Foundation Investigation Report
Culvert Replacement, Unnamed Creek
Station 20+210, Township of Vasiloff, Algoma District
Highway 17

GWP 5119-06-00

Geocres No: 42C-42
Site No: 38C-155/C

Prepared for
MTO Northeastern Region
447 McKeown Avenue
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Prepared By:

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Table of Contents

APPENDICIES

Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ministry of Transportation Northeastern Region (MTO) to provide a foundation investigation and design services for the proposed culvert replacement at Station 20+210, Township of Vasiloff, district of Algoma. The site is located approximately 20 km east of the junction of Highway 17 and Highway 631 (White River), and roughly 12 km west of Obatanga Provincial Park boundaries. The site coordinates are as follows:

- Latitude: 48.464629°
- Longitude: -85.116777°

This project has been assigned Geocres No. 42C-42 and structural site number 38C-155/C.

The foundation investigation was conducted to provide subsurface data to for stability analysis of finished grade and safe excavation slopes, provide commentary on conceptual cofferdam design and roadway protection measures, and for replacement recommendations including but not limited to lateral earth pressures, foundation types (deep and shallow as applicable) and associated ULS resistances and SLS reactions.

A total of 8 boreholes were advanced for this investigation. Two boreholes were advanced through the embankment at the culvert location, three at the inlet and three at the outlet (two of the boreholes at each end of the culvert were at potential cofferdam locations). All borehole locations were determined through consultation with the MTO. This report (Part A) describes the subsurface conditions encountered during the investigation.

2 Site Description

The foundation investigation was conducted to investigate subsurface conditions at the culvert located at Station 20+210 Township of Vasiloff, Algoma District. The culvert is located beneath an embankment that crosses low lying terrain where the unnamed creek (Tributary to the South White River) flows from an area of low lying terrain towards a small lake to the north.

The culvert is a 3 m x 35 m structural plate corrugated steel arch pipe with an invert at approximately 406.8 m. Native sand and gravel deposits were observed at the ground surface, within borrow areas approximately 100 m south and 200 m north of the site. The maximum height of the embankment is approximately 6 m with side slopes of approximately 1.5(H) to 1(V). The original ground elevation near the culvert is approximately 408.6 m (BH 3). The water level in the creek was measured at 408.0 m in October 2016.

Photo 2.1 – Near Station 20+210 Facing South

Photo 2.2 – Near Station 20+210 Facing North

2.1 Surficial Geology

Available surficial geology mapping (OGS NOEGTS Map 5096 – Pukaskwa River) indicates the site is located in a predominantly sand and gravel glaciofluvial outwash plain. Peat organic terrain, alluvial plain and rock knob terrains are also found within this area. Topography in the area has low local relief in plains and channels. Drainage is

described as dry with mixed wet and dry areas. An esker is located south of the site, and multiple sand and gravel pits are nearby.

3 Investigation Procedures

A geotechnical site investigation was undertaken between October 12 and 23, 2016. A total of 8 boreholes were advanced during the field investigation. The borehole locations and depths were determined through conversations with the MTO and are illustrated on the Borehole Location Plan found in Appendix C.

The borehole locations were identified in the field by TBTE personnel and service clearances were completed prior to mobilizing the drill rig to site. The boreholes were advanced using a track mounted drill rig, equipped with hollow stem augers and a cat head used to carry out Standard Penetration Testing (SPT). Soil samples were obtained at the boreholes from the auger flights and using a split spoon sampler as a part of the SPT.

All aspects of implementation of geotechnical test holes were completed in accordance with the Ministry of Environment Regulation 903, as amended by Regulation 128/03. Boreholes on the road surface were capped with cold mix asphalt upon decommissioning.

Borehole locations were surveyed by TBTE and were referenced to elevations provided on MTO Plate No. 980-17/19-0 Station 19+700 to 20+400 Surveyed October 1993 TWP of Vasiloff. The provided MTO Plate drawing is based on NAD 83 CSRS MTM Zone 13, and Canadian Geodetic Vertical Datum CGVD28.

4 Laboratory Testing

Samples which were obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content, liquid and plastic limit tests, and grain size analysis. The results of this testing are shown on the Borehole Logs (Appendix A and on the laboratory data reports Appendix B). In order to classify

the bedrock with respect to strength, point load tests were carried out on select rock core.

In addition to routine testing, a single sample (BH1, SS3) was selected for analytical laboratory testing. Analytical tests performed included conductivity, moisture content, pH, Redox Potential, resistivity, chloride, sulphide and sulphate testing. Test results are included in Section 5 and Appendix B.

5 Subsurface Conditions

Details of the subsurface conditions are provided on the test hole logs (Appendix A), and on the Soil Strata Drawings (Appendix C).

The subsurface soils at this site typically consist of sands and gravels overlying bedrock. All boreholes were terminated in bedrock.

5.1 Asphalt

Asphalt was encountered at the surface Boreholes 2 and 6 (elevation 413.9 m at both locations). The asphalt was approximately 100 mm thick.

5.2 Organic Material

A layer of organics was encountered at the surface of Borehole 5 (elevation 408.4 m) and beneath the fill at Borehole 7 (elevation 409.0 m). The organic material thickness ranged from 0.7 to 0.9 m, with natural moisture contents ranging from 109 to 280 %.

5.3 Embankment Fill

Granular embankment fills, with occasional cobbles, were identified beneath the asphalt at Boreholes 2 and 6. The embankment fill thickness ranged from 5.5 to 5.7 m, and extended to elevations ranging from 408.1 to 408.3 m. A 0.5 m thick layer of fill was encountered at the toe of the embankment slope at Borehole 7. Three samples were selected for grain size distribution testing. The test results indicated a grain size distribution of 2 to 30 % gravel, 59 to 83 % sand, and 11 to 17 % silt/clay sized particles. The fill is in a loose to dense condition as indicated by “N” values of 6 to 39 blows/0.3 m.

5.4 Gravel (Possible Fill)

Gravel (possible fill) was encountered beneath the embankment fill at Borehole 2. The gravel has a thickness of 1.4 m, and extended to an elevation of 406.7 m. The gravel is in a dense condition as indicated by an "N" value of 44 blows/0.3 m.

5.5 Silt and Sand

Sand and silt was encountered beneath the organics in Borehole 7. The silt and sand has a thickness of 4.9 m, and extended to an elevation of 402.9 m. A single sample was selected for grain size distribution testing. The test result indicated a grain size distribution of 1 % gravel, 44 % sand, and 55 % silt/clay sized particles. The material is in a loose to compact condition as indicated by "N" values of 9 and 17 blows/0.3 m.

5.6 Sand

Sand with trace gravel, and some silt to silty, gravelly sand was encountered beneath the fill at Boreholes 2 and 6, beneath the organics at Borehole 5, beneath the silt and sand at Borehole 7, and from the surface of Boreholes 1 and 8, ranging in elevation from 406.1 to 409.0 m. This layer ranged in thickness from 1.4 to 7.6 m extending to elevations 401.4 to 406.6 m). Occasional cobbles were also encountered within this stratum. Thirteen samples were selected for grain size distribution testing. The test results indicated a grain size distribution of 1 to 30 % gravel, 44 to 88 % sand, and 3 to 32 % silt/clay sized particles. The condition of this material ranges from very loose to very dense as indicated by "N" values of 4 to 62 blows/0.3 m.

A sample of this material from Borehole 1 was submitted for corrosivity and conductivity testing, detailed results are provided in Appendix B. The results are summarized as follows:

Table 5.1: Analytical Testing Results

Test	Unit	Result
Conductivity	mS/cm	0.428
Moisture	%	14.7
Acidity/Basicity	pH	7.8
Redox Potential	mV	126
Resistivity	ohm*cm	2340

Chloride	ppm	109
Sulphide (as S)	mg/kg	<0.2
Sulphate	ppm	<20

5.7 Bedrock

Bedrock was confirmed below the sand at all borehole locations at depths ranging from 3.7 to 7.6 m (Elevations 401.4 to 406.6). The bedrock elevations are provided in the following table.

Table 5.2: Bedrock Depths and Elevations

Borehole	Surface Elevation (m)	Bedrock depth from ground surface (m)	Bedrock Elevation (m)
1	408.3	6.1	402.2
2	413.9	8.6	405.3
3	408.6	3.7	404.9
4	408.4	4.6	403.8
5	408.4	4.6	403.8
6	413.9	7.3	406.6
7	409.0	6.1	402.9
8	409.0	7.6	401.4

Generally, the bedrock encountered was pink and grey gneiss, with moderate to high weathering at the top of the core with decreased weathering with depth. Detailed bedrock core logs and photos are provided as Appendix D.

In order to classify the bedrock with respect to strength, 24 point load tests were completed on selected core samples. The test results are tabulated below:

Table 5.3: Estimated Uniaxial Compressive Strength of Bedrock

Borehole	Test depth from ground surface (m)	Test Elevation (m)	*Estimated Uniaxial Compressive Strength (MPa)
1	8.4	399.9	511
2	9.2	404.7	353

2	13.2	400.7	422
2	14.1	399.8	381
2	15.0	398.9	389
3	6.5	402.1	452
3	7.6	401.0	467
3	8.3	400.3	527
3	8.9	399.7	582
4	4.7	403.7	493
4	5.9	402.5	501
5	8.0	400.4	529
5	9.7	398.7	291
5	10.4	398.0	356
6	7.7	406.2	437
6	9.9	404.0	434
6	11.0	402.9	516
6	12.1	401.8	393
7	7.9	401.1	563
7	9.3	399.7	540
7	10.2	398.8	531
8	8.2	400.8	629
8	9.2	399.8	586
8	10.4	398.6	491

** Estimated based on published correlations with point load testing*

Based on the estimated uniaxial compressive strength of the intact rock, the bedrock is extremely strong (uniaxial compressive strengths greater than 250 MPa).

The rock quality designation (RQD) is an indirect measure of the number of fractures and the amount of jointing in the rock mass. The RQD is expressed as a percentage of the ratio of the summed core lengths (greater than 100 mm) to the total length cored. The RQD index is used to provide a classification for the rock quality according to the following limits.

Table 5.4: RQD / Rock Quality Designation

RQD (%)	Rock Quality	Total Number of Samples of Each Designation
0 – 25	Very Poor	6
25 – 50	Poor	5
50 – 75	Fair	3
75 – 90	Good	1
90 – 100	Excellent	11

The RQD measured over the core lengths ranged from 0 to 100% indicating the rock quality varies from very poor to excellent.

6 Ground Water

Groundwater levels were measured upon completion of drilling operations and are summarized in the table below. Groundwater levels will vary from season to season and from the effects of heavy precipitation events. At the time of the investigation the water level in the creek was near elevation 407.3 m.

Table 6.1: Groundwater Levels

-Borehole	Groundwater Depth (m)	Groundwater Elevation (m)	Date Measured
1	1.0	407.3	Oct 12, 2016
2	7.0	406.9	Oct 14, 2016
3	0.8	407.8	Oct 15, 2016
4	0.8	407.6	Oct 17, 2016
5	0.1	408.3	Oct 22, 2016
6	4.8	409.1	Oct 20, 2016
7	0.4	408.6	Oct 21, 2016
8	0.2	408.8	Oct 23, 2016

7 Miscellaneous

Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The drill equipment for this investigation was operated by TBT Engineering Limited. The field operations were supervised by Walter Mainville. Laboratory testing was supervised by T. Fummerton C.E.T. This report was prepared by Steven Seller, P.Eng, and reviewed by W. Hurley, P.Eng (TBTE designated principal contact identified for MTO Foundation Engineering projects).

8 Limitations

Conclusions presented in this report are based on the information determined at a limited number of test hole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of dewatering procedures which may be considered cannot readily be determined from boreholes. These include local and seasonal fluctuations of the groundwater level, changes in soil conditions between test locations, thin and/or discontinuous layers of highly permeable soils, etc.

The information contained within this report in no way reflects any environmental aspect of the site or soil.

9 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate the contact us at your convenience.

Yours truly,
For TBT ENGINEERING

Steven Seller, P.Eng
Senior Project Engineer

Wayne Hurley, P.Eng.
Principal Contact for MTO Foundations

APPENDIX A
Borehole Logs

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	75 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	-	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	-	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	-	COMPRESSION INDEX
C_s	-	SWELLING INDEX
C_α	-	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	-	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{VO}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_s	-	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	-	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	-	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	-	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	-	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	-	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No 1

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370169; E:222247 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.10 - 2016.10.10 LATITUDE 48.464736 LONGITUDE -85.11642 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
408.3											
0.0	SAND - trace silt, trace gravel, brown, loose to compact		1	AS		▽	408				Water level @ 1.0m on completion. 6 88 (6)
			2	SS	4						
	- - - - - - occasional cobbles		3	SS	26		407				Flowing sand @ 1.5m.
405.4			4	SS	10		406				
2.9	SAND - Gravelly, Silty, occasional cobbles & boulders, compact to very dense		5	SS	62		405				25 49 (26) Auger refusal @ 3.2m. Advanced with casing.
			6	SS	19		404				
402.2							403				
6.1	BEDROCK - Gneiss, pink & grey		1	RC			402				RC #1 REC 100% RQD 73.3%
			2	RC			401				RC #2 REC 100% RQD 100%
399.2							400				
9.1	End of Borehole @ 9.1m.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370147; E:222229 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.14 - 2016.10.14 LATITUDE 48.464535 LONGITUDE -85.11666 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
413.9											
413.8 / 0.1	ASPHALT - 100mm										
413.3 / 0.6	FILL - GRAVEL		1	AS			413				Water level @ 7.0m on completion.
	FILL - SAND - some silt, trace gravel, grey/brown, loose to very dense		2	SS	60						2 83 (15)
			3	SS	20		412				
			4	SS	8						
			5	SS	34		411				
	- - - - - - occasional cobbles						410				
			6	SS	39		409				
407.9			7	SS	44		408				
6.0	GRAVEL (possible fill) - grey, dense					▽					Auger refusal @ 6.2m. Advanced with casing.
406.7							407				
7.2	SAND - Gravelly, some silt, compact		8	SS	22		406				30 58 (12)
405.3											
8.6	BEDROCK - Gneiss, pink & grey		1	RC			405				RC #1 REC 68% RQD 22% RC #2 REC 47.7% RQD 36.6%
			2	RC			404				
			3	RC			403				RC #3 REC 33.3% RQD 0%
			4	RC			402				RC #4 REC 56% RQD 40%
			5	RC			401				RC #5 REC 100% RQD 85.3%
398.8							400				
15.1	End of Borehole @ 15.1m.						399				

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370173; E:222237 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.15 - 2016.10.15 LATITUDE 48.464767 LONGITUDE -85.116555 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
408.6											
0.0	SAND - Silty, some gravel, brown, compact to dense		1	AS		▽	408		○		13 64 (23)
			2	SS	21				○		Water level @ 0.8m on completion.
	- - - - -						407				
406.5	- numerous cobbles		3	SS	46				○		
2.1	SAND - Gravelly, some silt, occasional cobbles, grey, compact		4	SS	24		406		○		27 54 (19)
			5	SS	13				○		Auger refusal @ 3.7m. Continued with casing.
404.9							405				
3.7	BEDROCK - Gneiss, pink & grey		1	RC							RC #1 REC 92.2% RQD 74.4%
			2	RC			404				RC #2 REC 66.6% RQD 18%
							403				
			3	RC			402				RC #3 REC 72% RQD 56%
							401				
400.5			4	RC							RC #4 REC 100% RQD 100%
8.1	End of Borehole @ 8.1m.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370175; E:222242 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.17 - 2016.10.17 LATITUDE 48.464787 LONGITUDE -85.116485 CHECKED BY S.S.

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, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	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
408.4											
0.0	SAND - trace silt, trace gravel, brown		1	AS		▽	408		○		5 92 (3)
407.8											
0.6	SAND - Gravelly, trace silt, trace organics, occasional cobbles, grey, loose to compact		2	SS	12				○		23 71 (6) Water level @ 0.8m on completion.
			3	SS	100+		407				On cobble.
			4	SS	100+		406				On cobble.
			5	SS	7		405		○		
403.8							404				
4.6	BEDROCK - Gneiss, pink & grey		1	RC			403				RC #1 REC 98.7% RQD 90.7%
			2	RC			402				RC #2 REC 100% RQD 48%
400.8							401				
7.6	End of Borehole @ 7.6m.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370152; E:222197 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.19 - 2016.10.22 LATITUDE 48.464576 LONGITUDE -85.1170909 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
408.4											
0.0	ORGANICS - black		1	AS		▽	408		280.2		Water level @ 0.1m on completion.
407.5									109.5		
0.9	SAND - some gravel, trace silt, very loose to dense		2	SS	2		407				
			3	SS	5						
			4	SS	8		406				15 77 (8)
			5	SS	49						15 77 (8)
403.8							405				
							404				
4.6	BEDROCK - Gneiss, pink & grey		1	RC			403				RC #1 REC 42% RQD 13.3%
			2	RC			402				RC #2 REC 61.3% RQD 32%
			3	RC			401				RC #3 REC 82.7% RQD 44%
			4	RC			400				RC #4 REC 100% RQD 92%
397.8							399				
							398				
10.6	End of Borehole @ 10.6m.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370168; E:222216 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.20 - 2016.10.20 LATITUDE 48.46472 LONGITUDE -85.116832 CHECKED BY S.S.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
413.9											
413.8 / 0.1	ASPHALT - 100mm										
	FILL - SAND - trace gravel to Gravelly, some silt, occasional cobbles, brown, compact to dense		1	AS							30 59 (11)
			2	SS	34		413				Water level @ 4.8m on completion.
			3	SS	11		412				
			4	SS	6						
			5	SS	33		411				5 79 (16)
			6	SS	23	▽	410 / 409				
408.3											
5.6	SAND - Gravelly, Silty, occasional cobbles & boulders		7	SS	100+		408				On cobble.
406.6							407				
7.3	BEDROCK - Gneiss, pink & grey		1	RC			406				RC #1 REC 100% RQD 100%
			2	RC			405				RC #2 REC 37.7% RQD 0%
			3	RC			404				RC #3 REC 100% RQD 90.9%
			4	RC			403				RC #4 REC 98% RQD 98%
401.8							402				
12.1	End of Borehole @ 12.1m.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370140; E:222206 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.21 - 2016.10.21 LATITUDE 48.464473 LONGITUDE -85.116962 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
409.0											
0.0 408.5	FILL - SAND - trace organics, brown		1	AS		▽	408		○ 154.8		Water level @ 0.4m on completion.
0.5 407.8	ORGANICS - some sand, trace wood		2	SS	4						
1.2	SILT & SAND - trace gravel, grey, loose to compact		3	SS	9		407		○		1 44 (55)
406.1			4	SS	17				○		
3.0	SAND - some gravel, some silt, grey, compact		5	SS	14		406		○		
			6	SS	25		405		○		17 66 (17)
402.9							404				
6.1	BEDROCK - Gneiss, Gravelly, pink & grey		1	RC			403				RC #1 REC 37% RQD 0%
			2	RC			402				RC #2 REC 100% RQD 96.6%
			3	RC			401				RC #3 REC 100% RQD 100%
398.4							400				
10.6	End of Borehole @ 10.6m.						399				

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO MOD 16-138 MTO UNNAMED CREEK.GPJ ONTARIO MTO.GDT 7/6/17

RECORD OF BOREHOLE No 8

1 OF 1 **METRIC**

W.P. 5119-06-00 LOCATION Unnamed Creek N:5370158; E:222204 MTM Zone:13 ORIGINATED BY W.M.

DIST NER HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM Geodetic DATE 2016.10.23 - 2016.10.23 LATITUDE 48.464633 LONGITUDE -85.116999 CHECKED BY S.S.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
409.0											
0.0	SAND - Silty, trace gravel, brown, loose to compact		1	AS		▽			○		Water level @ 0.2m on completion.
	- - - - -										
	- grey		2	SS	20		408		○		1 67 (32)
			3	SS	5		407		○		
			4	SS	29				○		
	- - - - -						406		○		21 67 (12)
	- gravelly, some silt		5	SS	25						
							405				
			6	SS	18				○		
							404				
	- - - - -						403		○		
	- occasional cobbles		7	SS	23						
401.4							402				
7.6	BEDROCK - Gneiss, grey & white		1	RC			401				RC #1 REC 100% RQD 95.3%
							400				
			2	RC							RC #2 REC 100% RQD 98.6%
398.4							399				
10.6	End of Borehole @ 10.6m.										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #1 | Lab# 16-16517

Client: MTO NER | Logger: Larry Wells

Site: Sta.20+210 Vasiloff Twp. | Date: Oct. 26/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 6.10	1	100.0%	73.3%	**Pink and Grey Gneiss**		S								
To	To 7.60														
From	7.6 7.60	1	100.0%	100.0%	**Pink and Grey Gneiss**		S								
To	To 9.10														
From	From														
To	To														
From	From														
To	To														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 2

Project #: 16-138 | Borehole #2 | Lab# 16-16518

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.26/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 8.60	1	68.0%	22.0%	**Pink and Grey Gneiss (Highly Fractured with Gravelly Sections)**		M/H								
To	To 9.10														
From	From 9.10	1	47.7%	36.6%	**Pink and Grey Gneiss (Highly Fractured)**		M/H								
To	To 10.60														
From	From 10.60	1	33.3%	0.0%	**Pink and Grey Gneiss (Totally Crumbled with sub-rounded aggregate particles)**		M/H								
To	To 12.10														
From	From 12.10	1	56.0%	40.0%	**Pink and Grey Gneiss (Highly Fractured)**		M/H								
To	To 13.60														

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 2 of 2

Project #: 16-138 | Borehole #2 | Lab# 16-16518

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.26/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 13.60	1	100.0%	85.3%	**Pink and Grey Gneiss**		S								
To	To 15.10														
From	From 0.00														
To	To 0.00														
From	From 0.00														
To	To 0.00														
From	From 0.00														
To	To 0.00														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #3 | Lab# 16-16519

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.26/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 3.70	1	92.2%	74.4%	**Pink and Grey Gneiss (Fractured)**		S								
To	To 4.60														
From	From 4.60	1	66.6%	18.0%	**Pink and Grey Gneiss (Highly Fractured, Crumbly)**		S/M								
To	To 6.10														
From	From 6.10	1	72.0%	56.0%	**Pink and Grey Gneiss (Highly Fractured)**		S								
To	To 7.60														
From	From 7.60	1	100.0%	100.0%	**Pink and Grey Gneiss**		S								
To	To 8.10														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #4 | Lab# 16-16520

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.28/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 4.60	1	98.7%	90.7%	**Pink and Grey Gneiss**		S								
To	To 6.10														
From	From 6.10	1	100.0%	48.0%	**Pink and Grey Gneiss (Fractured)**		S								
To	To 7.60														
From	From														
To	To														
From	From														
To	To														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Aperture
O = Open
C = Closed
F = Filled

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

ROCK CORE LOG

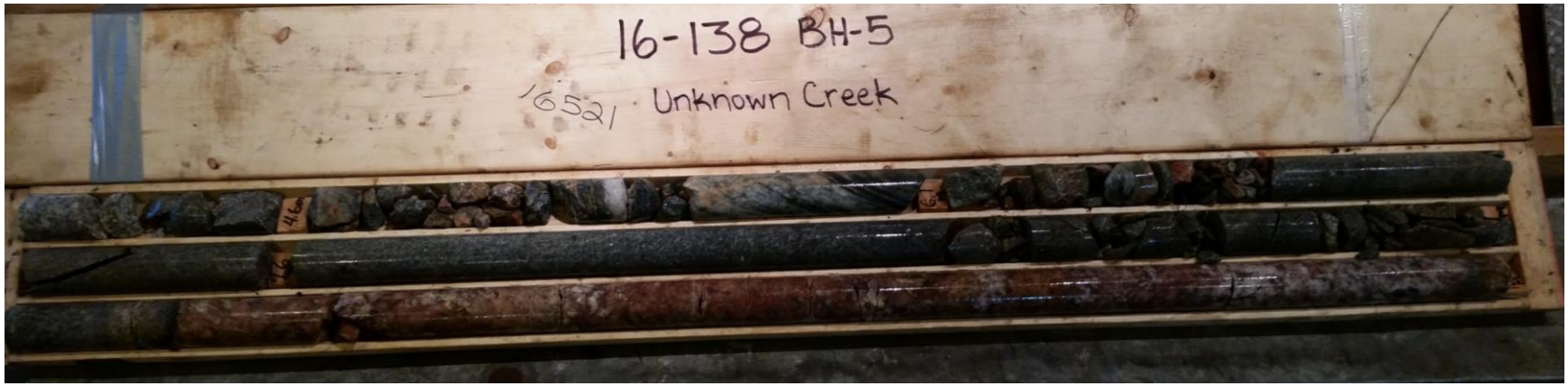
Page 1 of 1

Project #: 16-138	Borehole #5	Lab# 16-16521
Client: MTO NER	Logger: Larry Wells	
Site: Sta. 20+210 Vasiloff Twp.	Date: Oct.28/16	

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 4.60	1	42.0%	13.3%	**Pink and Grey Gneiss (Highly Fractured, Gravelly)**		S/M								
To	To 6.10														
From	From 6.10	1	61.3%	32.0%	**Pink and Grey Gneiss (Highly Fractured, Gravelly)**		S/M								
To	To 7.60														
From	From 7.60	1	82.7%	44.0%	**Pink and Grey Gneiss (Highly Fractured)**		S								
To	To 9.10														
From	From 9.10	1	100.0%	92.0%	**Pink and Grey Gneiss**		S								
To	To 10.60														

Full Rock Core Dry

Full Rock Core Wet



Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #6 | Lab# 16-16522

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.31/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 7.30	1	100.0%	100.0%	**Pink and Grey Gneiss**		S								
To	To 8.20														
From	From 8.20	1	37.7%	0.0%	**Pink and Grey Gneiss (Highly Fractured)**		M/H								
To	To 9.50														
From	From 9.50	1	100.0%	90.9%	**Pink and Grey Gneiss**		S								
To	To 10.60														
From	From 10.60	1	98.0%	98.0%	**Pink and Grey Gneiss**		S								
To	To 12.10														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #7 | Lab# 16-16523

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.31/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 6.10	1	37.0%	0.0%	**Pink and Grey Gneiss (Highly Fractured, Gravelly)**		M/H								
To	To 7.60														
From	From 7.60	1	100.0%	96.6%	**Pink and Grey Gneiss**		S								
To	To 9.10														
From	From 9.10	1	100.0%	100.0%	**Pink and Grey Gneiss**		S								
To	To 10.60														
From	From 0.00	1													
To	To 0.00														

Full Rock Core Dry

Full Rock Core Wet

Rock Core Detail

TBT ENGINEERING
CONSULTING GROUP

Strength (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

Discontinuity type
B = Bedding joint
J = Cross Joint
F = Fault
S = Shear Plane

Roughness
RU = Rough undulating
RP = Rough planar
SU = Smooth undulating
SP = Smooth planar
LU = Slicken sided undulating
LP = Slicken sided planar

Orientation
F = Flat (0-20°)
D = Dipping (20-50°)
V = Near Vertical (>50°)

Aperture
O = Open
C = Closed
F = Filled

ROCK CORE LOG | Page 1 of 1

Project #: 16-138 | Borehole #8 | Lab# 16-16524

Client: MTO NER | Logger: Larry Wells

Site: Sta. 20+210 Vasiloff Twp. | Date: Oct.31/16

Weathering
U = Unweathered (No signs)
S = Slightly (Oxidized)
M = Moderately (Discoloured)
H = Highly (Friable)
C = Completely (Soil-like)

Spacing
VW = Very wide = >3m
W = Wide = 1-3m
M = Moderate = 0.3-1m
C = Close = 5-30cm
VC = Very close = <5cm

Filling
T = Tight, hard
O = Oxidized
SA = Slightly altered, clay free
S = Sandy, Clay free
Si = Sandy, silty, minor clay
NC = Non-softening clay
SC = Swelling, softening clay
N= No filling

DEPTH FROM SURFACE (m)	DEPTH (m)	BOX/RUN	% REC (m)	% RQD (m)	GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES
								# OF SETS	TYPE(S)	Orientation	SPACING	Roughness	APERTURE	FILLING	
From	From 7.60	1	100.0%	95.3%	**Grey and White Gneiss**		S								
To	To 9.10														
From	From 9.10	1	100.0%	98.6%	**Grey and White Gneiss**		S								
To	To 10.60														
From	From 0.00														
To	To 0.00														
From	From 0.00														
To	To 0.00														

Full Rock Core Dry

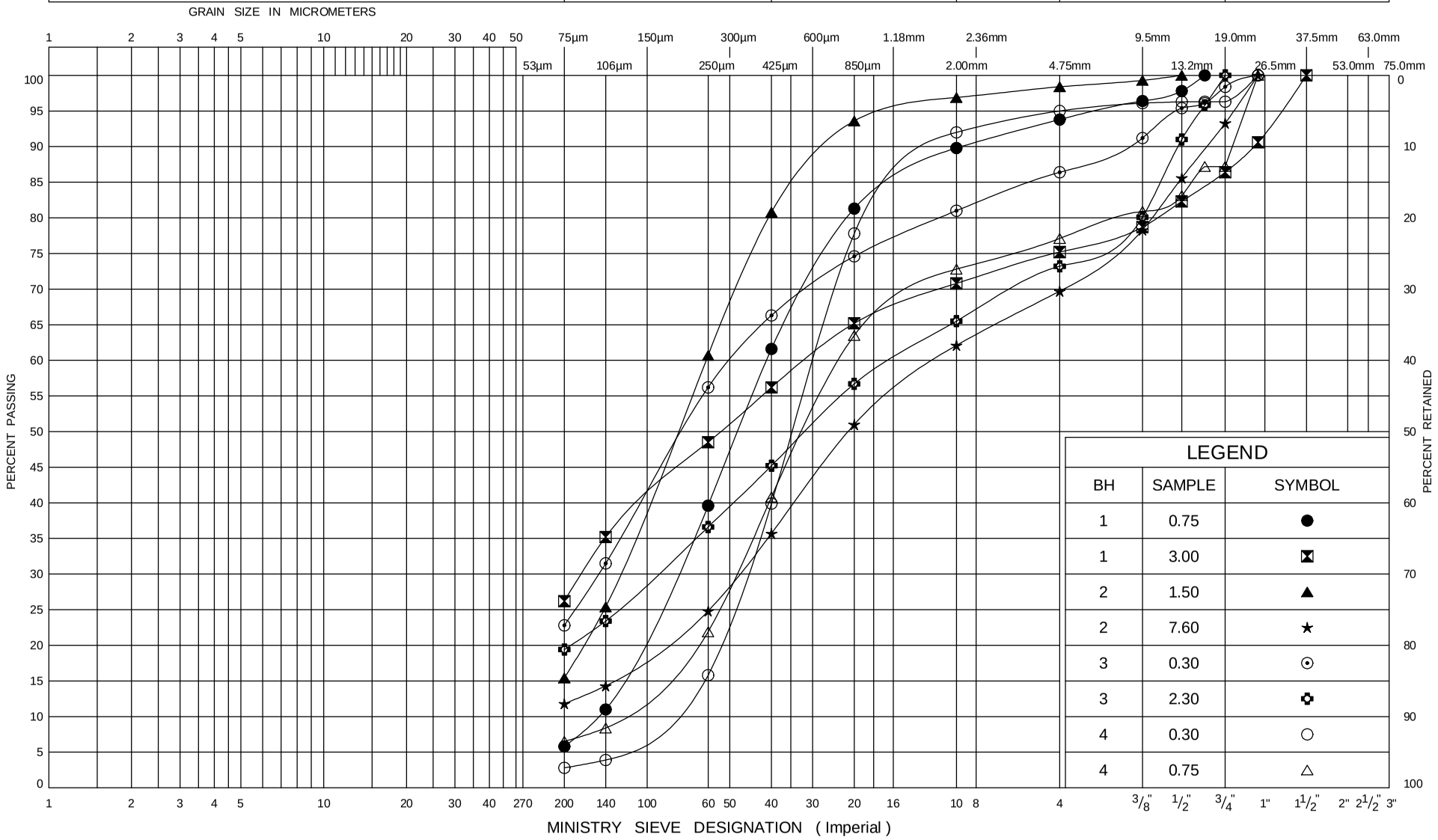
Full Rock Core Wet

Rock Core Detail

APPENDIX B
Laboratory Test Data

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
1	0.75	●
1	3.00	⊠
2	1.50	▲
2	7.60	★
3	0.30	⊙
3	2.30	✿
4	0.30	○
4	0.75	△

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

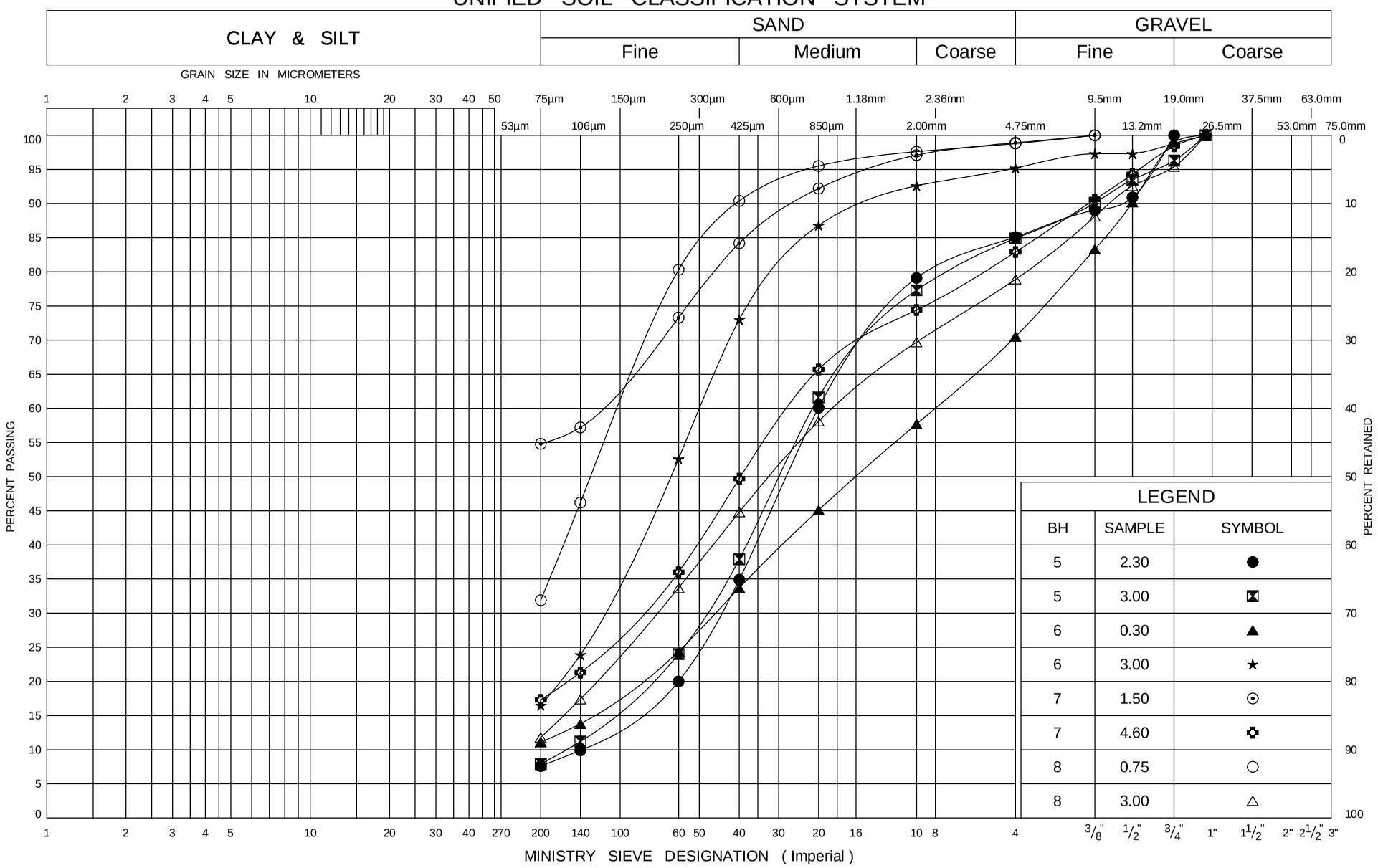
FIG No

W P 5119-06-00

Culvert Investigation

ONTARIO MOT GRAIN SIZE 16-138 MTO UNNAMED CREEK.GPJ ONTARIO MOT.GDT 21/6/17

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 16-138 MTO UNNAMED CREEK.GPJ ONTARIO MOT.GDT 21/6/17

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

FIG No

W P 5119-06-00

Culvert Investigation

TBTE Engineering Group
ATTN: Doug Steele
1918 Younge St.
Thunder Bay ON P7E 6T9

Date Received: 01-NOV-16
Report Date: 10-NOV-16 14:42 (MT)
Version: FINAL

Client Phone: 807-624-5160

Certificate of Analysis

Lab Work Order #: L1851596

Project P.O. #: NOT SUBMITTED
Job Reference: 16-138
C of C Numbers:
Legal Site Desc:

Christine Paradis
Project Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1851596-1				
	Description	Soil				
	Sampled Date	12-OCT-16				
	Sampled Time	09:30				
	Client ID	UNNAMED CREEK BH1 SS3				
Grouping	**Analyte**					
SOIL						
Physical Tests	Conductivity (mS/cm)	0.428				
	% Moisture (%)	14.7				
	pH (pH units)	7.80				
	Redox Potential (mV)	126				
	Resistivity (ohm*cm)	2340				
Leachable Anions & Nutrients	Chloride (ppm)	109				
	Sulphide (as S) (mg/kg)	<0.20				
Anions and Nutrients	Sulphate (ppm)	<20				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SO4-WT	Soil	Sulphate	EPA 300.0
SULPHIDE-WT	Soil	Sulphide (as S)	APHA 4500S2D

Sulphide in Soil analysis is based on APHA 4500 S2D. A sub-sample of the soil sample is distilled, sulphuric acid and sodium hydroxide are added to the distillate. The sample is then analyzed on a spectrophotometer.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

APPENDIX C
Borehole Locations and Soil Strata Drawing

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

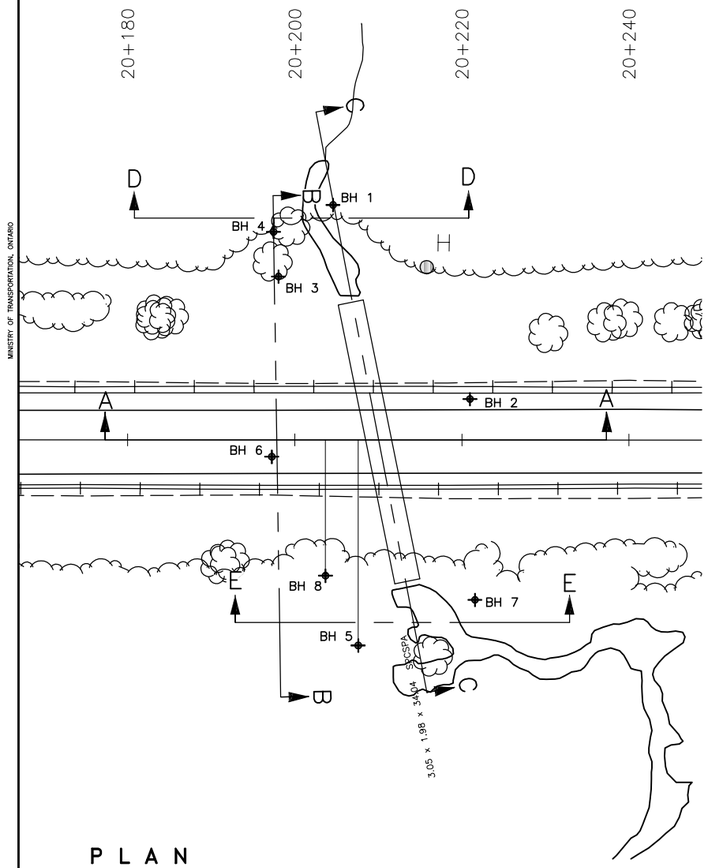
GEOCRES No. 42C-42
CONT No. .
GWP No. 5119-06-00

HWY 17
CULVERT INVESTIGATION @ UNNAMED CREEK
BOREHOLE LOCATIONS AND SOIL STRATA

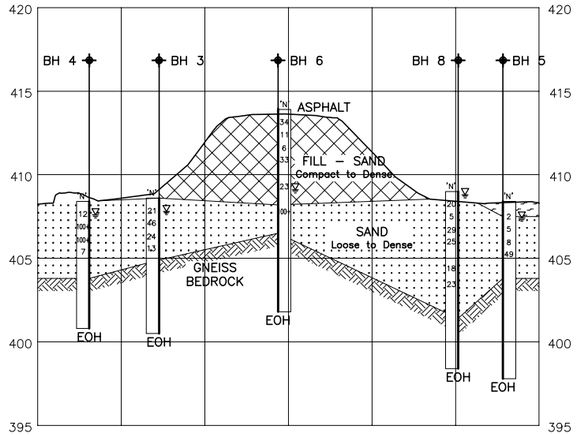
SHEET 1

Ontario
Ministry of Transportation
Northeastern Region

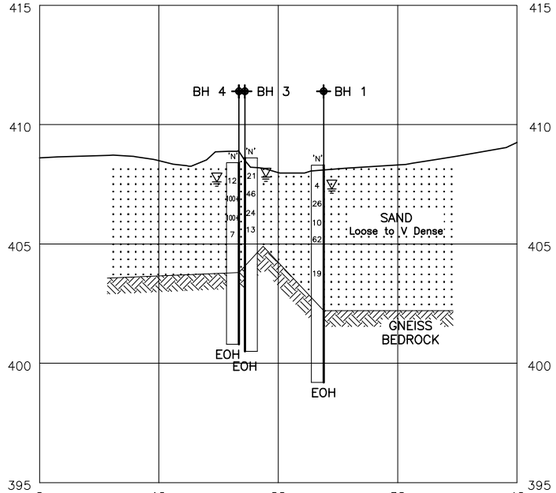
TBT ENGINEERING
CONSULTING GROUP



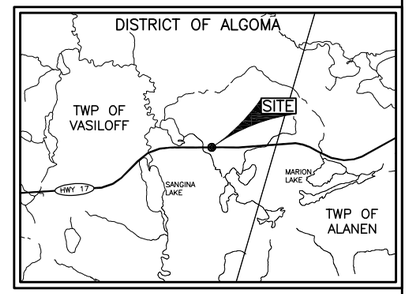
PLAN
SCALE
10 0 10 m



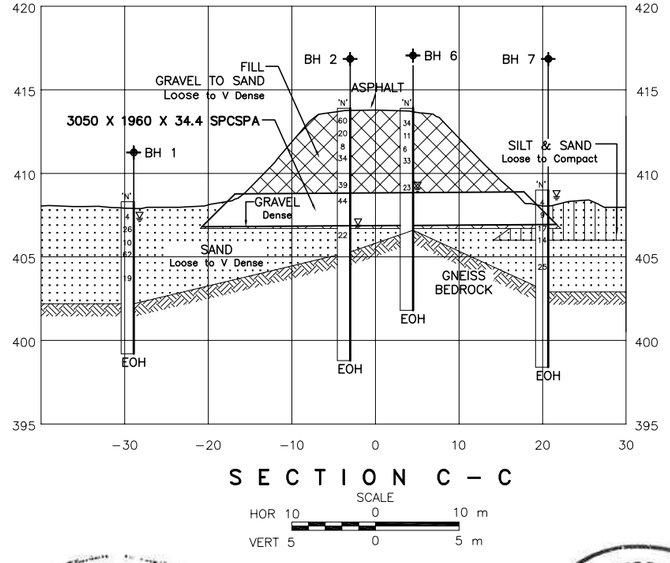
SECTION B – B
SCALE
HOR 10 0 10 m
VERT 5 0 5 m



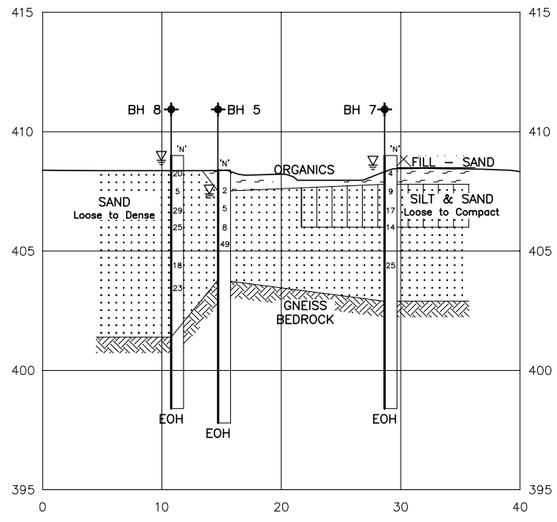
SECTION D – D
SCALE
HOR 10 0 10 m
VERT 5 0 5 m



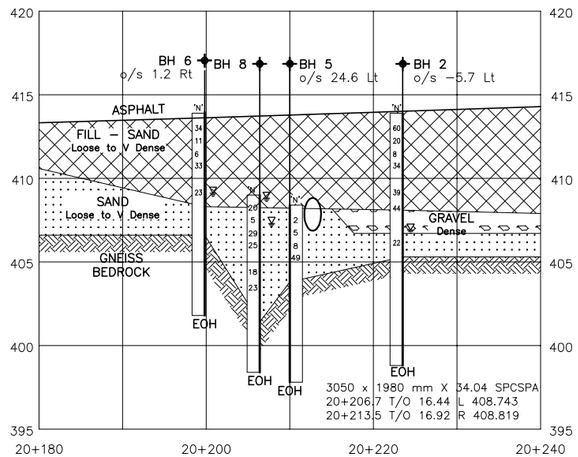
KEY PLAN
2.0 km 2.0 km



SECTION C – C
SCALE
HOR 10 0 10 m
VERT 5 0 5 m



SECTION E – E
SCALE
10 m 0 HOR 10
5 m 0 VERT 5



SECTION A – A
SCALE
HOR 10 0 10 m
VERT 5 0 5 m

SOIL STRATA SYMBOLS

- TOPSOIL/ ORGANICS
- SAND & SILT
- FILL – SAND OR GRAVEL
- GRAVEL
- SAND
- BEDROCK

LEGEND

- Borehole
- 'N' Std Pen Test (Blows/0.3m)
- Water Level
- Water Level on completion
- EOH End of Borehole
- AR Auger Refusal
- CGR Cable Guide Rail
- oFOTS Fibre Optic Transmission Systems

No	ELEVATION	CO-ORDINATES (MTM) NORTH	EAST
BH 1	408.3	13 5 370 169	222 247
BH 2	413.9	13 5 370 147	222 229
BH 3	408.6	13 5 370 173	222 237
BH 4	408.4	13 5 370 175	222 242
BH 5	408.4	13 5 370 152	222 197
BH 6	413.9	13 5 370 168	222 216
BH 7	409.0	13 5 370 140	222 206
BH 8	409.0	13 5 370 158	222 204

NOTE: ELEVATIONS ARE REFERENCED FROM PLAN PLATE No. 980-17/19-0 PROFILE ELEVATION.

LICENSED PROFESSIONAL ENGINEER
W.R. HURLEY
21013503
Sept 29, 2017
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.W.S. SELLER
100043505
Sept 29/17
PROVINCE OF ONTARIO

-NOTE-
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS			
170929	TB	ISSUED	
170621	TB	DRAFT	
		DESCRIPTION	

CO-ORDINATES Lat 48.464629° Long -85.116777°

DESIGN		CHK		CODE XXXXX-XX	LOAD XX-XXX-XXX	DATE 20161224
DRAWN	TB	CHK	GM	SITE 38C-155/C		APPENDIX .

Sep 29, 2017 - 1:02pm Login name: tbtaiden
Drawing Name: K:\Projects\2016\16-139 MTO HDT Hwy 17 Post Eng\Foundations\2_Unnamed Creek\Drawings\Unnamed Creek FNDN FINAL.dwg