

Foundation Investigation Report

Culvert #34 Highway 101

Station 16+932 Township of Muskego

GWP 5383-11-00

Geocres No.: 42B-8

SUBMITTED TO:

Hatch Mott MacDonald
200 South Syndicate
Thunder Bay, Ontario
P7E 1C9



SUBMITTED BY:

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TBT ENGINEERING
CONSULTING GROUP

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Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering Limited (TBTE) has been retained by Hatch Mott MacDonald (HMM) to provide foundation investigation and design services for the proposed culvert replacements on Highway 101 at four separate locations. These sites are a part of the, Highway 101 Resurfacing, from 0.3 km west of Young Street in Foleyet, easterly for 20.9 km, to 0.7 km east of Horwood Lake Road. The foundation investigations were conducted to provide subsurface data for the proposed culvert replacements.

This report addresses the conditions for Culvert #34 located at Sta. 16+932 in the Township of Muskego. The remaining foundation sites (Culvert 17, Culvert 21 and Culvert 48) are addressed under separate covers.

This investigation consisted of two midpoint boreholes drilled adjacent to the existing culvert and two boreholes drilled at the culvert openings, laboratory testing and geotechnical analysis of the data. This report (Part A) describes the subsurface conditions encountered during the investigation. The boreholes are labeled from 200 to 203.

The MTO Foundation section has assigned GEOCRES No. 42B-8 to this site.

2 Site Description

The foundation investigations were completed to investigate subsurface conditions for Culvert #34 located at Sta. 16+932 along Hwy 101 in the Township of Muskego.

Highway 101 runs in an east-west direction at this location. The culvert located at this site is composed of an 800 mm centreline CSP which is to be replaced with an 800 mm pipe culvert. The culvert services an unnamed water course.

The culvert site is located in a rural area of moderate terrain relief. The area is generally tree covered with bedrock outcrops.

The road embankment at this location is approximately 4.0 m high on the right side and 4.5 m on the left side with side slopes of approximately 2 horizontal to 1 vertical on both sides. A low lying swamp area was encountered at both sides of the embankment of the existing culvert openings along Highway 101.

Photo 2.1 – Looking Southerly from Culvert



2.1 Surficial Geology

Available surficial geology mapping (OGS NOEGTS Map 5102 – Foleyet) indicates the site is located in a terrain unit comprised of bedrock knob with a subordinate landform of

sand and boulder till ground moraine. The surrounding terrain is of moderate local relief which is rolling to undulating.

3 Investigation Procedures

A geotechnical site investigation was undertaken from August 22 to 24, 2013 for Boreholes 200 – 202 and November 26, 2013 for Borehole 203. Access to Borehole 203 required the use of swamp mats to traverse the wet soft ground. The borehole locations are illustrated on the Borehole Location and Soil Strata Drawing found in Appendix D.

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 an all-terrain 750 CME drill rig equipped with hollow stem augers and an automatic hammer used to conduct Standard Penetration Testing (SPT). Where auger drilling methods proved unsatisfactory, casing was advanced using wash boring techniques. Due to poor ground conditions swamp mats were used to gain access to drill the borehole at the culvert outlet (Borehole 203). Soil samples were obtained from the auger flights and using a split spoon sampler as a part of the Standard Penetration Testing. Refusal material was sampled using diamond coring techniques.

Surveys were completed by HMM and were based on North American Datum 1983, MTM CSRS Zone 12. HMM has indicated control was established from existing published Horizontal Control Monuments and a Geodetic Benchmark using the Canadian Geodetic Vertical Datum 1928. The following horizontal control points and vertical control points were utilized throughout this project (as provided by HMM):

- HCM #00820020065, #00820020066, #00820020067, #00820020068, #00820020071, #00820020072 and #00820020073
- VCM (GBM) #00819728231 Elev. 329.411, #00819728232 Elev. 328.108, #00819728233 Elev. 343.051, #00819728235 Elev. 345.516, #00819728236 Elev. 349.557 and #00819728239 Elev. 336.635

All boreholes were backfilled with a bentonite mixture following drilling. Temporary standpipes have been removed and decommissioned.

4 Laboratory Testing

Samples which were obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content, Atterberg limits and grain size analysis (where appropriate). The results of this testing are shown on the Borehole Logs (Appendix A) and on the laboratory data reports (Appendix B).

5 Sub-Surface Conditions

Details of the subsurface conditions are provided on the borehole logs (Appendix A) and on the Soil Strata Drawing (Appendix D).

The subsurface soils through the embankment at this site typically consist of embankment fills which overlie native sand over bedrock. Silts and organic matter were encountered within the boreholes at the culvert openings. Occasional cobbles were present within the fill materials and sand layer. All boreholes extended to practical refusal (100+ blows/0.3 m) and refusal material was drilled and/or sampled using diamond casing/coring techniques.

5.1 Asphalt

Asphalt was encountered at embankment surface at Boreholes 201 and 202, which were drilled through the shoulder of the highway. The asphalt's thickness ranged from 45 to 50 mm.

5.2 Fill – Sand to Sand and Gravel

Sand to sand and gravel fill with occasional to numerous cobbles was encountered beneath the asphalt at Borehole 201 and 202. The fill was encountered at elevation 344.4 with a thickness ranging from 4.6 to 5.6 m. A layer of sand fill was also encountered below the surficial root mat in Borehole 203. The sand fill was encountered at elevation 340.5 in Borehole 203 with a thickness of 0.8 m. Grain size analysis conducted on selected samples of the fill material indicate the layer consist of 6 - 39% gravel , 49 - 74% sand and 9 - 41% silt/clay size particles. The material is typically compact to dense as indicated by "N" values of 18 to 42 blows/0.3 m, with one "N" value

of 4 blows/0.3 m within Borehole 201. A single blow count of >100 blows per 0.3 m was measured in Borehole 200, indicative of a cobble or boulder.

5.3 Organic Matter

Organic matter was encountered at Borehole 202 and 203, at the ground surface (elevation 340) of Borehole 203 and elevation 339.8 at Borehole 202. The thickness of the organic matter ranged from 0.2 to 0.9 m. Based on a single sample the natural moisture content of this material is 87 %.

5.4 Silt

Silt was encountered beneath organic matter at Borehole 203. The silt layer was encountered at elevation 339.4 with a thickness of 0.9 m. Grain size distribution analyses conducted on a selected sample indicate the material consists of 0% gravel, 4% sand, and 96% silt/clay sized particles. Atterberg limit tests conducted on the selected sample indicates the material is non plastic. The silt is compact as indicated by "N" value of 17 blows/0.3 m.

5.5 Sand

Sand with occasional cobbles was encountered at all borehole locations. The sand was encountered at elevations ranging from 338.5 to 340.6 and varied in thickness from 2.7 to 6.7 m. Five samples were selected for grain size distribution testing. The sand ranges from some silt to silty with trace to some gravel. The test results indicate a grain size distribution of 1 to 19 % gravel, 49 to 72 % sand, and 15 to 33 % silt/clay sized particles. The sand is very loose to compact as indicated by "N" values ranging from 1 to 28 blows/0.3 m. The presence of cobbles encountered within the sand resulted in "N" occasional values of 100+blows/0.3m.

5.6 Gravel

A gravel layer with occasional cobbles was encountered below the sand in Borehole 200. The gravel layer was encountered at elevation 337.9 with a thickness of 1.2m. Grain size distribution analyses conducted on a selected sample indicate the material consists of 64 % gravel, 30 % sand, and 5 % silt/clay sized particles. The gravel is very compact indicated by "N" value 20 blow/0.3m.

5.7 Bedrock

Bedrock was encountered at all borehole locations. The following table indicates the recorded bedrock elevation and depth at each borehole. Bedrock was encountered underlying the sand in Boreholes 201,202 and 203 and beneath the gravel at Borehole 200. Bedrock was sampled using diamond coring techniques. The bedrock encountered is medium grained biotite granite in Borehole 202 and paragneiss in Borehole 200,201 and 203. Detailed core logs and photos of the rock cores are provided in Appendix A.

Table 5.1: Bedrock

Borehole Number	Bedrock Depth (m)	Bedrock Elevation
200	3.9	336.7
201	11.9	332.5
202	11.9	332.5
203	9.9	334.0

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 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 5.2: RQD/ Rock Quality Correlation

RQD %	ROCK QUALITY
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

The RQD as presented on the borehole and core logs varies from 45 to 100 %. The majority of RQDs were measured to be 69 to 100 % and can be described as fair to excellent, with one sample with an RQD of 45 % indicating poor quality at Borehole 201.

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

Table 5.3: Estimated Uniaxial Compressive Strength

Borehole Number	Depth (m)	Elevation	*Estimated Uniaxial Compressive Strength (MPa)
200	5.20	331.5	220
	5.60	331.1	255
	6.90	329.8	269
201	12.60	319.9	304
	13.80	318.7	271
	14.90	317.6	268
202	12.00	320.5	158
	12.80	319.7	143
	13.70	318.8	175

* Estimated based on published correlations.

Based on the range in estimated uniaxial compressive strength, the intact bedrock is classified as very strong to extremely strong.

5.8 Ground Water

The ground water levels observed upon completion of drilling on August 22, 2013 are provided below. Ground water levels will vary from season to season and from the effects of heavy precipitation events.

Table 5.4: Ground Water Level

Borehole	Depth below Ground Surface (m)	Elevation
200	0.7	339.8
203	0.3	340.4

6 Miscellaneous

Laboratory testing was conducted at the TBT Engineering Limited laboratory in Thunder Bay. The drill equipment for this investigation was operated by TBT Engineering. The field operations were supervised by Alan Finke and Peter Pilgrim. 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).

7 Limitations

Conclusions and recommendations presented in this report are based on the information determined at the borehole 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.

8 Closure

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

Yours truly,

For TBT ENGINEERING



Steven Seller, P.Eng
Senior Project Engineer



Wayne Hurley, P.Eng.
Senior Engineer
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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

	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	l	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	l	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	l	COMPRESSION INDEX
C_s	l	SWELLING INDEX
C_a	l	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	l	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_i	l	SENSITIVITY = $\frac{C_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

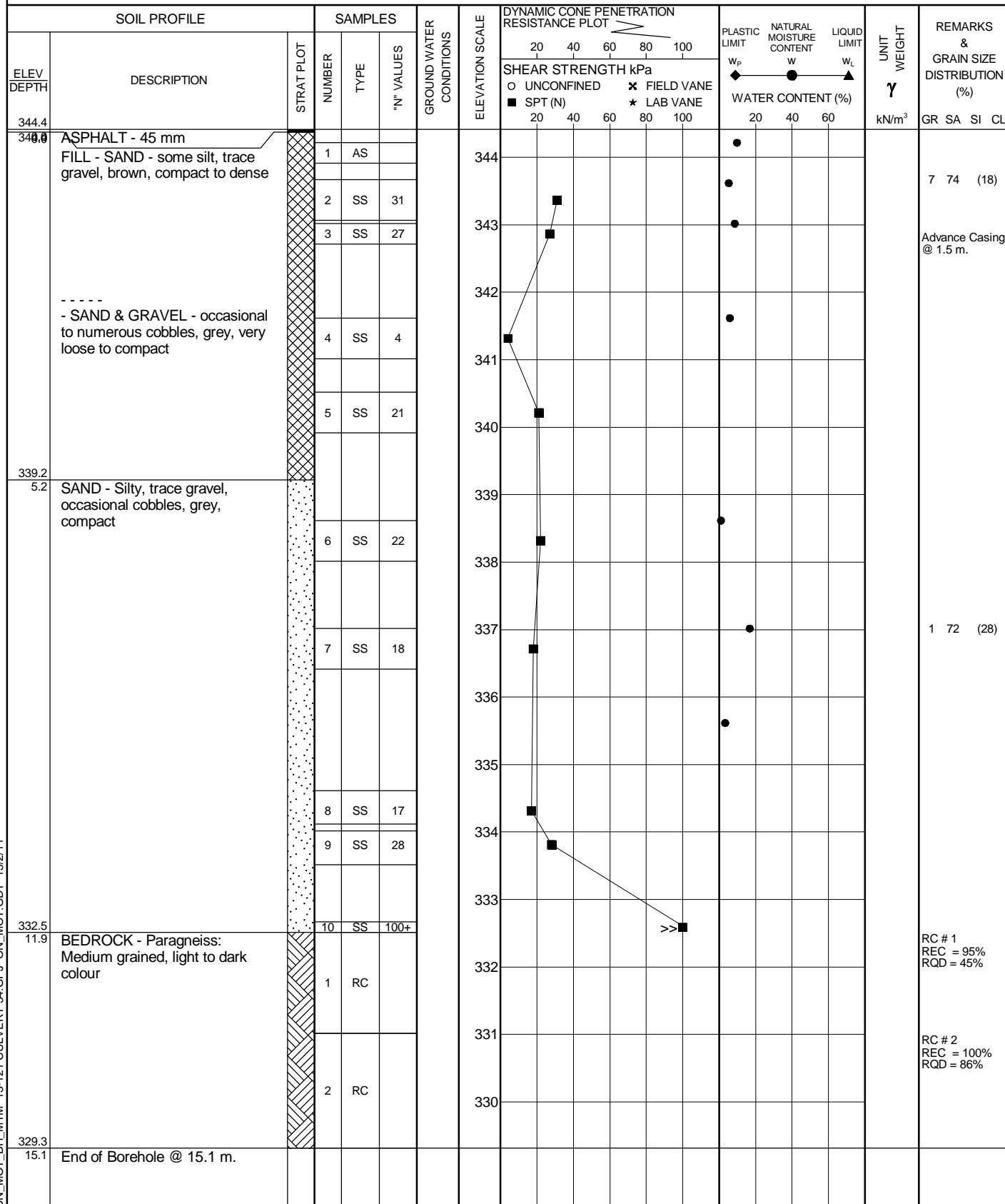
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	l, %	VOID RATIO	e_{min}	l, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	l, %	POROSITY	I_D	l	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	l, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	l	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	l	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	l	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	l	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	l, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

TBT Engineering Consulting Group		RECORD OF Borehole No 200				1 OF 1		METRIC					
W.P. 5383-11-00		PROJECT Culvert Investigation		SITE NO. Culvert #34		ORIGINATED BY C.H.							
TWP Muskego HWY 101		LOCATION MTM 12 N5344078.417, E206388.076		TBTE JOB# 13-121		COMPILED BY T.B.							
DATE 2013 August 22		BOREHOLE TYPE Hollow Stem Auger/B Casing/Core		DATUM Geodetic		CHECKED BY S.S.							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES						SHEAR STRENGTH kPa
340.6						20	40	60	80	100			
0.0	SAND - some gravel, some silt, brown, compact to very dense		1	AS									
			2	SS	16								
			3	SS	100+								
337.9	GRAVEL - Sandy, trace silt, numerous cobbles, brown, compact		4	SS	20								
336.7	BEDROCK - Paragneiss: Medium grained, light to dark colour		5	SS	100+								
333.4			1	RC									
			2	RC									
7.2	End of Borehole @ 7.2 m.												

x³, ★³: Numbers refer to Sensitivity
 NP Non Plastic
 ○ 3% STRAIN AT FAILURE

ONL_MOT_BH_MTM 13-121 CULVERT 34.GPJ ONL_MOT_GDT 15/2/11

TBT Engineering Consulting Group		RECORD OF Borehole No 201		1 OF 1	METRIC
W.P. 5383-11-00	PROJECT Culvert Investigation	SITE NO. Culvert #34	ORIGINATED BY C.H.		
TWP Muskego HWY 101	LOCATION MTM 12 N5344077.912, E206373.416	TBTE JOB# 13-121	COMPILED BY T.B.		
DATE 2013 August 23	BOREHOLE TYPE Hollow Stem Auger	DATUM Geodetic	CHECKED BY S.S.		



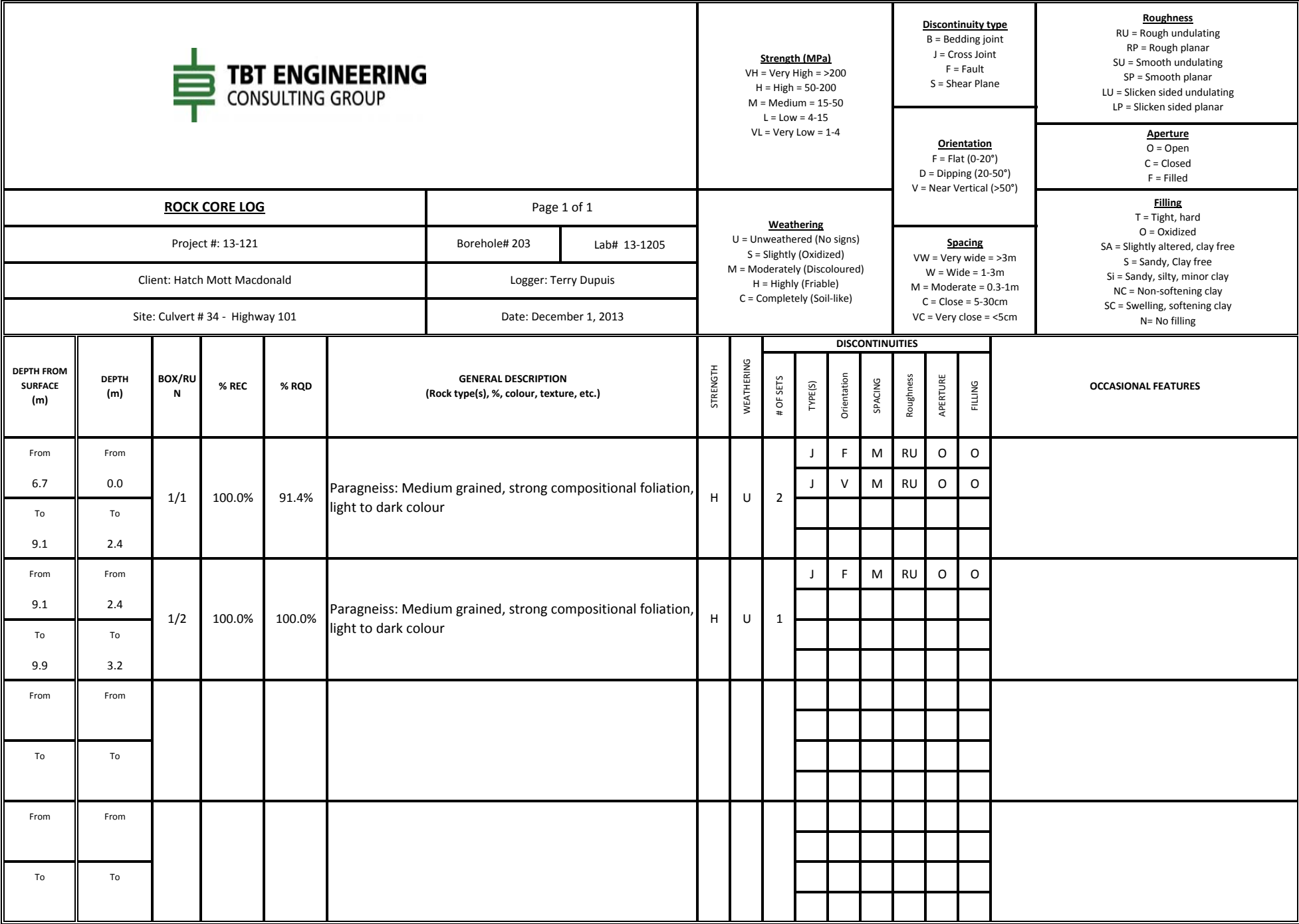
ONL_MOT_BH_MTM 13-121 CULVERT 34.GPJ ONL_MOT_GDT 15/2/11

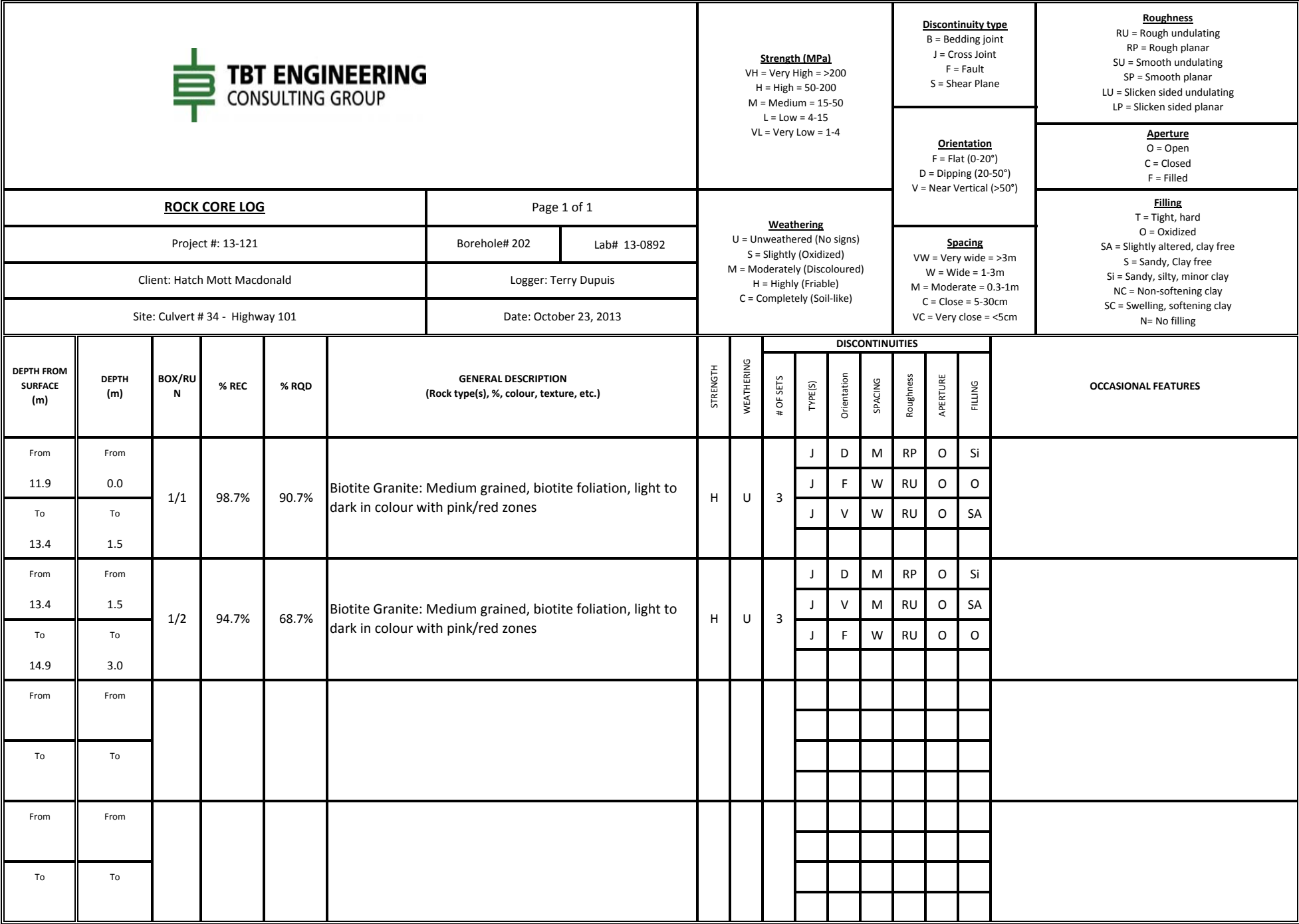
\times^3, \star^3 : Numbers refer to Sensitivity
 NP Non Plastic
 O 3% STRAIN AT FAILURE

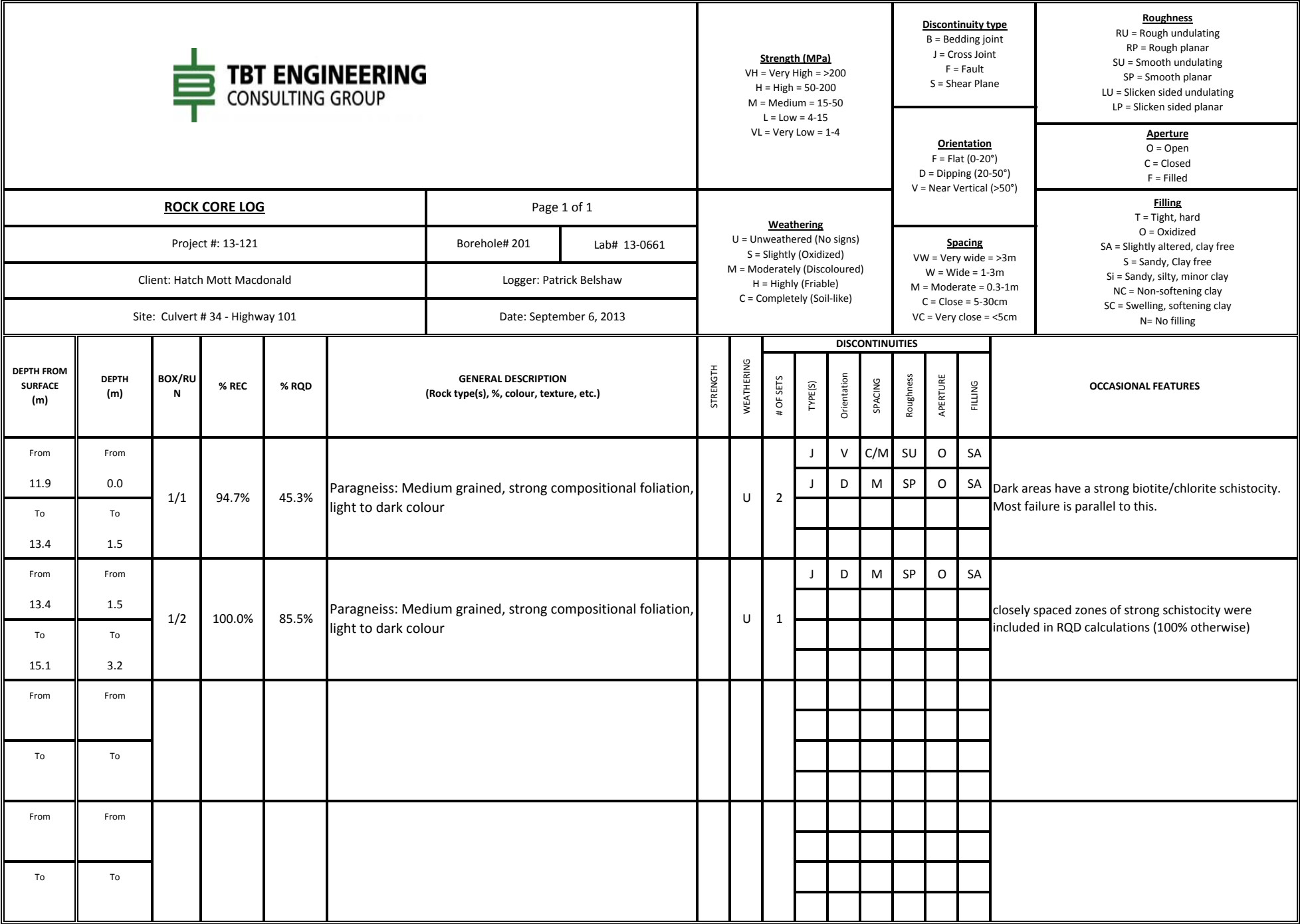
TBT Engineering Consulting Group			RECORD OF Borehole No 202			1 OF 1			METRIC												
W.P. 5383-11-00			PROJECT Culvert Investigation			SITE NO. Culvert #34			ORIGINATED BY C.H.												
TWP Muskego HWY 101			LOCATION MTM 12 N5344068.454, E206373.193			TBTE JOB# 13-121			COMPILED BY T.B.												
DATE 2013 August 24			BOREHOLE TYPE Hollow Stem Auger/B Casing/Core			DATUM Geodetic			CHECKED BY S.S.												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE														
344.4	ASPHALT - 50 mm						344														
340.9	FILL - SAND & GRAVEL - trace silt, brown to grey		1	AS																	39 52 (9)
	- SAND & SILT to Silty - trace to some gravel, occasional cobbles, compact to dense		2	SS	42																Water level @ 4.3 m on completion.
			3	SS	30																14 50 (35)
			4	SS	20																
			5	SS	23																11 65 (24)
			6	SS	18																
339.8	PEAT - numerous cobbles, brown		7	SS	15																6 53 (41)
338.7	SAND - Silty, some to trace gravel, occasional cobbles, grey, loose to compact		8	SS	12																19 49 (33)
			9	SS	16																
			10	SS	10																
			11	SS	8																6 65 (29)
332.9	SAND - Gravelly, some silt, occasional cobbles, grey, compact		12	SS	27																27 55 (18)
332.5	BEDROCK - Biotite Granite: Medium grained, light to dark in colour with pink/red zones		1	RC																	RC # 1 REC = 99% RQD = 91%
329.5			2	RC																	RC # 2 REC = 95% RQD = 69%
14.9	End of Borehole @ 14.9 m.																				

ONL_MOT_BH_MTM 13-121 CULVERT 34.GPJ ONL_MOT_GDT 15/2/11

TBT Engineering Consulting Group			RECORD OF Borehole No 203			1 OF 1			METRIC					
W.P. 5383-11-00			PROJECT Culvert Investigation			SITE NO. Culvert #34			ORIGINATED BY C.H.					
TWP Muskego HWY 101			LOCATION MTM 12 N5344071, E206357			TBTE JOB# 13-121			COMPILED BY T.B.					
DATE 2013 November 26			BOREHOLE TYPE Hollow Stem Auger/Core			DATUM Geodetic			CHECKED BY S.S.					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT		
340.7								20 40 60 80 100	W _p	W	W _L	γ	GR SA SI CL	
340.6	ROOTMAT/ORGANICS		1	AS			340	○ UNCONFINED	◆				Water level @ 0.3 m on completion.	
0.2	FILL - SAND - grey							✕ FIELD VANE						
340.0			2	SS	1			★ LAB VANE						
0.8	PEAT & ORGANICS							■ SPT (N)						
339.4			3	SS	17		339						0 4 (96)	
1.3	SILT - trace sand, grey, compact													
338.5			4	SS	3		338							
2.2	SAND - Silty, trace gravel, occasional cobbles, grey, very loose to compact		5	SS	21								5 72 (23)	
			6	SS	1		337						Flowing Sand	
			7	SS	1		336						Flowing Sand	
			8	SS	100+		335							
334.0														
6.7	BEDROCK - Paragneiss: Medium grained, light to dark colour		1	RC			334						RC # 1 REC = 100% RQD = 91%	
			2	RC			333							
							332							
330.8							331						RC # 2 REC = 100% RQD = 100%	
9.9	End of Borehole @ 9.9 m.													

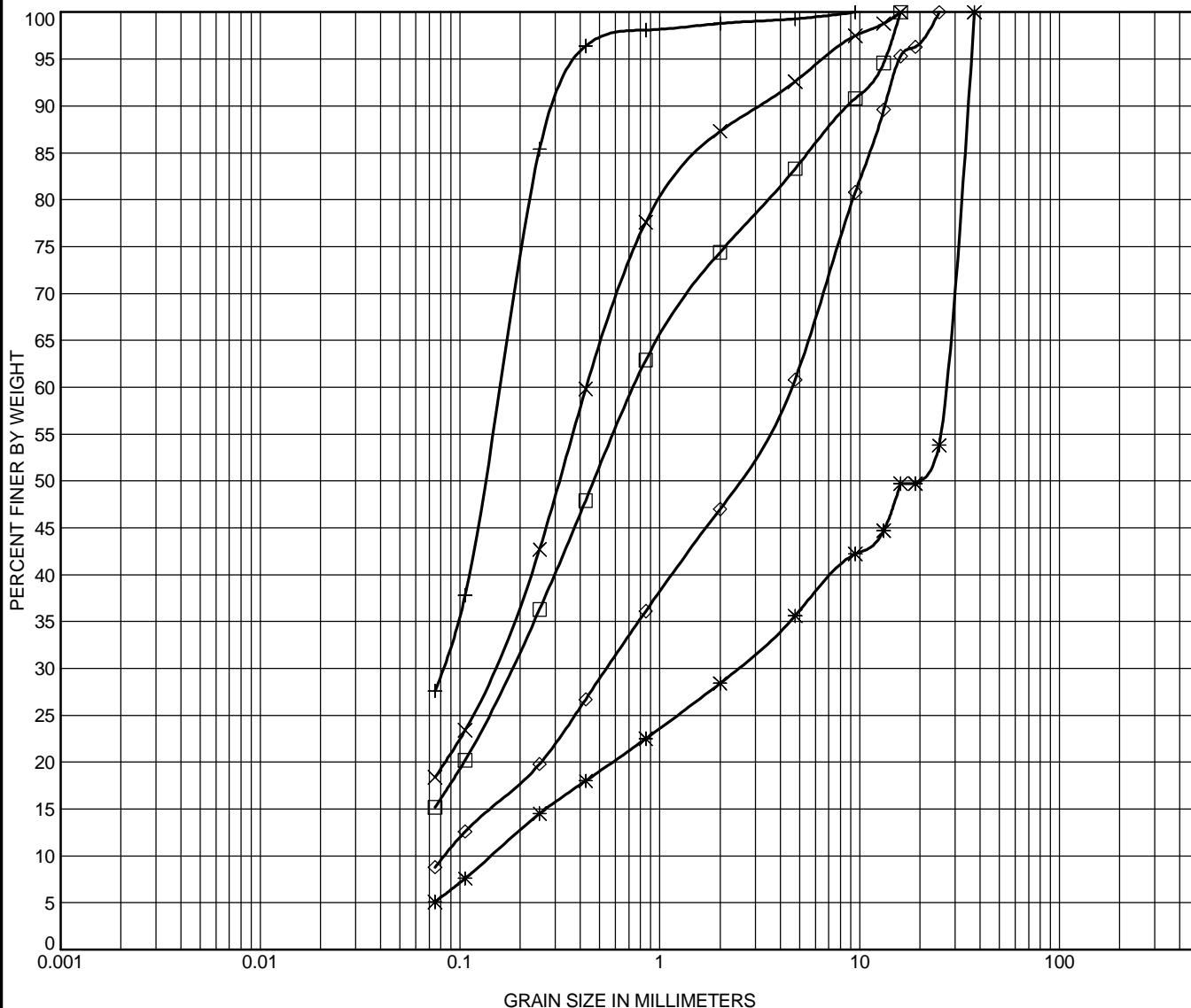






APPENDIX B

Laboratory Test Data



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
TILL - SILTS & SANDS & GRAVELS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 200	0.75	16	0.743	0.179		16.7	68.1	15.2	
* 200	3.00	37.5	26.398	2.424	0.143	64.4	30.5	5.1	
× 201	0.75	16	0.428	0.142		7.4	74.2	18.4	
+ 201	7.40	9.5	0.158	0.081		0.7	71.7	27.6	
◇ 202	0.40	25	4.518	0.542	0.084	39.2	52.0	8.8	



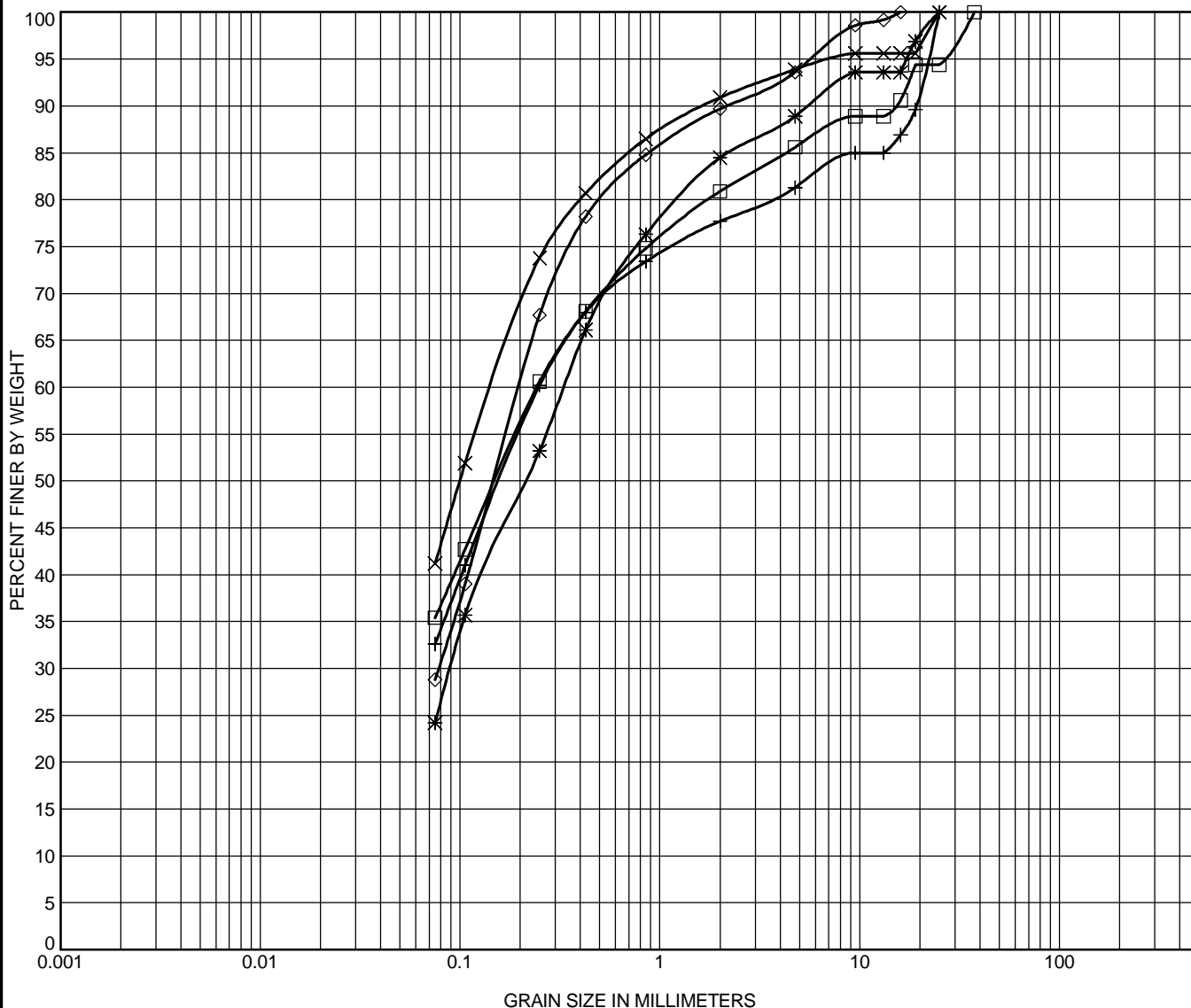
TBT Engineering Ltd.
1918 Yonge Street
Thunder Bay, Ontario P7E 6T9
PH: 807-624-5160
FX: 807-624-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: Culvert Investigation

W P: 5383-11-00

DIST: Muskego HWY: 101



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
TILL - SILTS & SANDS & GRAVELS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 202	1.50	37.5	0.243			14.4	50.2	35.4	
* 202	3.00	25	0.331	0.089		11.1	64.7	24.2	
× 202	4.50	25	0.146			6.1	52.7	41.2	
+ 202	6.00	25	0.248			18.7	48.7	32.6	
◇ 202	10.50	16	0.199	0.078		6.4	64.8	28.8	



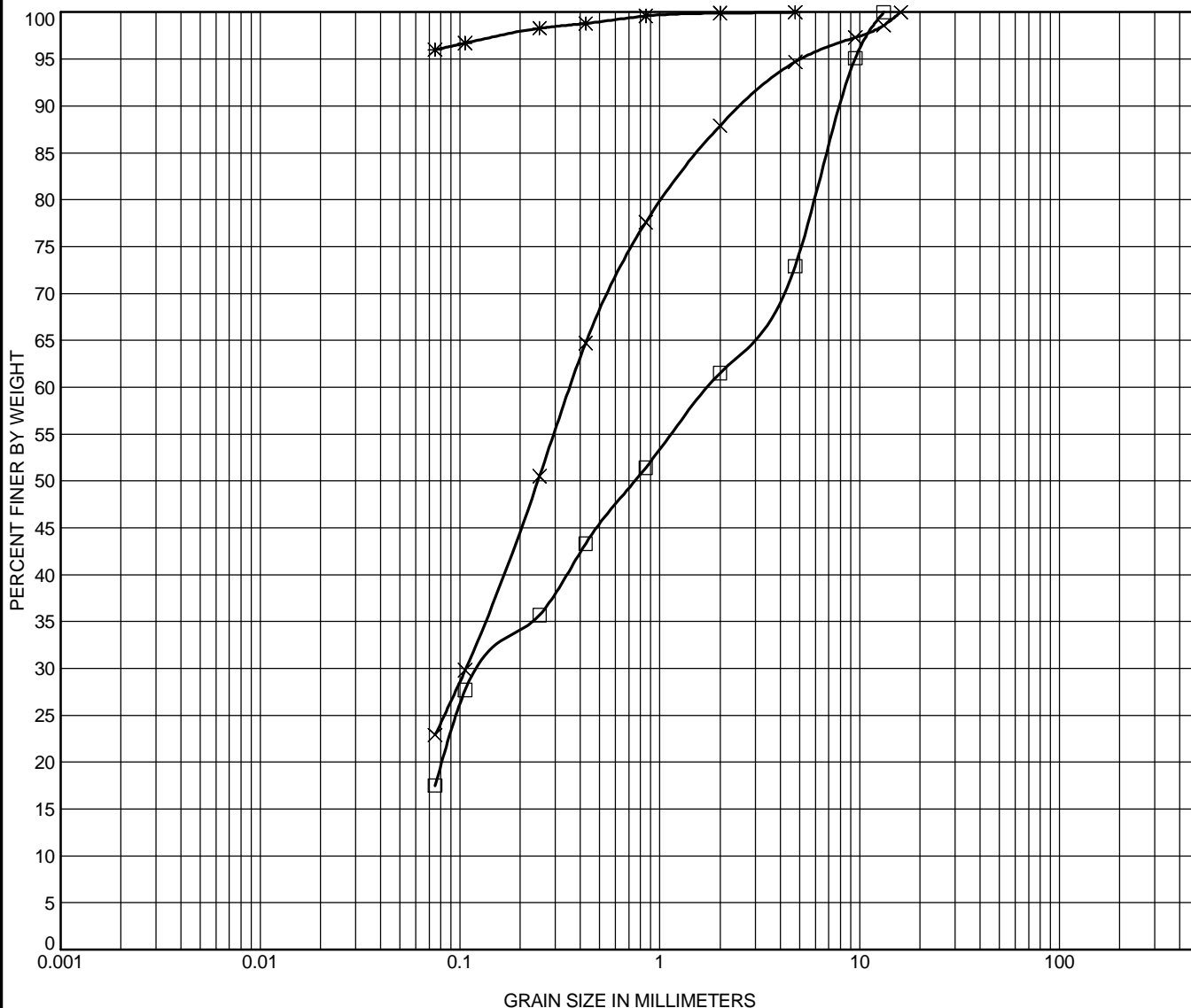
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GRAIN SIZE DISTRIBUTION

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SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
TILL - SILTS & SANDS & GRAVELS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 202	12.00	13.2	1.761	0.136		27.1	55.4	17.5	
* 203	1.50	4.75				0.0	4.0	96.0	
× 203	3.00	16	0.357	0.107		5.3	71.8	22.9	



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APPENDIX C

Borehole Locations and Soil Strata Drawing

