	20	108	90	110	NV	70	130
Strontium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00002	0	20	104	90	110	105	70	130
Titanium (total)	EMS0061-SEP22	mg/L	0.00005	<0.00005	6	20	101	90	110	NV	70	130
Thallium (total)	EMS0061-SEP22	mg/L	0.000005	<0.000005	ND	20	96	90	110	99	70	130
Uranium (total)	EMS0061-SEP22	mg/L	0.000002	<0.000002	1	20	108	90	110	118	70	130
Vanadium (total)	EMS0061-SEP22	mg/L	0.00001	<0.00001	3	20	99	90	110	102	70	130
Zinc (total)	EMS0061-SEP22	mg/L	0.002	<0.002	2	20	101	90	110	110	70	130

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
pH	EWL0055-SEP22	No unit	0.05	NA	1		100			NA		

QC SUMMARY

Reactive Phosphorus by SFA

Method: SM 4500-P F | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-004

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
Phosphorus (total reactive)	SKA0035-SEP22	mg/L	0.03	<0.03	ND	10	104	90	110	93	75	125
Phosphorus (total reactive)	SKA0048-SEP22	mg/L	0.03	<0.03	6	10	108	90	110	NV	75	125

Suspended Solids

Method: SM 2540D | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-004

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
Total Suspended Solids	EWL0066-SEP22	mg/L	2	< 2	1	10	99	90	110	NA		

Turbidity

Method: SM 2130 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-003

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
Turbidity	EWL0064-SEP22	NTU	0.10	< 0.10	4	10	100	90	110	NA		

QC SUMMARY

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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

No: 010115

- 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: Scott R
Received By (signature): S
Received Date (mm/dd/yyyy): 09/01/2022 (mm\dd\yy)
Custody Seal Present: ☐
Cooling Agent Present: ☐ Ice
Received Time: 11:30
Custody Seal Intact: ☐
Temperature Upon Receipt (°C): 9 2x 3
LAB LIMS #: SRPT-40015-16

REPORT INFORMATION	INVOICE INFORMATION	PROJECT INFORMATION
Company: Thurber Eng LTD	☑ (same as Report Information)	Quotation #: P.O. #:
Contact: Rachel Bourassa	Company:	Project #: 33309 Site Location/ID: EMO, ON
Address: 2010 Winston Park Dr #103 Oakville ON L6M 5R7	Contact:	
	Address:	
Phone: 416 523 1015		
Email: rbourassa@thurber.ca	Phone:	
Email:	Email:	

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:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☑ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

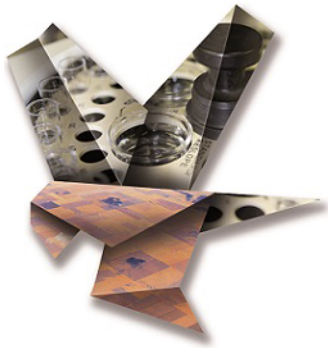
ANALYSIS REQUESTED

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH☐ ABN☐ SVOC(all)☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ VOC☐ BTEX☐ BTEX/F1☐ F2-F4☐	VOC☐ BTEX☐ THM☐	Pesticides OC☐ OP☐	TCLP M&I ☐ VOC ☐ PCB☐ B(a)P ☐ ABN ☐ Ignit.☐	Water Pkg Gen. ☐ Ext.☐	Sewer Use:	TSS	Lab Filtered Metals	Corrosivity	General Water Characterization Package		COMMENTS:
1	Cameron Creek SW	Aug 28/22		15	Water											✓	✓	✓	✓		
2	22-01	Aug 28/22		14	Water											✓	✓		✓		
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions: Corrosivity Includes PH, Soluable Sulphate, Chloride, Resistivity, Electrical Conductivity

Sampled By (NAME): Greg Stanhope	Signature: GS	Date: Aug / 28 / 2022 (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	Signature: Rachel Bourassa	Date: Aug / 31 / 2022 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018



FINAL REPORT

CA40015-SEP22 R1

33309, Emo, ON.

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7, Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA40015-SEP22
Project	33309, Emo, ON.	Received	09/01/2022
Order Number		Approved	09/14/2022
Samples	Surface Water (1)	Report Number	CA40015-SEP22 R1
		Date Reported	11/11/2022

COMMENTS

MAC - Maximum Acceptable Concentration
AO/OG - Aesthetic Objective / Operational Guideline
NR - Not reportable under applicable Provincial drinking water regulations as per client.

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody Number:010115

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON.

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

Parameter	Units	RL	L1	Result
General Chemistry				
Total Suspended Solids	mg/L	2		4
Alkalinity	mg/L as CaCO3	2		226
Bicarbonate	mg/L as CaCO3	2		226
Carbonate	mg/L as CaCO3	2		< 2
OH	mg/L as CaCO3	2		< 2
Colour	TCU	3		144
Conductivity	uS/cm	2		436
Turbidity	NTU	0.10		4.1
Ammonia+Ammonium (N)	as N mg/L	0.1		< 0.1
Phosphorus (total reactive)	mg/L	0.03		0.03
Total Organic Carbon	mg/L	1		38
Ion Ratio	-	-9999		1.03
Total Dissolved Solids (calculated)	mg/L	-9999		222
Conductivity (calculated)	uS/cm	-9999		470
Langeliers Index 4° C	@ 4° C	-9999		0.18
Saturation pH 4°C	pHs @ 4°C	-9999		7.84

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.

Project: 33309, Emo, ON.

Project Manager: Rachel Bourassa

Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

Parameter	Units	RL	L1	Result
Metals and Inorganics				
Fluoride	mg/L	0.06		0.11
Bromide	mg/L	0.3		< 0.3
Nitrite (as N)	as N mg/L	0.03		< 0.03
Nitrate (as N)	as N mg/L	0.06		< 0.06
Sulphate	mg/L	0.2		1.0
Hardness (dissolved)	mg/L as CaCO3	0.05		236
Aluminum (dissolved)	mg/L	0.001	0.075	0.006
Aluminum (0.2µm)	mg/L	0.001	0.075	0.007
Arsenic (dissolved)	mg/L	0.0002		0.0033
Boron (dissolved)	mg/L	0.002		0.021
Barium (dissolved)	mg/L	0.00008		0.0195
Beryllium (dissolved)	mg/L	0.000007		0.000018
Cobalt (dissolved)	mg/L	0.000004		0.000562
Calcium (dissolved)	mg/L	0.01		60.9
Cadmium (dissolved)	mg/L	0.000003		< 0.000003
Copper (dissolved)	mg/L	0.0002		0.0007
Chromium (dissolved)	mg/L	0.00008		< 0.00008
Iron (dissolved)	mg/L	0.007		0.240
Potassium (dissolved)	mg/L	0.009		2.05
Magnesium (dissolved)	mg/L	0.001		20.5
Manganese (dissolved)	mg/L	0.00001		0.153

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.
Project: 33309, Emo, ON.
Project Manager: Rachel Bourassa
Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

Parameter	Units	RL	L1	Result
Metals and Inorganics (continued)				
Molybdenum (dissolved)	mg/L	0.00004		0.00117
Nickel (dissolved)	mg/L	0.0001		0.0032
Sodium (dissolved)	mg/L	0.01		2.83
Phosphorus (dissolved)	mg/L	0.003		0.045
Lead (dissolved)	mg/L	0.00009		< 0.00009
Silicon (dissolved)	mg/L	0.02		9.30
Silver (dissolved)	mg/L	0.00005		< 0.00005
Strontium (dissolved)	mg/L	0.00008		0.114
Thallium (dissolved)	mg/L	0.000005		< 0.000005
Tin (dissolved)	mg/L	0.00006		< 0.00006
Titanium (dissolved)	mg/L	0.00005		0.00062
Antimony (dissolved)	mg/L	0.0009		< 0.0009
Selenium (dissolved)	mg/L	0.00004		0.00022
Uranium (dissolved)	mg/L	0.000002		0.000365
Vanadium (dissolved)	mg/L	0.00001		0.00078
Zinc (dissolved)	mg/L	0.002		< 0.002
Hardness	mg/L as CaCO3	0.05		226
Aluminum (total)	mg/L	0.001		0.106
Arsenic (total)	mg/L	0.0002	0.005	0.0034
Boron (total)	mg/L	0.002	0.2	0.018
Barium (total)	mg/L	0.00008		0.0223

FINAL REPORT

CA40015-SEP22 R1

Client: Thurber Engineering Ltd.
Project: 33309, Emo, ON.
Project Manager: Rachel Bourassa
Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

Metals and Inorganics (continued)

Parameter	Units	RL	L1	Result
Beryllium (total)	mg/L	0.000007	1.1	0.000012
Cobalt (total)	mg/L	0.000004	0.0009	0.00102
Calcium (total)	mg/L	0.01		56.3
Cadmium (total)	mg/L	0.000003	0.0005	< 0.000003
Copper (total)	mg/L	0.0002	0.005	0.0008
Chromium (total)	mg/L	0.00008	0.1	0.00031
Iron (total)	mg/L	0.007	0.3	0.556
Potassium (total)	mg/L	0.009		2.11
Magnesium (total)	mg/L	0.001		20.7
Manganese (total)	mg/L	0.00001		0.475
Molybdenum (total)	mg/L	0.00004	0.04	0.00135
Nickel (total)	mg/L	0.0001	0.025	0.0035
Sodium (total)	mg/L	0.01		2.92
Phosphorus (total)	mg/L	0.003	0.01	0.059
Lead (total)	mg/L	0.00009	0.025	0.00011
Silicon (total)	mg/L	0.02		8.10
Silver (total)	mg/L	0.00005	0.0001	< 0.00005
Strontium (total)	mg/L	0.00008		0.117
Thallium (total)	mg/L	0.000005	0.0003	< 0.000005
Tin (total)	mg/L	0.00006		< 0.00006
Titanium (total)	mg/L	0.00005		0.00438

FINAL REPORT

Client: Thurber Engineering Ltd.
Project: 33309, Emo, ON.
Project Manager: Rachel Bourassa
Samplers: Greg Stanhope

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	Cameron Creek SW
Sample Matrix	Surface Water
Sample Date	28/08/2022

Parameter	Units	RL	L1	Result
Metals and Inorganics (continued)				
Antimony (total)	mg/L	0.0009	0.02	< 0.0009
Selenium (total)	mg/L	0.00004	0.1	0.00016
Uranium (total)	mg/L	0.000002	0.005	0.000375
Vanadium (total)	mg/L	0.00001	0.006	0.00115
Zinc (total)	mg/L	0.002	0.02	< 0.002
Cation sum	meq/L	-9999		4.78
Anion Sum	meq/L	-9999		4.62
Anion-Cation Balance	% difference	-9999		1.70
Other (ORP)				
pH	No unit	0.05	8.6	8.02
Chloride	mg/L	0.2		2.8
Mercury (total)	mg/L	0.00001	0.0002	< 0.00001
Mercury (dissolved)	mg/L	0.00001	0.0002	< 0.00001

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
Cameron Creek SW				
Cobalt	SM 3030/EPA 200.8	mg/L	0.00102	0.0009
Iron	SM 3030/EPA 200.8	mg/L	0.556	0.3
Phosphorus	SM 3030/EPA 200.8	mg/L	0.059	0.01

QC SUMMARY

Alkalinity

Method: SM 2320 I Internal ref.: ME-CA-[ENV]EWL-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
Alkalinity	EWL0055-SEP22	mg/L as CaCO3	2	< 2	0	20	100	80	120	NA		

Ammonia by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-007

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
Ammonia+Ammonium (N)	SKA0060-SEP22	as N mg/L	0.1	<0.1	ND	10	101	90	110	102	75	125
Ammonia+Ammonium (N)	SKA0069-SEP22	as N mg/L	0.1	<0.1	2	10	102	90	110	99	75	125

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 I Internal ref.: ME-CA-[ENV]IC-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
Bromide	DIO0070-SEP22	mg/L	0.3	<0.3	ND	20	99	90	110	102	75	125
Nitrite (as N)	DIO0070-SEP22	mg/L	0.03	<0.03	ND	20	99	90	110	102	75	125
Nitrate (as N)	DIO0070-SEP22	mg/L	0.06	<0.06	ND	20	100	90	110	103	75	125
Chloride	DIO0136-SEP22	mg/L	0.2	<0.2	2	20	100	90	110	100	75	125
Sulphate	DIO0136-SEP22	mg/L	0.2	<0.2	2	20	100	90	110	97	75	125
Chloride	DIO0178-SEP22	mg/L	0.2	<0.2	16	20	103	90	110	106	75	125
Sulphate	DIO0178-SEP22	mg/L	0.2	<0.2	2	20	97	90	110	NV	75	125

Carbon by SFA

Method: SM 5310 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-009

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
Total Organic Carbon	SKA5019-SEP22	mg/L	1	<1	0	20	100	90	110	96	75	125

QC SUMMARY

Carbonate/Bicarbonate

Method: SM 2320 | Internal ref.: ME-CA-[ENV]EWL-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
Carbonate	EWL0055-SEP22	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		
Bicarbonate	EWL0055-SEP22	mg/L as CaCO3	2	< 2	0	10	NA	90	110	NA		
OH	EWL0055-SEP22	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		

Colour

Method: SM 2120 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-002

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
Colour	EWL0075-SEP22	TCU	3	< 3	ND	10	100	80	120	NA		

QC SUMMARY

Conductivity

Method: SM 2510 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Conductivity	EWL0055-SEP22	uS/cm	2	< 2	0	20	99	90	110	NA		

Fluoride by Specific Ion Electrode

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-014

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Fluoride	EWL0070-SEP22	mg/L	0.06	<0.06	ND	10	103	90	110	97	75	125
Fluoride	EWL0083-SEP22	mg/L	0.06	<0.06	0	10	102	90	110	99	75	125

Mercury by CVAAS

Method: EPA 7471A/SM 3112B I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Mercury (total)	EHG0005-SEP22	mg/L	0.00001	< 0.00001	18	20	105	80	120	101	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-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
Silver (total)	EMS0061-SEP22	mg/L	0.00005	<0.00005	ND	20	107	90	110	99	70	130
Aluminum (total)	EMS0061-SEP22	mg/L	0.001	<0.001	3	20	100	90	110	99	70	130
Aluminum (0.2µm)	EMS0061-SEP22	mg/L	0.001	<0.001	3	20	100	90	110	99	70	130
Arsenic (total)	EMS0061-SEP22	mg/L	0.0002	<0.0002	2	20	102	90	110	91	70	130
Barium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00002	10	20	106	90	110	108	70	130
Beryllium (total)	EMS0061-SEP22	mg/L	0.000007	<0.000007	ND	20	96	90	110	88	70	130
Boron (total)	EMS0061-SEP22	mg/L	0.002	<0.002	12	20	101	90	110	99	70	130
Calcium (total)	EMS0061-SEP22	mg/L	0.01	<0.01	3	20	101	90	110	102	70	130
Cadmium (total)	EMS0061-SEP22	mg/L	0.000003	<0.000003	ND	20	104	90	110	104	70	130
Cobalt (total)	EMS0061-SEP22	mg/L	0.000004	<0.000004	10	20	105	90	110	107	70	130
Chromium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00008	1	20	99	90	110	92	70	130
Copper (total)	EMS0061-SEP22	mg/L	0.0002	<0.0002	ND	20	103	90	110	119	70	130
Iron (total)	EMS0061-SEP22	mg/L	0.007	<0.007	ND	20	97	90	110	125	70	130
Potassium (total)	EMS0061-SEP22	mg/L	0.009	<0.009	1	20	96	90	110	114	70	130
Magnesium (total)	EMS0061-SEP22	mg/L	0.001	<0.001	0	20	95	90	110	109	70	130
Manganese (total)	EMS0061-SEP22	mg/L	0.00001	<0.00001	9	20	101	90	110	91	70	130
Molybdenum (total)	EMS0061-SEP22	mg/L	0.00004	<0.00004	3	20	102	90	110	108	70	130
Sodium (total)	EMS0061-SEP22	mg/L	0.01	<0.01	3	20	98	90	110	110	70	130
Nickel (total)	EMS0061-SEP22	mg/L	0.0001	<0.0001	4	20	99	90	110	104	70	130
Lead (total)	EMS0061-SEP22	mg/L	0.00009	<0.00001	0	20	106	90	110	111	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 I Internal ref.: ME-CA-[ENV]SPE-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
Phosphorus (total)	EMS0061-SEP22	mg/L	0.003	<0.003	13	20	96	90	110	NV	70	130
Antimony (total)	EMS0061-SEP22	mg/L	0.0009	<0.0009	ND	20	98	90	110	128	70	130
Selenium (total)	EMS0061-SEP22	mg/L	0.00004	<0.00004	ND	20	102	90	110	89	70	130
Silicon (total)	EMS0061-SEP22	mg/L	0.02	<0.02	13	20	93	90	110	NV	70	130
Tin (total)	EMS0061-SEP22	mg/L	0.00006	<0.00006	ND	20	108	90	110	NV	70	130
Strontium (total)	EMS0061-SEP22	mg/L	0.00008	<0.00002	0	20	104	90	110	105	70	130
Titanium (total)	EMS0061-SEP22	mg/L	0.00005	<0.00005	6	20	101	90	110	NV	70	130
Thallium (total)	EMS0061-SEP22	mg/L	0.000005	<0.000005	ND	20	96	90	110	99	70	130
Uranium (total)	EMS0061-SEP22	mg/L	0.000002	<0.000002	1	20	108	90	110	118	70	130
Vanadium (total)	EMS0061-SEP22	mg/L	0.00001	<0.00001	3	20	99	90	110	102	70	130
Zinc (total)	EMS0061-SEP22	mg/L	0.002	<0.002	2	20	101	90	110	110	70	130

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-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
pH	EWL0055-SEP22	No unit	0.05	NA	1		100			NA		

QC SUMMARY

Reactive Phosphorus by SFA

Method: SM 4500-P F | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Phosphorus (total reactive)	SKA0035-SEP22	mg/L	0.03	<0.03	ND	10	104	90	110	93	75	125
Phosphorus (total reactive)	SKA0048-SEP22	mg/L	0.03	<0.03	6	10	108	90	110	NV	75	125

Suspended Solids

Method: SM 2540D | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Total Suspended Solids	EWL0066-SEP22	mg/L	2	< 2	1	10	99	90	110	NA		

Turbidity

Method: SM 2130 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Turbidity	EWL0064-SEP22	NTU	0.10	< 0.10	4	10	100	90	110	NA		

QC SUMMARY

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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

No: 010115

- 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

Laboratory Information Section - Lab use only

Received By: Scott R
Received Date (mm/dd/yyyy): 09/01/2022 (mm\dd\yy)
Received Time: 11:30

Received By (signature): S
Custody Seal Present: ☐
Custody Seal Intact: ☐

Cooling Agent Present: ☐ Ice
Temperature Upon Receipt (°C): 9 2x 3

LAB LIMS #: SRPT-40015-16

REPORT INFORMATION

Company: Thurber Eng LTD
Contact: Rachel Bourassa
Address: 2010 Winston Park Dr #103 Oakville ON L6M 5R7
Phone: 416 523 1015
Email: rbourassa@thurber.ca
Email:

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #:
P.O. #:
Project #: 33309
Site Location/ID: EMO, ON

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:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ___ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☑ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH☐ ABN☐ SVOC(all)☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ VOC☐ BTEX☐ BTEX/F1☐ F2-F4☐	VOC☐ BTEX☐ THM☐	Pesticides OC☐ OP☐	TCLP M&I ☐ VOC ☐ PCB☐ B(a)P ☐ ABN ☐ Ignit.☐	Water Pkg Gen. ☐ Ext.☐	Sewer Use:	TSS	Lab Filtered Metals	Corrosivity	General Water Characterization Package		COMMENTS:
1	Cameron Creek SW	Aug 28/22		14	Water											✓	✓	✓	✓		
2	22-01	Aug 28/22		14	Water											✓	✓		✓		
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions: Corrosivity Includes PH, Soluable Sulphate, Chloride, Resistivity, Electrical Conductivity

Sampled By (NAME): Greg Stanhope	Signature: GS	Date: Aug / 28 / 2022	(mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	Signature: Rachel Bourassa	Date: Aug / 31 / 2022	(mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

THURBER

Appendix C

Site Photographs

THURBER

Photo 1: Looking south at culvert inlet (August 2022)

THURBER

Photo 2: Looking east along north embankment near culvert inlet (April 2022)

THURBER

Photo 3: Looking west along north embankment near culvert inlet (August 2022)

THURBER

Photo 4: Looking north at culvert outlet (May 2022)

THURBER

Photo 5: Looking west along south embankment near culvert outlet (August 2022)

THURBER

Photo 6: Looking east along south embankment near culvert outlet (August 2022)

THURBER

Photo 7: Looking east along Highway 11 near culvert outlet (taken by Hatch)

THURBER

Photo 8: Looking west along Highway 11 near culvert inlet (taken by Hatch)

THURBER

Appendix D

Borehole Locations and Soil Strata Drawings

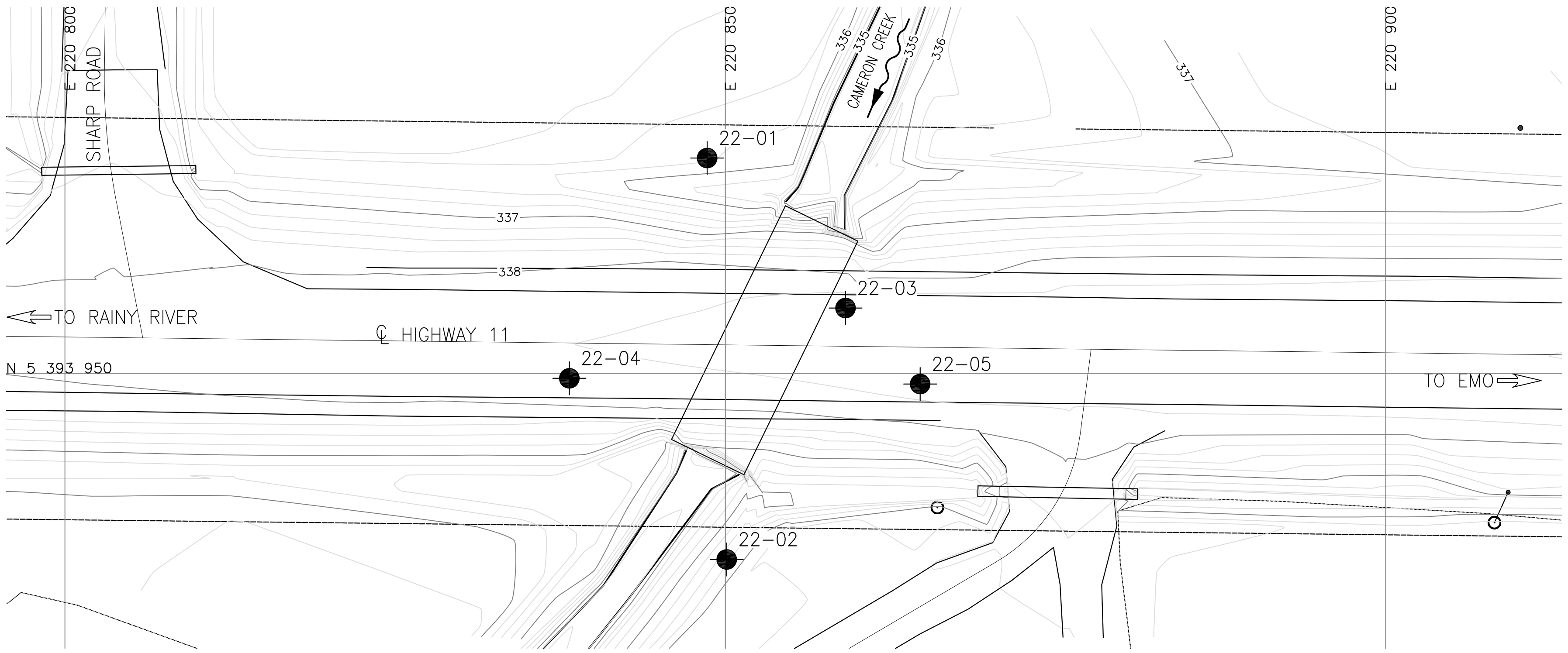
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 6120-17-00

HIGHWAY 11
CROSSING AT
CAMERON CREEK
BOREHOLE LOCATIONS AND SOIL STRATA

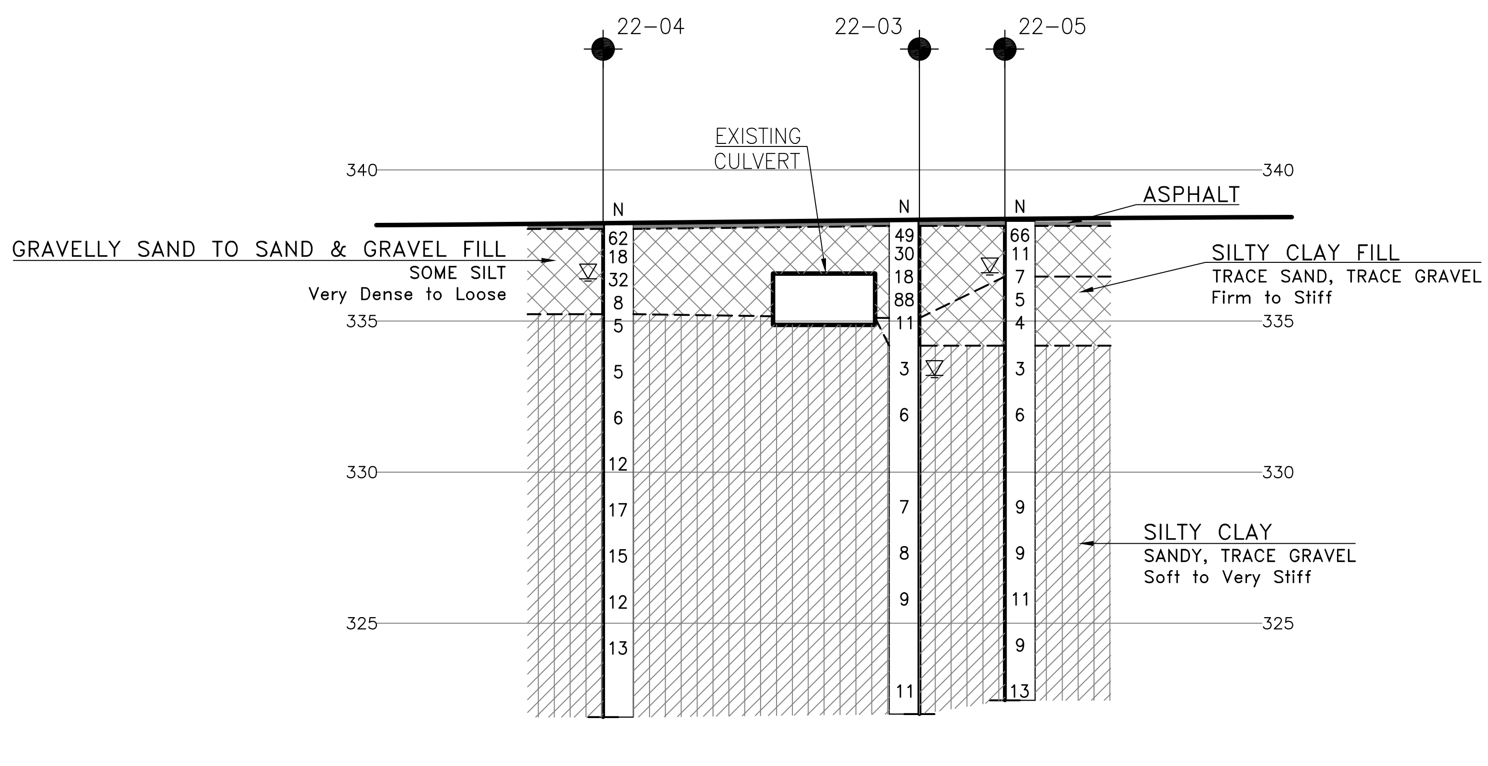
SHEET

THURBER ENGINEERING LTD.



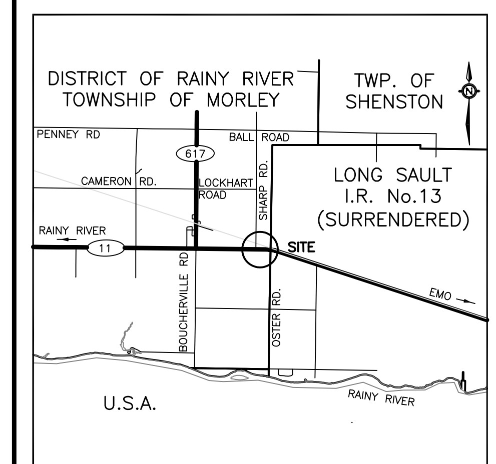
PLAN

10 0 10 20m
SCALE 1:500



PROFILE ALONG ℄ HIGHWAY 11

10 0 10 20m H 1:500
5 0 5 10m V 1:250



KEYPLAN

LEGEND

Symbol	Description
●	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
▼	Head Artesian Water
┃	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
22-01	336.3	5 393 966.3	220 848.6
22-02	336.7	5 393 935.9	220 850.1
22-03	338.3	5 393 954.9	220 859.1
22-04	338.2	5 393 949.6	220 838.2
22-05	338.3	5 393 949.2	220 864.8

-NOTES-

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 16.

GEOCRES No. 52D-37

REVISIONS	DATE	BY	DESCRIPTION

DESIGN RB	CHK MEF	CODE	LOAD	DATE JAN 2023	
DRAWN AN	CHK RB	SITE 45X-0160/C0	STRUCT	DWG 1	

FILENAME: H:\Drafting\33000\33309\TED-33309-PLPR-CC.dwg
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METRIC

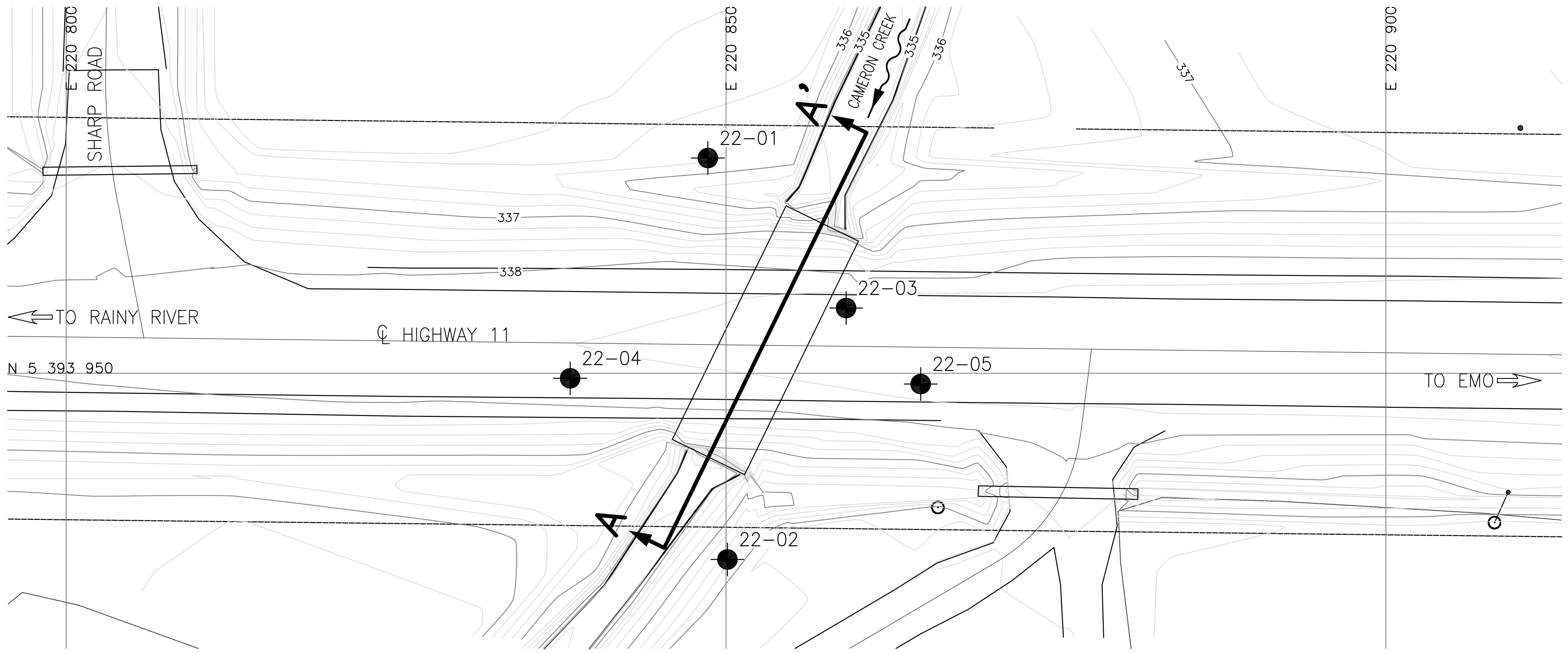
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 6120-17-00

HIGHWAY 11
CROSSING AT
CAMERON CREEK
BOREHOLE LOCATIONS AND SOIL STRATA

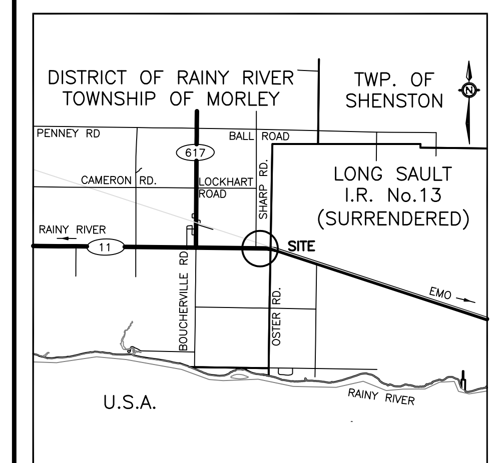
SHEET

THURBER ENGINEERING LTD.

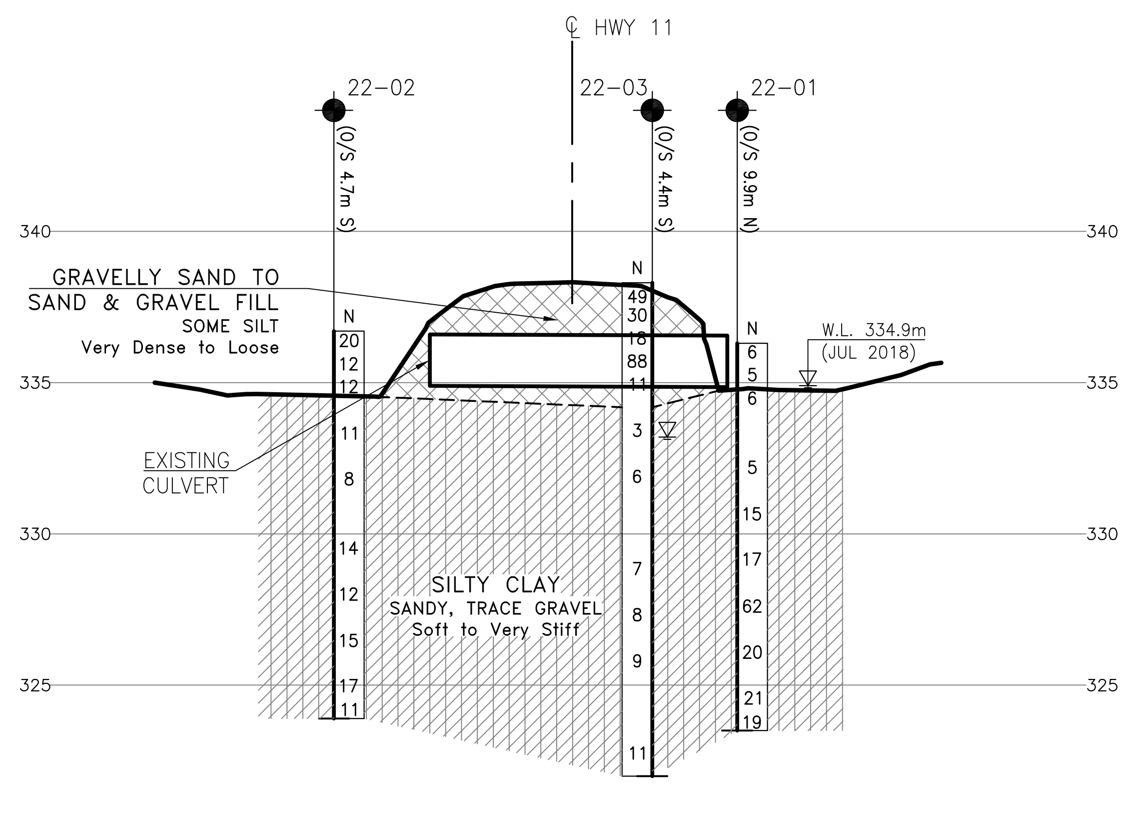


PLAN

SCALE 1:500



KEYPLAN



PROFILE ALONG A-A'

H 1:500
V 1:250

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
▼	Head Artesian Water
┃	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
22-01	336.3	5 393 966.3	220 848.6
22-02	336.7	5 393 935.9	220 850.1
22-03	338.3	5 393 954.9	220 859.1
22-04	338.2	5 393 949.6	220 838.2
22-05	338.3	5 393 949.2	220 864.8

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3) Coordinate system is MTM NAD 83 Zone 16.

GEOCRES No. 52D-37

REVISIONS	DATE	BY	DESCRIPTION
DESIGN RB	CHK MEF	CODE	LOAD	DATE JAN 2023
DRAWN AN	CHK RB	SITE 45X-0160/C0	STRUCT	DWG 1

Appendix E

Foundation Comparison

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GEOTECHNICAL COMPARISON OF ALTERNATIVE FOUNDATION TYPES

Corrugated Steel Pipe (CSP), Structural Steel CSP (SPCSP), or Twin SPCSPs	Concrete Box Culvert	Rehabilitation with Concrete Box Culvert Extensions
Advantages: i. Ease of construction. ii. Segmented pipes can accommodate some potential differential settlement along culvert axis iii. Less expensive than concrete box culvert option.	Advantages: i. Relatively rapid installation and less disturbance to subgrade soils if pre-cast segments are used. ii. Segmental option can accommodate some potential differential settlement along culvert axis.	Advantages: i. Less disposal of existing embankment fill, which can remain in place. ii. Less expensive than replacement options.
Disadvantages: i. Steel pipes may have shorter design life than concrete culverts. ii. Multiple pipes needed to meet hydraulic requirements. iii. Potential for differential settlement where the widened highway meets the existing embankment.	Disadvantages: i. More expensive than a CSP culvert or box culvert extension option. ii. Potential for differential settlement where the widened highway meets the existing embankment.	Disadvantages: i. Potential for differential settlement between existing box culvert and extension segments. ii. May still need excavations through the highway to install temporary stream diversion pipe.
FEASIBLE	**FEASIBLE**	**FEASIBLE**

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Appendix F

List of Referenced OPSS and OPSD Documents and Suggested Wording for Operational Constraints

1. **The following Special Provisions and OPSS Documents are referenced in this report:**

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 401	Construction Specification for Trenching, Backfilling, and Compacting
OPSS.PROV 421	Construction Specification for Pipe Culvert Installation in Open Cut
OPSS 422	Construction Specification for Precast Reinforced Concrete Box Culverts in Open Cut
OPSS.PROV 501	Construction Specification for Compacting
OPSS 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 517	Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS.PROV 902	Construction Specification for Excavating and Backfilling Structures
SP FOUN0003	Dewatering Structure Excavations
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSS 1005	Material Specification for Aggregates – Streambed Material
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1205	Material Specification for Clay Seal
OPSS.PROV 1860	Material Specification for Geotextiles
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 803.010	Backfill and Cover for Concrete Culverts with Spans Less Than or Equal to 3.0 m
OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets
OPSD 3090.100	Foundation Frost Penetration Depths for Northern Ontario

2. Suggested Wording for Operational Constraints

- **Suggested Text for Operational Constraint on Subgrade Preparation**

The Contractor is advised that the soil that will be exposed at the culvert subgrade level is moisture sensitive and may become disturbed or otherwise negatively impacted when subjected to construction or personnel traffic, freeze-thaw actions, ingress or ponding water. The Contractor shall be responsible for protecting the subgrade by implementing adequate groundwater control measures and minimizing construction and personnel traffic on the founding subgrade.

The subgrade preparation and placement and compaction of the bedding material must be carried out in the dry.

Any buried topsoil, excessively soft soil, large cobbles and boulders, and any soft, very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition.

Immediately following excavation, the base should be inspected by the foundation engineering specialist to confirm that the exposed subgrade surface conforms to the design requirements.

- **Suggested Text for Operational Constraint on Temporary Excavation Slopes**

The Contractor is notified that unsupported temporary slopes at this site, for excavations or otherwise, are not stable if inclined 1H:1V or steeper above the groundwater level. Temporary slopes are therefore restricted to inclinations of no steeper than 3H:1V below the groundwater level and 1.5H:1V above the groundwater level.

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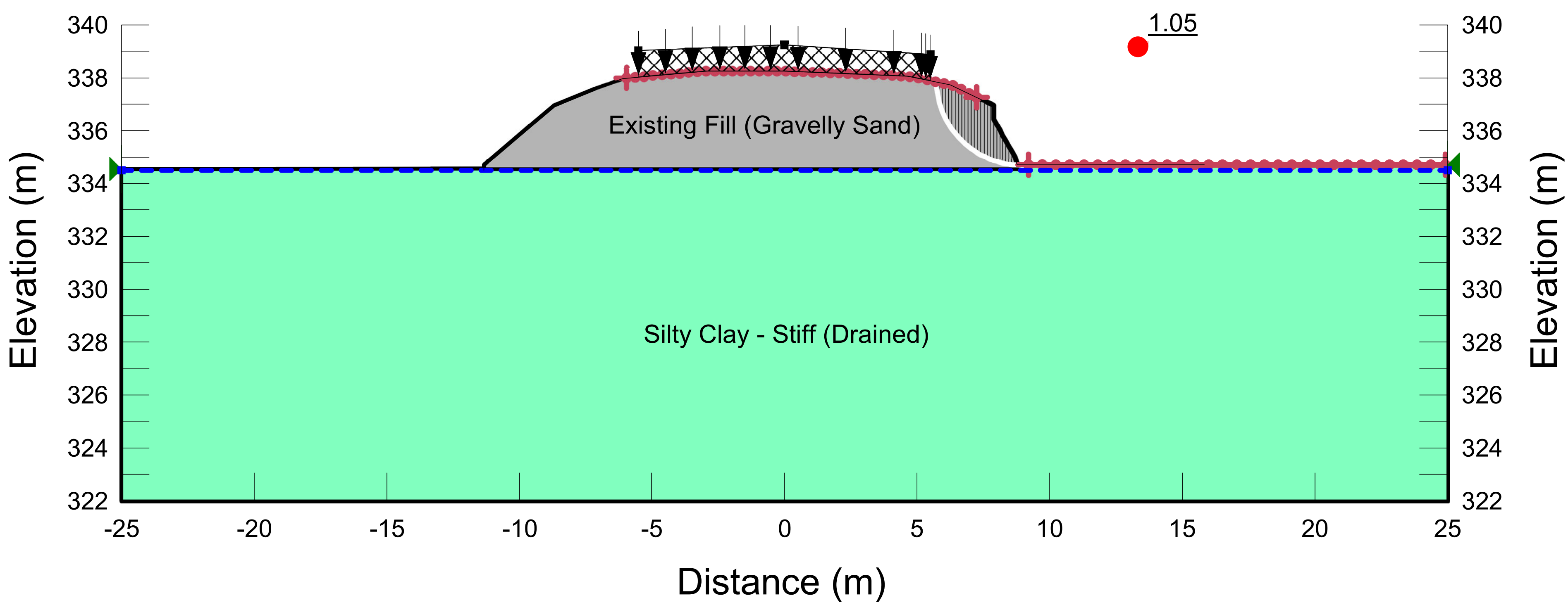
Appendix G

Slope Stability Analysis Figures

CAMERON CREEK CULVERT

FIGURE 1 - EXISTING (SHALLOW)
DRAINED CONDIITON

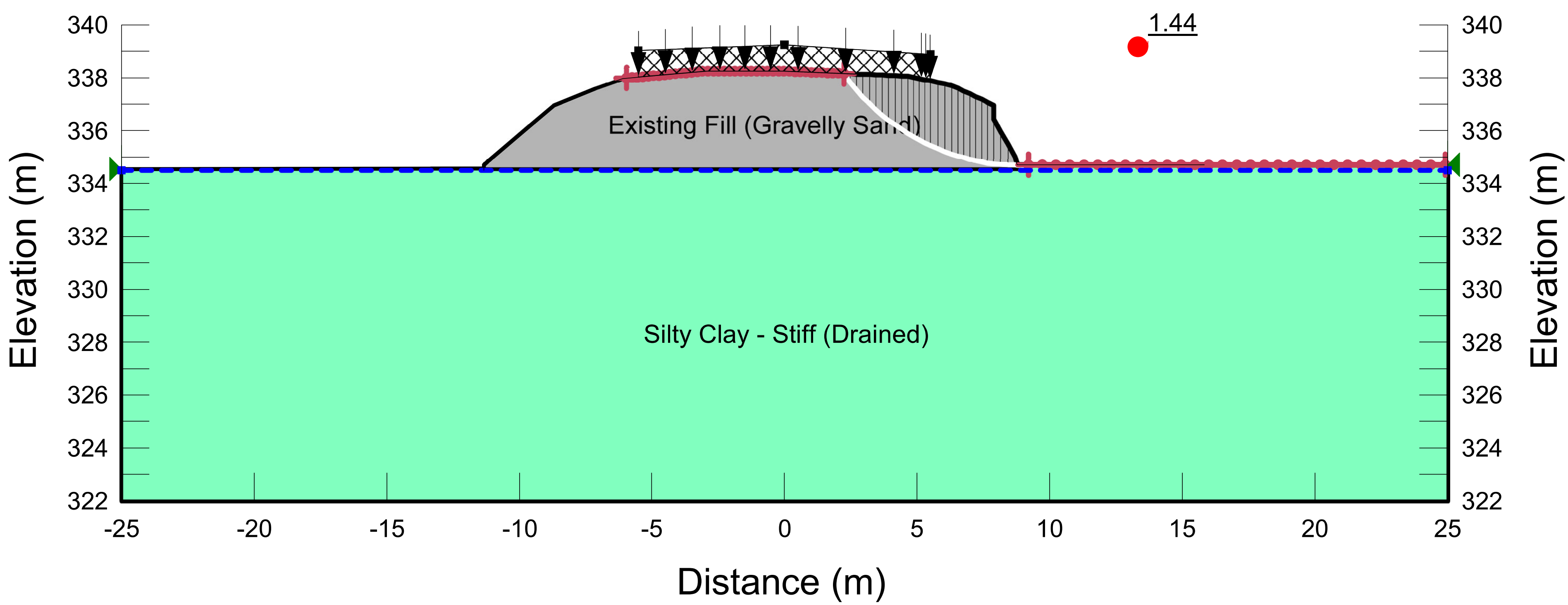
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Fill (Gravelly Sand)	Mohr-Coulomb	21	0	32
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25



CAMERON CREEK CULVERT

FIGURE 2 - EXISTING (DEEP)
DRAINED CONDIITON

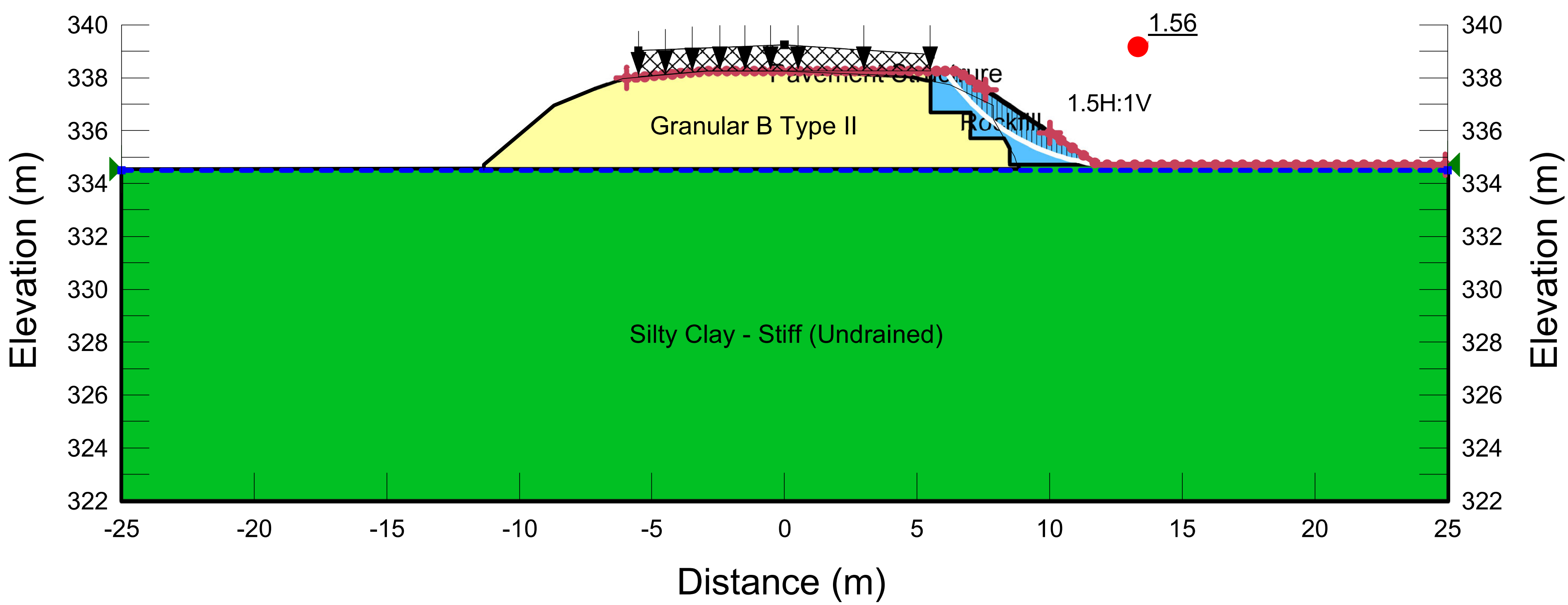
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Fill (Gravelly Sand)	Mohr-Coulomb	21	0	32
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25



CAMERON CREEK CULVERT

FIGURE 3 -
1.5H:1V ROCKFILL KEY
(SHALLOW)
UNDRAINED CONDIITON

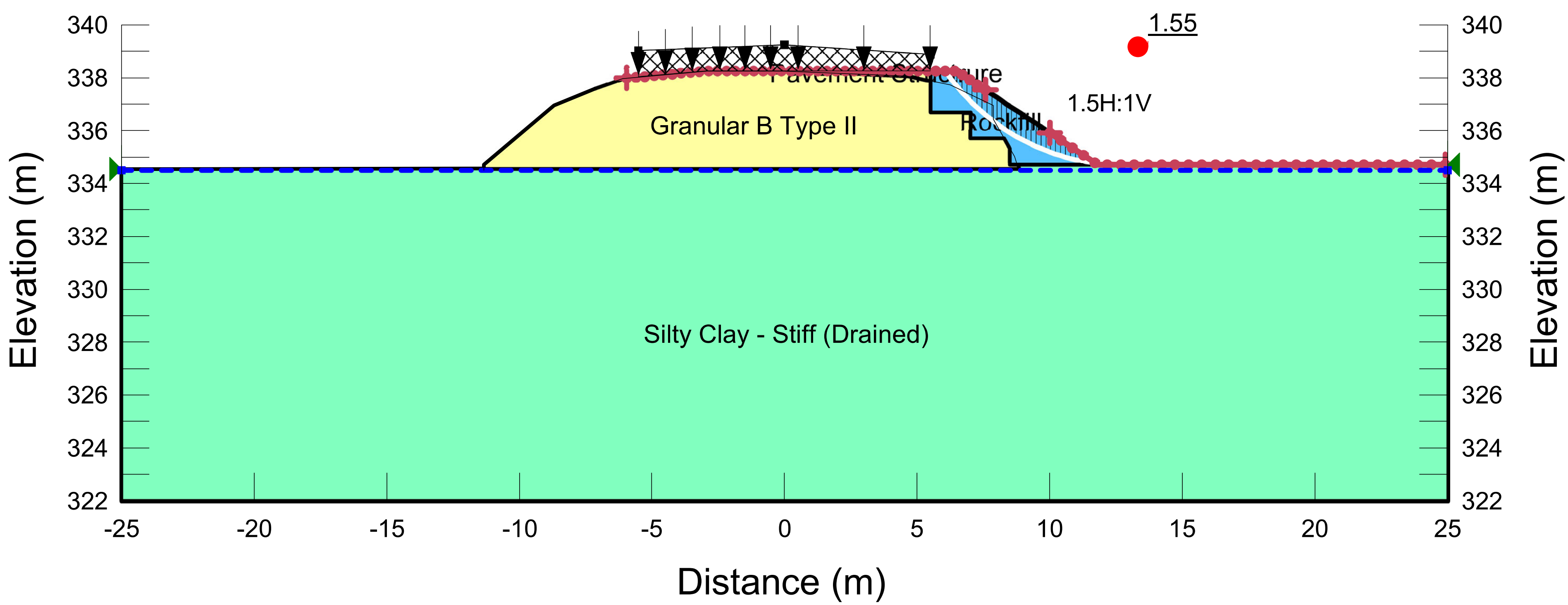
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular B Type II	Mohr-Coulomb	22				0	35
	Pavement Structure	Mohr-Coulomb	22				0	35
	Rockfill	Mohr-Coulomb	19				0	42
	Silty Clay - Stiff (Undrained)	S=f(depth)	18	50	1.5	67		



CAMERON CREEK CULVERT

FIGURE 4 - 1.5H:1V ROCKFILL KEY (SHALLOW) DRAINED CONDIITON

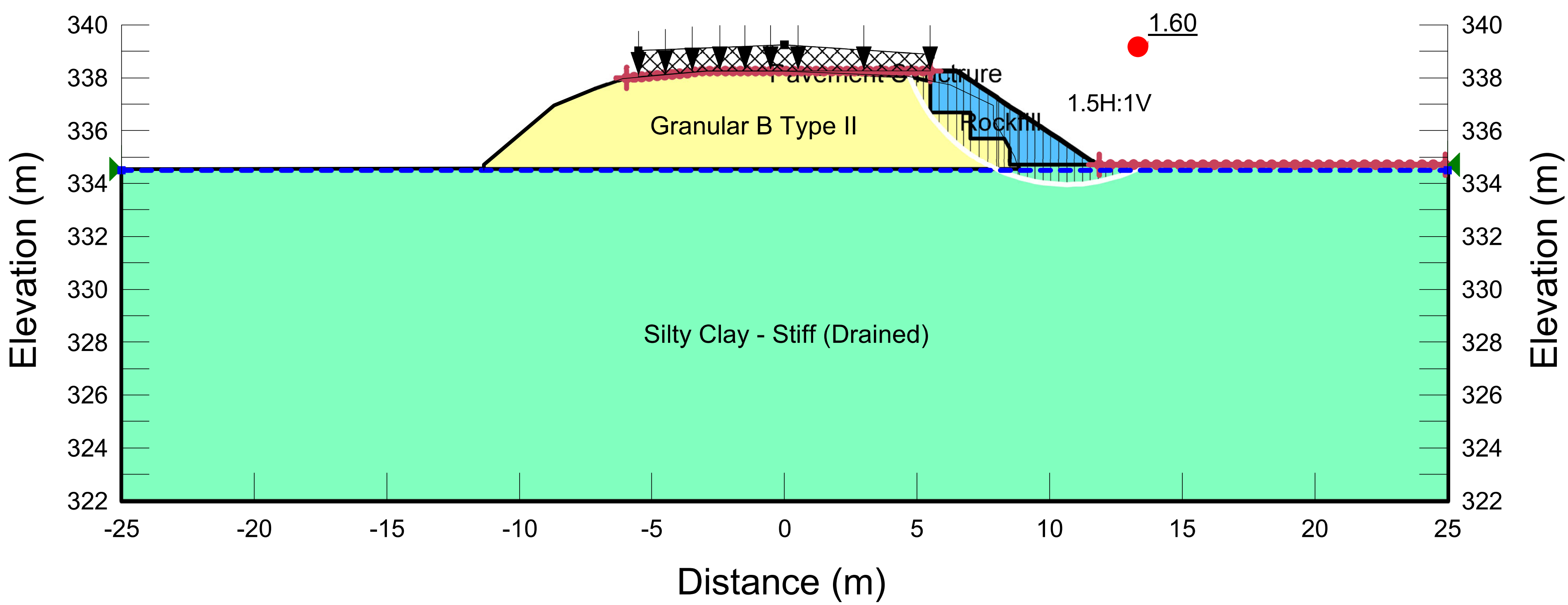
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular B Type II	Mohr-Coulomb	22	0	35
	Pavement Structrure	Mohr-Coulomb	22	0	35
	Rockfill	Mohr-Coulomb	19	0	42
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25



CAMERON CREEK CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular B Type II	Mohr-Coulomb	22	0	35
	Pavement Structure	Mohr-Coulomb	22	0	35
	Rockfill	Mohr-Coulomb	19	0	42
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25

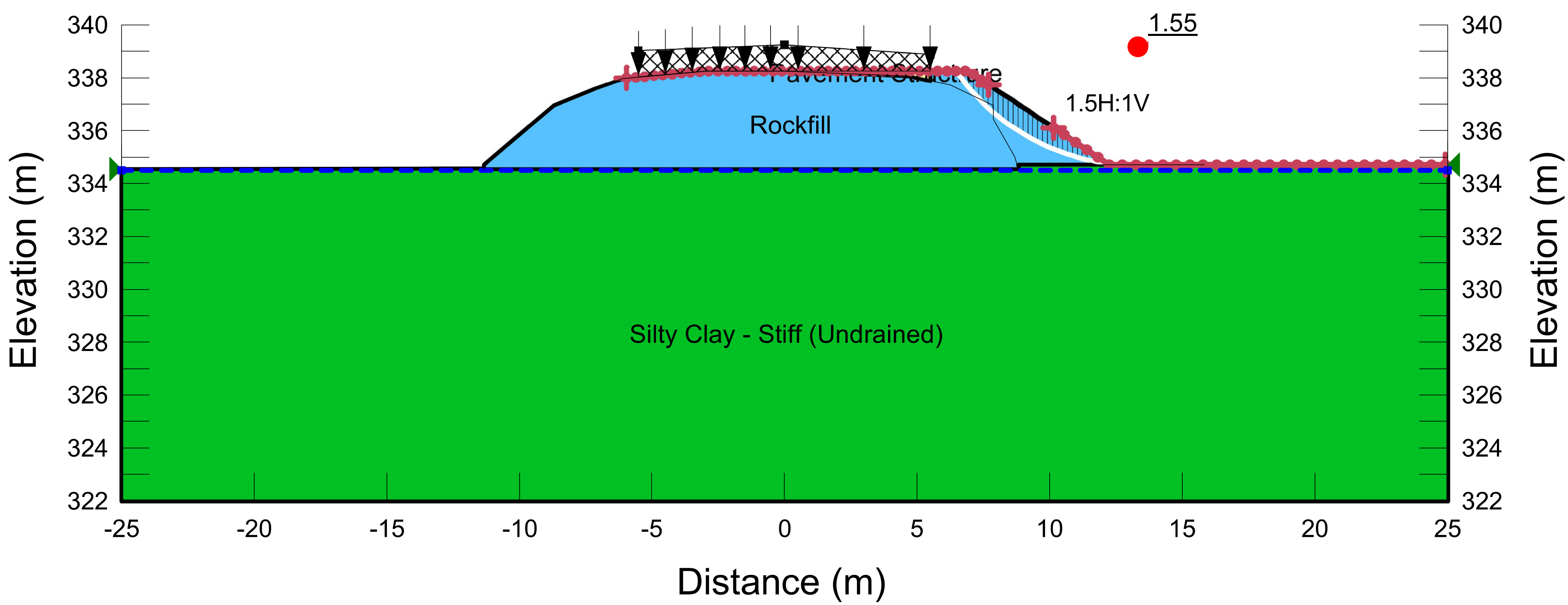
FIGURE 5 - 1.5H:1V ROCKFILL KEY (DEEP) DRAINED CONDITION



CAMERON CREEK CULVERT

FIGURE 6 -1.5H-1V ALL ROCKFILL
UNDRAINED CONDITION

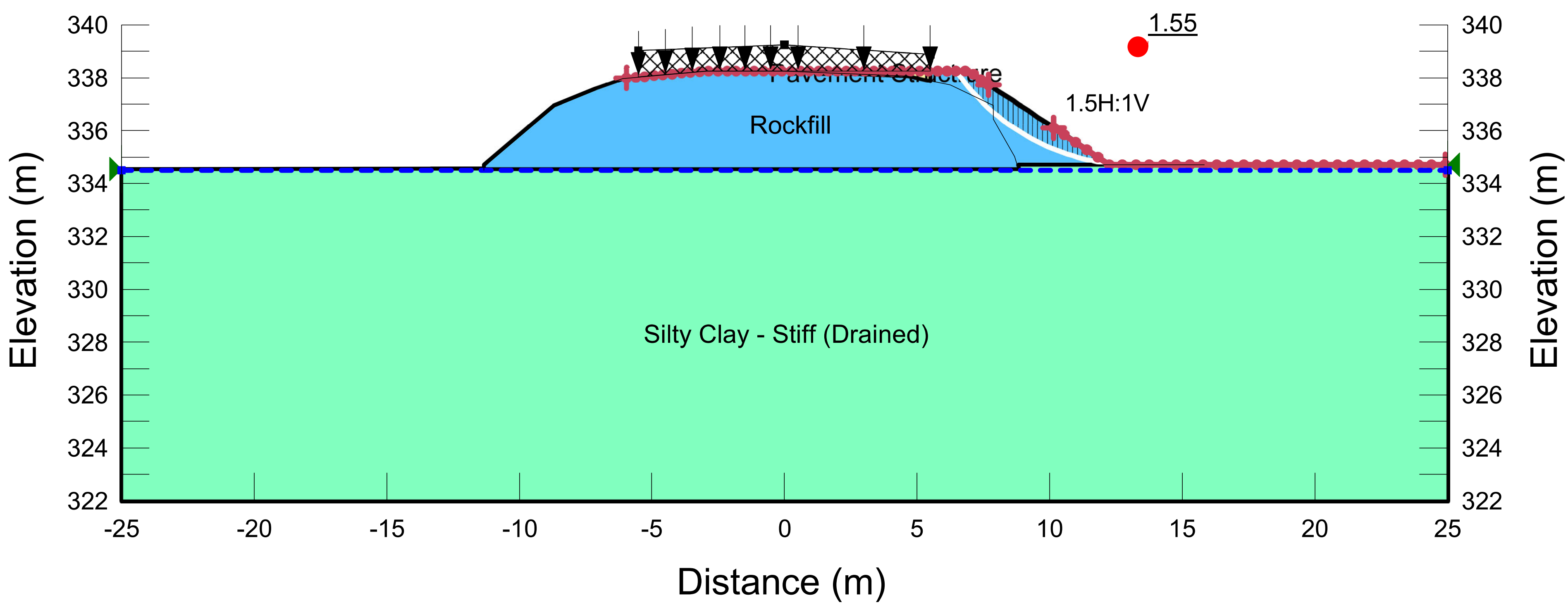
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Pavement Structrure	Mohr-Coulomb	22				0	35
	Rockfill	Mohr-Coulomb	19				0	42
	Silty Clay - Stiff (Undrained)	S=f(depth)	18	60	1.5	80		



CAMERON CREEK CULVERT

FIGURE 7 -1.5H-1V ALL ROCKFILL
DRAINED CONDITION

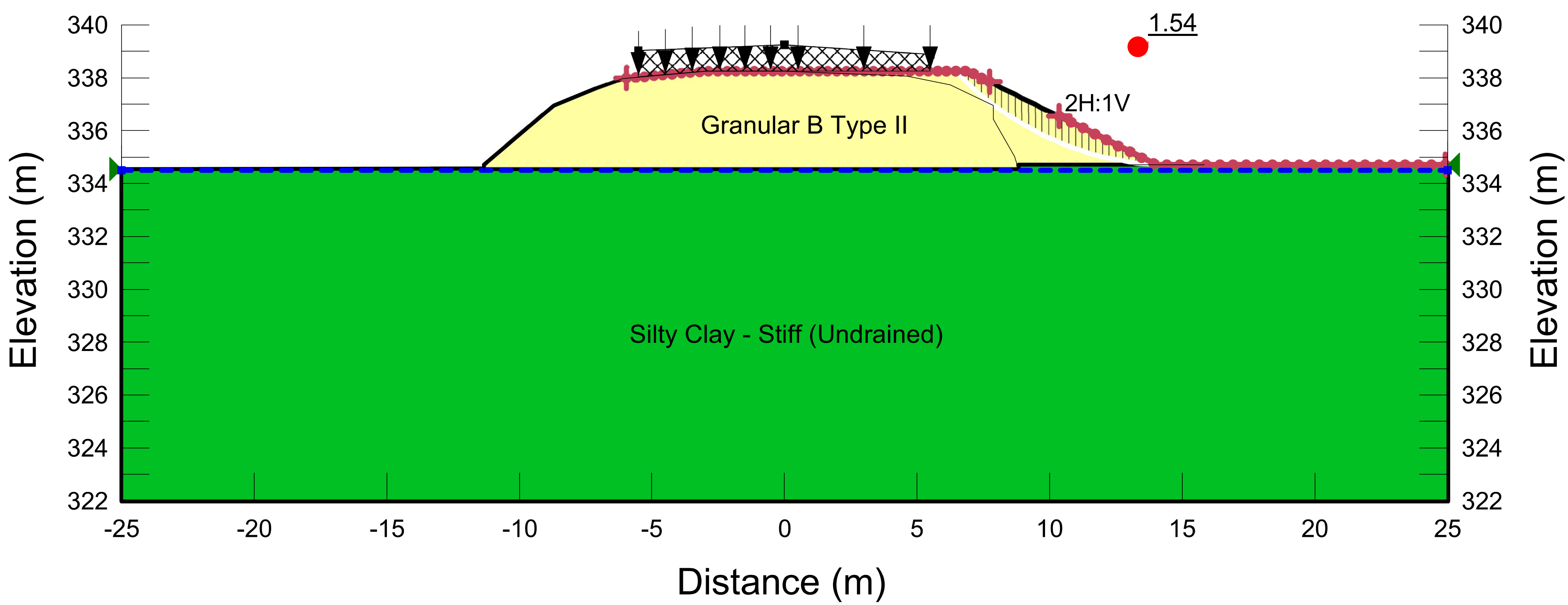
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Pavement Structrure	Mohr-Coulomb	22	0	35
	Rockfill	Mohr-Coulomb	19	0	42
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25



CAMERON CREEK CULVERT

FIGURE 8 -1.5H-1V ALL GRANULAR FILL
UNDRAINED CONDITION

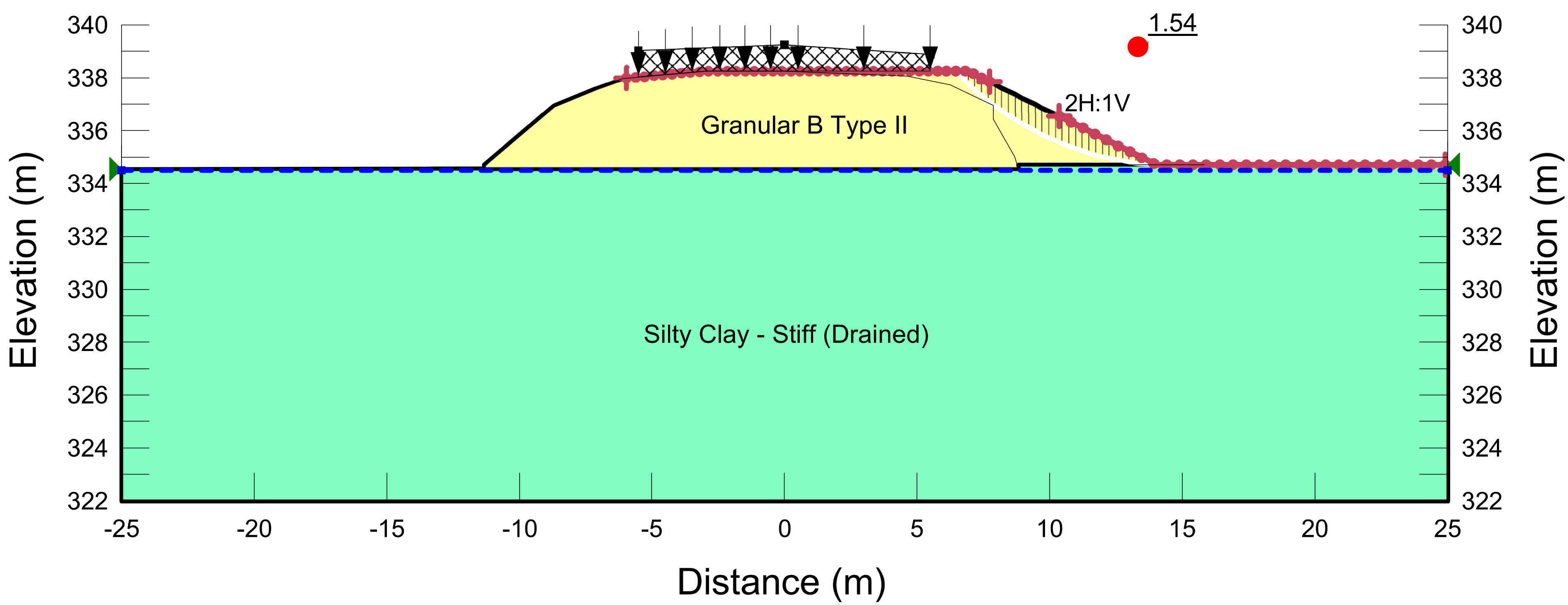
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(yellow)	Granular B Type II	Mohr-Coulomb	22				0	35
(green)	Silty Clay - Stiff (Undrained)	S=f(depth)	18	60	1.5	80		



CAMERON CREEK CULVERT

FIGURE 9 -1.5H:1V ALL GRANULAR FILL DRAINED CONDITION

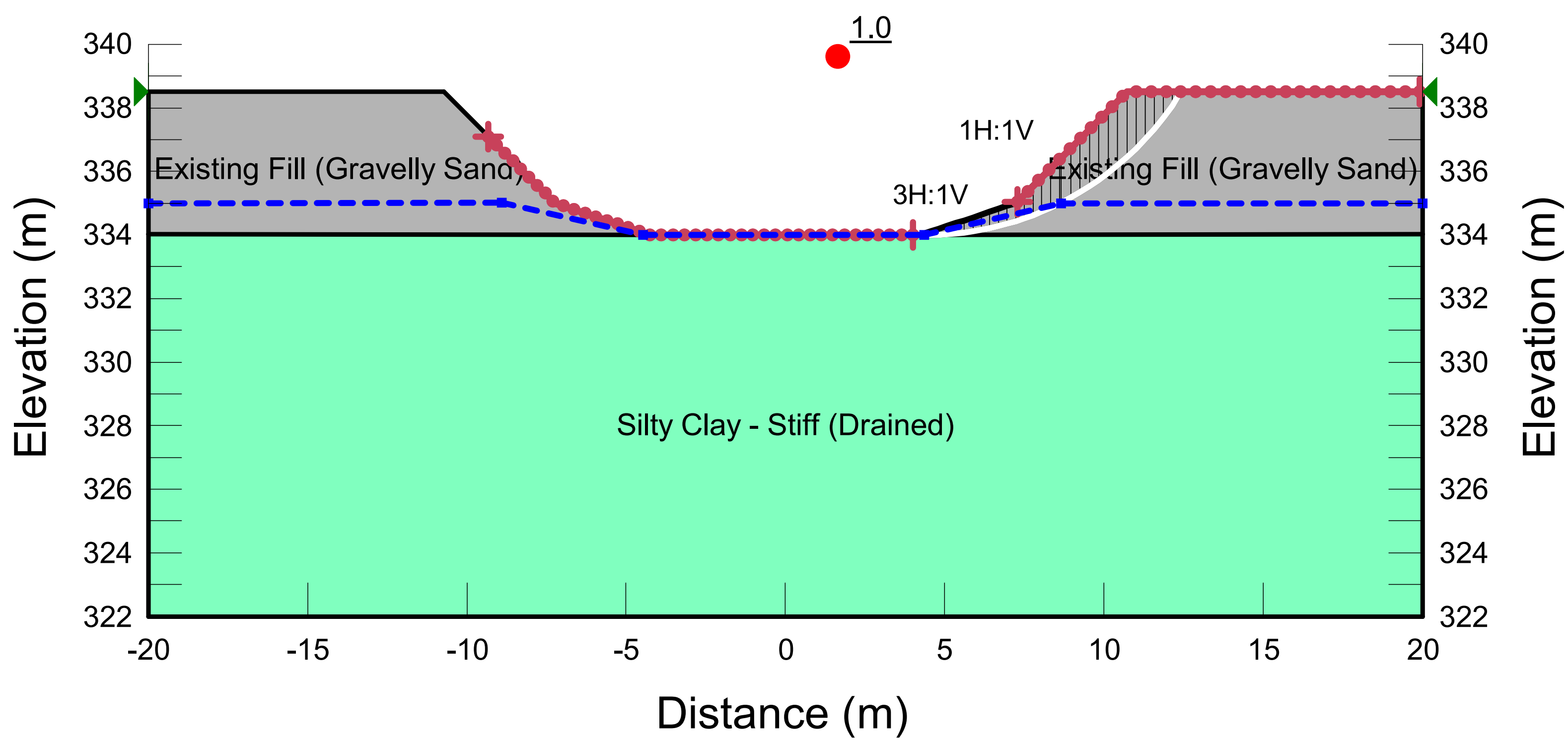
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular B Type II	Mohr-Coulomb	22	0	35
	Silty Clay - Stiff (Drained)	Mohr-Coulomb	18	5	25



CAMERON CREEK CULVERT

FIGURE 10 - TEMPORARY EXCAVATION (1H:1V & 3H:1V) DRAINED CONDITION

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Fill (Gravelly Sand)	21	0	32
	Silty Clay - Stiff (Drained)	18	5	25



CAMERON CREEK CULVERT

FIGURE 11 - TEMPORARY EXCAVATION (1.5H:1V & 3H:1V) DRAINED CONDITION

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Fill (Gravelly Sand)	21	0	32
	Silty Clay - Stiff (Drained)	18	5	25