THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
WATABEAG RIVER BRIDGE REPLACEMENT
WATABEAG LAKE ROAD, TOWNSHIP OF MCEVAY
NEW LISKEARD DISTRICT, ONTARIO
W.P 5026-14-01, SITE NO. 47-068

GEOCRES No. 42A-111

Report

to

MMM Group Limited

Date: January 24, 2017
File: 19-5161-252

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the existing Watabeag River Bridge carrying Watabeag Lake Road over the river, in the Township of McEvay, New Liskeard District, Ontario.

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

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 5014-E-0024.

2. SITE DESCRIPTION

The existing Watabeag River Bridge is located on Watabeag Lake Road, approximately 46.1 km north of Highway 66 and 28.7 km south of Highway 11, in the Township of McEvay. The local road runs generally in the north-south direction.

The existing bridge built in 1975 is a single span, single lane timber deck structure approximately 12 m in length. The superstructure is supported by closed faced timber cribs. Watabeag River flows from east to west at the bridge location and discharges into Lake Watabeag. In the vicinity of the existing bridge, the river banks are between 2.5 m and 3 m in height. The land on both sides of the river is densely vegetated with trees, shrubs and grass.

The bridge is supported on timber crib abutments. Deterioration of the timber forming the cribs was evident predominantly at the contact with the river water. Erosion of the river banks at the bridge location, including over-steepening/erosion of the front slopes at the abutments and

undermining/loss of ground below the timber cribs can be observed on the photographs enclosed in Appendix C.

Based on published geological information, the general area of the project is covered by glacial outwash deposits of silts, sands and gravel along ridges/eskers reflecting the subglacial drainage. The outwash deposits are underlain by Precambrian mafic to intermediate metavolcanic bedrock.

3. INVESTIGATION PROCEDURES

The field investigation program for this project was carried out between September 8 and September 21, 2016. The program consisted of drilling and sampling four (4) boreholes numbered 16-01 to 16-04. Boreholes 16-01 and 16-02 were drilled at the north and south abutments to depths of 24.9 m and 15.8 m, respectively. Boreholes 16-03 and 16-04 were located within the south and north approach embankments and both boreholes were drilled to 11.3 m depth. The approximate locations of all completed boreholes are shown on the attached Borehole Locations and Soil Strata Drawing enclosed in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling operations. The ground surface elevations for the boreholes were derived from the Preliminary General Arrangement drawing provided to Thurber by MMM. The borehole locations were tied in to the existing bridge features, and elevations related to a local datum were obtained from the General Arrangement Plan.

Track-mounted CME 45 drill rig was used to drill the boreholes. The boreholes were advanced using NW casing/wash boring techniques. An NQ core barrel was used to penetrate through cobbles and boulders in all boreholes, where encountered. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures, as per ASTM D-1586-99.

The drilling and sampling operations were supervised on a full time basis by members 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.

Groundwater conditions in the open boreholes were observed throughout the drilling operations and in open boreholes after completion of drilling. The groundwater level observations may not be representative of the site conditions, as water was used during wash boring operations and coring to advance boreholes through the encountered cobbles and boulders. The boreholes were

backfilled in general accordance with MOE Regulation 903 (amended by Ontario Reg. 372). Completion details of the piezometers and borehole are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole Number	Borehole Depth/Base Elev. (m)	Completion Details
North Approach	16-04	11.3 / 82.3	Bentonite holeplug to surface.
North Abutment	16-01	24.9 / 67.8	Bentonite holeplug from 10.7 m to surface.
South Abutment	16-02	15.8 / 76.3	Bentonite holeplug to surface.
South Approach	16-03	11.3 / 81.3	Bentonite holeplug and cuttings to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer). All laboratory tests were carried out to MTO and / or ASTM Standards, as appropriate. The results of the geotechnical laboratory program are summarized on the Record of Borehole sheets included in Appendix A and on figures presented 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 samples of the native sand, and a sample of surface water from the creek upstream of the bridge were collected. The samples were submitted to SGS Laboratories in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate. The results of the analytical testing are summarized in Section 6 below and the Certificates of the Analysis are enclosed 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 in these sheets and on the “Borehole Locations and Soil Strata” drawing included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. The factual data presented on the Record of Borehole sheets take precedence over this general description and should be used for interpretation of the site

conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In summary, the embankment fill at this site overlies an extensive cohesionless deposit varying in composition from sand to sand and gravel and containing occasional to frequent cobbles and boulders. The cohesionless deposit was encountered to a depth of as much as 24.9 m investigated in the boreholes.

It was noted that numerous cobbles and boulders were exposed in Watabeag River bed, indicating that the river is cutting through very coarse deposits.

Water level in the Watabeag River was indicated on the Preliminary General Arrangement drawing at Elev. 90.2 on June 9, 2015.

As pointed out in Section 3 of this report, all quoted elevations in this report, refer to local datum.

5.1 Embankment Fill

Embankment fill as much as 2.7 m thick was encountered extending from ground surface in all drilled boreholes. The embankment fill comprised sand and gravel, with trace to some silt, trace organic matter and occasional cobbles and boulders. A 0.8 m layer of sand fill was encountered in Borehole 16-02 overlying the sand and gravel fill. The thickness of the fill near the abutments ranged from 2.1 m to 2.7m decreasing to 1.5 m some distance away within the approaches. The underside of the fill was encountered between Elev. 90.0 at the abutments, and as high as Elev. 92.1 within the approaches.

SPT N-values measured in the fill ranged from 5 blows per 0.3 m penetration to 27 blows per 0.3 m penetration, indicating a loose to compact relative density. One recorded SPT ‘N’ value of 56 blows per 0.3 m penetration in Borehole 16-03 was probably indicative of the presence of cobble or boulder. The measured water contents of fill samples ranged from 3% to 22%.

The results of grain size analyses conducted on samples of the fill are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figures B1 and B2 of Appendix B. The results are summarized in the following table.

Soil Particle	Sand Fill	Sand and Gravel Fill
	Percentage (%)	
Gravel	11	35 to 46
Sand	80	48 to 57
Silt and Clay	9	6 to 8

5.2 Upper Sand

Immediately underlying the embankment fill in Boreholes 16-01, 16-03 and 16-04 was a layer of sand with trace gravel and trace to some silt. The sand layer was 0.8 m to 1.0 m thick and extended to depths ranging from 2.3 m to 3.7 m. The underside of the sand was encountered between Elev. 89.0 in Borehole 16-01 and Elev. 91.3 in Borehole 16-04.

SPT 'N' values obtained in the sand ranged from 7 blows for 0.3 m penetration to 45 blows per 0.3 m penetration, indicating a loose to dense relative density. The measured water contents of sand samples ranged from 10% to 15%.

5.3 Upper Gravelly Sand to Sand and Gravel

Underlying the upper sand layer, and the fill material in Borehole 16-02, was a layer of gravelly sand to sand and gravel with trace silt. Cobbles and boulders were encountered in this deposit, which required coring to advance the boreholes, as noted on the Record of Borehole sheets. This deposit varied in thickness from 1.6 m to 5.3 m. The underside of the gravelly sand to sand and gravel was encountered between 3.7 m depth (Elev.88.4) in Borehole 16-02 to 7.6 m depth (Elev. 86.0) in Borehole 16-04. SPT N-values measured in the upper gravelly sand and sand and gravel generally ranged from 16 blows per 0.3 m penetration to 58 blows per 0.3 m penetration, indicating a compact to very dense relative density. One sample in Borehole 16-01 recorded 8 blows per 0.3 m of penetration, indicating a "pocket" of loose sand. The results of grain size analysis conducted on a sample of the upper sand and gravel are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figures B3 of Appendix B. The results are summarized in the following table.

Soil Particle	Percentage (%)
Gravel	51
Sand	42
Silt and Clay	7

The measured water contents of sand samples ranged from 7% to 19%.

5.4 Lower Sand

Another cohesionless deposit labelled as a lower sand underlies the gravelly sand and sand and gravel in all boreholes. The sand deposit contained trace to some gravel and trace to some silt. Cobbles and boulders were encountered in this deposit and had to be cored to advance the boreholes. Where penetrated in Boreholes 16-01 to 16-03, the deposit was 1.5 m to 2.3 m in thickness with the underside between a depth of 5.6 m (Elev.86.5) and 8.4 m (Elev.84.3). Borehole 16-04 was terminated in the lower sand at a depth of 11.3 m (Elev. 82.3).

Another sand layer was encountered beneath a 1.5 m of compact gravelly sand in Borehole 16-03. This layer extended from a depth of 7.6 m (Elev. 85.0) to the base of Borehole 16-03 at a depth of 11.3 m (Elev. 81.3).

SPT 'N' values obtained in the lower sand ranged from 2 blows for 0.3 m penetration to 35 blows per 0.3 m penetration, indicating a very loose to dense relative density.

Samples of the lower sand were subjected to the grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown on Figure B4 of Appendix B.

Soil Particles	%
Gravel	0 to 5
Sand	79 to 99
Silt & Clay	1 to 16

Measured moisture contents ranged from 11% to 23%.

5.5 Lower Sand and Gravel to Gravelly Sand

A coarse cohesionless deposit ranging in composition from sand and gravel to gravelly sand was encountered at depths in Boreholes 16-01 to 16-03. This deposit contained trace silt and frequent cobbles and boulders, which required coring to advance the boreholes. The boulders encountered in the boreholes were up to 350 mm in size.

In Boreholes 16-01 and 16-02, the sand and gravel underlies the lower sand below depths of 8.4 m (Elev. 84.3) and 5.6 m (Elev. 86.5), respectively, and extends to the base of the boreholes at depths of 24.9 m (Elev. 67.8) and 15.8 m (Elev. 76.3). Zones of sandy gravel were observed in

the deposit. A 1.5 m thick layer of gravelly sand was encountered in Borehole 16-03 extending below 6.1 m depth (Elev. 86.5) within the lower sand.

SPT 'N' values obtained in the lower sand and gravel to gravelly sand ranged from 20 blows for 0.3 m penetration to in excess of 100 blows per 0.3 m penetration, indicating a compact to very dense relative density, typically being compact to dense. The SPT 'N' values above 100 blows per 0.3 m of penetration are considered to be indicative of the presence of cobbles and boulders.

Samples of the lower sand and gravel to gravelly sand underwent grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown on Figure B5 of Appendix B.

Soil Particles	%
Gravel	48 to 66
Sand	34 to 51
Silt & Clay	0 to 4

Measured moisture contents ranged from 10% to 19%.

5.6 Groundwater Conditions

Where possible, water levels were monitored in the open boreholes during drilling operations. Wash boring and/or coring methods were used to advance all boreholes and therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater levels. The water levels observed upon completion of drilling are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
16-01	September 11, 2016	- 0.6 [1)]	93.3	Open Borehole
16-02	N/A	N/A	-	Not Available
16-03	September 20, 2016	2.4	90.2	Open Borehole
16-04	September 21, 2016	2.7	90.9	Open Borehole

Note: [1)] Upon completion of drilling, the water level in the casing was observed at 0.6 m above the ground. This was a short term observation and may be due to an upward groundwater gradient or possible the effects of the circulating fluid used in drilling. The borehole was sealed with the bentonite on completion of drilling.

The recorded levels are short-term readings and seasonal fluctuations of the groundwater and river level are to be expected. In particular, the water level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The Preliminary General Arrangement drawing provided by MMM Group indicated water level in Watabeag River at Elev. 90.2 0n June 9, 2015.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Two samples of the native sand and a sample of surface water from the Watabeag River were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are summarized in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results		
			Soil Samples		Watabeag River Water
			BH 16-02, Sample 7	BH 16-01, Sample 5	
Corrosivity Index	-	-	4	4	-
pH	-	-	8.26	8.09	7.84
Redox Potential	mV	mV	177	170	159
Sulphide	%	mg/L	<0.02	<0.02	<0.006
Moisture (wet wt)	%	%	15.77	11.43	-
pH	-	-	9.09	9.15	-
Chloride	µg/g	mg/L	1.3	2	0.34
Sulphate	µg/g	mg/L	13	12	2.7
Electrical Conductivity	mS/cm	µS/cm	67	64	144
Resistivity	ohms.cm	ohms.cm	14900	15600	696

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7. MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The ground surface elevations at the borehole locations were derived from the Preliminary General Arrangement drawing provided to Thurber by MMM. As indicated in Section 3 of this report, the elevations on the General Arrangement drawing were based on the local datum.

Thurber obtained utility clearances for the borehole locations prior to drilling. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET. The drilling operations were supervised by Mr. Omar Ali and Mr. Simon Paxton of Thurber. Eastern Ontario Diamond Drilling of Hawkesbury, Ontario, supplied a track-mounted CME-45 drill rig and conducted the drilling, sampling and in-situ testing operations.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was conducted by SGS Canada Inc.

Interpretation of the field data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng The report was reviewed by Mr. Alastair Gorman, M.Sc., P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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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

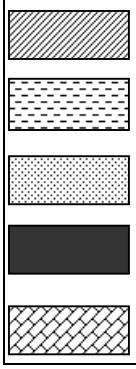
ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

Bedding	**Bedding Plane Spacing**
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length
Solid Core Recovery:(SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run
Rock Quality Designation:(RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a % 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			

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 16-01 1 OF 3 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY SMP

HWY Watabeag Road BOREHOLE TYPE HW/NW Casing COMPILED BY AN

DATUM Local DATE 2016.09.08 - 2016.09.11 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
92.7	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace to some silt, trace organics, occasional cobbles and boulders Loose to Compact Grey/Brown Moist (FILL)		1	SS	5		92	○	○		
			2	SS	6						
	Wood fragments at 1.5m		3	SS	7		91		○		
	Boulder (300mm) at 2.1m		4	SS	21		90		○		
90.0											
2.7	**SAND**, trace gravel, some silt Loose Grey Moist		5	SS	7		90		○		
89.0							89				
3.7	**SAND** and **GRAVEL**, trace silt Compact to Loose Grey Moist to Wet Cobble (150mm) at 3.8m		6	SS	16		88		○		
			7	SS	8		87		○		
86.6											
6.1	**SAND**, trace gravel, trace silt Loose Grey Moist		8	SS	9		86		○		0 98 2 (SI+CL)
	Cobbles/boulders at 7.3m		9	SS	9		85		○		
84.3											
8.4	**SAND** and **GRAVEL** to Sandy **GRAVEL**, trace silt, frequent cobbles and boulders Very Dense Grey						84				
							83				

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-01 2 OF 3 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY SMP

HWY Watabeag Road BOREHOLE TYPE HW/NW Casing COMPILED BY AN

DATUM Local DATE 2016.09.08 - 2016.09.11 CHECKED BY AMP

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
							82				
			10	SS	23				○		59 39 2 (SI+CL)
							81				
			11	SS	41				○		
	Cobbles/boulders 100mm at 12.8m, 300mm at 12.9m, 150mm at 13.1m and 300mm at 13.2m						80				
			12	SS	21		79		○		66 34 0 (SI+CL)
	Cobbles 100mm at 14.3m, 14.6m and 150mm at 14.9m						78				
	Frequent cobbles/boulders below 15.2m		13	SS	26				○		
	Cobbles/boulders 75mm at 15.8m, 350mm at 16.0m and 200mm at 16.5m						77				
			14	SS	20		76		○		
	Cobbles 50mm at 17.4m, 100mm at 17.5m, 150mm at 17.8m and 75mm at 18.0m						75				
			15	SS	50/ 0.0				○		61 36 3 (SI+CL)
	Cobbles 100mm at 18.6m, 200mm at 19.2.m and 100mm at 19.7m						74				
							73				

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-01 3 OF 3 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY SMP

HWY Watabeag Road BOREHOLE TYPE HW/NW Casing COMPILED BY AN

DATUM Local DATE 2016.09.08 - 2016.09.11 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × 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
	Continued From Previous Page		16	SS	56				○		
	Cobbles 75mm at 20.3m, 200mm at 20.6m and 21.0m						72				
	Cobbles/boulders 100mm at 21.6m, 21.8m, 200mm at 21.9, 100mm at 22.3m, 22.4m, 300mm at 22.6m and 125mm at 23.3m						71				
			17	SS	70/ 0.025		70				
							69				
67.8			18	SS	50/ 0.050		68		○		
24.9	END OF BOREHOLE AT 24.9m. WATER LEVEL AT 0.6m ABOVE GROUND SURFACE ON COMPLETION OF DRILLING. BENTONITE PLUG FROM 10.7m TO SURFACE.										

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

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

ONTMT4S 19-5161-252.GPJ 2015TEMPLATE(MTO).GDT 1/16/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-02 1 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY SMP

HWY Watabeag Road BOREHOLE TYPE HW/NW Casing COMPILED BY AN

DATUM Local DATE 2016.09.11 - 2016.09.13 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
92.1	GROUND SURFACE						92				
0.0	**SAND**, trace gravel, trace silt Loose Brown Moist (FILL)		1	SS	7				○		11 80 9 (SI+CL)
91.3											
0.8	**SAND** and **GRAVEL**, trace silt, occasional cobbles Compact Brown Moist (FILL)		2	SS	27		91		○		
			3	SS	19				○		
90.0							90				
2.1	Gravelly **SAND**, trace silt Dense Grey Moist to Wet		4	SS	35				○		
	Cobbles/boulders at 2.9m		5	SS	35		89				
88.4	Cobbles/boulders at 3.7m										
3.7	**SAND**, trace silt, trace gravel Very Loose Grey Moist to Wet		6	SS	2		88		○		
			7	SS	3				○		
86.5			8	SS	24		87		○		0 99 1 (SI+CL)
5.6	**SAND** and **GRAVEL** to Sandy **GRAVEL**, trace silt, frequent cobbles and boulders Compact to Very Dense Grey Moist to Wet		9	SS	37		86		○		48 51 1 (SI+CL)
	Cobbles/boulders at 6.7m, 6.9m, 7.0m and 7.3m						85				
			10	SS	26		84		○		
	Cobbles/boulders at 8.8m										
			11	SS	31		83		○		61 38 1 (SI+CL)
	Cobbles/boulders at 9.8m and 9.9m										

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-02 2 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY SMP

HWY Watabeag Road BOREHOLE TYPE HW/NW Casing COMPILED BY AN

DATUM Local DATE 2016.09.11 - 2016.09.13 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Cobbles/boulders at 10.4m						82				
			12	SS	26		81				
							80				
	Cobbles/boulders 150mm at 12.5m, 100mm at 12.6m, 150mm at 12.8m, 13.3m and 300mm at 13.4m		13	SS	21		79		○		
			14	SS	59		78		○		62 34 4 (SI+CL)
	Cobbles/boulders at 14.3m, 14.8m, 14.9m and 15.1m						77				
76.3			15	SS	57				○		
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-03 1 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY OA

HWY Watabeag Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Local DATE 2016.09.20 - 2016.09.20 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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
92.6	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, occasional cobbles Compact to Very Dense Brown Moist (FILL)		1	SS	20		92		○		46 48 6 (SI+CL)
			2	SS	56				○		
91.1							91				
1.5	**SAND**, some gravel, trace silt, occasional cobbles Dense Grey Moist		3	SS	45				○		
90.3							90		○		
2.3	Gravelly **SAND**, trace silt, occasional cobbles Compact Grey Moist		4	SS	22	▽					
			5	SS	22		89		○		
88.0							88				
4.6	**SAND**, some silt, trace gravel, occasional cobbles Loose Grey Moist		6	SS	8				○		5 79 16 (SI+CL)
86.5							87				
6.1	Gravelly **SAND**, trace silt, occasional cobbles Compact Grey Moist to Wet		7	SS	35		86		○		
85.0							85				
7.6	**SAND**, trace to some gravel, trace silt Loose to Compact Grey Moist to Wet		8	SS	7				○		
			9	SS	5		84				
							83		○		2 96 2 (SI+CL)

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-03 2 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY OA

HWY Watabeag Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Local DATE 2016.09.20 - 2016.09.20 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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
	Continued From Previous Page										
							82				
81.3			10	SS	14				○		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND WATER LEVEL AT 2.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-04 1 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY OA

HWY Watabeag Road BOREHOLE TYPE Coring COMPILED BY AN

DATUM Local DATE 2016.09.21 - 2015.09.21 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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
93.6	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, occasional cobbles Compact Grey Moist (FILL)		1	GS			93		○		35 57 8 (SI+CL)
92.1			1	SS	22				○		
1.5	**SAND**, trace to some silt, trace gravel Dense Grey Moist		2	SS	39		92		○		
91.3											
2.3	**SAND** and **GRAVEL**, trace silt Dense to Very Dense Grey Moist		3	SS	46	▽	91		○		51 42 7 (SI+CL)
			4	SS	58		90		○		
	Cobbles and boulders from 4.1m to 5.9m										
			5	SS	23		89		○		
			6	SS	48		88		○		
86.0							87				
7.6	**SAND**, trace gravel, trace silt Loose to Dense Grey Moist to Wet		7	SS	7		86		○		
			8	SS	15		85		○		
							84				

Continued Next Page

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-04 2 OF 2 METRIC

WP# 5026-14-01 LOCATION Watabeag River Bridge ORIGINATED BY OA

HWY Watabeag Road BOREHOLE TYPE Coring COMPILED BY AN

DATUM Local DATE 2016.09.21 - 2015.09.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Boulder (300mm) at 10.1m						83				
82.3			9	SS	35				○		3 94 3 (SI+CL)
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 2.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 19-5161-252.GPJ 2015TEMPLATE(MTO).GDT 11/21/16

THURBER

Appendix B

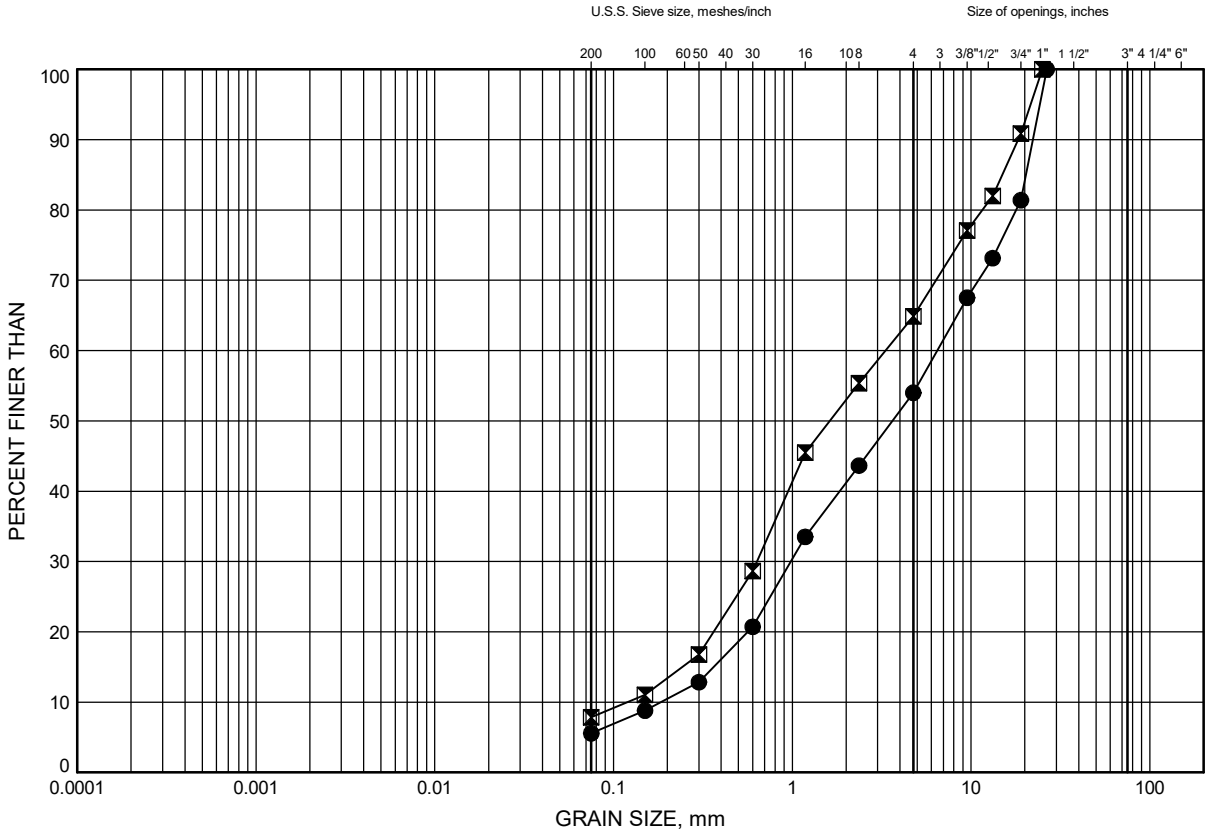
Geotechnical and Analytical Laboratory Test Results

Watabeag River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND and GRAVEL FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-03	0.30	
⊠	16-04	0.30	

Date October 2016

GWP# 5028-14-00

THURBER

Prep'd MFA

Chkd. AMP

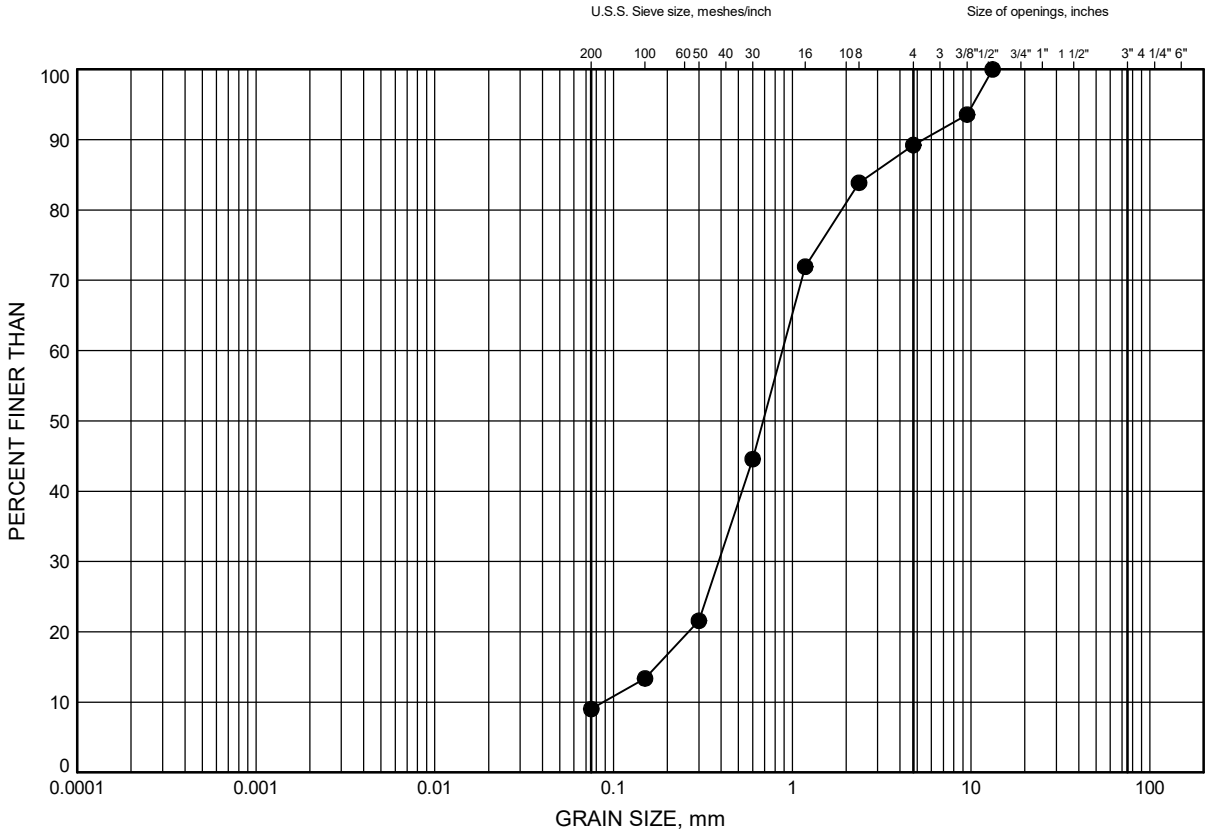
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/13/16

Watabeag River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-02	0.30	

Date October 2016

GWP# 5028-14-00

THURBER

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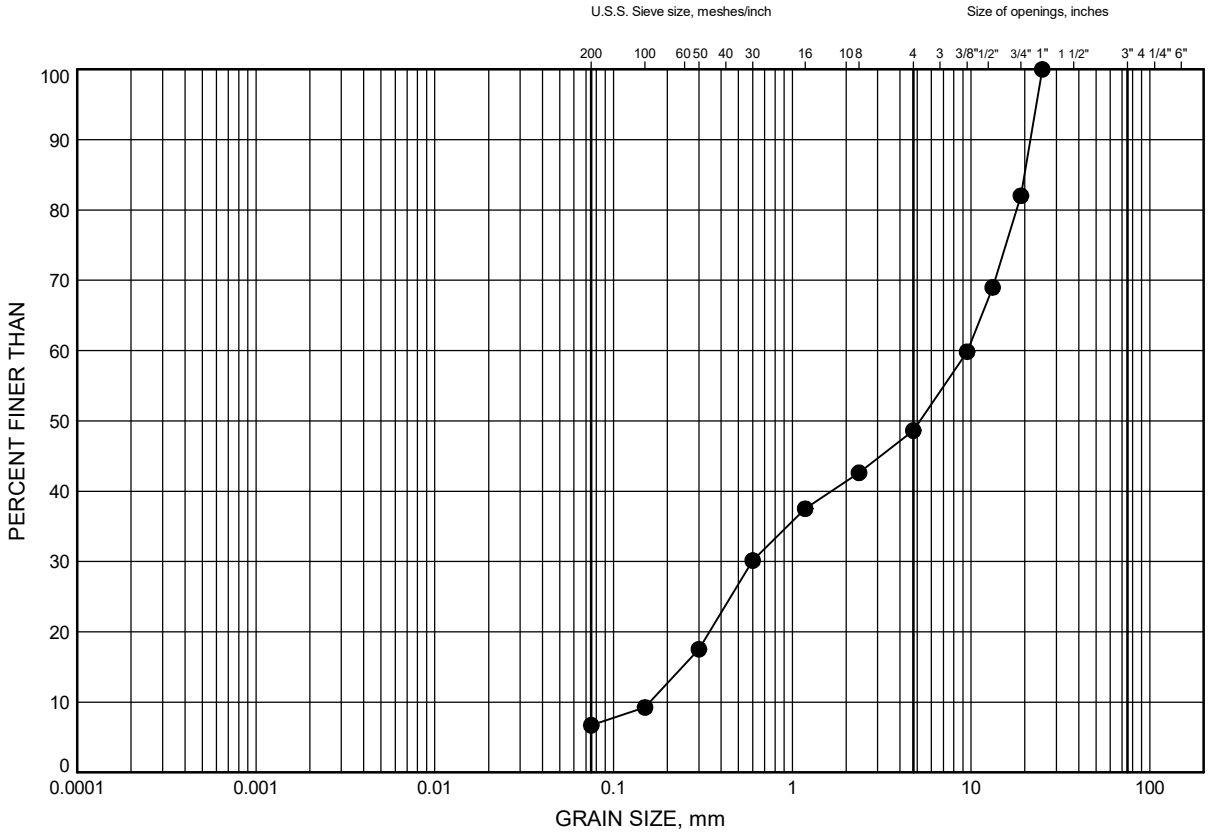
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/13/16

Watabeag River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

Upper SAND and GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-04	2.59	

Date October 2016

GWP# 5028-14-00

THURBER

Prep'd MFA

Chkd. AMP

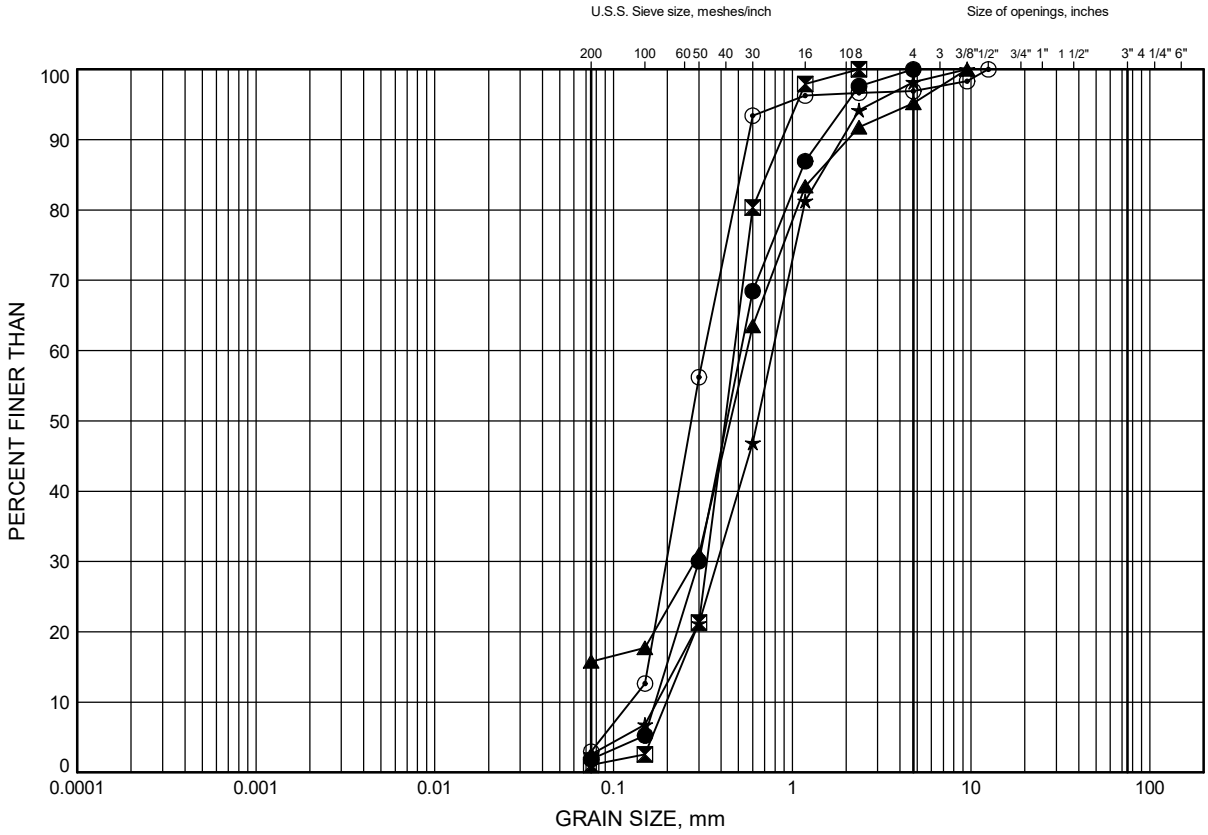
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/13/16

Watabeag River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	6.40	
⊠	16-02	5.47	
▲	16-03	4.88	
★	16-03	9.45	
⊙	16-04	10.97	

Date October 2016

GWP# 5028-14-00

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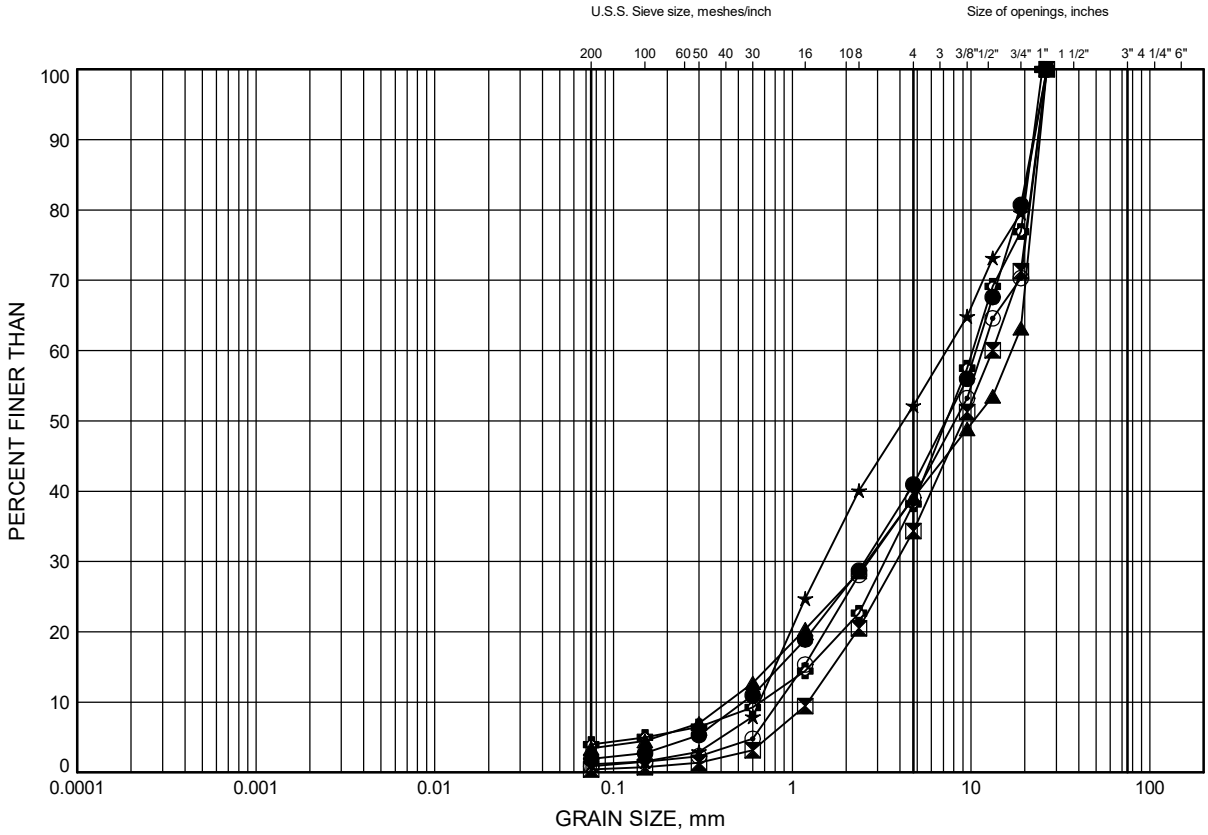
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/13/16

Watabeag River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B5

Lower SAND and GRAVEL to Sandy GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	11.28	
⊠	16-01	14.02	
▲	16-01	18.44	
★	16-02	6.40	
⊙	16-02	9.45	
✿	16-02	14.02	

Date October 2016

GWP# 5028-14-00

THURBER

Prep'd MFA

Chkd. AMP

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/13/16

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 19-5161-25R

04-October-2016

Thurber Engineering Ltd
Attn : Anna Piascik

2010 Winston Park Dr
Oakville, ON
L6H 5R7,

Phone: 905-829-8666
Fax:

Date Rec. : 28 September 2016
LR Report: **CA15537-SEP16**
Reference: 19-5161-25R Anna Piascik

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: BH16-2 Sample 7 15'-17'	6: BH16-1 Sa5, 10-12'
Sample Date & Time					28-Sep-16	28-Sep-16
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0
Corrosivity Index [none]	03-Oct-16	13:43	03-Oct-16	13:43	4	4
pH [no unit]	01-Oct-16	11:18	03-Oct-16	08:51	8.26	8.09
Soil Redox Potential [mV]	30-Sep-16	18:12	03-Oct-16	09:05	177	170
Sulphide [%]	30-Sep-16	13:45	30-Sep-16	14:05	< 0.02	< 0.02
% Moisture (wet wt) [%]	30-Sep-16	16:36	03-Oct-16	08:46	15.77	11.43
pH [no unit]	29-Sep-16	06:41	29-Sep-16	16:49	9.09	9.15
Chloride [µg/g]	30-Sep-16	19:39	03-Oct-16	08:18	1.3	2.0
Sulphate [µg/g]	30-Sep-16	19:39	04-Oct-16	11:03	13	12
Conductivity [uS/cm]	29-Sep-16	06:41	29-Sep-16	16:49	67	64
Resistivity (calculated) [Ohms.cm]	03-Oct-16	13:37	03-Oct-16	13:37	14900	15600

Temperature of Samples upon receipt 4 degrees C
Cooling agent present
Custody Seal not present

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.

Deanna Edwards

Deanna Edwards, B.Sc, C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

00007680868

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 19-5161-25R

LR Report : **CA15537-SEP16**

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Carbon/Sulphur	ME-CA-[ENV]ARD-LAK-AN-020	ASTM E1918
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
Metals Prep	ME-CA-[ENV]ARD-LAK-AN-013	
pH	ME-CA-[ENV]EWL-LAK-AN-001	SM 4500

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Project : 19-5161-25R
LR Report : **CA15537-SEP16**

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD	Acceptance Criteria	LCS / Spike Blank			Matrix Spike / Reference Material		
							Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0457-SEP16												
Chloride	0.4	µg/g	<0.4		11	20	98	80	120	99	75	125
Sulphate	0.4	µg/g	<0.4		3	20	102	80	120	94	75	125
Carbon/Sulphur - QCBatchID: ECS0040-SEP16												
Sulphide	0.02	%	<0.02		ND	20	108	80	120			
Conductivity - QCBatchID: EWL0413-SEP16												
Conductivity	2	uS/cm	4		0	10	98	90	110	NA		
pH - QCBatchID: ARD0081-SEP16												
pH	0.05	no unit			0	20	100	80	120			

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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Phone: 705-652-2000 FAX: 705-652-6365

Project : 19-5161-25R

07-October-2016

Thurber Engineering Ltd
Attn : Anna Piascik

2010 Winston Park Dr
Oakville, ON
L6H 5R7,

Phone: 905-829-8666
Fax:

Date Rec. : 03 October 2016
LR Report: **CA16007-OCT16**
Reference: 19-5161-25R Anna P.

CERTIFICATE OF ANALYSIS

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	6: Watabeag River
Sample Date & Time						28-Sep-16
Temperature Upon Receipt [°C]	---	---	--	--	---	4.0
pH [no unit]	04-Oct-16	10:07	05-Oct-16	11:53	0.05	7.84
Conductivity [µS/cm]	04-Oct-16	13:27	04-Oct-16	15:48	2	144
Resistivity (calculated) [MOhms.cm]	07-Oct-16	10:11	07-Oct-16	10:11	---	696
Redox Potential [mV]	04-Oct-16	13:20	06-Oct-16	10:29	---	159
Chloride [mg/L]	05-Oct-16	01:59	07-Oct-16	09:13	0.04	0.34
Sulphate [mg/L]	05-Oct-16	01:59	06-Oct-16	08:43	0.04	2.7
Sulphide [mg/L]	04-Oct-16	09:23	04-Oct-16	14:34	0.006	< 0.006

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
pH	ME-CA-[ENV]EWL-LAK-AN-006	SM 4500
Redox Potential		SM 2580
Sulphide by SFA	ME-CA-[ENV]SFA-LAK-AN-008	SM 4500

Deanna Edwards

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Project : 19-5161-25R
LR Report : **CA16007-OCT16**

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD	Acceptance Criteria	LCS / Spike Blank			Matrix Spike / Reference Material		
							Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0039-OCT16												
Chloride	0.04	mg/L	<0.04		1	20	97	80	120	98	75	125
Sulphate	0.04	mg/L	<0.04		0	20	101	80	120	99	75	125
Anions by IC - QCBatchID: DIO0055-OCT16												
Chloride	0.04	mg/L	<0.04		3	20	101	80	120	93	75	125
Conductivity - QCBatchID: EWL0034-OCT16												
Conductivity	2	µS/cm	NA		0	10	98	90	110	NA		
pH - QCBatchID: EWL0023-OCT16												
pH	0.05	no unit	NA		0		100			NA		
Redox Potential - QCBatchID: EWL0032-OCT16												
Redox Potential	no	mV	NA		2	20	101	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0018-OCT16												
Sulphide	0.006	mg/L	0.012		ND	20	92	80	120	79	75	125

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Appendix C

Selected Site Photographs

Photo 1 – Watabeag River Bridge; Looking North

Photo 2 – Watabeag River Bridge; Looking South

Photo 3 – Watabeag River Bridge - East Side; Looking Downstream

Photo 4 – Watabeag River Bridge - West Side; Looking Upstream

Photo 5 – North Abutment

Photo 6 – South Abutment

Photo 7 – Typical Sample of Cobbles and Boulders Cored in Borehole 16-01.

Photo 8 – Typical Sample of Cobbles and Boulders Cored in Borehole 16-02.

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Appendix D

Borehole Locations and Soil Strata Drawing

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

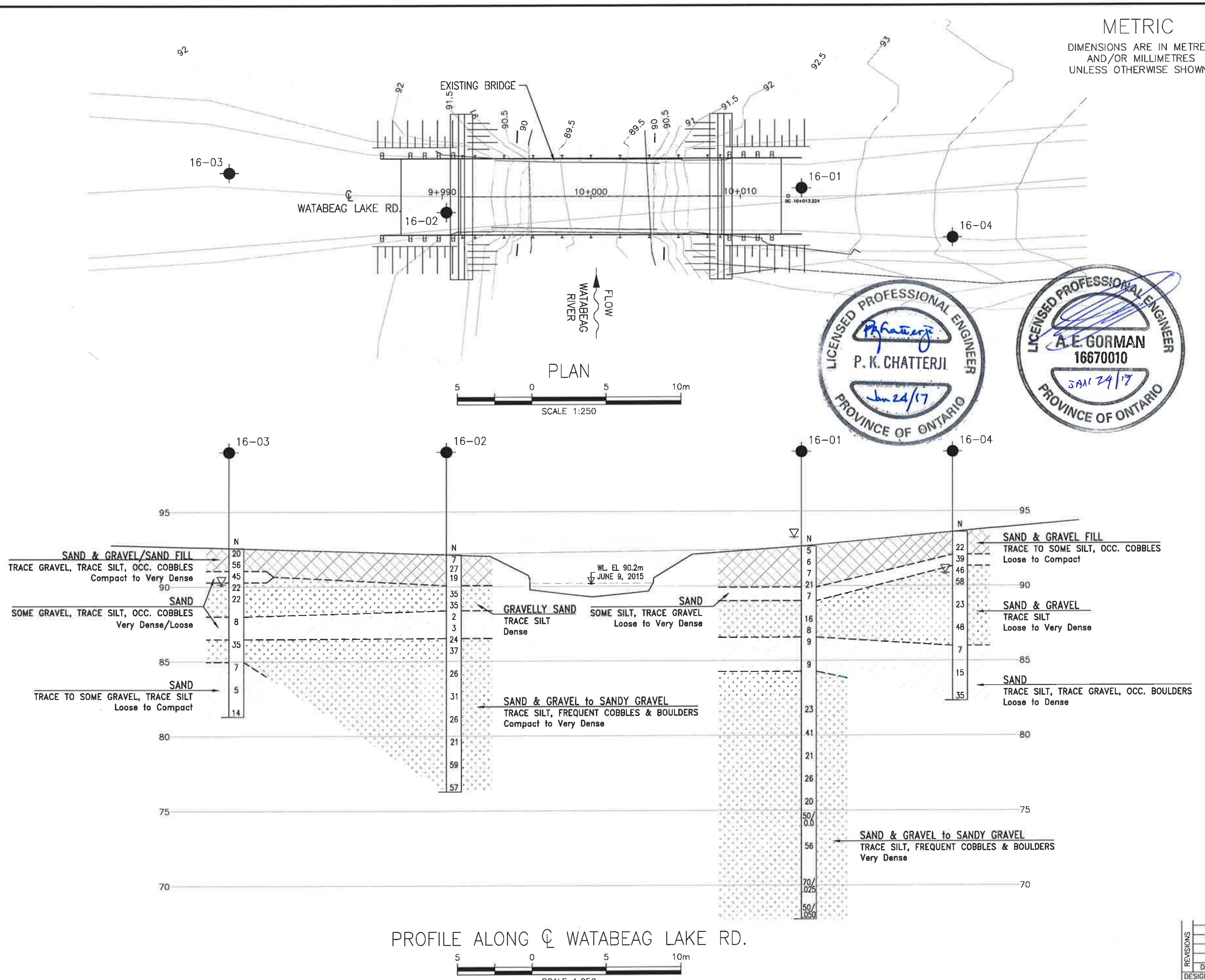
CONT No
WP No 5026-14-01

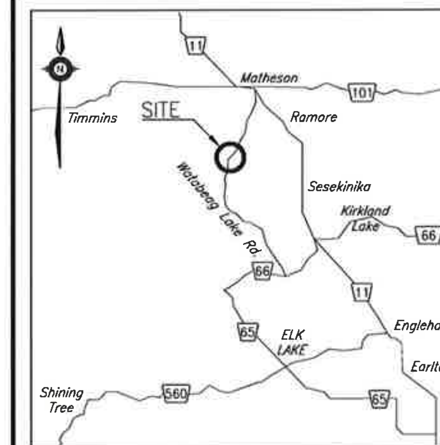
SHEET

WATABEAG RIVER BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.





KEYPLAN

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
16-01	92.7		
16-02	92.1		
16-03	92.6		
16-04	93.6		

-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) Local datum was used to obtain ground surface elevations at the borehole locations.

GEOCRES No. 42A-111

REVISIONS	DATE	BY	DESCRIPTION

DESIGN AMP	CHK PKC	CODE	LOAD	DATE JAN 2017
DRAWN AN	CHK AMP	SITE 47-068	STRUCT	DWG 1

FILENAME: H:\Drafting\19\5161\252\led1252-Plan&Profile(WatabeagRiverBridge).dwg
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