



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 9 CULVERT REPLACEMENT
TOWNSHIP OF GREENOCK – STA 11+475, CULVERT C8
BROCKTON, ONTARIO
LATITUDE: 44.108167°, LONGITUDE: -81.206103°
Agreement No.: 3020-E-0004-09**

GEOCRES Number: 41A-254

Report

to

GHD Group

Date: September 9, 2022
File: 33249



TABLE OF CONTENTS

PART A: FACTUAL INFORMATION

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES.....	2
4.	LABORATORY TESTING.....	3
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Topsoil	5
5.2	Embankment Fill.....	5
5.3	Silty Sand to Silt and Sand	5
5.4	Bedrock	6
5.5	Groundwater Conditions.....	7
6.	ANALYTICAL LABORATORY TESTING.....	7
6.1	Corrosivity and Sulphate Test Results	7
6.2	Provincial Water Quality Objectives (PWQO)	8
7.	MISCELLANEOUS	9

APPENDICES

Appendix A	Record of Borehole Sheets
Appendix B	Geotechnical and Analytical Laboratory Test Results
Appendix C	Site and Core Photographs
Appendix D	Borehole Locations and Soil Strata Drawing



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PART A: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of a non-structural culvert, Culvert C8 at STA 11+475 in the Township of Greenock, on Highway 9 in Brockton, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert site 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 GHD, under the Ministry of Transportation, Ontario (MTO) Retainer Agreement No. 3020-E-0004 Work Order #9.

2. SITE DESCRIPTION

The existing culvert is located on Highway 9, approximately 4.4 km east of Greenock, Ontario. Details of the culverts are as follows:

Station and Township	Culvert Size and Type	Length and Depth of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
11+475 Greenock	600 mm dia. CSP	55.65 m long 8.3 m deep	297.300 north	294.663 south

The existing culvert allows flow of an existing ditch under the approximately 5 to 7 m high embankment fill. Based on visual observations, signs of slope instability or erosion of the



embankment was not present at the culvert site. The lands surrounding the culvert site is generally agricultural and the occasional residential dwelling. The site topography consists of rolling hills with gentle slopes that are vegetated with grass and sparsely spaced trees in places. Site photographs can be found in Appendix C.

Based on published geological information, the site area lies within the physiographic region known as the Teeswater Drumlin Field where the overburden is expected to be comprised of glaciolacustrine deposits of sands and gravels.

Based on the Ontario Geological Survey (OGS) Map MRD219 titled “Paleozoic Geology of Southern Ontario”, the bedrock at the site is generally at a transition zone between the Amherstburg Formation and Bois Blanc Formation. Both the Amherstburg Formation and Bois Blanc Formation consists primarily of limestone and dolostone and is described as bituminous, cherty, and locally biohermal.

3. INVESTIGATION PROCEDURES

The field investigation and testing for this project was carried out on April 26, 27, and May 17, 2022, and consisted of drilling and sampling three boreholes, designated as Borehole C8-01 through C8-03, to depths between 4.9 m and 12.2 m (Elev. 293.2 m to 290.3 m). Boreholes C8-01 was advanced through the existing embankment on the eastbound paved shoulders, while Boreholes C8-02 and C8-03 were advanced in the ditches near the existing inlet and outlet, respectively.

The approximate locations of the boreholes from the investigation are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D.

Utility clearances were obtained prior to mobilization to the site. The as-drilled borehole locations and elevations were surveyed using a Trimble Catalyst DA1 antenna with centimeter accuracy.

Details of the drilling program, including drilling depths, piezometer installation and completion details are summarized in Table 3.1 below. Groundwater levels were noted in the open borehole upon completion of drilling at Borehole C8-01 and C8-02. A 19 mm diameter piezometer were installed in Borehole C8-03 to allow for the measurement of groundwater levels. The installation details are illustrated on the Record of Borehole sheets provided in Appendix B. The monitoring well was subsequently decommissioned on May 16, 2022, in accordance with O.Reg. 903 at the completion of the field program.

Table 3.1 – Borehole Completion Details

Borehole	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
C8-01	12.2 / 290.3	None Installed	Backfilled with bentonite holeplug and auger cuttings to surface.
C8-02	4.9 / 293.2	None Installed	Backfilled with bentonite holeplug and auger cuttings to surface.
C8-03	5.4 / 290.3	2.3 / 293.4	19 mm diameter piezometer pipe with a 1.5 m slotted screen. Piezometer was decommissioned, and borehole backfilled with bentonite in general accordance with O.Reg. 903.

A truck-mounted Diedrich D120 and a track-mounted Diedrich D50 drilling rig were used to advance the boreholes through the overburden using hollow stem augers and rotary drilling techniques within HW casing. Bedrock was cored using HQ-sized coring equipment. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in accordance with ASTM D1586.

All rock cores were logged and the Total Core Recovery (TCR), Solid Core Recovery (SCR), and Rock Quality Designation (RQD) were determined.

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.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses, where appropriate. Selected rock cores were submitted to Geomechnica Inc. in Toronto, Ontario, to carry out Unconfined Compression testing. The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in



Appendix B.

One sample of the sand fill, and one sample of the native sand from Borehole C8-01, and one sample of groundwater from the piezometer installed in Borehole C8-03 were submitted to AGAT Laboratories, a CALA accredited analytical laboratory in Mississauga, Ontario, for analytical testing of corrosivity parameters and sulphate content to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the steel elements of the structure. The results of the analytical testing from the investigation are summarized in Section 6 and are presented in Appendix B.

In addition, Groundwater quality samples were collected from the monitoring well for the purpose of considering disposal options and potential treatment needs at a preliminary level.

The monitoring wells were developed on May 11, 2022, prior to any sampling or in-situ testing, by purging at least three well volumes. The purpose of purging was to remove excess sediment that may have entered the well during installation, to increase the representativeness of the natural groundwater in the well and to improve the transmissivity of the sand pack and well screen. Development was assessed to be completed based on the number of well volumes purged, and qualitative observations such as a decrease in turbidity of the pumped water.

Groundwater quality samples were collected from the monitoring well installed in Borehole C8-03 using low flow sampling techniques. The samples were preserved in prepared laboratory sample bottles, stored in a cooler on ice, and submitted to SGS Canada Inc., for analysis of metals and inorganics (M&I) and general chemistry (GC) parameters for comparison to Provincial Water Quality Objectives (PWQO).

A set of filtered samples was collected in addition to unfiltered samples, to provide a preliminary measurement of dissolved, and assumedly not physically filterable, parameter exceedances.

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 Drawing included 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 on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions may vary between and beyond the



borehole locations.

In general, the subsurface conditions encountered consisted of sand and gravel to sandy silt embankment fill, underlain by native silty sand to silt and sand overlying bedrock. Descriptions of the individual strata are presented below.

5.1 Topsoil

A 100 mm and 75 mm thick layer of topsoil was encountered at ground surface at Boreholes C8-02 and C8-03, respectively, at the toes of the embankment.

5.2 Embankment Fill

Embankment fill generally comprised of sand and gravel, trace silt to sandy silt, trace to some gravel and clay was encountered from ground surface at all boreholes. Depending on where the boreholes were advanced, the thickness of fill ranged from 0.6 m to 7.5 m, which was fully penetrated between Elev. 297.4 m and 295.0 m.

SPT 'N' values recorded in the embankment fill ranged from 6 blows to 47 blows for 0.3 m of penetration, indicating a loose to dense condition. Measured moisture content in the fill, typically ranged from 5% to 11%. Moisture content of 50% and 39% were measured at the toe of embankment in Boreholes C8-02 and C8-03, respectively.

The results of grain size analysis carried out on samples of the granular fill are presented on Figure B1 in Appendix B and summarized as follows:

Soil Particle	Embankment Fill
Gravel	10 to 21
Sand	32 to 44
Silt	38 to 39
Clay	7 to 9

5.3 Silty Sand to Silt and Sand

A deposit of silty sand, some gravel, trace clay to silt and sand, trace gravel and clay, containing occasional fractured limestone fragments was encountered underlying the embankment fill at all boreholes. The deposit is between 0.3 m and 1.9 m thick and was fully penetrated at depths that ranged from 1.0 m to 9.1 m, or between Elev. 297.1 m and 293.1 m).



SPT 'N' values recorded in the silty sand to sand and silt typically ranged from 11 blows to 38 blows per 0.3 m penetration, indicating compact to dense conditions. SPT 'N' values as high as 50 blows per less than 0.1 m of penetration were recorded prior to encountering bedrock. The measured moisture content of the sandy silt to sand ranged from 12% to 20%.

The results of grain size analyses conducted on selected samples of the cohesionless deposit are presented on Figure B2 in Appendix B and summarized as follows:

Soil Particle	Silty Sand to Silt and Sand
Gravel	2 to 20
Sand	37 to 42
Silt	31 to 47
Clay	5 to 12

5.4 Bedrock

Bedrock underlying the overburden was proven by coring at all borehole locations. The depths and elevations of the bedrock surface are summarized as below.

Borehole	Depth to Bedrock from Ground Surface (m)	Bedrock Surface Elevation (m)
C8-01	9.1	293.4
C8-02	1.0	297.1
C8-03	2.6	293.1

Based on the elevation at which the bedrock surface was encountered, the bedrock is gently sloping downwards from north to south. The bedrock encountered consisted of slightly weathered to fresh dolostone/limestone. Photographs of the bedrock core are provided in Appendix C. The rock core quality parameters are summarized below:

Rock Core Quality Parameters	Range	Average
Total Core Recover (TCR), %	92 to 100	99
Solid Core Recover (SCR), %	33 to 100	74
Rock Quality Designation (RQD), %	0 to 100	22

The Rock Quality Designation (RQD) varied from 0% to 100% but is typically between 0% to 30%, indicating a rock mass of very poor to poor quality. The results of Unconfined Compression (UC)



testing carried out on selected core samples of the bedrock are presented in Appendix B and are summarized below. Based on the test results, the bedrock is classified as strong (R4) to very strong (R5).

Sample	Depth (m)	Uniaxial Compressive Strength, UCS (MPa)
C8-01 Run #2*	11.99 to 12.19	81.9
C8-02 Run #2	2.95 to 3.10	167.1

Note: * Core sample is mislabelled as C8-07 Run #2 on Geomechanica's report titled Rock Laboratory Testing Results in Appendix B.

5.5 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling and in piezometer installed in a borehole are presented on the record of boreholes and summarized in Table 5-1 below.

Table 5.1 – Groundwater Measurements

Borehole	Date of Measurement	Groundwater Level (m)		Remark
		Depth	Elevation	
C8-01	May 17, 2022	7.6	294.9	In open borehole upon completion of drilling
C8-02	April 26, 2022	Dry	Dry	In open borehole upon completion of drilling
C8-03	May 11, 2022	1.0	294.7	From piezometer
	May 16, 2022	1.0	294.7	

These groundwater levels are short-term observations and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

6. ANALYTICAL LABORATORY TESTING

6.1 Corrosivity and Sulphate Test Results

One sample of the sand fill, one sample of the native sand, and one sample of groundwater collected from the monitoring well was submitted for analytical testing of corrosivity parameters and sulphate. The analytical test results for the soil and groundwater samples are presented in Appendix B and are summarized in Table 6.1, and 6.2 below.



Table 6.1 – Analytical Test Results from Soil Samples

Borehole	C8-01	C8-01
Sample	SS9	SS11
Depth (ft, m)	20 to 22 6.1 to 6.7	25 to 27 7.6 to 8.3
Elevation (m)	296.1	294.6
Chloride (µg/g)	442	37
Sulphate (µg/g)	6	5
pH	8.18	8.32
Conductivity (mS/cm)	0.887	0.713
Resistivity (Ohm-cm)	1130	5780
Average Redox Potential (mV)	201	205

Table 6.2 – Analytical Test Results from Groundwater Sample

Monitoring Well	C8-03
Chloride (mg/L)	148
Sulphate (mg/L)	26600
pH	7.72
Conductivity (µS/cm)	1170
Resistivity (Ohm-cm)	855
Average Redox Potential (mV)	178

6.2 Provincial Water Quality Objectives (PWQO)

Testing of groundwater samples for comparison to the PWQO and Interim PWQO comprised analysis of general chemistry and selected metals and inorganic parameters. PWQO metals testing was carried out on an unfiltered ground water sample and a field-filtered sample. The results met the PWQO standards with the following exceptions:



Sample ID	Parameter	Units	Measured Concentration	PWQO	Interim PWQO
C8-03	<i>Arsenic</i>	<i>mg/L</i>	<i>0.011</i>	<i>0.1</i>	<i>0.005</i>
	<i>Dissolved Arsenic</i>	<i>mg/L</i>	<i>0.006</i>	<i>0.1</i>	<i>0.006</i>
	Cobalt	mg/L	0.0118	-	0.0009
	Copper	mg/L	0.045	-	0.005
	Iron	mg/L	24.8	0.3	-
	<i>Lead</i>	<i>mg/L</i>	<i>0.024</i>	<i>0.025</i>	<i>0.005</i>
	Phosphorous	mg/L	0.09	-	0.01 - 0.03
	Nickel	mg/L	0.039	0.025	-
	Silver	mg/L	0.0021	0.0001	-
	Thallium	mg/L	0.0004	-	0.0003
	Tungsten	mg/L	0.034	-	0.03
	Uranium	mg/L	0.007	-	0.005
	Vanadium	mg/L	0.054	-	0.006
	Zinc	mg/L	0.112	0.03	0.02

Notes:

Italics indicate the parameter has exceeded the interim PWQO but not the PWQO where both exist

“-“ indicates that the PWQO or interim PWQO standard does not exist

It should be noted that the results of the groundwater samples were representative at the time of sampling and provide a general understanding of groundwater quality under those conditions; however, the water quality may vary from the results obtained based on location, time, meteorological conditions, and on the selected construction and dewatering methods.

In addition, the extent of suspended solids in the groundwater or in water that is collected during construction dewatering (for example from a sump in an open excavation) will affect the concentrations of many parameters that may be regulated based on discharge location, particularly metals. The value of testing groundwater quality during the investigation is primarily to identify the types of contaminants that may need to be managed, the extent to which they are dissolved and therefore unlikely to be filtered by physical means alone, and the presence of anthropogenic contaminants that are listed in the given discharge criteria that may require specific treatment.

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to mobilizing to site. The as-drilled boreholes

Client: GHD

Date: September 9, 2022

File No.: 33249

Page: 9 of 11

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locations and elevations were surveyed using a Trimble Catalyst DA1.

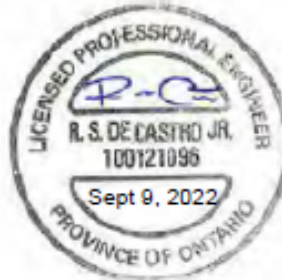
Walker Drilling Ltd. of Utopia, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the field investigation. The field investigation was supervised on a full-time basis by Mr. George Azzopardi of Thurber. The overall management of the field program was conducted by Mr. Rod de Castro, P.Eng., of Thurber.

Geotechnical laboratory testing on soil samples was carried out in Thurber's geotechnical laboratory. Unconfined Compression testing on rock cores was carried out by Geomechanica Inc. Analytical laboratory testing on soil and water samples was carried out by AGAT Laboratories.

Interpretation of the field data and preparation of this report was carried out by Messrs. Rod de Castro, P.Eng., and Christopher Ng, P.Eng., respectively. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects at Thurber.



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Client: GHD
File No.: 33249

Date: September 9, 2022
Page: 11 of 11

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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


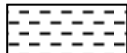



$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 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.

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

UNIFIED SOILS CLASSIFICATION

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

RECORD OF BOREHOLE No C8-01

1 OF 2

METRIC

GWP# 3075-14-00 LOCATION C8 Culvert; MTM NAD83-10: N 4 886 774.0 E 168 216.7 ORIGINATED BY GA
 DIST HWY 9 BOREHOLE TYPE Hollow Stem Augers/ HQ Coring COMPILED BY AA
 DATUM Geodetic DATE 2022.05.17 - 2022.05.17 LATITUDE 44.108219 LONGITUDE -81.206168 CHECKED BY RdC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
302.5	GROUND SURFACE							20	40	60	80	100								
0.0	SAND and GRAVEL , trace silt Dense to Very Dense Brown Moist (FILL)		1	SS	47		302							○						
			2	SS	30									○						
301.1							301													
1.4	Silty SAND , trace gravel and clay Compact to Dense Brown Moist (FILL)		3	SS	18									○			10 44 39 7			
			4	SS	33		300							○						
299.5																				
3.0	Gravelly, Silty SAND , trace clay Compact Brown Moist (FILL)		5	SS	28		299							○						
			6	SS	15									○			21 32 38 9			
			7	SS	14		298							○						
			8	SS	10		297							○						
			9	SS	21		296							○						
			10	SS	15															
295.0							295													
7.5	Silty SAND , some gravel, trace clay Compact to Dense Brown Wet		11	SS	27									○			13 42 40 5			
			12	SS	31		294							○						
293.4																				
9.1	DOLOSTONE/LIMESTONE fresh to moderately weathered, grey and beige Horizontal fractures from a depth of 9.1m to 9.3m and 9.6m to 9.8m		1	RUN			293										RUN #1 TCR=100% SCR=100% RQD=60%			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10


(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C8-01

2 OF 2

METRIC

GWP# 3075-14-00 LOCATION C8 Culvert; MTM NAD83-10: N 4 886 774.0 E 168 216.7 ORIGINATED BY GA
DIST HWY 9 BOREHOLE TYPE Hollow Stem Augers/ HQ Coring COMPILED BY AA
DATUM Geodetic DATE 2022.05.17 - 2022.05.17 LATITUDE 44.108219 LONGITUDE -81.206168 CHECKED BY RdC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					
	Horizontal fractures at a depth of 9.3m, 9.4m, 9.6m, 9.9m, 10.0m, 10.1m, and 10.2m						292									3	RUN #2 TCR=100% SCR=100% RQD=100% UCS=81.9MPa
	Horizontal fractures at a depth of 10.7m, 10.8m, 11.00m, 11.1m, 11.7m, 11.9m, and 12.0m						291									1	
			2	RUN												3	
																2	
																0	
290.3																1	
12.2	END OF BOREHOLE AT A DEPTH OF 12.20m. BOREHOLE OPEN AND WATER LEVEL A DEPTH OF 7.6m.															2	

RUN #2
TCR=100%
SCR=100%
RQD=100%
UCS=81.9MPa

RECORD OF BOREHOLE No C8-02

1 OF 1

METRIC

GWP# 3075-14-00 LOCATION C8 Culvert; MTM NAD83-10: N 4 886 802.6 E 168 212.2 ORIGINATED BY MA
 DIST HWY 9 BOREHOLE TYPE Hollow Stem Augers/ HQ Coring COMPILED BY AA
 DATUM Geodetic DATE 2022.04.26 - 2022.04.26 LATITUDE 44.108476 LONGITUDE -81.206232 CHECKED BY RdC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
298.1	GROUND SURFACE							20 40 60 80 100		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
0.0	TOPSOIL: (100mm)												
0.1	Sandy SILT , trace to some gravel and clay, containing rootlets		1	SS	9								
297.4	Loose												
0.7	Dark Brown												
297.1	Moist		2	SS	50/								
1.0	(FILL)				0.075								
	Silty SAND , some gravel and clay, containing fractured limestone												
	Very Dense		1	RUN									
	Brown												
	Moist												
	DOLOSTONE/LIMESTONE slightly weathered, highly fractured, grey, very strong		2	RUN									
	Highly fractured zone from a depth of 1.0m to 4.0m												
			3	RUN									
			4	RUN									
293.2	END OF BOREHOLE AT A DEPTH OF 4.9m.												
4.9													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C8-03

1 OF 1

METRIC

GWP# 3075-14-00 LOCATION C8 Culvert; MTM NAD83-10: N 4 886 747.3 E 168 213.9 ORIGINATED BY MA
DIST HWY 9 BOREHOLE TYPE Hollow Stem Augers/ HQ Coring COMPILED BY AA
DATUM Geodetic DATE 2022.04.27 - 2022.04.27 LATITUDE 44.107979 LONGITUDE -81.206197 CHECKED BY RdC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							WATER CONTENT (%) PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L						
295.7	GROUND SURFACE							20	40	60	80	100									
0.0 0.1	TOPSOIL: (75mm)		1	SS	6																
295.0	Silty SAND , trace gravel and clay Loose Brown Moist (FILL)																				
0.7			2	SS	11																
294.3	SILT and SAND , trace gravel and clay Compact Brown Wet																				
1.4			3	SS	38																
	SAND , with fracture limestone Dense to Very Dense Brown Wet																				
293.1			4	SS	50/																
2.6	DOLOSTONE/LIMESTONE slightly weathered, grey and beige, strong				0.100																
	Highly fractured zone from a depth of 2.6 to 5.4m		1	RUN																RUN #1 TCR=92% SCR=42% RQD=0%	
			2	RUN																RUN #2 TCR=100% SCR=80% RQD=10% UCS=81.9MPa	
			3	RUN																RUN #3 TCR=100% SCR=88% RQD=0%	
290.3																					
5.4	END OF BOREHOLE AT A DEPTH OF 17.83m. Monitoring Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2022.05.11 1.0 294.7 2022.05.16 1.0 294.7																				

+³, ×³: Numbers refer to
Sensitivity

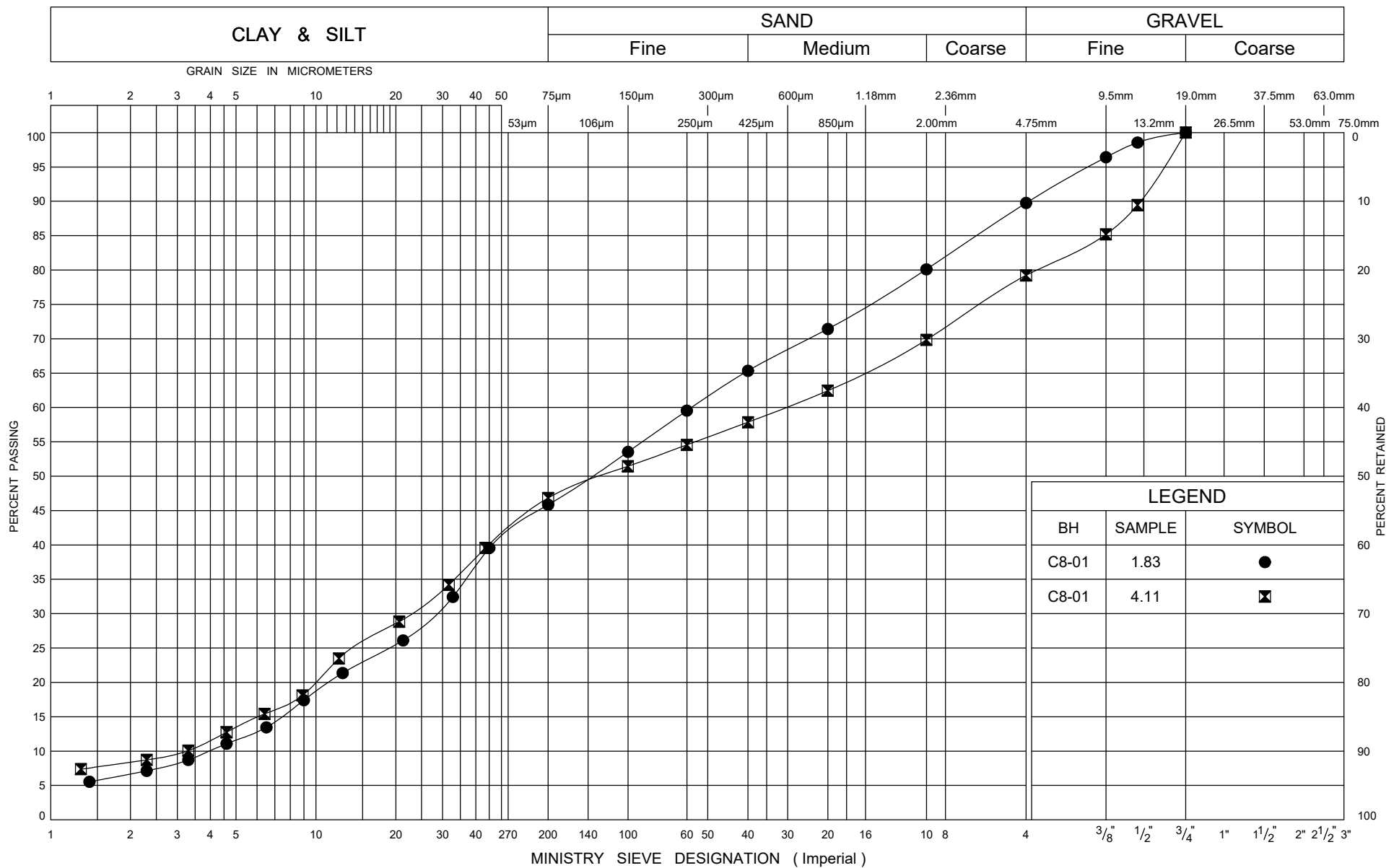
20
15
10

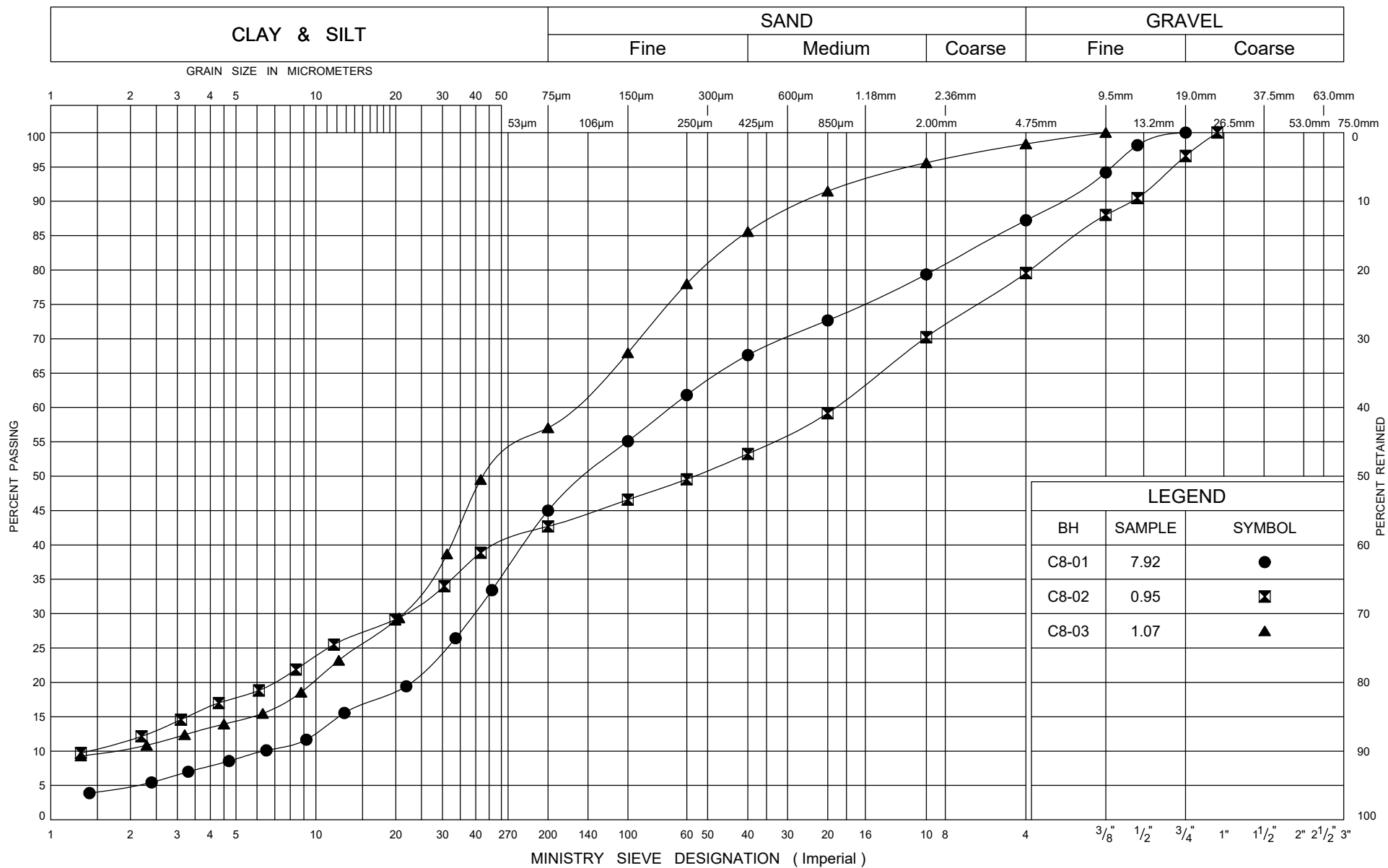
(%) STRAIN AT FAILURE





Appendix B

Geotechnical and Analytical Laboratory Test Results and Well Test Results







Uniaxial Compression Test

Client	Thurber Engineering Ltd.	Project	33249
Sample	BH C8-01, Run 2	Depth	39' 4" - 40' 0"
<div>Specimen parameters</div> <div><div>Diameter (mm) ^a</div><div>Length (mm) ^a</div><div>Bulk density ρ (g/cm³)</div><div>UCS (MPa)</div><div>Lithology</div><div>Failure description ^b</div></div>		<div>Prior to testing</div> <div></div>	<div>After testing</div> <div></div>
<div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div> <div>^b Failure description: ³ Inclined shear fracture and axial splitting failure;</div>			
Remarks: Loading rate of: 0.05 mm/min.			
Performed by	EM/MB	Date	2022-05-30

Uniaxial Compression Test

Client	Thurber Engineering Ltd.	Project	33249
Sample	BH C8-02, Run 2	Depth	9' 8" - 10' 2"
<div>Specimen parameters</div>		Prior to testing	After testing
Diameter (mm) ^a	63.37		
Length (mm) ^a	118.11		
Bulk density ρ (g/cm ³)	2.596		
UCS (MPa)	167.1		
Lithology	Dolostone/Limestone		
Failure description ^b	3, 2		
<div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet. ^b Failure description: ³ Inclined shear fracture and axial splitting failure; ² Length:Diameter ratio less than 2;</div>			
Remarks: Loading rate of: 0.125 mm/min.			
Performed by	MB/MB	Date	2022-05-19

CLIENT NAME: THURBER ENGINEERING LTD
SUITE 103, 2010 WINSTON PARK DRIVE
OAKVILLE, ON L6H5R7
(905) 829-8666

ATTENTION TO: Rod de Castro

PROJECT: WR 3020-E-0004

AGAT WORK ORDER: 22T896882

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

WATER ANALYSIS REVIEWED BY: Yris Verastegui, Report Reviewer

DATE REPORTED: May 27, 2022

PAGES (INCLUDING COVER): 21

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.



Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Corrosivity Package

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

				C6-01 SS7	C6-01 SS10 22.	C8-01 SS9	C8-01 SS11
SAMPLE DESCRIPTION:				15-17'	5-24.3'	20-22'	25-27'
SAMPLE TYPE:				Soil	Soil	Soil	Soil
DATE SAMPLED:				2022-05-16	2022-05-16	2022-05-17	2022-05-17
Parameter	Unit	G / S	RDL	3874389	3874395	3874396	3874397
Chloride (2:1)	µg/g		2	279	186	442	37
Sulphate (2:1)	µg/g		2	9	22	6	5
pH (2:1)	pH Units		NA	7.85	8.70	8.18	8.32
Electrical Conductivity (2:1)	mS/cm		0.005	0.605	0.531	0.887	0.173
Resistivity (2:1) (Calculated)	ohm.cm		1	1650	1880	1130	5780
Redox Potential 1	mV		NA	163	191	204	215
Redox Potential 2	mV		NA	163	190	201	201
Redox Potential 3	mV		NA	164	190	199	199

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3874389-3874397 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Nivine Basly



Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

(Water) Inorganic Chemistry

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

SAMPLE DESCRIPTION:				22-01		22-02		C6-02		C8-03
SAMPLE TYPE:				Water		Water		Water		Water
DATE SAMPLED:				2022-05-16 16:45		2022-05-16 17:00		2022-05-17 18:15		2022-05-17 14:00
Parameter	Unit	G / S	RDL	3874272	RDL	3874309	RDL	3874310	RDL	3874314
pH	pH Units		NA	7.77	NA	7.72	NA	7.77	NA	7.72
Electrical Conductivity	µS/cm		2	1670	2	719	2	1760	2	1170
Resistivity	ohms.cm			599		1390		568		855
Chloride	mg/L		0.12	354	0.10	18.6	0.24	399	0.12	148
Sulphate	µg/L		100	60700	100	144000	190	23400	100	26600
SAMPLE DESCRIPTION: Greenock Creek										
SAMPLE TYPE:				Water						
DATE SAMPLED:				2022-05-16 17:30						
Parameter	Unit	G / S	RDL	3874388						
pH	pH Units		NA	7.90						
Electrical Conductivity	µS/cm		2	542						
Resistivity	ohms.cm			1850						
Chloride	mg/L		0.10	18.9						
Sulphate	µg/L		100	10300						

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3874272-3874388 Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Iris Veraistegui



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

(Water) TSS, CrVI

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		C6-02	C8-03
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2022-05-17 18:15	2022-05-17 14:00
Parameter	Unit	G / S	RDL	3874310	3874314
Total Suspended Solids	mg/L		10	75	8650
Chromium VI	mg/L	0.001	0.001	<0.001	<0.001

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

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Iris Veraistegui



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AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Dissolved Metals in Water (mg/L)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		C6-02	C8-03
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2022-05-17 18:15	2022-05-17 14:00
Parameter	Unit	G / S	RDL	3874310	3874314
Dissolved Aluminum	mg/L	*	0.004	0.014	0.013
Dissolved Antimony	mg/L	0.020	0.001	<0.001	<0.001
Dissolved Arsenic	mg/L	0.1	0.001	0.003	0.006
Dissolved Barium	mg/L		0.002	0.022	0.073
Dissolved Beryllium	mg/L	*	0.0005	<0.0005	<0.0005
Dissolved Bismuth	mg/L		0.002	<0.002	<0.002
Dissolved Boron	mg/L	0.2	0.010	0.079	0.062
Dissolved Cadmium	mg/L	0.0002	0.0001	<0.0001	<0.0001
Dissolved Chromium	mg/L		0.002	<0.002	<0.002
Dissolved Cobalt	mg/L	0.0009	0.0005	<0.0005	0.0007
Dissolved Copper	mg/L	0.005	0.001	0.006	0.003
Dissolved Iron	mg/L	0.3	0.010	<0.010	0.015
Dissolved Lead	mg/L	*	0.0005	0.0008	<0.0005
Dissolved Manganese	mg/L		0.002	0.131	0.376
Dissolved Molybdenum	mg/L	0.040	0.002	0.003	0.007
Dissolved Nickel	mg/L	0.025	0.001	0.002	0.003
Dissolved Phosphorus	mg/L		0.05	<0.05	<0.05
Dissolved Selenium	mg/L	0.1	0.001	0.002	<0.001
Dissolved Silver	mg/L	0.0001	0.0001	<0.0001	<0.0001
Dissolved Silicon	mg/L		0.05	3.75	6.29
Dissolved Strontium	mg/L		0.005	0.243	0.218
Dissolved Thallium	mg/L	0.0003	0.0003	<0.0003	<0.0003
Dissolved Tin	mg/L		0.002	<0.002	<0.002
Dissolved Titanium	mg/L		0.002	<0.002	<0.002
Dissolved Uranium	mg/L	0.005	0.0005	0.0011	0.0038
Dissolved Vanadium	mg/L	0.006	0.002	<0.002	<0.002
Dissolved Zinc	mg/L	0.030	0.005	<0.005	<0.005
Dissolved Zirconium	mg/L	0.004	0.004	<0.004	<0.004

Certified By:

Iris Veraestegui



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AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

5835 COOPERS AVENUE
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FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Dissolved Metals in Water (mg/L)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

3874310-3874314 Metals analysis completed on a filtered sample.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Iris Veraástegui



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PROJECT: WR 3020-E-0004

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<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

O. Reg. 153(511) - Sodium Adsorption Ratio (Water)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		22-01	22-02	C6-02	C8-03	Greenock Creek
		SAMPLE TYPE:		Water	Water	Water	Water	Water
		DATE SAMPLED:		2022-05-16 16:45	2022-05-16 17:00	2022-05-17 18:15	2022-05-17 14:00	2022-05-16 17:30
Parameter	Unit	G / S	RDL	3874272	3874309	3874310	3874314	3874388
Sodium Adsorption Ratio (Calculated)		NA		6.06	2.95	5.44	3.27	0.653

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Iris Veraástegui



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AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Redox in water

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		22-01	22-02	C6-02	C8-03	Greenock Creek
		SAMPLE TYPE:		Water	Water	Water	Water	Water
		DATE SAMPLED:		2022-05-16 16:45	2022-05-16 17:00	2022-05-17 18:15	2022-05-17 14:00	2022-05-16 17:30
Parameter	Unit	G / S	RDL	3874272	3874309	3874310	3874314	3874388
Redox Potential	mV		NA	133	174	170	178	186

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3874272-3874388 Redox potential was measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Iris Veraistegui



Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		C6-02		C8-03
		SAMPLE TYPE:		Water		Water
		DATE SAMPLED:		2022-05-17 18:15		2022-05-17 14:00
Parameter	Unit	G / S	RDL	3874310	RDL	3874314
Electrical Conductivity	µS/cm		2	1760	2	1170
pH	pH Units	6.5-8.5	NA	7.77	NA	7.72
Saturation pH (Calculated)				6.34		6.27
Langelier Index (Calculated)				1.43		1.45
Hardness (as CaCO ₃) (Calculated)	mg/L		0.5	989	0.5	982
Total Dissolved Solids	mg/L		10	1000	10	662
Alkalinity (as CaCO ₃)	mg/L		5	365	5	423
Bicarbonate (as CaCO ₃)	mg/L		5	365	5	423
Carbonate (as CaCO ₃)	mg/L		5	<5	5	<5
Hydroxide (as CaCO ₃)	mg/L		5	<5	5	<5
Fluoride	mg/L		0.05	<0.05	0.05	<0.05
Chloride	mg/L		0.24	399	0.12	148
Nitrate as N	mg/L		0.07	0.88	0.05	0.69
Nitrite as N	mg/L		0.05	<0.05	0.05	<0.05
Bromide	mg/L		0.06	<0.06	0.05	<0.05
Sulphate	mg/L		0.19	23.4	0.10	26.6
Ortho Phosphate as P	mg/L		0.13	<0.13	0.10	<0.10
Ammonia as N	mg/L		0.02	0.04	0.02	<0.02
Ammonia-Un-ionized (Calculated)	mg/L	0.02	0.000002	0.00120	0.000002	<0.000002
Total Phosphorus	mg/L	*	0.02	0.37	0.02	0.09
Total Organic Carbon	mg/L		0.5	4.8	0.5	39.1
True Colour	TCU		5.00	<5.00	5.00	7.62
Turbidity	NTU		0.5	51.0	0.9	3730
Total Calcium	mg/L		0.32	213	0.32	270
Total Magnesium	mg/L		0.34	111	0.34	74.7
Total Potassium	mg/L		1.15	6.13	1.15	8.99
Total Sodium	mg/L		0.45	270	0.45	164
Aluminum-dissolved	mg/L	*	0.004	0.004	0.004	<0.004
Total Antimony	mg/L	0.020	0.001	<0.001	0.001	<0.001

Certified By:

Iris Veraástegui



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

		SAMPLE DESCRIPTION:		C6-02		C8-03
		SAMPLE TYPE:		Water		Water
		DATE SAMPLED:		2022-05-17 18:15		2022-05-17 14:00
Parameter	Unit	G / S	RDL	3874310	RDL	3874314
Total Arsenic	mg/L	0.1	0.003	0.006	0.003	0.011
Total Barium	mg/L		0.002	0.084	0.002	0.250
Total Beryllium	mg/L	*	0.001	<0.001	0.001	0.001
Total Boron	mg/L	0.2	0.010	0.076	0.010	0.079
Total Cadmium	mg/L	0.0002	0.0001	<0.0001	0.0001	<0.0001
Total Chromium	mg/L		0.003	0.016	0.003	0.044
Total Cobalt	mg/L	0.0009	0.0005	0.0053	0.0005	0.0118
Total Copper	mg/L	0.005	0.001	0.018	0.001	0.045
Total Iron	mg/L	0.3	0.010	14.1	0.010	24.8
Total Lead	mg/L	*	0.001	0.006	0.001	0.024
Total Manganese	mg/L		0.002	0.756	0.002	0.884
Dissolved Mercury	mg/L	0.0002	0.0001	<0.0001	0.0001	<0.0001
Total Molybdenum	mg/L	0.040	0.002	0.004	0.002	0.008
Total Nickel	mg/L	0.025	0.003	0.021	0.003	0.039
Total Selenium	mg/L	0.1	0.002	0.004	0.002	0.009
Total Silver	mg/L	0.0001	0.0001	<0.0001	0.0001	0.0021
Total Strontium	mg/L		0.005	0.335	0.005	0.331
Total Thallium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0004
Total Tin	mg/L		0.002	<0.002	0.002	0.002
Total Titanium	mg/L		0.010	0.252	0.010	0.425
Total Tungsten	mg/L	0.030	0.010	<0.010	0.010	0.034
Total Uranium	mg/L	0.005	0.002	<0.002	0.002	0.007
Total Vanadium	mg/L	0.006	0.002	0.020	0.002	0.054
Total Zinc	mg/L	0.030	0.020	0.046	0.020	0.112
Total Zirconium	mg/L	0.004	0.004	0.005	0.004	<0.004
Lab Filtration Aluminum Dissolved				2022/05/25		2022/05/25
Lab Filtration mercury				2022/05/25		2022/05/25

Certified By:

Iris Veraestegui



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

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CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: Highway 9, Brockton ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2022-05-18

DATE REPORTED: 2022-05-27

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.
3874310-3874314 Dilution required, RDL has been increased accordingly.
Un-ionized Ammonia detection limit is a calculated RDL. The calculation of Un-ionized Ammonia is based on lab measured parameters (ammonia as N, pH and temperature). Values are reported as calculated.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Iris Veraistegui



Exceedance Summary

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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TEL (905)712-5100
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CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Rod de Castro

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
3874310	C6-02	ON PWQO	Dissolved Metals in Water (mg/L)	Dissolved Copper	mg/L	0.005	0.006
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Cobalt	mg/L	0.0009	0.0053
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Copper	mg/L	0.005	0.018
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Iron	mg/L	0.3	14.1
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Vanadium	mg/L	0.006	0.020
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Zinc	mg/L	0.030	0.046
3874310	C6-02	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Zirconium	mg/L	0.004	0.005
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Cobalt	mg/L	0.0009	0.0118
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Copper	mg/L	0.005	0.045
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Iron	mg/L	0.3	24.8
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Nickel	mg/L	0.025	0.039
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Silver	mg/L	0.0001	0.0021
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Thallium	mg/L	0.0003	0.0004
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Tungsten	mg/L	0.030	0.034
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Uranium	mg/L	0.005	0.007
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Vanadium	mg/L	0.006	0.054
3874314	C8-03	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Zinc	mg/L	0.030	0.112



Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

PROJECT: WR 3020-E-0004

SAMPLING SITE: Highway 9, Brockton ON

AGAT WORK ORDER: 22T896882

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Soil Analysis

RPT Date: May 27, 2022			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	3875821		42	42	0.4%	< 2	94%	70%	130%	104%	80%	120%	105%	70%	130%
Sulphate (2:1)	3875821		389	394	1.4%	< 2	95%	70%	130%	101%	80%	120%	NA	70%	130%
pH (2:1)	3865809		8.19	8.18	0.1%	NA	96%	80%	120%						
Electrical Conductivity (2:1)	3865809		0.174	0.174	0.2%	< 0.005	96%	80%	120%						
Redox Potential 1	3874389						100%	90%	110%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.

Certified By: _____



Nivine Basily

Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

PROJECT: WR 3020-E-0004

SAMPLING SITE: Highway 9, Brockton ON

AGAT WORK ORDER: 22T896882

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Water Analysis															
RPT Date: May 27, 2022			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

(Water) Inorganic Chemistry

pH	3869835		7.35	7.36	0.1%	NA	102%	90%	110%						
Electrical Conductivity	3869835		281	282	0.4%	< 2	103%	90%	110%						
Chloride	3874310	3874310	399	391	2.0%	< 0.10	93%	70%	130%	101%	80%	120%	NA	70%	130%
Sulphate	3874310	3874310	23400	22700	3.1%	< 100	97%	70%	130%	102%	80%	120%	100%	70%	130%

Redox in water

Redox Potential	3874272	3874272	133	122	8.6%	NA	100%	90%	110%						
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Water Quality Assessment - PWQO (mg/L)

Electrical Conductivity	3869835		281	282	0.4%	< 2	103%	90%	110%						
pH	3869835		7.35	7.36	0.1%	NA	102%	90%	110%						
Total Dissolved Solids	3866735		450	454	0.9%	< 10	102%	80%	120%						
Alkalinity (as CaCO3)	3869835		88	89	1.1%	< 5	87%	80%	120%						
Bicarbonate (as CaCO3)	3869835		88	89	1.1%	< 5	NA								
Carbonate (as CaCO3)	3869835		<5	<5	NA	< 5	NA								
Hydroxide (as CaCO3)	3869835		<5	<5	NA	< 5	NA								
Fluoride	3874310	3874310	<0.05	<0.05	NA	< 0.05	109%	70%	130%	102%	80%	120%	107%	70%	130%
Chloride	3874310	3874310	399	391	2.0%	< 0.10	93%	70%	130%	101%	80%	120%	NA	70%	130%
Nitrate as N	3874310	3874310	0.88	0.88	0.0%	< 0.05	97%	70%	130%	102%	80%	120%	100%	70%	130%
Nitrite as N	3874310	3874310	<0.05	<0.05	NA	< 0.05	97%	70%	130%	102%	80%	120%	104%	70%	130%
Bromide	3874310	3874310	<0.06	<0.06	NA	< 0.05	108%	70%	130%	101%	80%	120%	100%	70%	130%
Sulphate	3874310	3874310	23.4	22.7	3.0%	< 0.10	97%	70%	130%	102%	80%	120%	100%	70%	130%
Ortho Phosphate as P	3874310	3874310	<0.13	<0.13	NA	< 0.10	95%	70%	130%	93%	80%	120%	93%	70%	130%
Ammonia as N	3867074		<0.02	<0.02	NA	< 0.02	101%	70%	130%	100%	80%	120%	110%	70%	130%
Total Phosphorus	3868914		<0.02	<0.02	NA	< 0.02	102%	70%	130%	99%	80%	120%	97%	70%	130%
Total Organic Carbon	3869835		2.1	2.2	NA	< 0.5	100%	90%	110%	93%	90%	110%	84%	80%	120%
True Colour	3866735		<5.00	<5.00	NA	< 5	98%	90%	110%						
Turbidity	3873125		3.0	3.0	0.0%	< 0.5	100%	80%	120%						
Total Calcium	3873629		88.5	85.4	3.6%	< 0.10	94%	70%	130%	95%	80%	120%	99%	70%	130%
Total Magnesium	3873629		25.6	24.9	2.8%	< 0.10	93%	70%	130%	95%	80%	120%	101%	70%	130%
Total Potassium	3873629		3.11	3.25	4.4%	< 0.50	94%	70%	130%	96%	80%	120%	99%	70%	130%
Total Sodium	3873629		13.3	12.9	3.1%	< 0.10	95%	70%	130%	95%	80%	120%	102%	70%	130%
Aluminum-dissolved	3874310	3874310	0.004	0.004	NA	< 0.004	91%	70%	130%	115%	80%	120%	117%	70%	130%
Total Antimony	3873629		<0.001	<0.001	NA	< 0.001	98%	70%	130%	100%	80%	120%	86%	70%	130%
Total Arsenic	3873629		<0.003	<0.003	NA	< 0.003	97%	70%	130%	90%	80%	120%	89%	70%	130%
Total Barium	3873629		0.027	0.027	0.0%	< 0.002	97%	70%	130%	101%	80%	120%	90%	70%	130%
Total Beryllium	3873629		<0.001	<0.001	NA	< 0.001	96%	70%	130%	91%	80%	120%	94%	70%	130%
Total Boron	3873629		0.015	0.016	NA	< 0.010	101%	70%	130%	101%	80%	120%	95%	70%	130%
Total Cadmium	3873629		<0.0001	0.0007	NA	< 0.0001	96%	70%	130%	99%	80%	120%	89%	70%	130%
Total Chromium	3873629		<0.003	<0.003	NA	< 0.003	101%	70%	130%	103%	80%	120%	91%	70%	130%

Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

ATTENTION TO: Rod de Castro

SAMPLING SITE: Highway 9, Brockton ON

SAMPLED BY: GA

Water Analysis (Continued)

RPT Date: May 27, 2022			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Cobalt	3873629		<0.0005	<0.0005	NA	< 0.0005	97%	70%	130%	94%	80%	120%	91%	70%	130%
Total Copper	3873629		0.003	0.002	NA	< 0.001	99%	70%	130%	104%	80%	120%	89%	70%	130%
Total Iron	3873629		0.020	0.031	NA	< 0.010	100%	70%	130%	94%	80%	120%	93%	70%	130%
Total Lead	3873629		<0.001	<0.001	NA	< 0.001	95%	70%	130%	87%	80%	120%	83%	70%	130%
Total Manganese	3873629		0.003	0.003	NA	< 0.002	96%	70%	130%	93%	80%	120%	90%	70%	130%
Dissolved Mercury	3892445		<0.0001	<0.0001	NA	< 0.0001	98%	70%	130%	97%	80%	120%	94%	70%	130%
Total Molybdenum	3873629		<0.002	<0.002	NA	< 0.002	99%	70%	130%	96%	80%	120%	95%	70%	130%
Total Nickel	3873629		<0.003	<0.003	NA	< 0.003	93%	70%	130%	95%	80%	120%	95%	70%	130%
Total Selenium	3873629		<0.002	<0.002	NA	< 0.002	102%	70%	130%	97%	80%	120%	94%	70%	130%
Total Silver	3873629		<0.0001	<0.0001	NA	< 0.0001	97%	70%	130%	96%	80%	120%	92%	70%	130%
Total Strontium	3873629		0.120	0.123	2.5%	< 0.005	92%	70%	130%	92%	80%	120%	87%	70%	130%
Total Thallium	3873629		<0.0003	<0.0003	NA	< 0.0003	90%	70%	130%	93%	80%	120%	91%	70%	130%
Total Tin	3873629		<0.002	<0.002	NA	< 0.002	92%	70%	130%	83%	80%	120%	79%	70%	130%
Total Titanium	3873629		<0.010	<0.010	NA	< 0.010	97%	70%	130%	92%	80%	120%	91%	70%	130%
Total Tungsten	3873629		<0.010	<0.010	NA	< 0.010	86%	70%	130%	86%	80%	120%	80%	70%	130%
Total Uranium	3873629		<0.002	<0.002	NA	< 0.002	90%	70%	130%	93%	80%	120%	89%	70%	130%
Total Vanadium	3873629		<0.002	<0.002	NA	< 0.002	97%	70%	130%	93%	80%	120%	93%	70%	130%
Total Zinc	3873629		0.039	0.055	NA	< 0.020	101%	70%	130%	99%	80%	120%	88%	70%	130%
Total Zirconium	3873629		<0.004	<0.004	NA	< 0.004	100%	70%	130%	103%	80%	120%	90%	70%	130%
Dissolved Metals in Water (mg/L)															
Dissolved Aluminum	3873125		0.044	0.045	2.2%	< 0.004	95%	70%	130%	101%	80%	120%	98%	70%	130%
Dissolved Antimony	3873125		<0.001	<0.001	NA	< 0.001	101%	70%	130%	97%	80%	120%	97%	70%	130%
Dissolved Arsenic	3873125		<0.001	<0.001	NA	< 0.001	96%	70%	130%	90%	80%	120%	98%	70%	130%
Dissolved Barium	3873125		0.049	0.049	0.0%	< 0.002	98%	70%	130%	100%	80%	120%	98%	70%	130%
Dissolved Beryllium	3873125		<0.0005	<0.0005	NA	< 0.0005	100%	70%	130%	94%	80%	120%	112%	70%	130%
Dissolved Bismuth	3873125		<0.002	<0.002	NA	< 0.002	94%	70%	130%	101%	80%	120%	99%	70%	130%
Dissolved Boron	3873125		0.019	0.018	NA	< 0.010	101%	70%	130%	100%	80%	120%	109%	70%	130%
Dissolved Cadmium	3873125		<0.0001	<0.0001	NA	< 0.0001	100%	70%	130%	95%	80%	120%	100%	70%	130%
Dissolved Chromium	3873125		<0.002	<0.002	NA	< 0.002	98%	70%	130%	99%	80%	120%	98%	70%	130%
Dissolved Cobalt	3873125		<0.0005	<0.0005	NA	< 0.0005	96%	70%	130%	108%	80%	120%	96%	70%	130%
Dissolved Copper	3873125		0.003	0.003	NA	< 0.001	100%	70%	130%	97%	80%	120%	95%	70%	130%
Dissolved Iron	3873125		0.054	0.052	3.8%	< 0.010	93%	70%	130%	109%	80%	120%	100%	70%	130%
Dissolved Lead	3873125		0.0006	0.0005	NA	< 0.0005	98%	70%	130%	98%	80%	120%	96%	70%	130%
Dissolved Manganese	3873125		0.005	0.004	NA	< 0.002	95%	70%	130%	110%	80%	120%	98%	70%	130%
Dissolved Molybdenum	3873125		<0.002	<0.002	NA	< 0.002	100%	70%	130%	104%	80%	120%	100%	70%	130%
Dissolved Nickel	3873125		<0.001	<0.001	NA	< 0.001	96%	70%	130%	107%	80%	120%	98%	70%	130%
Dissolved Phosphorus	3873125		<0.05	<0.05	NA	< 0.05	108%	70%	130%	91%	80%	120%	88%	70%	130%
Dissolved Selenium	3873125		<0.001	<0.001	NA	< 0.001	98%	70%	130%	85%	80%	120%	97%	70%	130%
Dissolved Silver	3873125		<0.0001	<0.0001	NA	< 0.0001	94%	70%	130%	106%	80%	120%	93%	70%	130%



Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

ATTENTION TO: Rod de Castro

SAMPLING SITE: Highway 9, Brockton ON

SAMPLED BY: GA

Water Analysis (Continued)

RPT Date: May 27, 2022			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Dissolved Silicon	3873125		3.47	3.33	4.1%	< 0.05	95%	70%	130%	93%	80%	120%	99%	70%	130%
Dissolved Strontium	3873125		0.159	0.171	7.3%	< 0.005	96%	70%	130%	109%	80%	120%	97%	70%	130%
Dissolved Thallium	3873125		<0.0003	<0.0003	NA	< 0.0003	99%	70%	130%	101%	80%	120%	99%	70%	130%
Dissolved Tin	3873125		<0.002	<0.002	NA	< 0.002	93%	70%	130%	94%	80%	120%	90%	70%	130%
Dissolved Titanium	3873125		<0.002	<0.002	NA	< 0.002	101%	70%	130%	102%	80%	120%	101%	70%	130%
Dissolved Uranium	3873125		<0.0005	<0.0005	NA	< 0.0005	92%	70%	130%	100%	80%	120%	98%	70%	130%
Dissolved Vanadium	3873125		<0.002	<0.002	NA	< 0.002	97%	70%	130%	110%	80%	120%	100%	70%	130%
Dissolved Zinc	3873125		0.042	0.042	0.0%	< 0.005	101%	70%	130%	95%	80%	120%	102%	70%	130%
Dissolved Zirconium	3873125		<0.004	<0.004	NA	< 0.004	98%	70%	130%	100%	80%	120%	98%	70%	130%
(Water) TSS, CrVI															
Total Suspended Solids	3866685		<10	<10	NA	< 10	98%	80%	120%						
Chromium VI	3876843		<0.001	<0.001	NA	< 0.001	100%	70%	130%	103%	80%	120%	110%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.

Certified By:

Iris Veraestegui

Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

ATTENTION TO: Rod de Castro

SAMPLING SITE: Highway 9, Brockton ON

SAMPLED BY: GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Electrical Conductivity	INOR-93-6000	modified from SM 2510 B	PC TITRATE
Resistivity		SM 2510 B	EC METER
Chloride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Total Suspended Solids	INOR-93-6028	modified from EPA 1684, ON MOECC E3139, SM 2540C,D	BALANCE
Chromium VI	INOR-93-6073	modified from SM 3500-CR B	LACHAT FIA
Dissolved Aluminum	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Antimony	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Arsenic	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Barium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Beryllium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Bismuth	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Boron	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Cadmium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Chromium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Cobalt	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Copper	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Iron	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Lead	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Manganese	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Molybdenum	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Nickel	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Phosphorus	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Selenium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Silver	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Silicon	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Strontium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Thallium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Tin	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Dissolved Titanium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Uranium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Vanadium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Zinc	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Zirconium	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Sodium Adsorption Ratio (Calculated)		McKeague 3.26 & EPA SW-846 6010B	CALCULATION
Redox Potential		SM 2580 B	REDOX POTENTIAL ELECTRODE
Saturation pH (Calculated)		SM 2320 B	CALCULATION
Langelier Index (Calculated)		SM 2330B	CALCULATION
Hardness (as CaCO ₃) (Calculated)	MET-93-6105	modified from EPA SW-846 6010C & 200.7 & SM 2340 B	CALCULATION
Total Dissolved Solids	INOR-93-6028	modified from EPA 1684, ON MOECC E3139, SM 2540C, D	BALANCE
Alkalinity (as CaCO ₃)	INOR-93-6000	Modified from SM 2320 B	PC TITRATE
Bicarbonate (as CaCO ₃)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Carbonate (as CaCO ₃)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Hydroxide (as CaCO ₃)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Ortho Phosphate as P	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	modified from SM 4500-NH ₃ H	LACHAT FIA
Ammonia-Un-ionized (Calculated)		MOE REFERENCE, PWQOs Tab 2	CALCULATION
Total Phosphorus	INOR-93-6022	modified from SM 4500-P B and SM 4500-P E	SPECTROPHOTOMETER
Total Organic Carbon	INOR-93-6049	modified from SM 5310 B	SHIMADZU CARBON ANALYZER
True Colour	INOR-93-6074	modified from SM 2120 B	LACHAT FIA
Turbidity	INOR-93-6044	modified from SM 2130 B	NEPHELOMETER
Total Calcium	MET-93-6105	modified from EPA 6010D	ICP/OES
Total Magnesium	MET-93-6105	modified from EPA 6010D	ICP/OES
Total Potassium	MET-93-6105	modified from EPA 6010D	ICP/OES
Total Sodium	MET-93-6105	modified from EPA 6010D	ICP/OES
Aluminum-dissolved	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Total Antimony	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Arsenic	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Barium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Beryllium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Boron	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Cadmium	MET -93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Chromium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS



Method Summary

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AGAT WORK ORDER: 22T896882

PROJECT: WR 3020-E-0004

ATTENTION TO: Rod de Castro

SAMPLING SITE: Highway 9, Brockton ON

SAMPLED BY: GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Cobalt	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Copper	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Iron	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Lead	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Manganese	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Dissolved Mercury	MET-93-6100	modified from EPA 245.2 and SM 3112 B	CVAAS
Total Molybdenum	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Nickel	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Selenium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Silver	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Strontium	INOR-93-6003	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Thallium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Tin	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Titanium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Tungsten	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Uranium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Vanadium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zinc	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zirconium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Lab Filtration Aluminum Dissolved	SR-78-9001		FILTRATION
Lab Filtration mercury	SR-78-9001		FILTRATION

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Thurber Engineering Ltd
Contact: Rod de Castro
Address: 2010 Winston Park Drive Unit 103
Oakville ON L6H 5R7
Phone: 647.525.3710 Fax: _____
Reports to be sent to:
1. Email: rod.decastro@thurber.ca
2. Email: _____

Regulatory Requirements:

(Please check all applicable boxes)

- ☐ Regulation 153/04 ☐ Excess Soils R406 ☐ Sewer Use
☐ Ind/Com ☐ Sanitary ☐ Storm
☐ Res/Park ☐ Agriculture ☐ Region
☐ CCME ☐ Prov. Water Quality Objectives (PWQO)
☐ Other
Soil Texture (Check One) ☐ Coarse ☐ Fine

Is this submission for a Record of Site Condition?

☐ Yes ☐ No

Report Guideline on Certificate of Analysis

☐ Yes ☐ No

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Project Information:

Project: WR 3020-E-0004
Site Location: Highway 9, Buckton ON
Sampled By: GA
AGAT ID #: _____ PO: _____
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐

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

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/Special Instructions	Y/N	Field Filtered - Metals	Hg	Cu	DOC	O. Reg 153	O. Reg 558	O. Reg 406	Landfill Disposal Characterization TCLP	Excess Soils SPLP Rainwater Leach	Excess Soils Characterization Package	pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	PWQO (as per email)	Conductivity (as per email)	Concentration	Potentially Hazardous or High Concentration (Y/N)
22-01	16/5/22	11:45 AM	5	GW	5 bottles + 2 vials	Y																
22-02	16/5/22	11:45 AM	5	GW	5 bottles + 2 vials	Y																
C6-02	16/5/22	18:15 PM	5	GW	+ 8 bottles + 2 vials	Y																
C8-03	16/5/22	14:00 PM		GW	13 bottles + 4 vials	Y																
Garnock Creek	16/5/22	19:30 PM			5 bottles + 2 vials	Y																
C6-01 SS 7.15-13'	16/5/22		1	Soil																		
C6-01 SS 10.25-24'	16/5/22		1	Soil																		
C8-01 SS 9.10-20'	17/5/22		1	Soil																		
C8-01 SS 11.25-24'	17/5/22		1	Soil																		

Samples Relinquished By (Print Name and Sign): <u>Stephane Lorange</u>	Date: <u>May 18/22</u>	Time: <u>9:40am</u>	Samples Received By (Print Name and Sign): <u>Armando Lora</u>	Date: <u>5/18/22</u>	Time: <u>11:22AM</u>
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date:	Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date:	Time:

Page _____ of _____
Nº: **T 123748**

Laboratory Use Only

Work Order #: 22T896882
Cooler Quantity: 1 Kg (Bureau)
Arrival Temperatures: 6.8 17.9 18.4
Custody Seal Intact: ☒ Yes ☐ No ☐ N/A
Notes: Bagged Ice

Turnaround Time (TAT) Required:

Regular TAT (Most Analysis) ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM



THURBER ENGINEERING LTD.

Slug Test Analysis Report

Project: Grennock Creek Bridge

Number: 33249

Client: Ministry of Transportation of Ontario (MTO)

Location: Walkerton, Ontario

Slug Test: C8-03

Test Well: C8-03

Test Conducted by: GA

Test Date: 2022-05-17

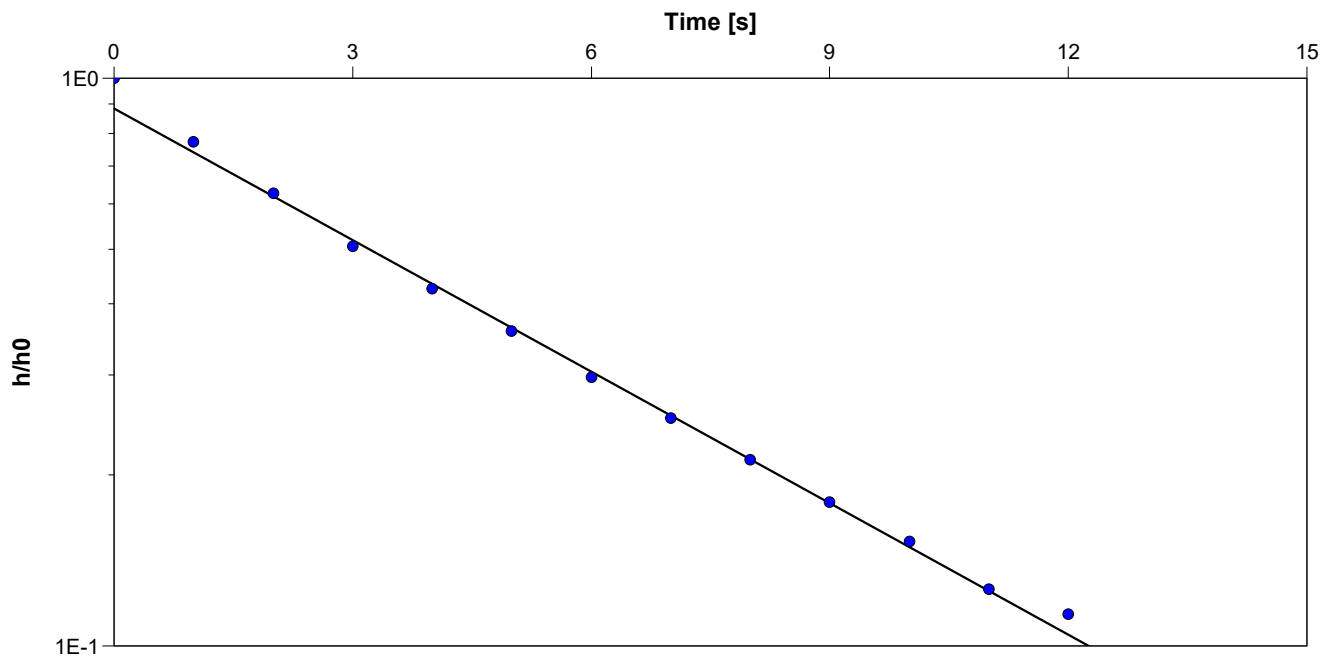
Analysis Performed by: ES

C8-03 SWRT Analysis

Analysis Date: 2022-06-09

Aquifer Thickness:

Checked By: AH



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

C8-03

1.6×10^{-4}



Appendix C
Site and Bedrock
Core Photographs



Photograph #1 – Looking East – C8 Culvert and North Embankment



Photograph #2 – Looking West – C8 Culvert and South Embankment



Photograph #3 – Bedrock Core Samples for Borehole C8-01

Run No. 1 – 9.1 m to 10.7 m

Run No. 2 – 10.7 m to 12.2 m



Photograph #5 – Bedrock Core Samples for Borehole C8-02

Run No. 1 – 1.4 m to 1.6 m

Run No. 2 – 1.6 m to 3.1 m

Run No. 3 – 3.1 m to 4.6 m

Run No. 4 – 4.6 m to 4.9 m



Photograph #6 – Bedrock Core Samples for Borehole C8-03

Run No. 1 – 2.6 m to 3.8 m

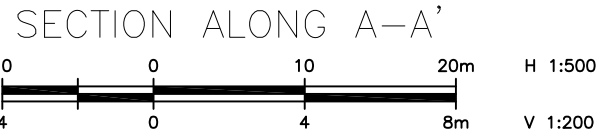
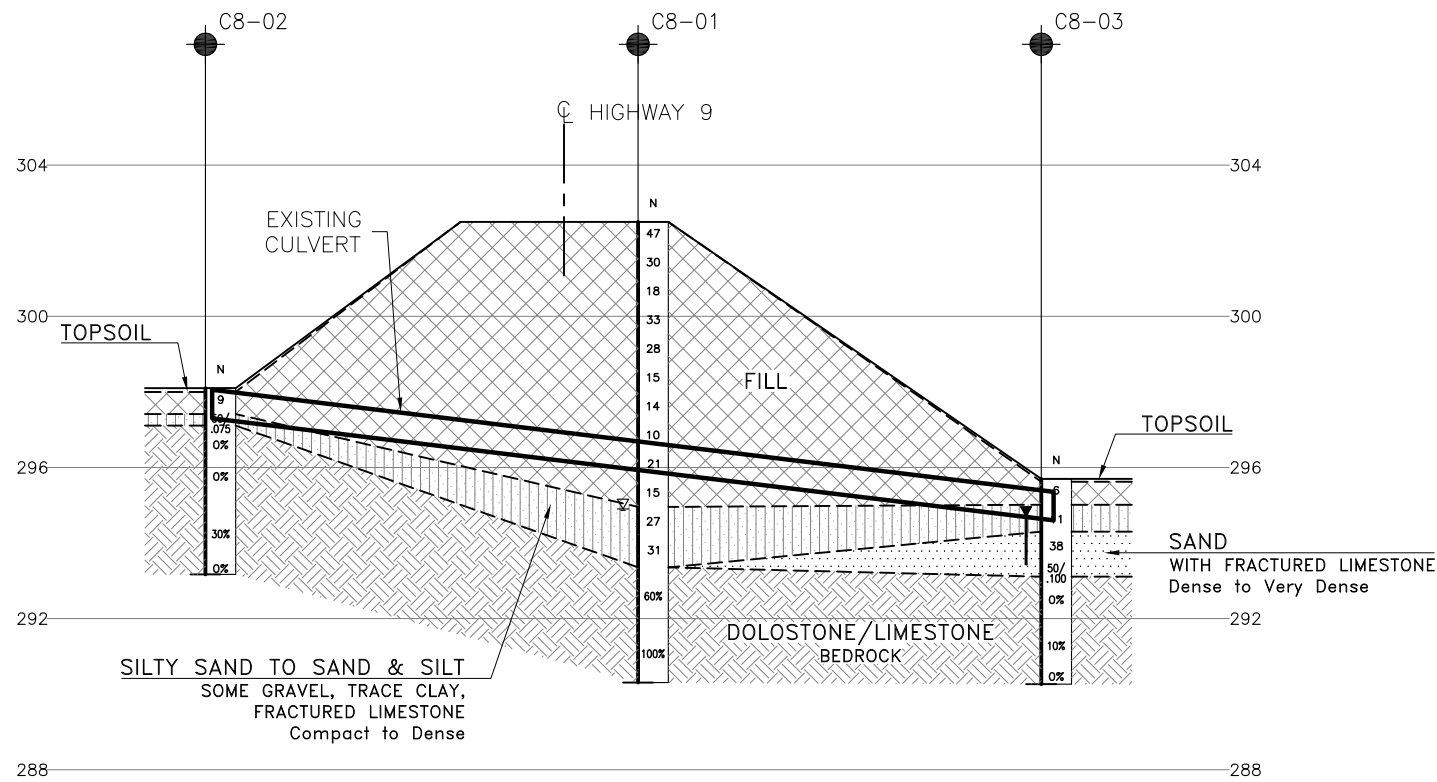
Run No. 2 – 3.8 m to 5.0 m

Run No. 3 – 5.0 m to 5.4 m



Appendix D

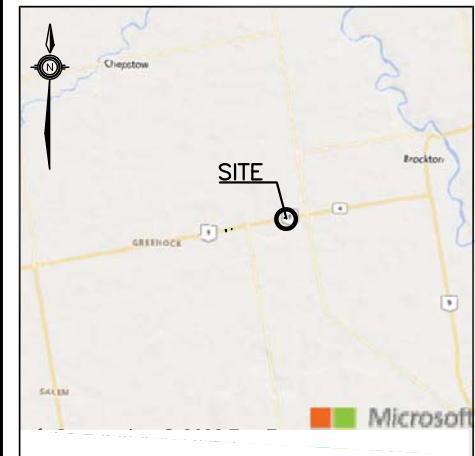
Borehole Locations and Soil Strata Drawing



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



CONT No		
WP No		
HIGHWAY 9 CULVERT C8 REHABILITATED BOREHOLE LOCATIONS AND SOIL STRATA		



KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (Previous Investigation)
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
C8-01	302.5	4 886 774.0	168 216.7
C8-02	298.1	4 886 802.6	168 212.2
C8-03	295.7	4 886 747.3	168 213.9

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 42A-254

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	Rdc	CHK PKC	CODE
DRAWN	AN	CHK Rdc	SITE
			LOAD
			DATE JUN 22
			STRUCT
			DWG 1