

Foundation Investigation Report

Culvert #17 Highway 101

Station 25+929 Township of Foleyet

GWP 5383-11-00

Geocres No.: 42B-11

SUBMITTED TO:

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



SUBMITTED BY:

TBT ENGINEERING LIMITED

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SUBMISSION DATE:

Mach 13, 2015



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, 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 #17 located at Sta. 25+929 in the Township of Foleyet. The remaining foundation sites (Culvert 21, Culvert 34 and Culvert 48) are addressed under separate covers.

This investigation consisted of two midpoint boreholes drilled adjacent to the existing culvert, two boreholes drilled for roadway protection, 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 400 to 405.

The foundation section has assigned GEOCRES No. 42B-11 to this site.

2 Site Description

The foundation investigations were carried out to investigate subsurface conditions for Culvert #17 located at Sta. 25+929 along Hwy 101 in the Township of Foleyet, County of New Liskeard Area. The culvert located at this site is a 1500 mm centreline CSP which is to be replaced with an 1800 mm pipe culvert. The culvert services the Black creek.

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 5.5 m high with side slopes of approximately 2 horizontal to 1 vertical on both the right and left side. The left side of road embankment side slope steepens to approximately 1 horizontal to 1 vertical from 3.5 m below the top of the embankment to the original ground elevation. A low lying swamp area was encountered at both ends of the existing culvert along Highway 101. There is a bedrock outcrop westerly on the right side of the highway. The water level in the water course at the culvert inlet was measured at approx. elevation of 323.4 on September 11, 2013.

Photo 2.1 – Looking Easterly 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 September 11 to the 21, 2013 for Boreholes 400 . 404 and November 26, 2013 for Borehole 405. 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 mounted drill rig equipped with hollow stem augers and a cat head used to carry out Standard Penetration Testing (SPT). Where auger drilling methods proved unsatisfactory, casing was advanced using wash boring techniques. 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. Due to poor ground conditions swamp mats were used to gain access to drill the borehole at the culvert outlet (Borehole 405).

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 and core logs (Appendix A) and on the Soil Strata Drawing (Appendix D).

The subsurface soils at this site typically consist of fills (through the embankment) which overlie silts over bedrock. All boreholes with the exception of Borehole 400 extended to refusal material which was drilled and/or sampled using diamond casing/coring techniques.

5.1 Asphalt

Asphalt was encountered at ground surface at Boreholes 401, 402, 403, and 404. The asphalt thickness is 45 mm.

5.2 Organic Matter

Organic matter was encountered at the ground surface of Borehole 400 and 405. The material thickness ranged between 0.2 to 0.5 m.

5.3 Fill - Sand

Sand and gravel fill to sand and silt with trace gravel was encountered beneath the asphalt at Boreholes 401, 402, 403, and 404, and beneath the organic matter at Boreholes 400 and 405. The fill was encountered at elevations 328.1 to 328.3 and varied in thicknesses from 3.9 to 5.9 m at Boreholes 401, 402, 403 and 404. At Boreholes 400 and 405 the fill was encountered at elevations 323.4 and 324.4 with thickness of 2.9 and 0.2 m, respectively.

Four samples were selected for grain size distribution testing. The fill ranges from silt and sand with trace gravel; sand with some silt; to sand and gravel with trace silt. The test results indicate a grain size distribution of 0 to 35 % gravel, 37 to 84 % sand, and 8 to 58 % silt/clay sized particles. The presence of cobbles was noted within the fill. At several locations casing was used to advance the borehole through coarser materials following auger refusal.

Some organics were observed in the fill at Borehole 400 which was drilled near the toe of the slope.

The sand is typically compact to very dense as indicated by N_{60} values ranging from 16 to 48 blows/0.3 m. The fill is in a very loose to loose condition at Borehole 400 as indicated by N_{60} values ranging from 2 to 9 blows/0.3m.

5.4 Silt

Silt was encountered beneath the fill in all six boreholes. The silt layer was encountered at elevations ranging from 321.0 to 324.5 and varied in thickness from 4.2 to 10.3 m.

Nine samples were selected for grain size distribution testing. The material ranges from silt with trace to some sand. The test results indicate a grain size distribution of 0 % gravel, 1 to 12 % sand, and 88 to 100 % silt/clay sized particles. Atterberg limit tests conducted on selected samples of the silt indicates the material is non plastic.

The silt is typically loose to compact as indicated by N_{60} values ranging from 5 to 23 blows/0.3 m. A single N_{60} value of 3 blows/0.3 m was recorded at Borehole 405 at a depth of 9.1 m. At Borehole 401 at a depth of 13.6 m a very dense silt layer was encountered as indicated by an N_{60} value of 100+ blows/0.3 m.

5.5 Sand

Silty sand was encountered below the silt in Borehole 400. The sand layer was encountered at an elevation 316.8 with a thickness of 1.5 m. The sand is very loose indicated by an N_{60} value of 1 blows/0.3m.

5.6 Gravel

A silty, sandy gravel layer with occasional cobbles was encountered below the sand in Borehole 400 and below the silt in Borehole 404. The gravel layer was encountered at an elevation of 315.3 with a thickness of 0.3 m. Grain size analysis conducted on selected samples of the gravel layer indicate the layer consist of 55% gravel , 22 % sand and 24% silt/clay size particles. The gravel is dense to very dense as indicated by an N_{60} value of 49 blows/0.3m.

5.7 Bedrock

Bedrock was encountered at all borehole locations with the exception of Borehole 400. The following table indicates the recorded bedrock elevation and depth at each borehole. Bedrock was encountered underlying the silt at Borehole 401,402,403 and 405 and underlying gravel at Borehole 400. Bedrock was sampled using diamond coring techniques. The bedrock in Boreholes 401,402,403,404 and 405 is composed of medium grained monzodiorite, with Borehole 400 composed of fine grained biotite granite. 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
401	1.4	314.2
402	1.3	314.6
403	1.5	313.5
404	1.5	314.7
405	1.7	314.0

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 38 to 100 %. The majority of RQDs were measured to be 68 to 100 % and can be described as fair to excellent, with one sample with an RQD of 38 % indicating poor quality at Borehole 402. 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)
401	14.3	314.1	265
	14.80	313.6	271
402	13.80	314.5	245
	14.70	313.6	172
403	15.40	312.8	85
	15.90	312.3	232
404	13.80	314.6	215
	14.90	313.5	272

* Estimated based on published correlations.

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

5.8 Ground Water

The ground water levels were observed upon completion of drilling from September 11 to November 26, 2013 are provided below. Ground water levels will vary from season to season and from the effects of heavy precipitation events. The water level at the culvert inlet was measured at approx. elevation of 323.4 on September 11, 2013.

Table 5.4: Ground Water Level

Borehole	Depth below Ground Surface (m)	Elevation
400	0.5	323.4
405	0.9	323.7

6 Miscellaneous

Laboratory testing was carried out 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.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer.

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 the contact us at your convenience.

Yours truly,

For TBT ENGINEERING



Steven Seller, P.Eng
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

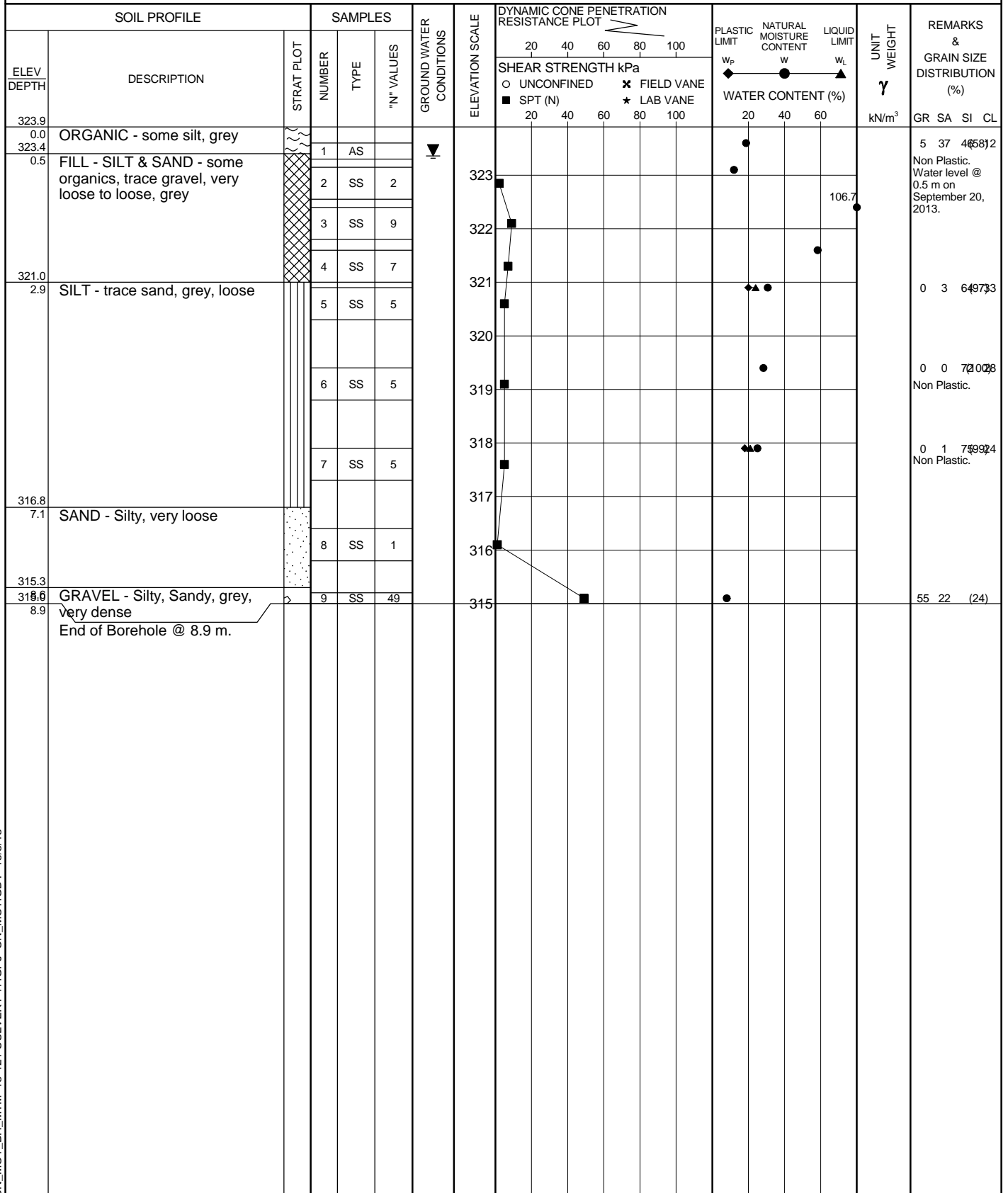
MECHANICAL PROPERTIES OF SOIL

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^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

TBT Engineering Consulting Group		RECORD OF Borehole No 400		1 OF 1	METRIC
W.P. 5383-11-00	PROJECT Culvert Investigation	SITE NO. Culvert #17	ORIGINATED BY C.H.		
TWP Foleyet HWY 101	LOCATION MTM N5347486.648, E200325.713	TBTE JOB# 13-121	COMPILED BY T.B.		
DATE 2013 September 11	BOREHOLE TYPE Hollow Stem Auger	DATUM Geodetic	CHECKED BY S.S.		

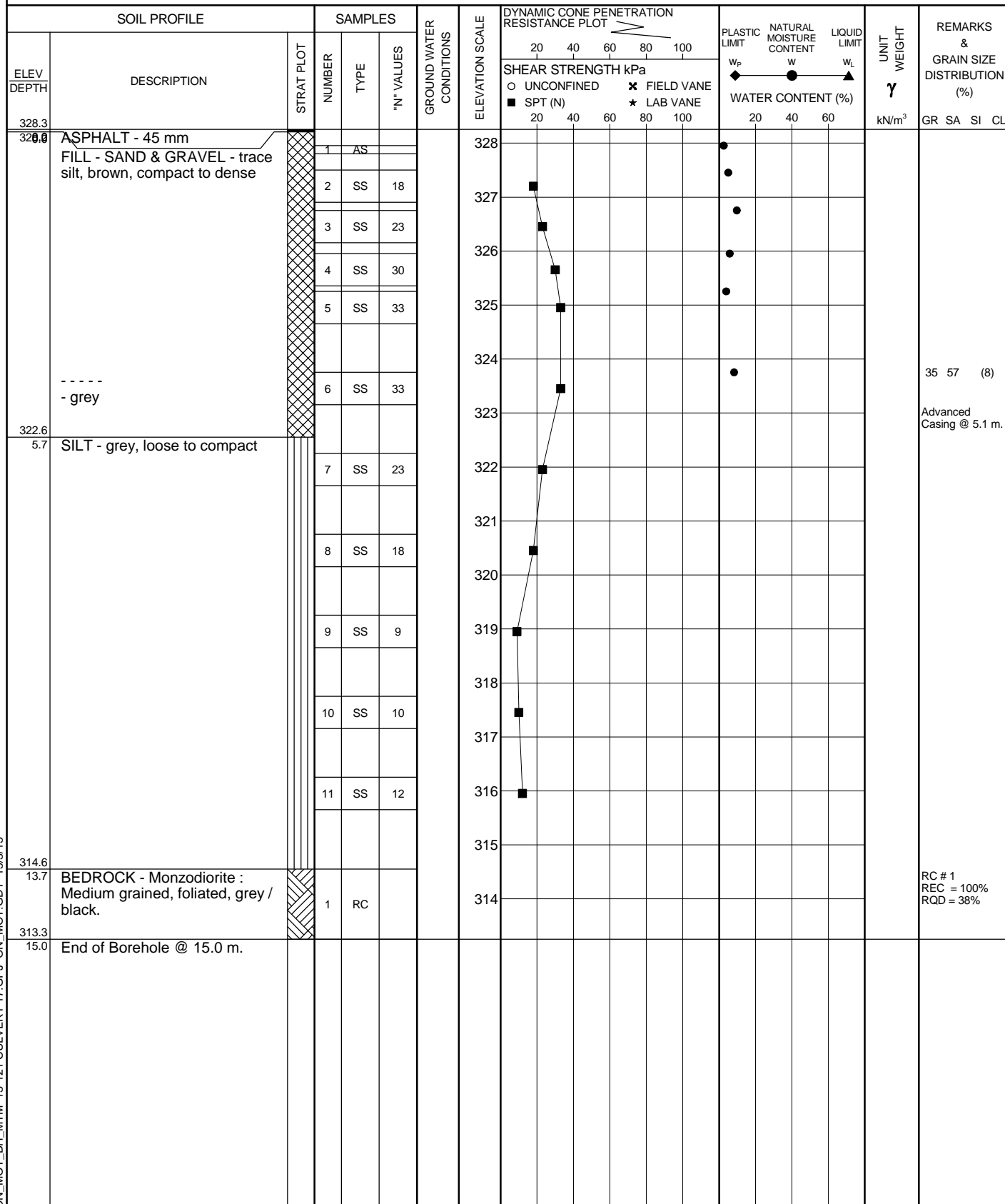


x³, ★³: Numbers refer to Sensitivity
 NP Non Plastic
 ○ 3% STRAIN AT FAILURE

ONL_MOT_BH_MTM 13-121 CULVERT 17.GPJ ONL_MOT_GDT 15/3/13

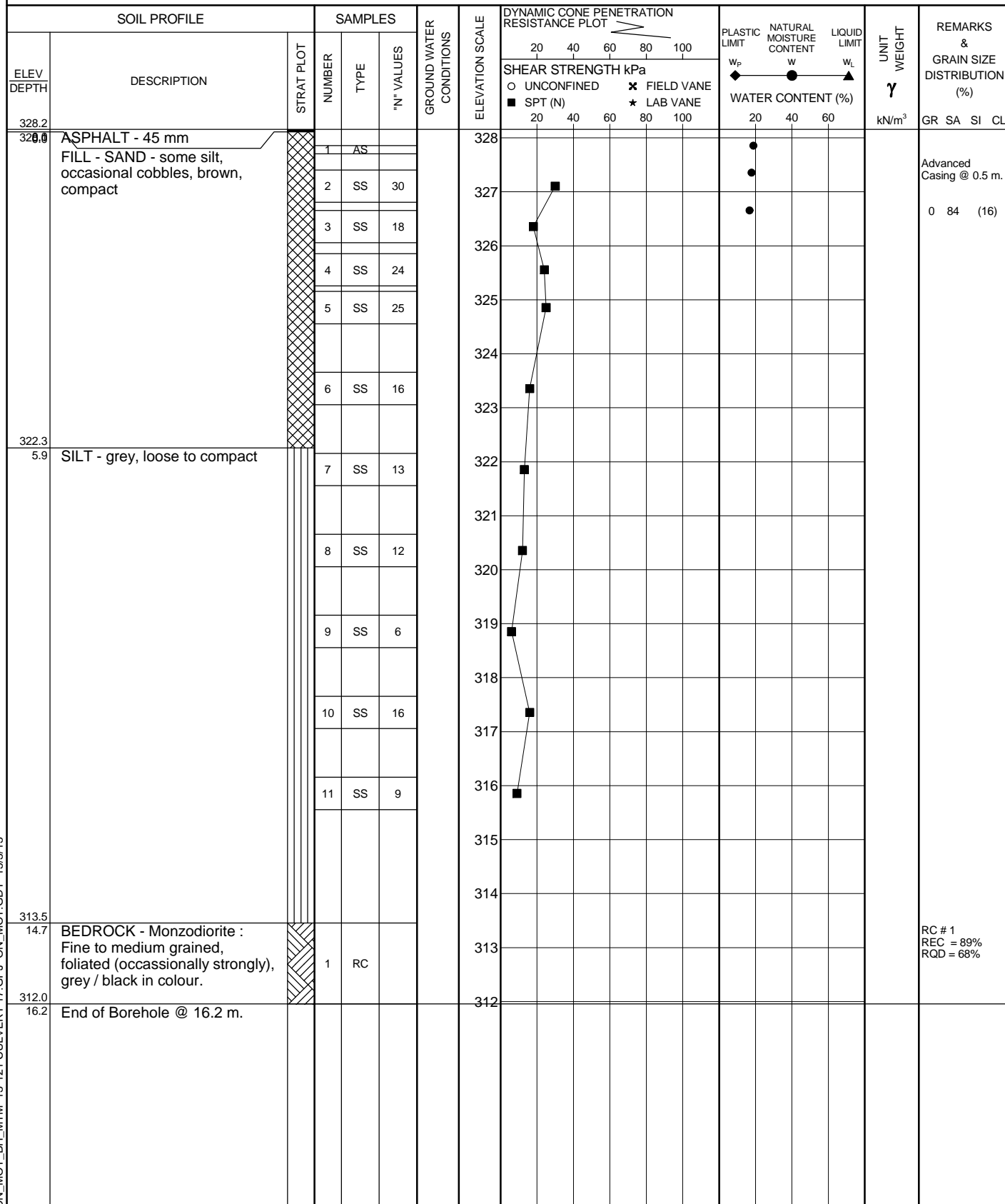
TBT Engineering Consulting Group			RECORD OF Borehole No 401			1 OF 1		METRIC											
W.P. 5383-11-00			PROJECT Culvert Investigation			SITE NO. Culvert #17		ORIGINATED BY P.P.											
TWP Foleyet HWY 101			LOCATION MTM N5347460.653, E200343.299			TBTE JOB# 13-121		COMPILED BY T.B.											
DATE 2013 September 18			BOREHOLE TYPE Hollow Stem Auger/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		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	20 40 60	20 40 60 80 100	20 40 60	γ	GR SA SI CL		
328.4	ASPHALT - 45 mm		1	AS			328												
328.0	FILL - SAND - some silt, trace gravel, occasional cobbles, brown, compact to very dense		2	SS	48		327											4 76 (20)	
			3	SS	14		326												
	----- - grey		4	SS	100+		325												
			5	SS	22		324												
324.5	SILT - grey, loose to compact		6	SS	14		323												
3.9			7	SS	8		322												
			8	SS	7		321												
			9	SS	11		320												
			10	SS	10		319												
			11	SS	10		318												
			12	SS	100+		317												
							316												
							315												
							314												
							313												
314.2	BEDROCK - Biotite Granite: Fine grained, massive with occasional slight biotite foliation, grey in colour.			1	RC														
14.2																			
312.8	End of Borehole @ 15.6 m.																		
15.6																			

TBT Engineering Consulting Group		RECORD OF Borehole No 402		1 OF 1	METRIC
W.P. 5383-11-00	PROJECT Culvert Investigation	SITE NO. Culvert #17	ORIGINATED BY P.P.		
TWP Foleyet HWY 101	LOCATION MTM N5347471.325, E200320.691	TBTE JOB# 13-121	COMPILED BY T.B.		
DATE 2013 September 19	BOREHOLE TYPE Hollow Stem Auger/Casing/Core	DATUM Geodetic	CHECKED BY S.S.		



ONL_MOT_BH_MTM 13-121 CULVERT 17.GPJ ONL_MOT_GDT 15/3/13

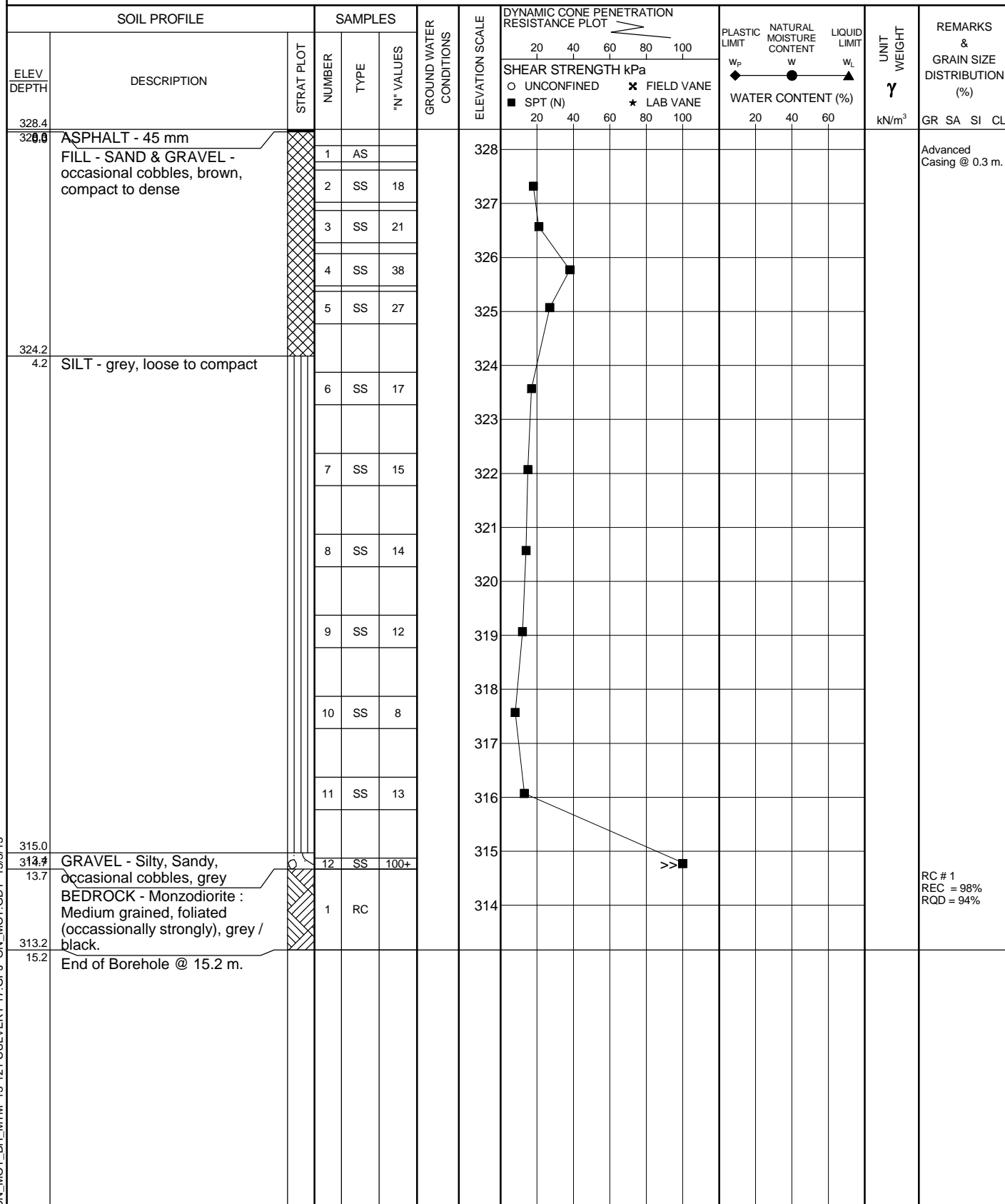
TBT Engineering Consulting Group		RECORD OF Borehole No 403		1 OF 1	METRIC
W.P. 5383-11-00	PROJECT Culvert Investigation	SITE NO. Culvert #17	ORIGINATED BY P.P.		
TWP Foleyet HWY 101	LOCATION MTM N5347478.09, E200307.297	TBTE JOB# 13-121	COMPILED BY T.B.		
DATE 2013 September 19	BOREHOLE TYPE Hollow Stem Auger/Casing/Core	DATUM Geodetic	CHECKED BY S.S.		



ONL_MOT_BH_MTM 13-121 CULVERT 17.GPJ ONL_MOT_GDT 15/3/13

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

TBT Engineering Consulting Group		RECORD OF Borehole No 404		1 OF 1	METRIC
W.P. 5383-11-00	PROJECT Culvert Investigation	SITE NO. Culvert #17	ORIGINATED BY P.P.		
TWP Foleyet HWY 101	LOCATION MTM N5347462.419, E200326.44	TBTE JOB# 13-121	COMPILED BY T.B.		
DATE 2013 September 21	BOREHOLE TYPE Hollow Stem Auger/Casing/Core	DATUM Geodetic	CHECKED BY S.S.		



ONL_MOT_BH_MTM 13-121 CULVERT 17.GPJ ONL_MOT_GDT 15/3/13

TBT Engineering Consulting Group			RECORD OF Borehole No 405			1 OF 1		METRIC					
W.P. 5383-11-00			PROJECT Culvert Investigation			SITE NO. Culvert #17		ORIGINATED BY P.P.					
TWP Foleyet HWY 101			LOCATION MTM N5347452, E200323			TBTE JOB# 13-121		COMPILED BY T.B.					
DATE 2013 November 26			BOREHOLE TYPE Hollow Stem Auger/Casing/Core			DATUM Geodetic		CHECKED BY S.S.					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p W W _L	γ	GR SA SI CL	
324.6 324.1 0.5	ORGANIC FILL - SAND & GRAVEL & PEAT - brown/black SILT - trace sand, brown, very loose to compact ----- - grey		1	AS			324						Water level @ 0.9 m on completion. 0 9 (91) 0 1 749926 Non Plastic. 0 1 809919 Non Plastic. RC # 1 REC = 94% RQD = 78%
			2	SS	11		323						
			3	SS	12		322						
			4	SS	8		321						
			5	SS	7		320						
			6	SS	6		319						
			7	SS	6		318						
			8	SS	8		317						
			9	SS	8		316						
			10	SS	3		315						
314.0 10.6	BEDROCK - Monzodiorite : Medium grained, strongly foliated, grey / black in colour.		1	RC			314						
312.3 12.3	End of Borehole @ 12.3 m.						313						

ROCK CORE LOG

Page 1 of 1

Project #: 13-121

Borehole# 401

Lab# 13-0893

Client: Hatch Mott Macdonald

Logger: TD / SD

Site: Highway 101

Date: October 23, 2013

<div>TBT ENGINEERING CONSULTING GROUP</div>										<div>Strength (MPa) VH = Very High = >200 H = High = 50-200 M = Medium = 15-50 L = Low = 4-15 VL = Very Low = 1-4</div>										<div>Discontinuity type B = Bedding joint J = Cross joint F = Fault S = Shear Plane</div>										<div>Roughness RU = Rough undulating RP = Rough planar SU = Smooth undulating SP = Smooth planar LU = Slicken sided undulating LP = Slicken sided planar</div>																			
<div>ROCK CORE LOG</div>										Page 1 of 1										<div>Weathering U = Unweathered (No signs) S = Slightly (Oxidized) M = Moderately (Discoloured) H = Highly (Friable) C = Completely (Soil-like)</div>										<div>Orientation F = Flat (0-20°) D = Dipping (20-50°) V = Near Vertical (>50°)</div>										<div>Aperture O = Open C = Closed F = Filled</div>									
										Borehole# 401					Lab# 13-0893																																		
										Logger: TD / SD					Date: October 23, 2013																																		
DEPTH FROM SURFACE (m)		DEPTH (m)		BOX/RUN		% REC		% RQD		GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)		STRENGTH		WEATHERING		# OF SETS		TYPE(S)		Orientation		SPACING		Roughness		APERTURE		FILLING																					
From	14.2	From	0.0	1/1		90.0%		76.4%		Biotite Granite: Fine grained, massive with occasional slight biotite foliation, grey in colour.		U		3		J	D	M	RU	O	O																												
To	15.6	To	1.4													J	F	M	RU	O	O																												
From		From														J	V	W	RP	O	O																												
To		To																																															
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To		To																																															
From		From																																															
To		To																																															

ROCK CORE LOG

Page 1 of 1

Project #: 13-121

Borehole# 403

Lab# 13-0895

Client: Hatch Mott Macdonald

Logger: TD / SD

Site: Highway 101

Date: October 24, 2013

Strength (MPa)				Discontinuity type				Roughness			
VH = Very High = >200 H = High = 50-200 M = Medium = 15-50 L = Low = 4-15 VL = Very Low = 1-4				B = Bedding joint J = Cross joint F = Fault S = Shear plane				RU = Rough undulating RP = Rough planar SU = Smooth undulating SP = Smooth planar LU = Slickensided undulating LP = Slickensided planar			
Weathering				Orientation				Aperture			
U = Unweathered (No signs) S = Slightly (Oxidized) M = Moderately (Discoloured) H = Highly (Friable) C = Completely (Soil-like)				F = Flat (0-20°) D = Dipping (20-50°) V = Near Vertical (>50°)				O = Open C = Closed F = Filled			
Spacing				Weathering				Filling			
VW = Very wide = >3m W = Wide = 1-3m M = Moderate = 0.3-1m C = Close = 5-30cm VC = Very close = <5cm				U = Unweathered (No signs) S = Slightly (Oxidized) M = Moderately (Discoloured) H = Highly (Friable) C = Completely (Soil-like)				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			
GENERAL DESCRIPTION (Rock type(s), %, colour, texture, etc.)				DISCONTINUITIES				OCCASIONAL FEATURES			

ROCK CORE LOG

Page 1 of 1

Project #: 13-121

Borehole# 405


Lab# 13-1206

Client: Hatch Mott Macdonald

Logger: Terry Dupuis

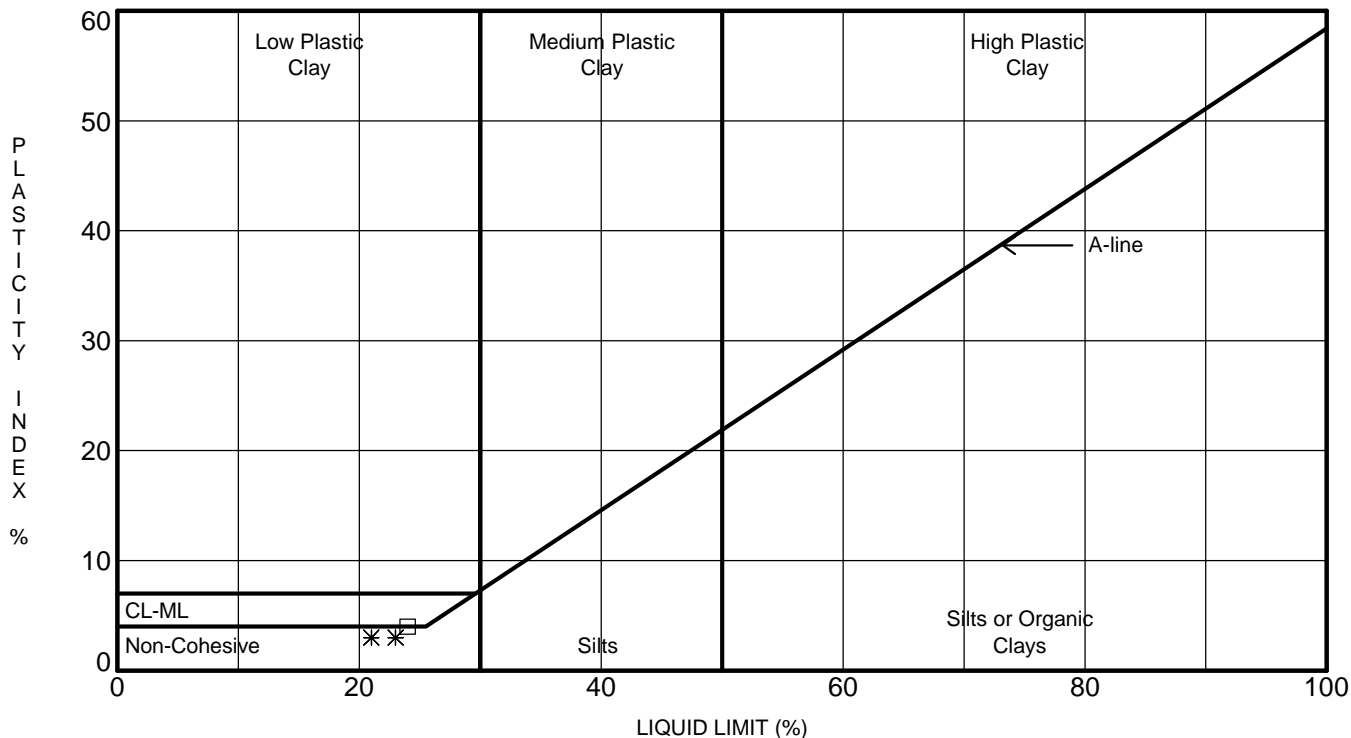
Site: Highway 101

Date: December 1, 2013

<div> TBT ENGINEERING CONSULTING GROUP</div>										<div><div>Strength (MPa)</div><div>VH = Very High = >200 H = High = 50-200 M = Medium = 15-50 L = Low = 4-15 VL = Very Low = 1-4</div></div>										<div><div>Discontinuity type</div><div>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</div></div>										<div><div>Roughness</div><div>RU = Rough undulating RP = Rough planar SU = Smooth undulating SP = Smooth planar LU = Slickensided undulating LP = Slickensided planar</div></div>																																																											
<div><div>ROCK CORE LOG</div><div><div>Project #: 13-121</div><div>Lab# 13-1206</div></div><div><div>Client: Hatch Mott Macdonald</div><div>Logger: Terry Dupuis</div></div><div><div>Site: Highway 101</div><div>Date: December 1, 2013</div></div></div>										<div><div>Weathering</div><div>U = Unweathered (No signs) S = Slightly (Oxidized) M = Moderately (Discoloured) H = Highly (Friable) C = Completely (Soil-like)</div></div>										<div><div>Orientation</div><div>F = Flat (0-20°) D = Dipping (20-50°) V = Near Vertical (>50°)</div></div>										<div><div>Aperture</div><div>O = Open C = Closed F = Filled</div></div>										<div><div>Filling</div><div>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</div></div>																																																	
										<div><div>GENERAL DESCRIPTION</div><div>(Rock type(s), %, colour, texture, etc.)</div></div>										<div><div>STRENGTH</div><div>H</div></div>										<div><div>WEATHERING</div><div>U</div></div>										<div><div>DISCONTINUITIES</div><div><div># OF SETS</div><div>2</div></div><div><div>TYPE(S)</div><div>J F M</div></div><div><div>Orientation</div><div>J D M</div></div><div><div>SPACING</div><div>RU</div></div><div><div>Roughness</div><div>RP</div></div><div><div>APERTURE</div><div>O</div></div><div><div>FILLING</div><div>O</div></div></div>																																																	
<div><div>DEPTH FROM SURFACE (m)</div><div>From</div><div>10.6</div><div>To</div><div>12.3</div></div>										<div><div>DEPTH (m)</div><div>From</div><div>0.0</div><div>To</div><div>1.7</div></div>										<div><div>BOX/RUN</div><div>1/1</div></div>										<div><div>% REC</div><div>94.1%</div></div>										<div><div>% RQD</div><div>78.2%</div></div>										<div><div>GENERAL DESCRIPTION</div><div>Monzodiorite : Medium grained, strongly foliated, grey / black in colour. Occasional fine grained intervals.</div></div>										<div><div>STRENGTH</div><div>H</div></div>										<div><div>WEATHERING</div><div>U</div></div>										<div><div>DISCONTINUITIES</div><div><div># OF SETS</div><div>2</div></div><div><div>TYPE(S)</div><div>J D</div></div><div><div>Orientation</div><div>M</div></div><div><div>SPACING</div><div>M</div></div><div><div>Roughness</div><div>RP</div></div><div><div>APERTURE</div><div>O</div></div><div><div>FILLING</div><div>O</div></div></div>									
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APPENDIX B

Laboratory Test Data



	Borehole No.	Sample No.	Depth (m)	LL%	PL%	PI%	M/C%	
□	400		3.00	24	20	4	31	
✱	400		6.00	21	18	3	25	
×	401		7.50	23	20	3	24	
+	401		9.00	23	20	3	23	



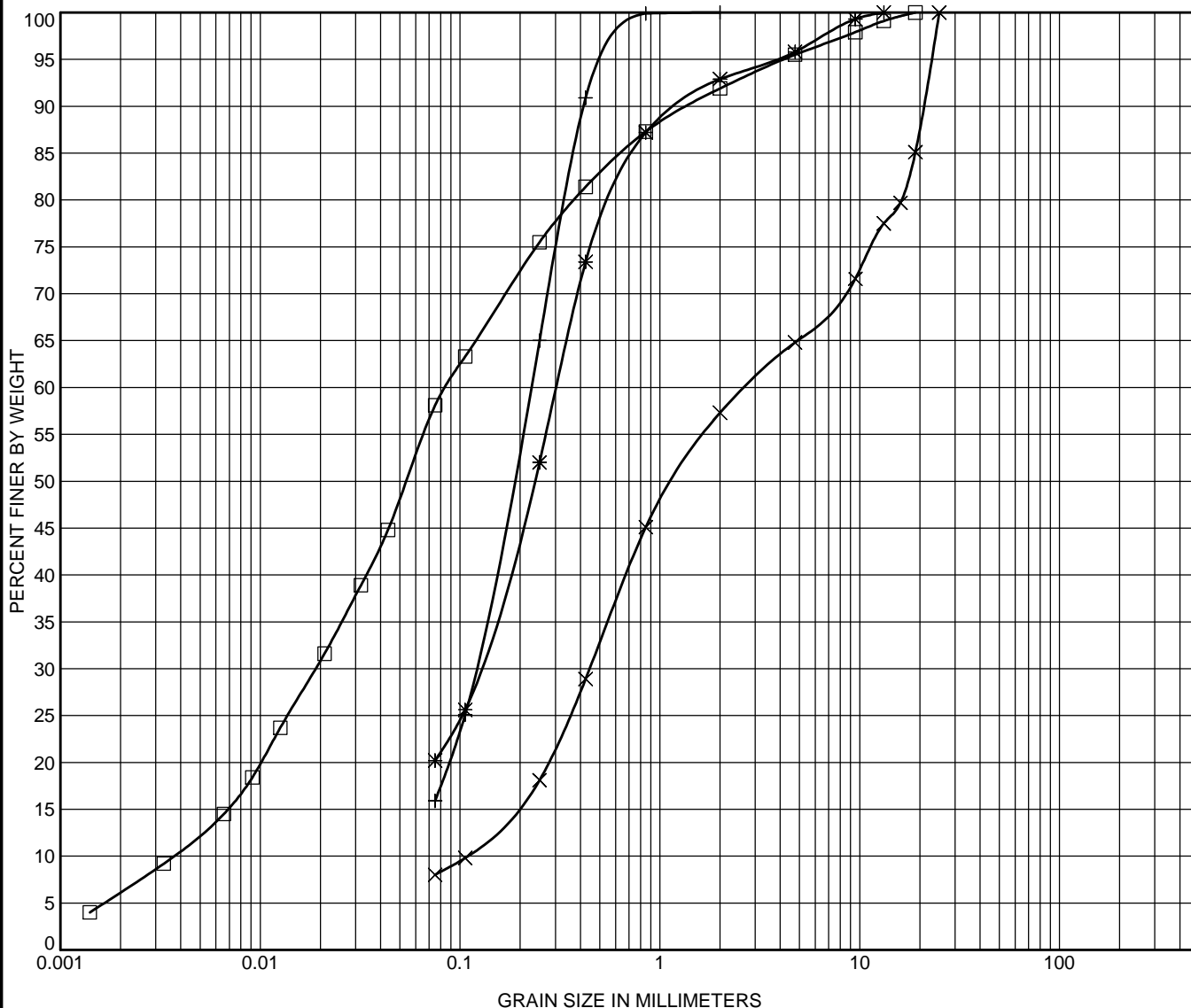
TBT Engineering Ltd.
 1918 Yonge Street
 Thunder Bay, Ontario P7E 6T9
 Telephone: 807-624-5160
 Fax: 807-624-5161

ATTERBERG LIMIT RESULTS

W P: 5383-11-00

District: Foleyet

Highway: 101



Remarks:
FILL - SAND/SILT & SAND/SAND & GRAVEL

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 400	0.30	19	0.085	0.019	0.004	4.5	37.4	58.1	
* 401	1.50	13.2	0.305	0.122		4.2	75.6	20.2	
× 402	4.50	25	2.731	0.445	0.108	35.2	56.8	8.0	
+ 403	1.50	2	0.225	0.118		0.0	84.1	15.9	



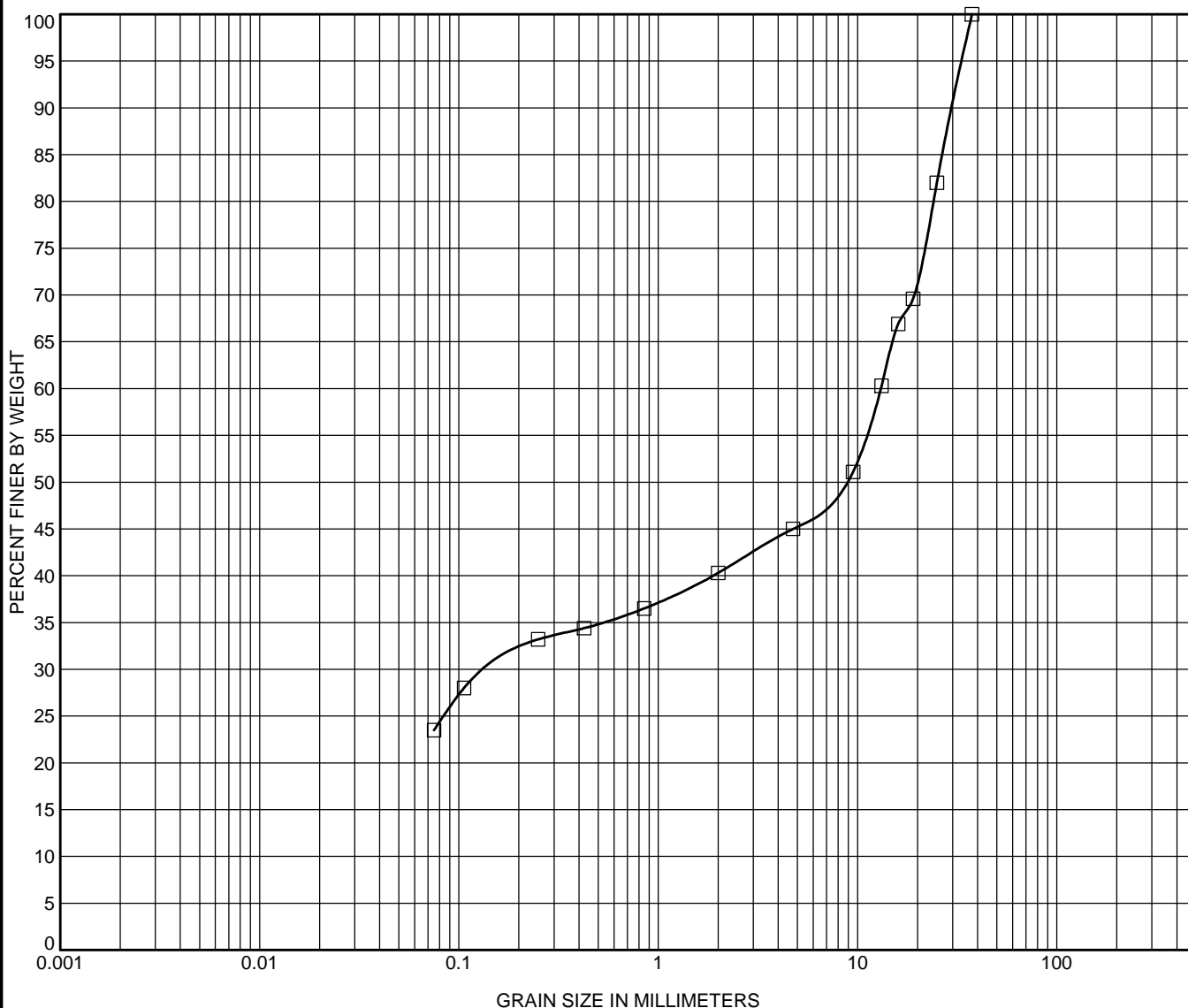
TBT Engineering Ltd.
1918 Yonge Street
Thunder Bay, Ontario P7E 6T9
PH: 807-624-5160
FX: 807-624-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: Culvert Investigation

W P: 5383-11-00

DIST: Foleyet HWY: 101



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
GRAVEL

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
400	8.80	37.5	13.059	0.147		55.0	21.5	23.5	



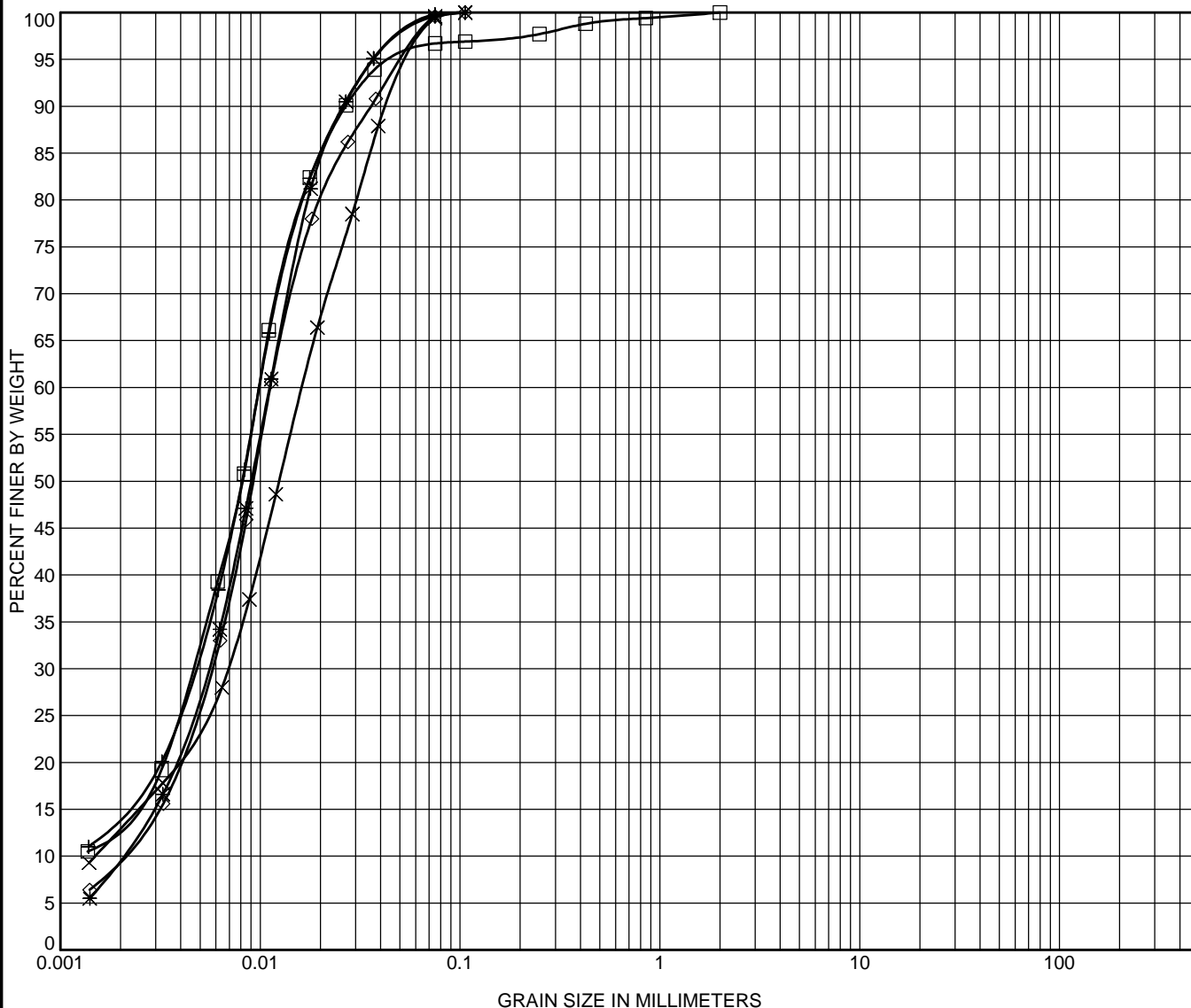
TBT Engineering Ltd.
1918 Yonge Street
Thunder Bay, Ontario P7E 6T9
PH: 807-624-5160
FX: 807-624-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: Culvert Investigation

W P: 5383-11-00

DIST: Foleyet HWY: 101



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SILT

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 400	3.00	2	0.01	0.005		0.0	3.3	96.7	
* 400	4.50	0.106	0.011	0.005	0.002	0.0	0.4	99.6	
× 400	6.00	0.106	0.016	0.007	0.001	0.0	0.6	99.4	
+ 401	7.50	0.106	0.01	0.005		0.0	0.2	99.8	
◇ 401	9.00	0.106	0.011	0.006	0.002	0.0	0.4	99.6	



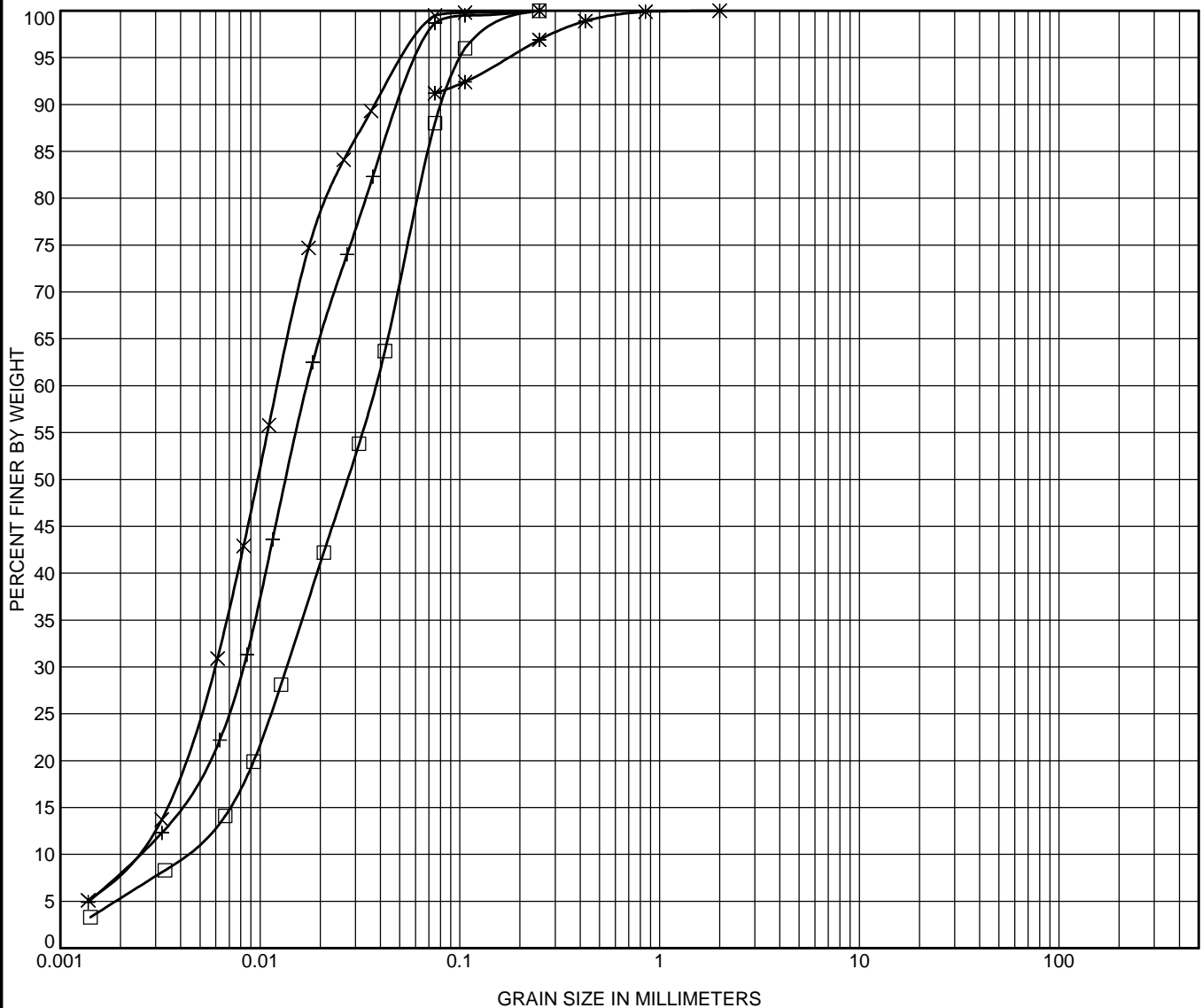
TBT Engineering Ltd.
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Thunder Bay, Ontario P7E 6T9
PH: 807-624-5160
FX: 807-624-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: Culvert Investigation

W P: 5383-11-00

DIST: Foleyet HWY: 101



Remarks:
SILT

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 401	12.00	0.25	0.038	0.014	0.004	0.0	12.0	88.0	
* 405	1.50	2				0.0	8.8	91.2	
× 405	3.80	0.25	0.012	0.006	0.002	0.0	0.5	99.5	
+ 405	9.10	0.25	0.017	0.008	0.002	0.0	1.3	98.7	



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FX: 807-624-5161
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Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

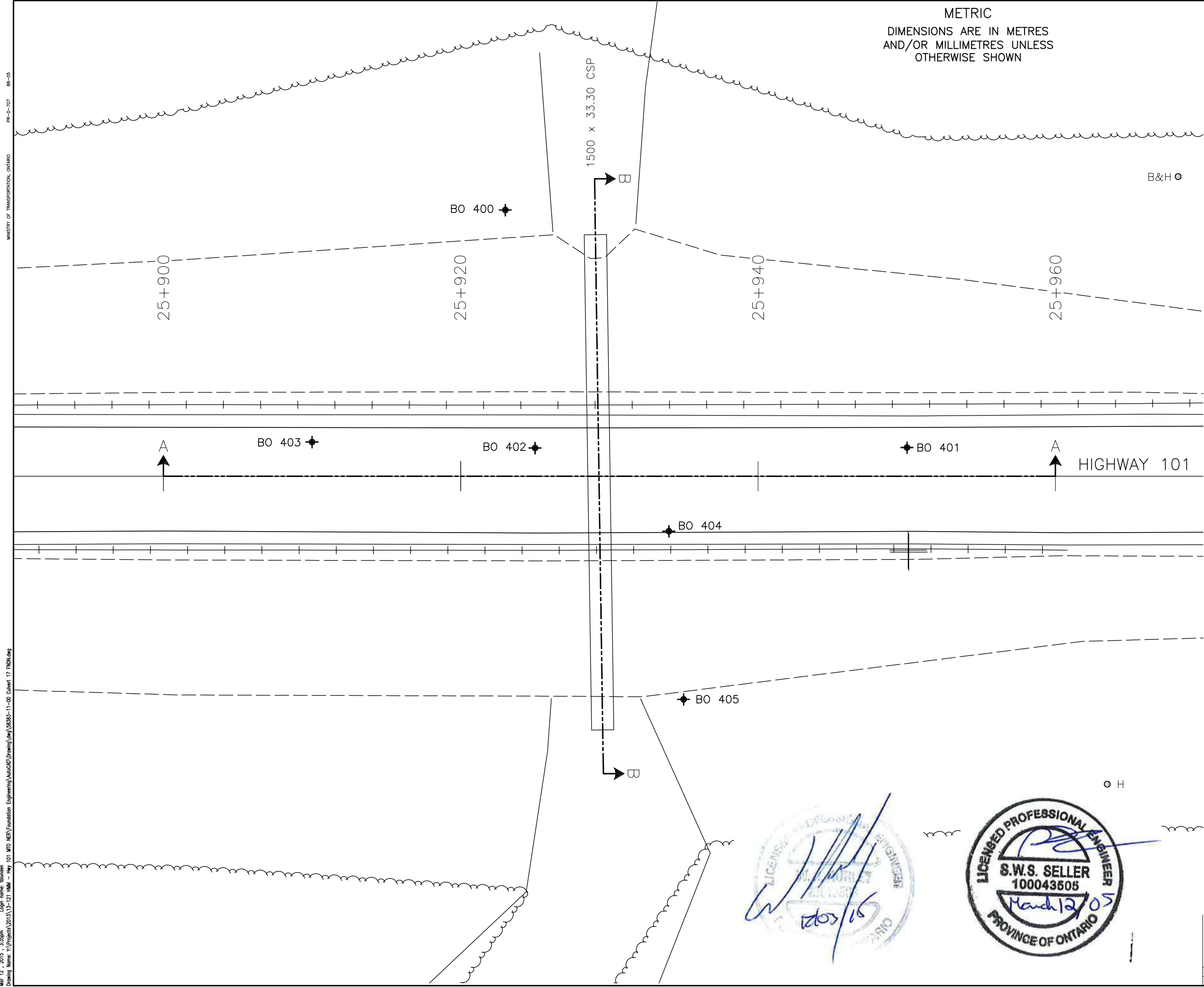
Project: Culvert Investigation

W P: 5383-11-00

DIST: Foleyet HWY: 101


APPENDIX C

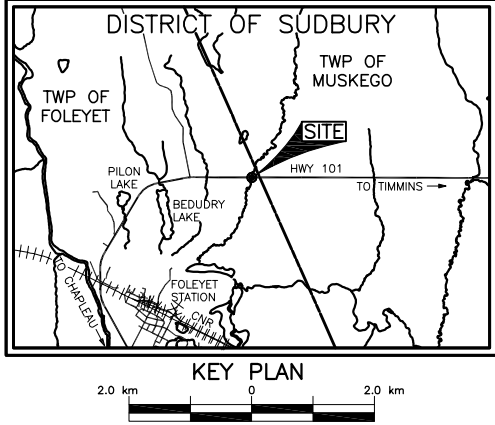
Borehole Locations and Soil Strata Drawing



MINISTRY OF TRANSPORTATION, ONTARIO
PR-D-707 88-05
Login name: iblinden
Drawing Name: \\projects\2013\13-121 HMM - Hwy 101 MTD MEX\Foundation Engineering\AutoCAD\Drawings\58383-11-00 Culvert 17 PLAN.dwg
Mar 12, 2015 3:35pm

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

GEOCREs No.	42B-11		
CONT	No.		
GWP	No.		5383-11-00
CULVERT 17 AT HWY 101 CULVERT INVESTIGATION BOREHOLE LOCATIONS AND SOIL STRATA		SHEET .	



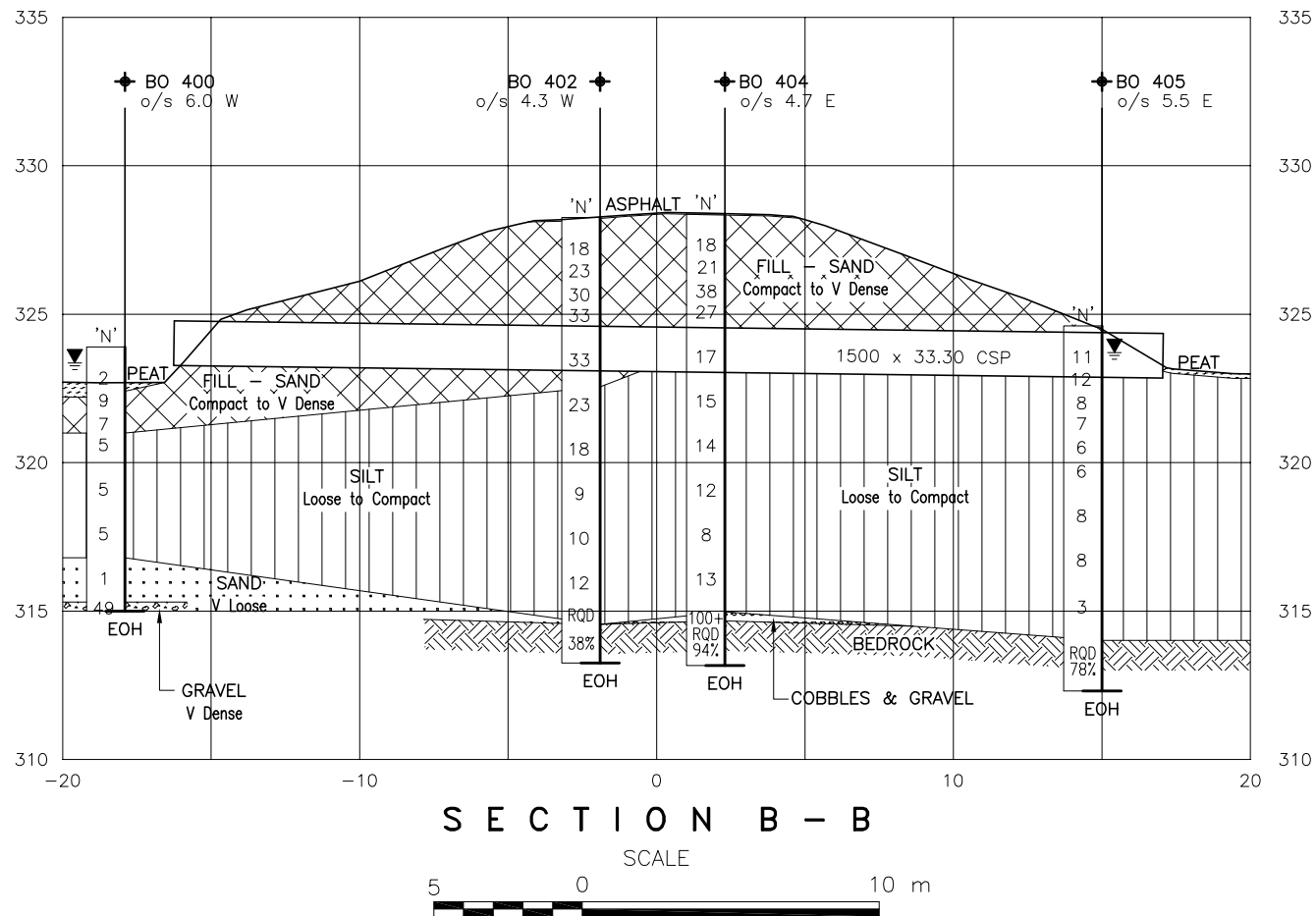
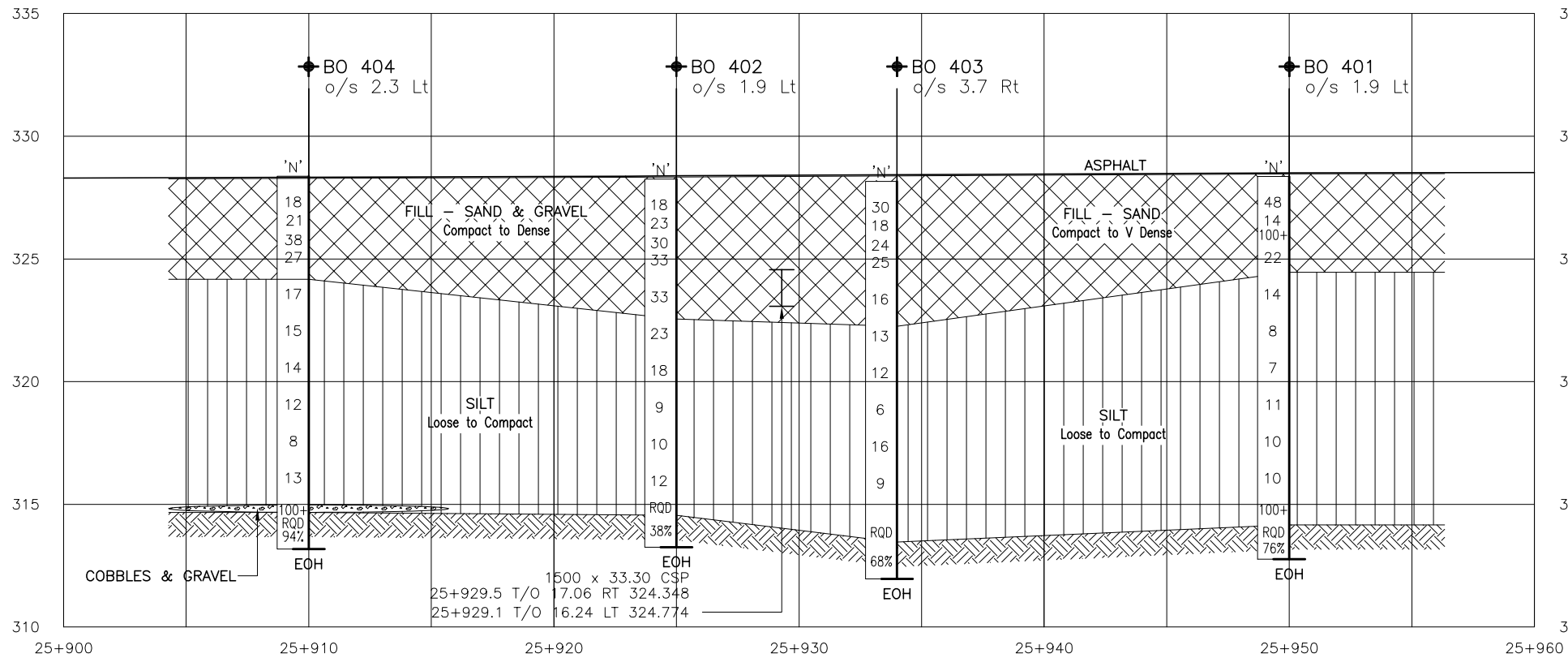
LEGEND				
◆ Borehole				
No	ELEVATION	CO-ORDINATES (MTM)		
		NORTH	EAST	
400	323.9	12 5 347 487	200 326	
401	328.4	12 5 347 461	200 343	
402	328.3	12 5 347 471	200 321	
403	328.2	12 5 347 478	200 307	
404	328.4	12 5 347 462	200 326	
405	324.6	12 5 347 452	200 323	

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



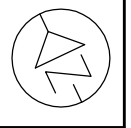
REVISIONS		WH		ISSUED IN DRAFT		DESCRIPTION	
DESIGN	SS	CHK	WH	CODE	XXXXX-XX	LOAD XX-XX-XX	DATE 2013/12/23
DRAWN	TB	CHK	WH	SITE	N/A		DWG 1

Mar 12, 2015, 3:36pm
Drawing Name: \\projects\2013\3-121 MM - Hwy 101 MTD NER\Foundation Engineering\AutoCAD\Drawing\dwg\58383-11-00 Culvert 17 FNDM.dwg
Login name: iblandin
PR-D-707 88-05 MINISTRY OF TRANSPORTATION, ONTARIO



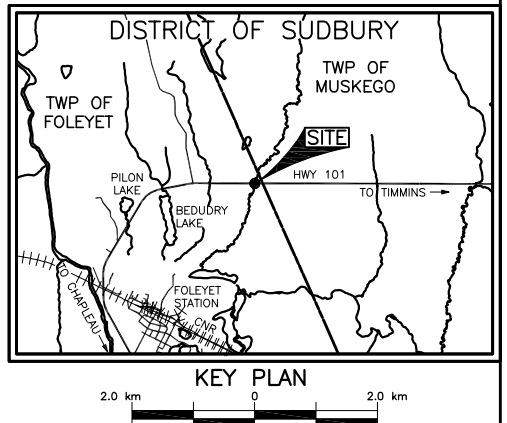
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN

GEOCREs No. 42B-11
CONT No. .
GWP No. 5383-11-00



CULVERT 17
AT HWY 101
CULVERT INVESTIGATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
.



SOIL STRATA SYMBOLS			
	TOPSOIL/PEAT		COBBLES
	FILL		GRAVEL
	SILT		BEDROCK
	SAND		

LEGEND			
	Borehole		
	'N' Std Pen Test (Blows/0.3m)		
	100% Rock Quality Designation (RQD)		
	Water Level		
	EOH		
No	ELEVATION	CO-ORDINATES (MTM)	
		NORTH	EAST
400	323.9	12 5 347 487	200 326
401	328.4	12 5 347 461	200 343
402	328.3	12 5 347 471	200 321
403	328.2	12 5 347 478	200 307
404	328.4	12 5 347 462	200 326
405	324.6	12 5 347 452	200 323

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

REVISIONS		ISSUED IN DRAFT		DESCRIPTION	
13/12/10	WH				
DESIGN	SS	CHK	WH	CODE	XXXXX-XX
DRAWN	TB	CHK	WH	SITE	N/A
				LOAD	XX-XX-XX
				DATE	2013/12/23
				DWG	2