THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF STRUCTURAL CULVERT No. 38S-480
HIGHWAY 639, 12.5 KM NORTH OF HIGHWAY 108 JUNCTION
CHRISTIAN CREEK CROSSING STATION 12+330
DISTRICT OF ALGOMA
W.P. 5264-10-01
5013-E-0041

GEOCRES NUMBER: 41J-97

SUBMITTED TO

MMM GROUP LIMITED

January 2016
19-5161-233

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the replacement of the Christian Creek Culvert located on Highway 639, within the District of Algoma, approximately 30 km north of Elliot Lake, Ontario. Thurber carried out the investigation as a subconsultant to MMM Group Limited (MMM) as part of Agreement No. 5013-E-0041.

No previous foundation investigation information for the subject culvert was available. The MTO Design Criteria Report for the Christian Creek Culvert Replacement Project dated June 2015, was provided by MMM for the preparation of this report.

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

2 SITE DESCRIPTION

Culvert 38S-480 is located at Station 12+330 on Highway 639, approximately 10.5 km south of Highway 546, near Elliot Lake. It is noted that for project orientation purposes, Highway 639 within the project limits, will be assumed to run south-north. The location of the culvert is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Within the project limits, Highway 639 is a two-lane, rural arterial, undivided highway with steel beam guide rails located on both sides of the highway. Based on the MTO Design Criteria Report the roadway cross-section consists of two, 3.5 m wide lanes with approximately 1.3 m wide granular shoulders. Culvert 38S-480 carries Christian Creek flow from east to west below the highway. The posted speed limit within the project limits is 80 km/hr. A 2010 AADT of 70 for Highway 639 within the project limits was provided to MMM by MTO. The iCorridor data between the years 2000 and 2008 indicates a fluctuation in AADT value from 190 to 60.

The Design Report also indicates that the existing culvert is a twin cell, timber box culvert that was constructed in 1981. The total length of structure is reported to be 27 m. Each cell is noted as being constructed with a span of 1.8 m and an interior height of 2.1 m. The height of the fill over the culvert was reported to be approximately 1.5 m. A structure inspection was conducted by MTO in May 2012, for Culvert 38S-480 with the report issued March 2014. The report recommended the structure to be replaced within 1 to 5 years of the inspection.

The slopes of the embankment were observed to be covered with rockfill and were graded at approximately 3.5H:1V (Horizontal:Vertical). The elevation at the centreline of the roadway was approximately 361.2 m. The elevation of the top of the culvert was approximately 358.7 m and 358.5 m at the inlet and outlet respectively. The stream bed was at elevation 356.3 m and 355.8 m at the inlet and outlet respectively.

The lands surrounding the roadway are typically forested with little to no development in the area. Frequent bedrock outcrops were noted in the area in close proximity to the south west and the east of the culvert site. Storm water drainage in the area is to ditches and culverts. Typical site photographs are presented in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locate clearances for the intended borehole locations. The results of the utility locates indicated that there were no buried utilities in the area of the proposed test holes at the time of the field investigation. It should be noted that utility locate clearances will be required for any future excavations.

The field investigation for this site included advancing four boreholes drilled on June 23 and 24, 2015. The stationing, offsets and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole	Location	Station	Offset (m)	Latitude	Longitude	Ground Surface Elevation (m)	Depth (m)
15-1	Highway 639 Northbound	12+323	2.3 RT	46.58569	-82.73905	361.1	5.6
15-2	Highway 639 Southbound	12+337	1.9 LT	46.58578	-82.73919	361.1	5.5
15-3	Culvert inlet	12+328	15.0 RT	46.58578	-82.73894	356.8	0.6
15-4	Culvert outlet	12+339	17.7 LT	46.58573	-82.73934	356.0	0 (Exposed bedrock)

The boreholes advanced through the roadway embankment were advanced with a CME truck mounted drill rig equipped with NW size casing. The inlet and outlet boreholes were advanced with portable drilling equipment. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing. Bedrock was cored in both embankment boreholes using NQ size coring equipment following ASTM Standard D6032-08. Bedrock core samples were stored in core boxes for transport.

A 25 mm inside diameter PVC monitoring well was installed in Boreholes 15-1. Well construction details are illustrated on the Record of Boreholes sheet provided in Appendix B.

The boreholes were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber on June 24, 2015. The vertical datum used was a temporary benchmark (TBM) provided by MMM, located at Station 12+349.720 with a geodetic elevation of 360.981 m. The location of the TBM is indicated on Drawing No. 1 in Appendix A.

4 LABORATORY TESTING

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analyses testing was also carried out on selected samples to MTO and ASTM standards.

The laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the culvert area is presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

For reference, the stratigraphy in the area of the boreholes through the embankment is generally characterized by asphalt surface treatment overlying gravel and sand with silt fill overlying gravel and sand material mixed with rockfill and frequent cobbles and boulders underlain by granite bedrock.

More detailed descriptions of the individual strata are presented below.

5.2 Pavement Structure

Surface Treatment:

An asphalt surface treatment layer with a thickness of 50 mm was encountered in both embankment boreholes.

Base Materials:

A granular fill layer consisting predominantly of gravel and sand with varying amounts of silt was encountered below the surface treatment in the embankment boreholes. This layer has a top elevation of 361.0 m and has a thickness ranging from 0.5 m to 0.8 m in Boreholes 15-1 and 15-2. The SPT ‘N’ values were 40 and 48 blows per 0.3 m of penetration; indicating a dense condition.

The moisture content of the samples tested was 2% and 3%. The results of grain size analysis conducted on two samples of the granular fill material are summarized in Table 5-1 and are illustrated on Figure 1 in Appendix C.

Table 5-1: Gradation Results for Granular Fill

Soil Particles	%
Gravel	50 and 51
Sand	47 and 44
Silt and Clay	3 and 5

5.3 Embankment Fill (Rockfill)

A fill layer consisting predominantly of gravel with varying amounts of sand mixed with rockfill with frequent cobbles and boulders was encountered beneath the pavement structure fill in both embankment boreholes. This layer has a top elevation of 360.2 m to 360.5 m and a thickness ranging from 4.0 m to 4.1 m in Boreholes 15-1 and 15-2. Rockfill was also observed in Borehole 15-3 extending from ground surface at elevation 356.8 m to a depth of 0.6 m. The SPT 'N' values ranged from 2 to 69 blows per 0.3 m of penetration; indicating a very loose to very dense condition; but typically compact to dense. Coring techniques were required to advance through this layer in Borehole 15-3.

The moisture content for the sample tested was 7%. The results of a grain size analysis test completed on a single sample of this material indicated a gravel content of 62%, sand content of 31%, and a fines content (combined silt and clay size particles) of 7%.

5.4 Bedrock

Granitic bedrock was encountered beneath the rockfill in both the embankment boreholes; as identified by visual inspection of NQ coring. Borehole 15-3 was terminated at refusal on inferred bedrock. Bedrock was exposed in Borehole 15-4. The bedrock surface ranged in elevation from 356.0 m to 356.4 m. Bedrock total core recovery was 100% in both cored boreholes, solid core recovery ranged from 85% to 87% and the RQD values ranged from 40% to 82%. Based on the RQD values the rock mass quality ranges from poor to good. The bedrock fractures had a flat orientation. The fracture index was 1 fracture per 0.3 m. A photograph of the bedrock cores is provided in Appendix B.

5.5 Groundwater Conditions

Groundwater levels were measured on completion of drilling in the open boreholes prior to backfilling; however these values are not considered representative of existing conditions as water was used to advance the casing and for bedrock coring operations.

A 25 mm inside diameter PVC monitoring well was installed in Boreholes 15-1. Groundwater level in the monitoring well was recorded on June 24, 2015 at a depth of 4.8 m; corresponding to an elevations of 356.3 m.

The water level in Christian Creek was measured at the time of Thurber's field investigation at a depth of 2.2 m below the top of the culvert at the inlet; corresponding to an elevation of 356.5 m.

The groundwater level in the area of the culvert is expected to reflect the water level in Christian Creek. These observations are short-term readings and seasonal fluctuations of the groundwater

level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

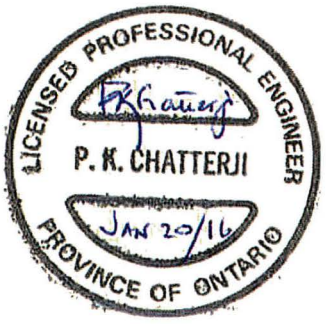
6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations, and determined the stationing, offsets and ground surface elevations based on contract drawings provided by MMM Group Limited. Marathon Drilling Co. Ltd. of Greely, Ontario supplied and operated the CME drill rig and portable drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full time basis by Mr. Christopher Murray of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

Kenton C. Power, P.Eng.
Geotechnical Engineer

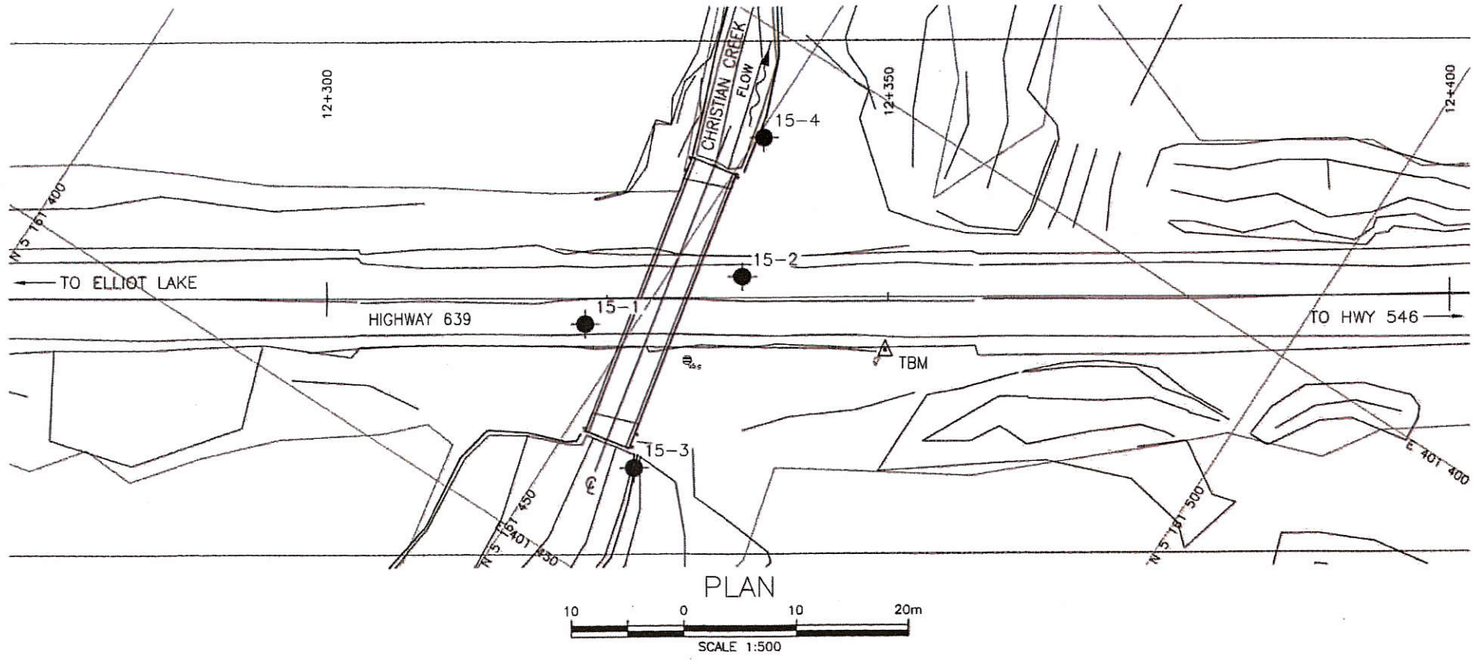
Fred J. Griffiths, P.Eng.
Senior Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

APPENDIX A

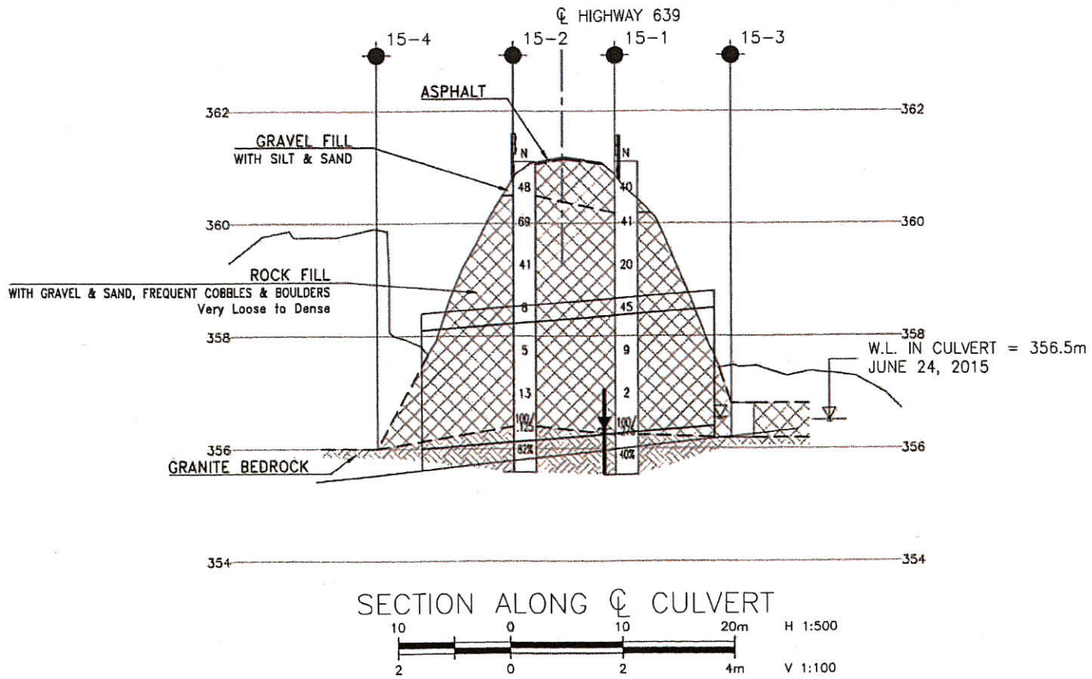
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS



PLAN

10 0 10 20m

SCALE 1:500



SECTION ALONG ℄ CULVERT

10 0 10 20m H 1:500

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

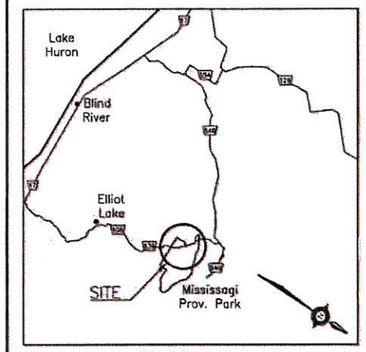
CONT No
GWP No 5264-10-00

HIGHWAY 639
CHRISTIAN CREEK
CULVERT 38S-480/C
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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
15-1	361.1	5 161 446.2	401 431.2
15-2	361.1	5 161 455.7	401 420.0
15-3	356.8	5 161 456.9	401 439.6
15-4	356.0	5 161 450.5	401 408.6

-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) Borehole locations are provided in MTM Zone 13 coordinates.

GEOCRES No. 41J-97

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Jan 20/16
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
JAN 20/16
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN CM	CHK PK	CODE	LOAD
DRAWN MFA	CHK FG	SITE 38S-480/C	STRUCT
			DATE JAN 2016
			DWG 1

FILENAME: H:\Drafting\161\5161\233\Ltr1233-PlanAProfile(ChristianCreekCulvert).dwg
PLOTDATE: 1/14/2016 12:54 PM

MINISTRY OF TRANSPORTATION, ONTARIO

APPENDIX B

RECORD OF BOREHOLE SHEETS
PHOTOGRAPHS OF ROCK CORE

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SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an “A” size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

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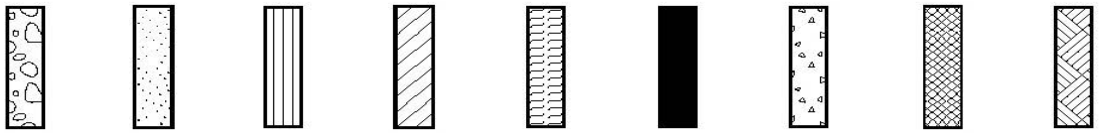
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel
Sand
Silt
Clay
Organics
Asphalt
Concrete
Fill
Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

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MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L= Liquid Limit

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EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-1 1 OF 1 METRIC

GWP# 5264-10-00 LOCATION Culvert 38S-480 12+323 2.3 RT CL ORIGINATED BY CM

HWY 639 BOREHOLE TYPE HSA / NQ Coring COMPILED BY CM

DATUM Geodetic DATE 2015.06.23 - 2015.06.23 CHECKED BY KP

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
361.1											
0.0 / 0.1	**50 mm Prime Surface Treatment**						361				
	GRAVEL (GP) and sand Dry Dense Brown		1	SS	40				○		50 47 3 (SI+CL)
360.2 / 0.9	**FILL**										
	ROCKFILL with gravel and sand Red to Brown Very Loose to Dense Frequent cobbles and boulders **FILL**		2	SS	41		360				
			3	SS	20						
			4	SS	45		359				
			5	SS	9		358				
			6	SS	2		357				
356.2			7	SS	100/275mm	▽					
4.9 / 355.5	**BEDROCK**, Granite Bedrock cored 4.8 m to 5.6 m Moderate weathering Thinly to Medium bedding Good Quality		1	RUN			356				RUN #1 TCR=100% SCR=87% RQD=40%
5.6	Very Hard Borehole terminated at 5.6 m in confirmed bedrock Water level in well at 4.75 m on 24/06/15										

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

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

ONTMT4S 19-5161-233.GPJ 2012TEMPLATE(MTO).GDT 27/7/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-2 1 OF 1 METRIC

GWP# 5264-10-00 LOCATION Culvert 38S-480 12+337 1.9 LT CL ORIGINATED BY CM

HWY 639 BOREHOLE TYPE NW Casing / NQ Coring COMPILED BY CM

DATUM Geodetic DATE 2015.06.23 - 2015.06.23 CHECKED BY KP

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
361.1											
0.0 / 0.1	**50 mm Prime Surface Treatment**										
	GRAVEL (GW-GM) and sand with silt Dry Dense Brown **FILL**		1	SS	48		361		○		51 44 5 (SI+CL)
360.5 / 0.6	ROCKFILL with gravel and sand Red to Brown Loose to Dense Frequent cobbles and boulders **FILL**		2	SS	69		360		○		62 31 7 (SI+CL)
	- Boulders from 0.6 m to 4.7 m		3	SS	41		359				
			4	SS	8		358				
			5	SS	5		357				
			6	SS	13		356				
356.4			7	SS	100/ 125mm						
4.7	**BEDROCK**, Granite Bedrock cored 4.7 m to 5.5 m Fresh weathering Medium bedding Excellent Quality Very Hard		1	RUN							RUN #1 TCR=100% SCR=85% RQD=82%
355.6 / 5.5	Borehole terminated at 5.5 m in confirmed bedrock										

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

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

ONTMT4S 19-5161-233.GPJ 2012TEMPLATE(MTO).GDT 27/7/15

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 15-3 1 OF 1 METRIC

GWP# 5264-10-00 LOCATION Culvert Inlet ORIGINATED BY CM

HWY 639 BOREHOLE TYPE Portable NW Casing / NQ Coring COMPILED BY CM

DATUM Geodetic DATE 2015.06.24 - 2015.06.24 CHECKED BY KP

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
356.8											
0.0	ROCKFILL Frequent cobbles and boulders						▼				
356.1											
0.6	Unable to progress casing past 0.6 m Unable to core into bedrock with portable drilling gear End of Borehole at 0.6 m on probable bedrock Water level at 0.25 m below surface in open borehole										

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

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

ONTMT4S 19-5161-233.GPJ 2012TEMPLATE(MTO).GDT 27/7/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-4 1 OF 1 METRIC

GWP# 5264-10-00 LOCATION Culvert Outlet ORIGINATED BY CM

HWY 639 BOREHOLE TYPE Portable NQ Coring COMPILED BY CM

DATUM Geodetic DATE 2015.06.24 - 2015.06.24 CHECKED BY KP

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 356.0	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	Visible Bedrock at surface Unable to core into bedrock with portable gear End of Borehole at 0 m on confirmed bedrock										

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

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

ONTMT4S 19-5161-233.GPJ 2012TEMPLATE(MTO).GDT 27/7/15

BH 15-1

Cored Length of 4.8 to 5.6 metres

Core Box 1 (of 1)

THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 639
Christian Creek Culvert 38S-480
Elliot Lake, Ontario

WP: 5264-10-01

Project No.: 19-5161-233

BH 15-2

Cored Length of 4.7 to 5.5 metres

Core Box 1 (of 1)

THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 639
Christian Creek Culvert 38S-480
Elliot Lake, Ontario

WP: 5264-10-01

Project No.: 19-5161-233

APPENDIX C

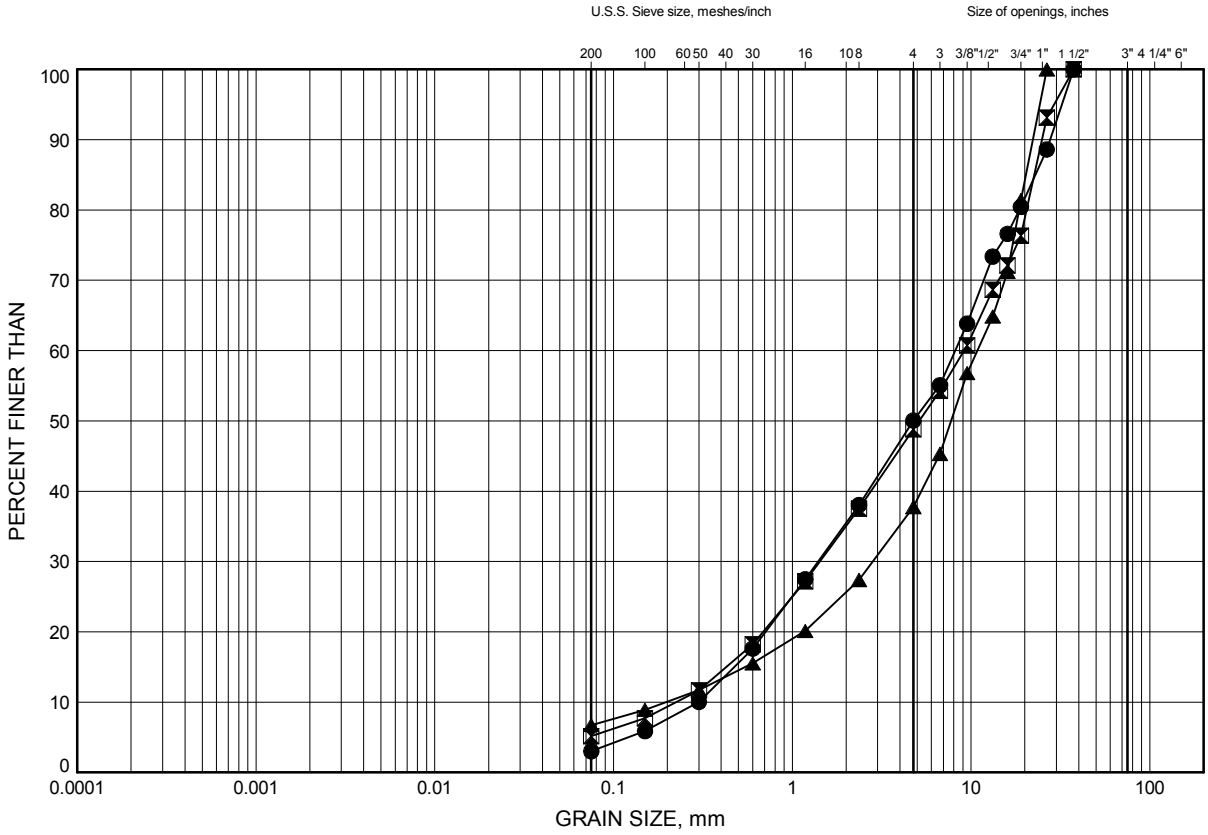
LABORATORY TEST RESULTS

Christian Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE 1

Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-1	0.46	360.64
⊠	15-2	0.46	360.68
▲	15-2	1.07	360.07

Date July 2015

GWP# 5264-10-00

THURBER

Prep'd KCP

Chkd. FG

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-233.GPJ 16/7/15

APPENDIX D

SELECTED PHOTOGRAPHS

Figure 1: Roadway Platform at Culvert 38S-480 Looking North

Figure 2: Culvert 38S-480 inlet looking west

Figure 3: Looking upstream from Culvert 38S-480

Figure 4: Culvert 38S-480 outlet looking east

Figure 5: End of Culvert 38S-480 Looking West