



FOUNDATION INVESTIGATION REPORT
for
HIGHWAY 403 W-E RAMP OVERPASS AT
QUEEN ELIZABETH WAY EBL
WP 2163-10-03, SITE NO. 10-284/2
CENTRAL REGION, ONTARIO

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FOUNDATION INVESTIGATION REPORT

for

Highway 403 W-E Ramp Overpass at Queen Elizabeth Way EBL
WP 2163-10-03, Site No. 10-284/2
Central Region, Ontario

1. INTRODUCTION

This report summarises the results of a foundation investigation carried out for a replacement of existing Queen Elizabeth Way (QEW) eastbound overpass over the Highway 403 W-E ramp in Oakville, Ontario. The study was conducted for Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation of Ontario (MTO).

The QEW passes over the Highway 403 W-E Ramp at approximate Station 23+917, QEW chainage (ref. Site Layout Drawing 'Hwy 403 W-N Ramp WBL Overpass Replacement' prepared by Stantec in October 2015). The existing overpass is a three span structure. The replacement bridge is proposed to be constructed on an alignment about 5 m south of the existing QEW centreline.

The ramp from QEW EB to Hwy 403 EB is referred to as the Highway 403 W-E Ramp in Contract 2. It is noteworthy that some background drawings and reports may refer to it as the Highway 403 W-N Ramp.

The existing road grade on Highway 403 at the bridge location varies between approximate elevation 139.5 and 141.5. The approach embankments are about 7 to 8 m high at the abutments.

The report provides subsurface information pertaining to the proposed structure and approaches within about 20 m of the abutments.

A preliminary foundation investigation and design report for the replacement of the Highway 403 W-E ramp under the QEW WBL bridge was completed by Thurber Engineering Ltd. in April 2013 and documented in GEOCREs No. 30M5-285. A foundation investigation and design report completed for the existing bridge in 1978 is documented in GEOCREs No. 30M5-117. Copies of



the logs for boreholes 2, 3, 5 to 8, 13-27 and 13-28 relevant for this structure are provided in Appendix FIR-A for reference.

All elevations in this report are expressed in meters.

2. SITE DESCRIPTION AND GEOLOGY

The site is situated about 0.5 km north of the QEW / Ford Drive interchange. The structure to be replaced carries QEW eastbound traffic over the W-E ramp connecting the QEW and Highway 403 in the Town of Oakville, Regional Municipality of Halton. The QEW runs approximately in the south-north direction at the overpass location. The performance of the existing structure foundations and related approach embankments appears to be satisfactory.

The study area lies in the physiographic region known as the South Slope that is bounded by the Peel Plain to the north and the Iroquois Plain to the south and extends from the Niagara escarpment to the Trent River, covering approximately 2,435 square kilometers. The South Slope is characterised by glacial till deposits overlying shale bedrock of the Queenston and Dundas Formations. (L.J. Chapman and D.F. Putnam, *The Physiography of Southern Ontario*, 3rd Edition, 1984).

Lands within the QEW / Highway 403 corridor near the site are generally vacant and grass covered. The topography is gently sloping down towards the south. The Highway 403 W-E ramp is within a cut, some 5 to 7 m below the QEW road grade.

Outside of the highway right of ways, land use primarily includes commercial and light industrial buildings and businesses. The Ford Motor Company occupies the majority of the land to the south of the QEW / Highway 403.

3. INVESTIGATION PROCEDURES

A review of the following reports available for the existing bridge was carried out. The subsurface information from boreholes 2, 3, 5 to 8, 13-27 and 13-28 advanced as part of the previous



investigations (GEOCRES Nos. 30M5-117 and 30M5-285) is considered to be relevant and used in this report.

1. Preliminary Foundation Investigation and Design Report
Highway 403 and QEW Widening
QEW from Trafalgar Road Easterly to East of Winston Churchill Blvd.
And
Highway 403 from QEW Northerly to Highway 407 and Winston Churchill Blvd.
Oakville and Mississauga, Ontario
WP 09-20007
(GEOCRES No. 30M5-285)
(by Thurber Engineering Ltd. dated April 2013)
2. Foundation Investigation and Design Report
W-N Ramp Hwy 403 under QEW
WP 159-75-06, Site 10-284
QEW, District 4, Hamilton
(GEOCRES No. 30M5-117)
(by MTO dated February 1978)

The field work for this study was carried out during the periods of January 22 to 23 and October 22 to November 6, 2015 and comprised 8 boreholes and 9 auger probes advanced to depths of 0.9 to 7.8 m. The locations of the boreholes and auger probes are indicated on Drawing ER-1, attached.

The borehole and auger probe locations were established in the field by Peto MacCallum Ltd. The coordinates and ground surface elevations at the boreholes were provided by Callon-Dietz Inc.

The boreholes and auger probes were advanced using continuous flight hollow and solid stem augers, powered by a track-mounted drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff. A total of four boreholes (19, 20, 22 and 24) were extended 3.0 to 3.1 m into bedrock using NQ diamond rock coring equipment supplemented by wash boring techniques.

Representative soil samples were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests (SPT) were conducted simultaneously



with the sampling operation to assess the strength characteristics of the substrata. The results of the field tests and observations are reported on the Record of Borehole sheets.

Groundwater conditions at the borehole and auger probe locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole. Upon completion of drilling, the boreholes and auger probes were backfilled with bentonite-cement grout in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determination. Atterberg limits testing (8) and grain size distribution analyses (8) were conducted on selected soil samples. The laboratory test results are presented in Figures ER-PC-1 to ER-PC-3, ER-GS-1 to ER-GS-3 and on the corresponding logs.

4. SUMMARISED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, bedrock descriptions, inferred stratigraphy, boundary elevations, standard penetration test data and groundwater observations. The results of laboratory Atterberg limits testing, grain size distribution analyses and natural moisture content determinations are also shown on the Record of Borehole sheets.

The borehole and auger probe locations, stratigraphic profile and cross-sections prepared from the borehole data are shown on Drawing ER-1. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised surficial topsoil or fill and a cohesive deposit of clayey silt / silty clay overlying shale bedrock. The



bedrock was contacted or inferred below the clayey silt / silty clay at depths of 0.3 to 4.7 m (elevation 133.4 to 144.8). The groundwater was at elevation 135.3 to 137.7.

The strata encountered are summarised below.

4.1 Topsoil

Surficial topsoil was identified in borehole 23 and auger probes AP-E, AP-F, AP-G and AP-H. The silty topsoil was 200 to 300 mm thick and penetrated at elevation 145.7 in borehole 23 and elevation 137.4 to 138.5 in the auger probes.

4.2 Fill

Asphalt 100 to 300 mm in thickness was present surficially in boreholes 9, 10, 19 to 22, 24, 13-27, 13-28 and overlay fill made up of gravelly sand and/or sand and gravel. The fill was compact to very dense, 3 to 8% in moisture content and extended to depths of 0.4 to 2.3 m (elevation 137.6 to 145.7).

Overlain by the granular fill at 1.4 m depth (elevation 145.7) in borehole 10 was a layer of clayey silt fill. This layer was 800 mm in thickness, stiff in consistency and penetrated at a depth of 2.2 m (elevation 144.9). The results of Atterberg limits testing and grain size distribution analysis performed on a cohesive sample of the fill from borehole 10 are presented in respective Figures ER-PC-1 and ER-GS-1. The liquid and plastic limits of the clayey silt fill were 30 and 20 respectively, thus giving the plasticity index of 10.

Surficial fill was present in auger probes AP-C, AP-D, AP-J and AP-K. The fill was composed of silty clay in auger probe AP-J or sand and gravel in the remaining auger probes. The fill had a thickness of 100 to 300 mm and was penetrated at elevation 138.5 to 139.7.

Directly beneath the topsoil at 0.3 m depth (elevation 145.7) in borehole 23 was clayey silt fill. Stiff in consistency, this unit was 600 mm thick and penetrated at 0.9 m depth (elevation 145.1).

4.3 Clayey Silt / Silty Clay

A cohesive deposit of clayey silt / silty clay was present surficially in boreholes 2, 3, 5 to 8 and auger probe AP-I and overlain by the topsoil or fill at depths of 0.1 to 2.3 m (elevation 137.4 to 145.1) in boreholes 9, 10, 19 to 24, 13-27, 13-28 and auger probes AP-C to AP-H, AP-J, AP-K. This deposit was 0.2 to 4.2 m in thickness and stiff to hard in consistency. The clayey silt / silty clay was penetrated at depths of 0.3 to 4.7 m (elevation 133.4 to 144.8).

The results of Atterberg limits testing and grain size distribution analyses conducted on 7 cohesive samples of the deposit are presented in respective Figures ER-PC-2, ER-PC-3 and ER-GS-2, ER-GS-3. The liquid and plastic limits of the clayey silt / silty clay ranged from 25 to 38 and from 17 to 20 respectively, with the plasticity index of 7 to 18. The moisture content of the deposit varied between 5 and 23%.

4.4 Bedrock

Bedrock was contacted or inferred by refusal below the clayey silt / silty clay at depths of 0.3 to 4.7 m (elevation 133.4 to 144.8) in all the boreholes and auger probes. The bedrock comprises a dark grey / green to purple highly weathered to unweathered low to medium strength shale with interbedded greenish grey limestone. The shale bedrock has thin horizontal bedding and dipping to vertical joints. Seams or layers of clayey silt / silty clay were also noted within the highly weathered zones of the bedrock. The shale bedrock is susceptible to wetting/drying cycles and not durable upon exposure to the elements.

The rock cores retrieved from boreholes 2, 3, 6, 7, 19, 20, 22, 24, 13-27 and 13-28 are described on the corresponding borehole logs. A detailed description of the rock cores in boreholes 20, 22 and 24 is given in Table A, appended. Photographs of the rock cores are shown in Appendix FIR-B.

The measured core recovery varied between 40 and 100% with the exception of the upper core sample in borehole 19 where it was 6%. The Rock Quality Designation (RQD) determined from the rock cores was in a range of 0 to 82%, typically 29 to 75%, thus indicating a poor to fair quality



rock. Both core samples in borehole 19 and the upper core sample in borehole 13-27 indicated a very poor quality rock with RQD values of 0 and 20% respectively. The rock quality was very poor (RQD of 13%) in a core sample in borehole 2 at elevation 143.3, however this zone was previously excavated below the Highway 403 W-E Ramp where the existing pavement grades currently range from elevation 139.1 to 141.1. The RQD was good in two core samples in boreholes 20 and 24.

At the west abutment and approach, the bedrock surface was contacted or inferred at depths of 0.3 to 4.7 m (elevation 133.4 to 143.8) in boreholes 3, 5, 6, 9, 19 to 21, 13-27 and auger probes AP-D to AP-G. The measured core recovery in boreholes 3, 6, 19, 20 and 13-27 varied between 6 and 100%. The RQD determined from the rock cores was in a range of 30 to 82%, indicating a poor to good quality rock, with the exception of both core samples in borehole 19 and the upper core sample in borehole 13-27 where the rock quality was very poor (RQD of 0 to 20%). The bedrock surface has a maximum difference in elevation of 10.4 m.

At the east abutment and approach, the bedrock surface was contacted or inferred at depths of 0.9 to 4.6 m (elevation 135.8 to 144.5) in boreholes 7, 8, 10, 22 to 24, 13-28 and auger probes AP-H to AP-K. The measured core recovery in boreholes 7, 22, 24 and 13-28 varied between 73 and 100%. The RQD determined from the rock cores was in a range of 32 to 78%, indicating a poor to good quality rock. The bedrock surface has a maximum difference in elevation of 8.7 m.

4.5 Groundwater

In the process of augering, water was detected at depths of 0.9 to 3.1 m (elevation 135.0 to 144.8) in boreholes 10, 19, 20 and 22. The groundwater level was measured in borehole 21 and auger probes AP-D to AP-G and AP-I at depths of 0.9 to 2.7 m (elevation 135.3 to 137.7) upon completion of drilling.

The groundwater levels at the site are not stabilised and are subject to seasonal fluctuations and precipitation patterns.



5. CLOSURE

The field work was mostly carried out under the supervision of Mr. S. Aziz and Mr. M. Khorsand, under the coordination of Mr. K. Daly, B.Eng, and direction of Mr. C.M.P. Nascimento, P.Eng., Project Manager. The equipment was supplied by Altech Drilling & Investigative Services Ltd. The laboratory testing of selected samples was carried out in the PML laboratory in Toronto.

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. C.M.P. Nascimento, P.Eng., Project Manager and MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.



Grigory O. Degil, PhD, P.Eng.
Senior Foundation Engineer



Carlos M.P. Nascimento, P.Eng.
Project Manager
MTO Designated Principal Contact



TABLE A
 ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	CORE NO.	DEPTH (m)	RECOVERY (%)	RQD (%)	DEPTH (m)	DESCRIPTION
20	8	4.7 – 6.2	93	73	4.7 – 7.8	SHALE WITH INTERBEDDED LIMESTONE: Dark grey to dark green, occasional purple shale, fine crystalline to aphanitic, with few stylitic partings, small chert nodules, low to medium strength, slightly weathered to unweathered, close spaced flat partings, smooth to rough planar, tight, with dipping to vertical joints, fair to good quality.
	9	6.2 – 7.8	95	82		
22	4	1.6 – 3.1	87	32	1.6 – 4.6	SHALE WITH INTERBEDDED LIMESTONE: Dark grey to dark green, occasional purple shale, fine crystalline to aphanitic, with few stylitic partings, small chert nodules, low to medium strength, slightly weathered to unweathered, close spaced flat partings, smooth to rough planar, tight, with dipping to vertical joints, poor to fair quality.
	5	3.1 – 4.6	83	50		

Notes:

Drilled: October 22 and 23, 2015
 Logged: October 28, 2015
 RQD = Rock Quality Designation

Originated: JO/SAT
 Compiled: PML
 Checked: CN



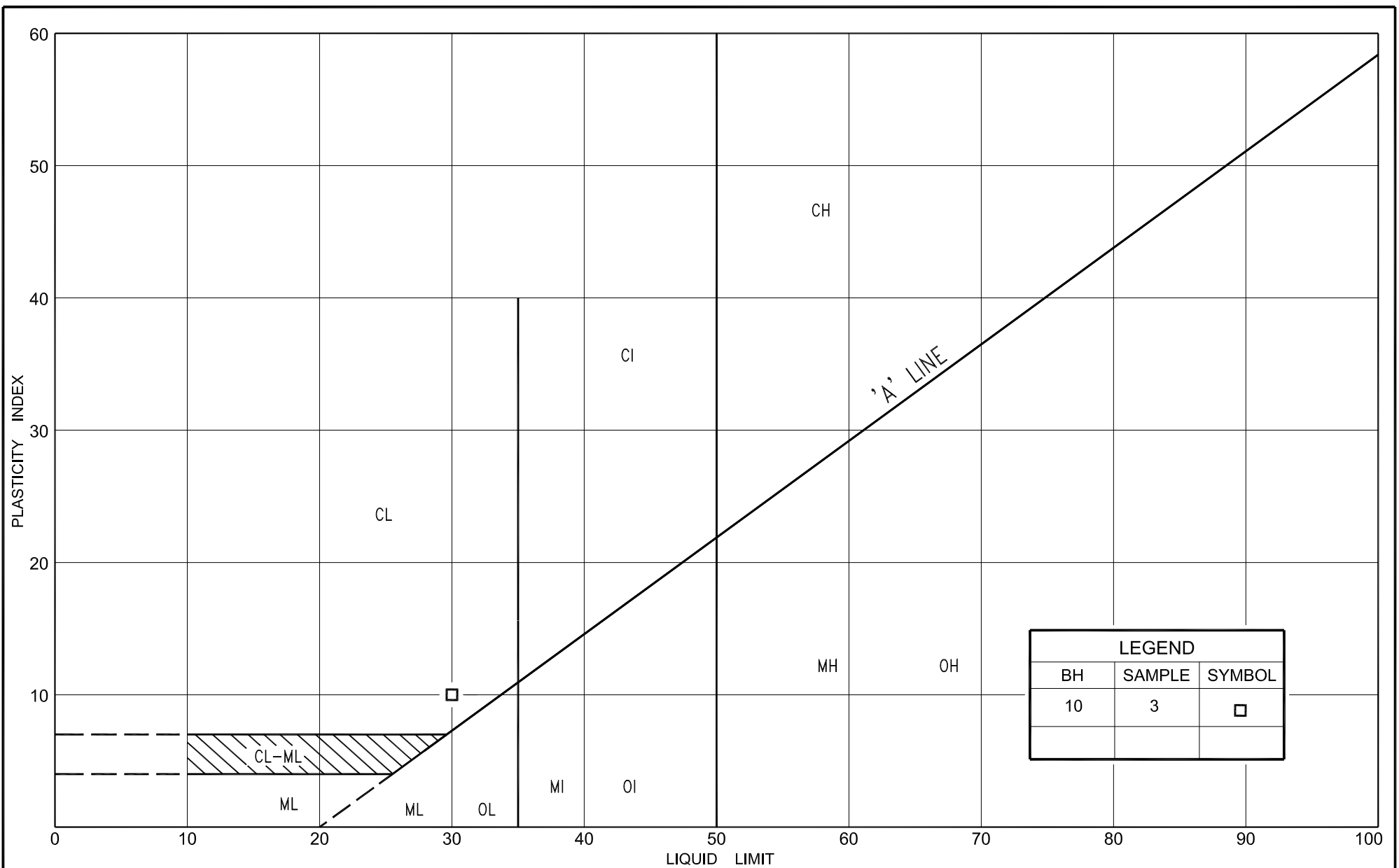
TABLE A
 ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	CORE NO.	DEPTH (m)	RECOVERY (%)	RQD (%)	DEPTH (m)	DESCRIPTION
24	6	4.1 – 5.6	97	78	4.1 – 7.2	SHALE WITH INTERBEDDED LIMESTONE: Dark grey / green to purple shale, fine grained, occasional interbedded grey limestone (effervesces freely in dilute (5%) hydrochloric acid), occasional fossil, low to medium strength, bedding in shale horizontal, laminated and fissile, slightly weathered to moderately weathered, close spaced flat partings, smooth planar, tight, with dipping to vertical joints, fair to good quality.
	7	5.6 – 7.2	73	52		

Notes:

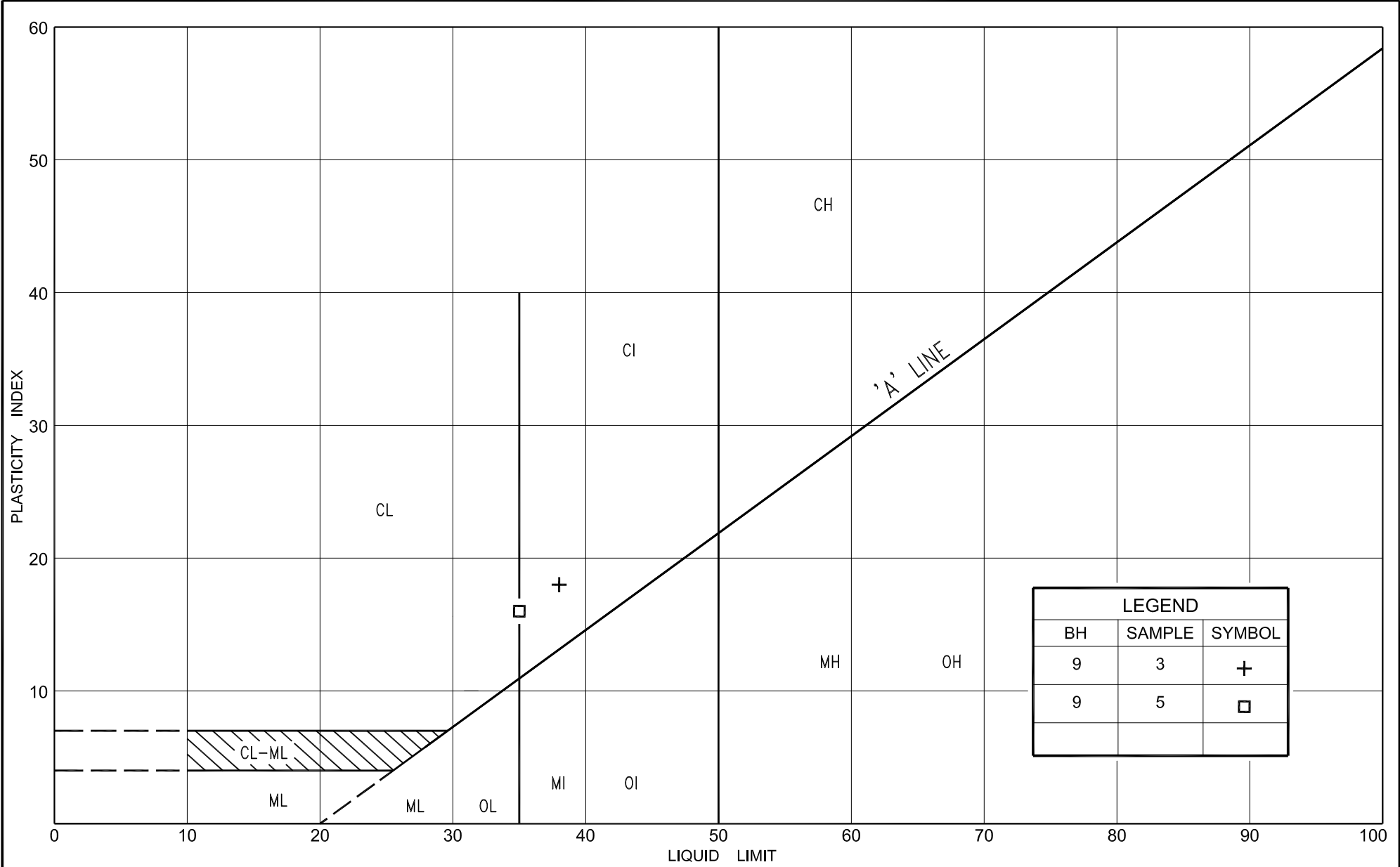
Drilled: November 5 and 6, 2015
 Logged: November 12, 2015
 RQD = Rock Quality Designation

Originated: JO/SAT
 Compiled: PML
 Checked: CN



PLASTICITY CHART
 CLAYEY SILT, some gravel, trace to some sand (CL)
 (FILL)

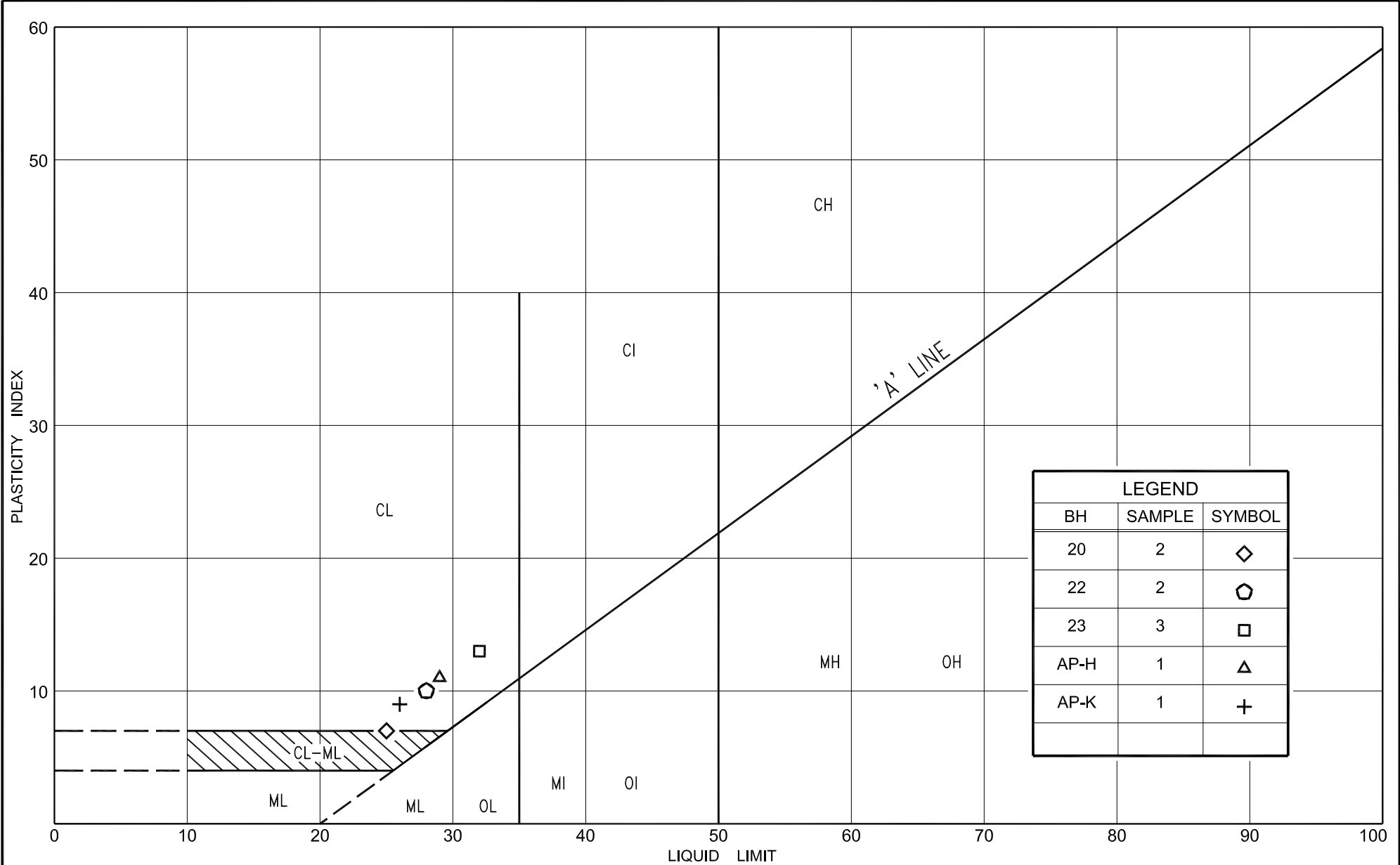
FIG No.	ER-PC-1
HWY:	403 / QEW
G.W.P. No.	2163-10-00



PLASTICITY CHART

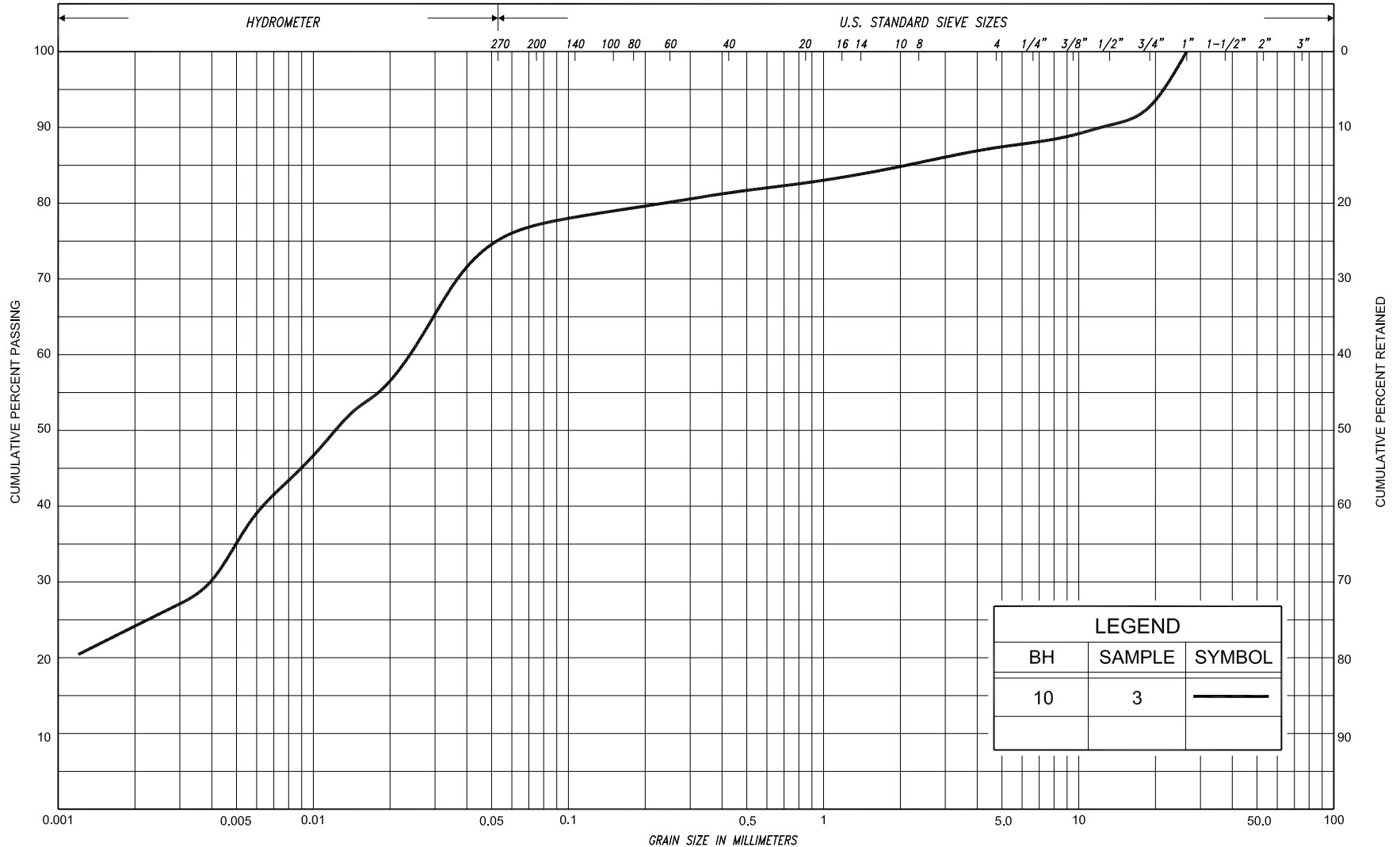
SILTY CLAY, some sand, trace gravel (CL-CI)

FIG No.	ER-PC-2
HWY:	403 / QEW
G.W.P. No.	2163-10-00



PLASTICITY CHART
CLAYEY SILT
trace to with sand, trace to some gravel (CL)

FIG No. ER-PC-3
HWY: 403 / QEW
G.W.P. No. 2163-10-00



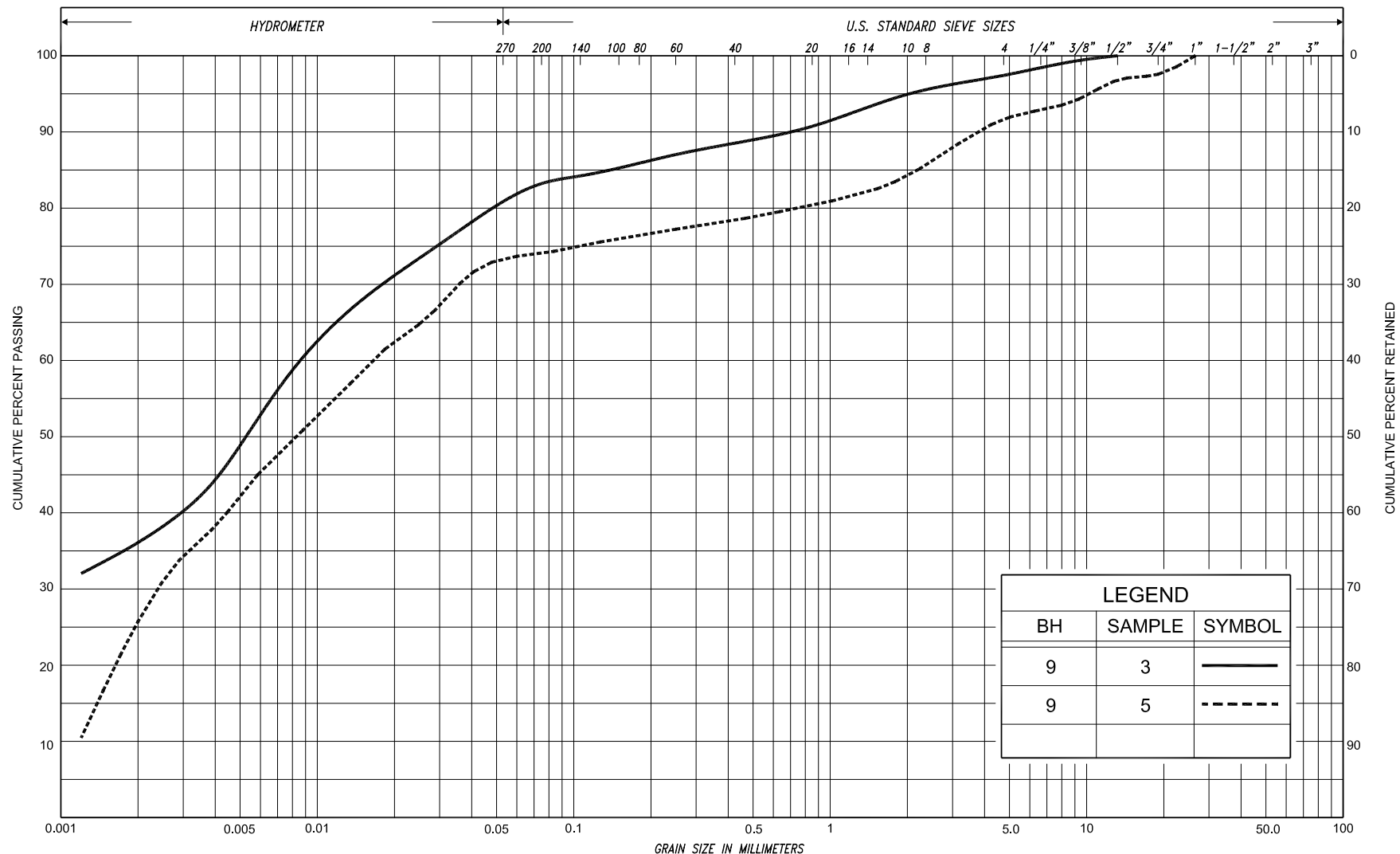
LEGEND		
BH	SAMPLE	SYMBOL
10	3	—

SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
				SAND								
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM	COARSE	GRAVEL		COBBLES	M.I.T.
CLAY		SILT		V. FINE		FINE	MED.	COARSE	GRAVEL			U.S. BUREAU
				SAND								



GRAIN SIZE DISTRIBUTION CLAYEY SILT, some gravel, trace to some sand (CL) (FILL)

FIG No.	ER-GS-1
HWY:	403 / QEW
G.W.P. No.	2163-10-00



SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL			COB BLES	UNIFIED		
					SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT						SAND										
CLAY			SILT			V. FINE		FINE	MED.	COARSE		GRAVEL					U.S. BUREAU
						SAND											

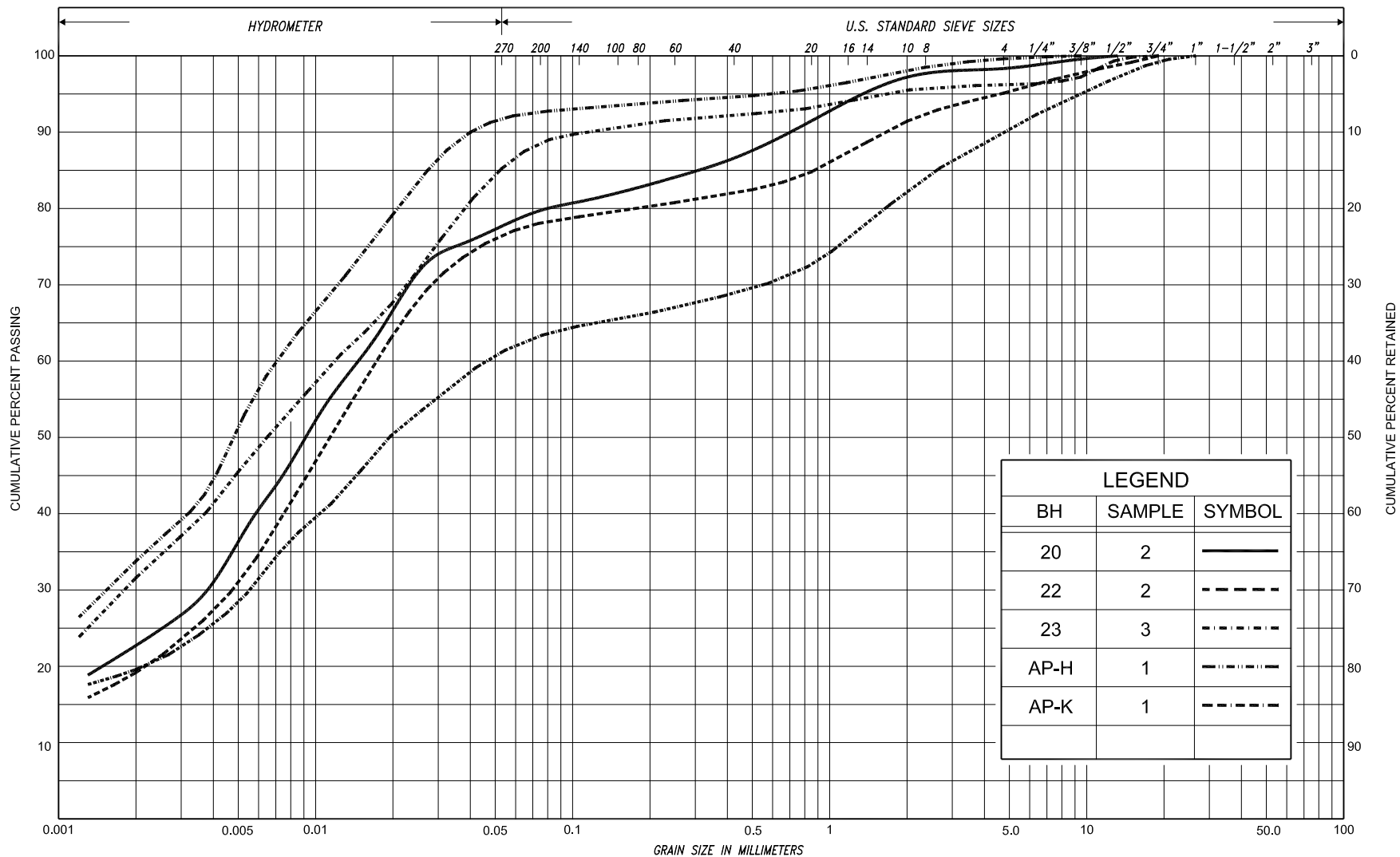
GRAIN SIZE DISTRIBUTION SILTY CLAY, some sand, trace gravel (CL-CI)

FIG No. ER-GS-2

HWY: 403 / QEW

G.W.P. No. 2163-10-00





SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
						SAND						
CLAY	FINE		MEDIUM	COARSE	FINE	MEDIUM SAND		COARSE	GRAVEL		COBBLES	M.I.T.
	SILT											
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU
				SAND								

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
 trace to with sand, trace to some gravel (CL)

FIG No. ER-GS-3
 HWY: 403 / QEW
 G.W.P. No. 2163-10-00



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.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

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	25 - 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
F V FIELD VANE	

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	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	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	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	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m ³	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kN/m ³	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m ³	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m ³ /s	RATE OF DISCHARGE
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL	WTP		WETTER THAN PLASTIC LIMIT	j	kN/m ³	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No 9

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 657.4 N; 290 776.0 E ORIGINATED BY S.A.
DIST Central BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY R.A.
DATUM Geodetic HWY QEW DATE January 26, 2015 CHECKED BY D.D.











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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
								○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL × LAB VANE											
					WATER CONTENT (%)														
					20 40 60 80 100					20 40 60									
143.9	Ground Surface																		
0.0	150mm asphalt over gravelly sand		1	SS	50/13cm														
143.1	Very dense Grey Moist to compact																		
0.8	(PAVEMENT FILL)		2	SS	11														
142.4	Sand and gravel organics																		
1.5	Compact Brown/ Moist grey (FILL)		3	SS	34														
	Silty clay some sand, trace gravel sand seams																		
	Hard to Reddish Moist very stiff brown/ grey		4	SS	25														
			5	SS	90/25cm														
140.3	Shale bedrock limestone embedded clayey silt to silty clay seams/layers																		
3.6																			
139.6			6	SS	50/5cm														
4.3	Highly weathered End of borehole																		
	Sample 6: Sampler bouncing																		
	* Borehole dry																		

RECORD OF BOREHOLE No 10

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 785.9 N; 290 799.8 E ORIGINATED BY S.A.
DIST Central BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY R.A.
DATUM Geodetic HWY QEW DATE January 26 & 27, 2015 CHECKED BY D.D.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
147.1	Ground Surface						20	40	60	80	100									
0.0	150mm asphalt over gravelly sand		1	SS	50/10cm		147													
146.5	Very dense Grey Moist to compact (PAVEMENT FILL)																			
0.6	Sand and gravel, organics		2	SS	23		146						○							
	Compact Brown/ Moist grey Clayey silt, some gravel trace to some sand gravel fill inclusions brick debris													⊞		13 10 53 24				
144.9	Stiff Reddish Moist brown/grey (FILL)		3	SS	8		145													
2.2	Clayey silt to silty clay trace sand, trace gravel cobbles												○							
144.5	Hard Reddish Moist brown		4	SS	50/13cm	▽*														
2.6	Shale bedrock clayey silt to silty clay seams/layers Highly weathered End of borehole						144													
143.4	Sample 5: Sampler bouncing		5	SS	50/10cm															
3.7	* 2015 01 26 ▽ Water level observed during drilling																			

RECORD OF BOREHOLE No 19

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 725.6 N; 290 774.3 E		ORIGINATED BY	M.Kh	
DIST	Central	BOREHOLE TYPE	C.F.H.S.A. and Rotary Diamond Coring		COMPILED BY	M.Kh	
DATUM	Geodetic	HWY	QEW	DATE	November 04, 2015	CHECKED BY	G.D.

[illegible]

RECORD OF BOREHOLE No 20

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 691.7 N; 290 789.3 E		ORIGINATED BY	M.Kh	
DIST	Central	BOREHOLE TYPE	C.F.H.S.A. and Rotary Diamond Coring		COMPILED BY	M.Kh	
DATUM	Geodetic	HWY	QEW	DATE	October 23, 2015	CHECKED BY	G.D.


[illegible]

RECORD OF BOREHOLE No 21

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 675.3 N; 290 795.6 E ORIGINATED BY M.Kh
DIST Central BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic HWY QEW DATE October 23, 2015 CHECKED BY G.D.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																			
138.0	Ground Surface						137																				
0.0	130mm asphalt over gravelly sand		1	SS	22																						
137.6	(PAVEMENT FILL)																										
0.4	Clayey silt some sand, trace gravel shale fragments		2	SS	50/5cm																						
	Hard Reddish Moist brown		3	SS	50/10cm																						
			4	SS	50/5cm																						
135.1	End of borehole																										
2.9	Refusal on probable bedrock																										
	Sample 4: Sampler bouncing																										

RECORD OF BOREHOLE No 22

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 702.9 N; 290 801.4 E		ORIGINATED BY	M.Kh	
DIST	Central	BOREHOLE TYPE	C.F.H.S.A. and Rotary Diamond Coring		COMPILED BY	M.Kh	
DATUM	Geodetic	HWY	QEW	DATE	October 22, 2015	CHECKED BY	G.D.

[illegible]

RECORD OF BOREHOLE No 23

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 754.8 N; 290 805.5 E		ORIGINATED BY	K.D.	
DIST	Central	BOREHOLE TYPE	Continuous Flight Solid Stem Augers		COMPILED BY	M.Kh	
DATUM	Geodetic	HWY	QEW	DATE	November 05 and 06, 2015	CHECKED BY	G.D.

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
146.0	Ground Surface				
0.0	Topsoil				
145.7	Clayey silt trace sand, trace gravel		1	SS	6
0.3	Stiff Reddish Moist brown (FILL)		2	SS	10
145.1	Clayey silt trace sand, trace gravel				
0.9	Stiff to hard Reddish Moist brown		3	SS	30
144.2	Shale bedrock				
1.8	Highly weathered Grey		4	SS	75
	Red		5	SS	94/20cm
			6	SS	50/10cm
140.8	End of borehole				
5.2	Refusal on probable bedrock				
	* Borehole dry				

RECORD OF BOREHOLE No 24

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 749.8 N; 290 778.1 E ORIGINATED BY S.A.
DIST Central BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Coring COMPILED BY M.Kh
DATUM Geodetic HWY QEW DATE November 05 and 06, 2015 CHECKED BY G.D.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
							20	40	60	80	100	20	40	60			
139.9	Ground Surface																
0.0	150mm asphalt over gravelly sand		1	SS	27												
139.4	(PAVEMENT FILL)																
0.5	Clayey silt some sand, trace gravel shale fragments		2	SS	50/13cm		139										
	Hard Reddish Moist brown		3	SS	50/5cm		138										
			4	SS	50/8cm		137										
			5	SS	50/10cm		136										
135.8	Shale bedrock limestone embedded		6	RC NQ	REC 97%		135									RQD 78%	
4.1	Slightly to moderately weathered		7	RC NQ	REC 73%		134									RQD 52%	
	Low to medium strength						133										
	Good to fair quality																
132.7	End of borehole																
7.2																	
	* Borehole charged with drilling water																
	C.F.H.S.A. denotes continuous flight hollow stem augers																

RECORD OF AUGER PROBE No AP-C

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 749.7 N; 290 754.2 E	ORIGINATED BY	M.Kh
DIST	Central HWY QEW	BOREHOLE TYPE	Continuous Flight Solid Stem Augers	COMPILED BY	M.Kh
DATUM	Geodetic	DATE	October 23, 2015	CHECKED BY	G.D.





SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES															
								SHEAR STRENGTH kPa										WATER CONTENT (%)		
139.1 0.0	Ground Surface					*														
139.0 0.1	Sand and gravel (FILL)						139													
	Silty clay																			
	Reddish brown																			
137.9 1.2	Highly weathered shale bedrock						138													
137.6 1.5	End of auger probe																			
	Refusal on probable bedrock																			

RECORD OF AUGER PROBE No AP-D

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 735.7 N; 290 760.7 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 23, 2015 CHECKED BY G.D.





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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20	40	60	80	100						
138.5 0.1	138.6 0.0	Ground Surface															
	138.3 0.3	Sand and gravel (FILL)															
		Silty clay															
	137.7 0.9	Reddish brown															
		Highly weathered shale bedrock															
		End of auger probe															
		Refusal on probable bedrock															

RECORD OF AUGER PROBE No AP-E

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 714.3 N; 290 772.8 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 23, 2015 CHECKED BY G.D.


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									
						<div> <div>20 40 60 80 100</div> <div> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE </div> </div>					<div> <div>20 40 60</div> <div>WATER CONTENT (%)</div> </div>						
138.2	Ground Surface																
138.0 0.2	Topsoil Silty clay, some gravel shale fragments Reddish brown						138										
136.7 1.5	Highly weathered shale bedrock						137										
136.1 2.1	End of auger probe Refusal on probable bedrock																
<p>* 2015 10 23</p> <p> Water level measured after drilling</p> <p>NOTE: Auger advanced fairly fast to 1.5m, then auger grinding to 2.1m depth.</p>																	

RECORD OF AUGER PROBE No AP-F

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 681.0 N; 290 788.8 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 23, 2015 CHECKED BY G.D.


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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
137.6	Ground Surface							20	40	60	80	100						
137.4 0.2	Topsoil																	
	Silty clay, some gravel shale fragments						137											
	Reddish brown																	
136.1 1.5	Highly weathered shale bedrock						136											
135.5 2.1	End of auger probe Refusal on probable bedrock																	
<div>* 2015 10 23</div> <div> Water level measured after drilling</div> <div>NOTE: Auger advanced fairly fast to 1.5m, then auger grinding to 2.1m depth.</div>																		

RECORD OF AUGER PROBE No AP-G

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 669.6 N; 290 794.9 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 23, 2015 CHECKED BY G.D.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
								○ UNCONFINED			+ FIELD VANE										
137.6	Ground Surface							20	40	60	80	100		20	40	60					
137.4 0.2	Topsoil						137														
	Silty clay, some gravel shale fragments																				
	Reddish brown																				
136.1 1.5	Highly weathered shale bedrock						136														
135.5 2.1	End of auger probe Refusal on probable bedrock																				
	<div>* 2015 10 23</div> <div> Water level measured after drilling</div> <div>NOTE: Auger advanced fairly fast to 1.5m, then auger grinding to 2.1m depth.</div>																				

RECORD OF AUGER PROBE No AP-H

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 702.4 N; 290 805.0 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 22, 2015 CHECKED BY G.D.

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										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
138.7	Ground Surface							20	40	60	80	100					GR SA SI CL			
138.5	Topsoil					138											1 6 59 34			
0.2	Clayey silt trace sand, trace gravel shale fragments		1	AS	-															
137.8	Reddish brown																			
0.9																				
137.6	Highly weathered shale bedrock																			
1.1	End of auger probe																			
	Refusal on probable bedrock																			
	* Auger probe dry																			

RECORD OF AUGER PROBE No AP-1

1 of 1

METRIC

G.W.P.	2163-10-00	LOCATION	Coords: 4 817 725.4 N; 290 799.8 E	ORIGINATED BY	M.Kh
DIST	Central HWY QEW	BOREHOLE TYPE	Continuous Flight Solid Stem Augers	COMPILED BY	M.Kh
DATUM	Geodetic	DATE	October 22, 2015	CHECKED BY	G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES												
								SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
138.9	Ground Surface																
0.0	Silty clay, some gravel shale fragments																
	Reddish brown																
137.7	Highly weathered shale bedrock																
1.2																	
136.2	End of auger probe																
2.7	Refusal on probable bedrock																
<div>* 2015 10 22</div> <div> Water level measured after drilling</div>																	

RECORD OF AUGER PROBE No AP-J

1 of 1

METRIC

G.W.P. 2163-10-00 LOCATION Coords: 4 817 751.4 N; 290 777.2 E ORIGINATED BY M.Kh
 DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
 DATUM Geodetic DATE October 22, 2015 CHECKED BY G.D.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
139.9	Ground Surface							20	40	60	80	100								
0.0 139.6 0.3	Silty clay, some gravel shale fragments																			
	Reddish brown (FILL)						139													
	Silty clay/clayey silt shale fragments																			
	Reddish brown						138													
136.8 3.1	End of auger probe Refusal on probable bedrock						137													
	* Auger probe dry																			

RECORD OF AUGER PROBE No AP-K

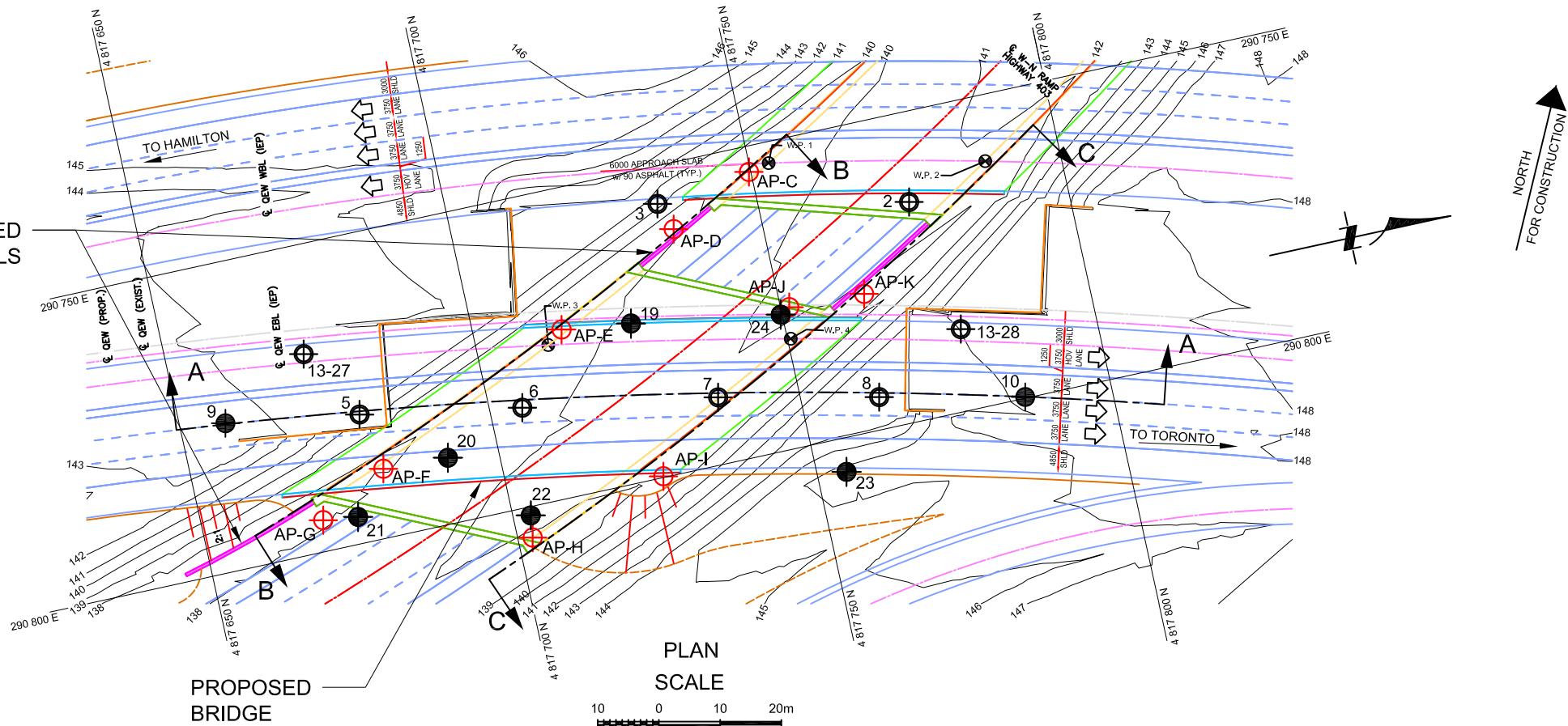
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METRIC

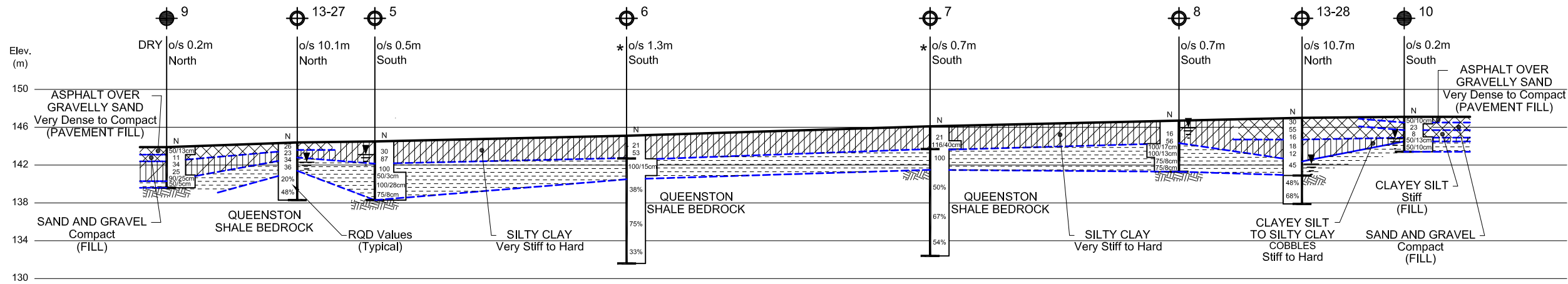
G.W.P. 2163-10-00 LOCATION Coords: 4 817 763.8 N; 290 777.7 E ORIGINATED BY M.Kh
DIST Central HWY QEW BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh
DATUM Geodetic DATE October 22, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
139.9	Ground Surface																
139.7 0.2	Sand and gravel (FILL)																
	Clayey silt, with sand trace to some gravel weathered shale fragments		1	AS	-											10 27 44 19	
138.7 1.2	Reddish brown																
	End of auger probe Refusal on probable bedrock																
	* Auger probe dry																

PROPOSED
RETAINING WALLS



PLAN
SCALE



PROFILE A - A
SCALE

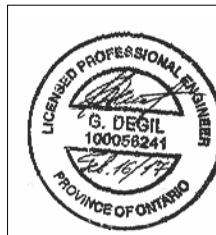


(Legend Continued)

BH No	ELEVATION	NORTHINGS	EASTINGS
GEOCRES REPORT BOREHOLES			
2	147.0	4 817 774.2	290 764.6
3	145.9	4 817 734.0	290 756.1
5	144.5	4 817 679.1	290 779.3
6	145.1	4 817 705.3	290 783.9
7	146.1	4 817 736.9	290 789.1
8	146.7	4 817 762.6	290 794.7
13-27	144.4	4 817 672.3	290 767.7
13-28	147.0	4 817 778.0	290 786.7

BH No	ELEVATION	NORTHINGS	EASTINGS
AP-G	137.6	4 817 669.6	290 794.9
AP-H	138.7	4 817 702.4	290 805.0
AP-I	138.9	4 817 725.4	290 799.8
AP-J	139.9	4 817 751.4	290 777.2
AP-K	139.9	4 817 763.8	290 777.7

(Legend Continued)



REF Stantec Drawing: 893-10-284-opt_c-ultimate.dwg undated

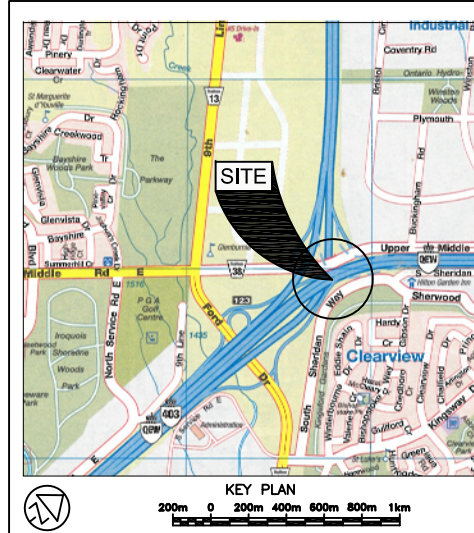
CONT No XXXX-XXX
GWP No 2163-10-00
WP No 2163-10-03

HIGHWAY 403 W-E RAMP OVERPASS
AT QUEEN ELIZABETH WAY EBL
Borehole Locations and Soil Strata



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

- Borehole
- Cone
- Borehole and Cone
- Geocres Report Borehole (30M5-117 & 30M5-285)
- Blows/0.3m (Std. Pen Test, 475 J/blow)
- Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation Jan. and Oct.-Nov. 2015
- * Water level not established
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

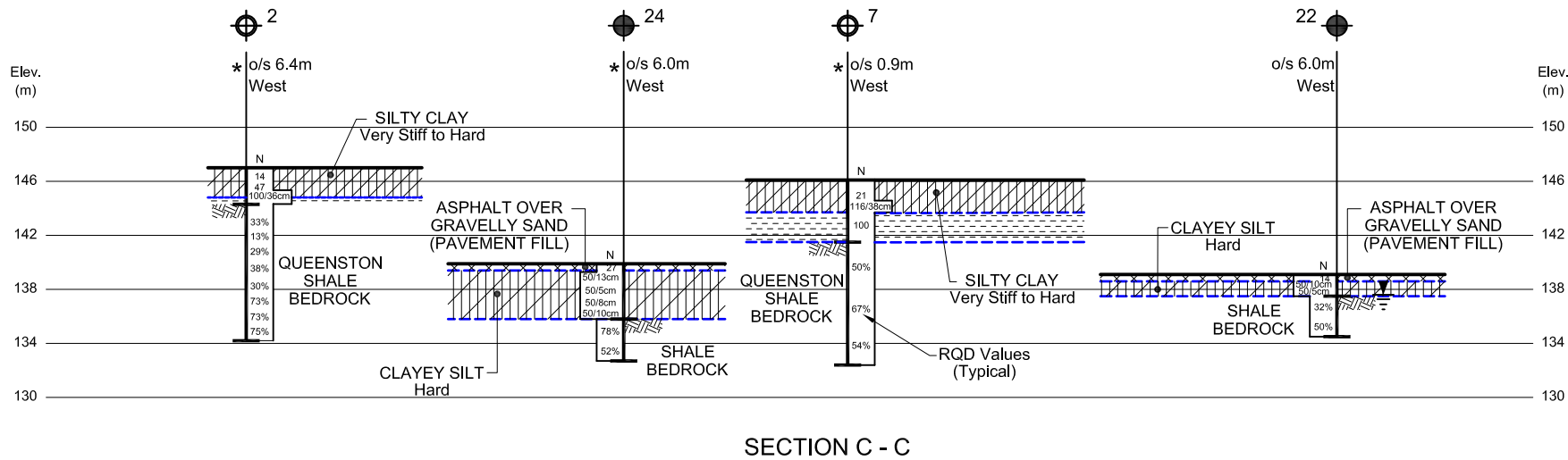
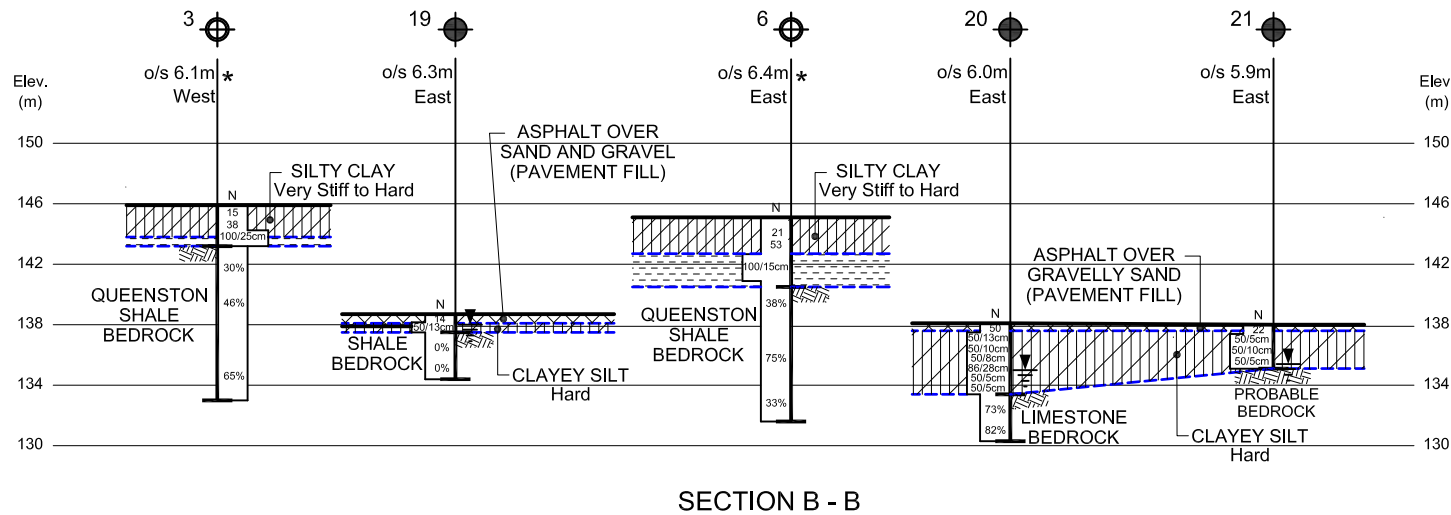
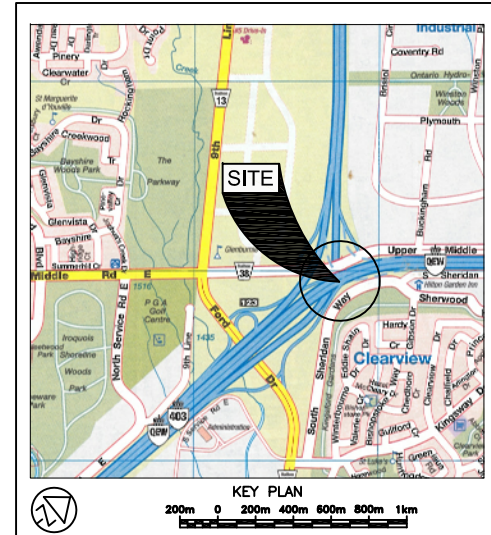
BH No	ELEVATION	NORTHINGS	EASTINGS
9	143.9	4 817 657.4	290 776.0
10	147.1	4 817 785.9	290 799.8
19	138.7	4 817 725.6	290 774.3
20	138.1	4 817 691.7	290 789.3
21	138.0	4 817 675.3	290 795.6
22	139.1	4 817 702.9	290 801.4
23	146.0	4 817 754.8	290 805.5
24	139.9	4 817 749.8	290 778.1
AP-C	139.1	4 817 749.7	290 754.2
AP-D	138.6	4 817 735.7	290 760.7
AP-E	138.2	4 817 714.3	290 772.8
AP-F	137.6	4 817 681.0	290 788.8

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 30M5-323			
HWY No	QEW / 403	CHECKED	GD
SUBMD	NA	DATE	FEB. 16, 2017
DRAWN	NA	SITE	10-284/2
CHECKED	GD	APPROVED	CN
DATE	FEB. 16, 2017	DWG	ER-1



LEGEND			
	Borehole		
	Cone		
	Borehole and Cone		
	Geocres Report Borehole (30M5-117 & 30M5-285)		
	Blows/0.3m (Std. Pen Test, 475 J/blow)		
	Blows/0.3m (60 Cone, 475 J/blow)		
	WL at time of investigation Jan. and Oct.-Nov. 2015		
	Water level not established		
	Head		
	ARTESIAN WATER		
	Encountered		
	PIEZOMETER		

BH No	ELEVATION	NORTHINGS	EASTINGS

FOR DETAILS, REFER TO DRAWING ER-1			

REVISIONS			

Geocres No. 30M5-323			
HWY No	QEW / 403	DATE	FEB. 16, 2017
SUBMD	NA	CHECKED	GD
DRAWN	NA	CHECKED	GD
		APPROVED	CN

- NOTES:
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - REFER TO DRAWING ER-1 FOR BOREHOLE LOCATION PLAN AND PROFILE A-A.
 - DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.
 - CHAINAGES FOR THE PROPOSED QEW EBL WERE NOT AVAILABLE.



REF Stantec Drawing: 893-10-284-opt_c-ultimate.dwg undated



APPENDIX FIR-A

Relevant GEOCREST Data

RECORD OF BOREHOLE No 2

W P 159-75-06 LOCATION N 15 805 618 E 953 900 Co-ords. ORIGINATED BY P.J.S.
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Augers, NX Casing and NXL Core COMPILED BY P.J.S.
DATUM Geodetic DATE December 15, 1977 CHECKED BY R.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		20	40	60	80	100					
482.2	Ground Level															
0.0	SILTY CLAY					480										
475.2	Very Stiff To Hard		1	SS	14											
7.0	QUEENSTON SHALE BEDROCK		2	SS	47											
			3	SS	100											
	Red To Grey Red Fine Texture Soft And Fissile With Thin Bedding Including A Few Thin Shaly Limestone Beds		4	NXL	80% Rec	470										RQD = 33
			5	NXL	41% Rec											RQD = 13
			6	NXL	81% Rec	470										RQD = 29
			7	NXL	81% Rec	460										RQD = 38
			8	NXL	85% Rec											RQD = 30
			9	NXL	97% Rec	450										RQD = 73
			10	NXL	87% Rec											RQD = 73
			11	NXL	100% Rec											RQD = 75
440.3	End Of Borehole															
41.9	Note: W.L. Not Established															

³, x⁵: Numbers refer to Sensitivity
20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

W P 159-75-06 LOCATION N 15 805 486 E 953 872 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, B Casing and BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 14, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
478.8	Ground Level																GR SA SI CL
0.0	SILTY CLAY																
	Very Stiff		1	SS	15												
477.8	To Hard		2	SS	38												
7.0	QUEENSTON SHALE BEDROCK		3	SS	100	10"	470										
	Red To Grey Red																
	Fine Texture		4	BXL Core	97% Rec		460										RQD = 30
	Soft And Fissile		5	BXL Core	70% Rec		450										RQD = 46
	With Thin Bedding																
	Including A Few																
	Thin Shaly Limestone		6	BXL Core	100% Rec		440										
	Beds																
	Limestone Bed 21'-21'7"																
	Shaly Limestone 33'-34'		7	BXL Core	100% Rec												RQD = 65
436.5	End Of Borehole																
42.5	Note: W.L. Not Established																

3, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

W P 159-75-06 LOCATION N 15 805 318 E 953 954 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 22, 1977 CHECKED BY R.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			20	40	60	80	100					
474.0	Ground Level																
0.0	SILTY CLAY						470										
	Very Stiff		1	SS	30												
466.0	To Hard		2	SS	87												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/13"		460										
	Red To Grey Red		4	SS	50/1"												
			5	SS	100/11"												
453.8			6	SS	75/3"												
20.2	End Of Borehole																

RECORD OF BOREHOLE No 6

W P 159-75-06 LOCATION N 15 805 395 E 953 965 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, BX Casing, BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 20, 1977 CHECKED BY R.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			20	40	60	80	100					
476.2	Ground Level																
0.0	SILTY CLAY						470										
	Very Stiff		1	SS	21												
468.2	To Hard		2	SS	53												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/6"		460										
	Red To Grey Red																
	Fine Texture		4	BXL	95% Core Rec		450										RQD = 38
	Soft And Fissile																
	With Thin Bedding																
	Including A Few Thin																
	Beds Of Shaly Limestone		5	BXL	100% Core Rec		440										RQD = 75
	Limestone Bed 31'9"-32'2"																
	Limestone Bed 40'6"-41'4"		6	BXL	95% Core Rec												RQD = 33
431.9																	
44.3	End Of Borehole																
	Note: W.L. Not Established																

+3, x5: Numbers refer to 20
 15 5 (%) STRAIN AT FAILURE
 Sensitivity 10

RECORD OF BOREHOLE No 7

W P 159-75-06 LOCATION N 15 805 525 E 953 990 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, BX Casing, BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 20, 1977 CHECKED BY R.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			20	40	60	80	100					
479.4	Ground Level																GR SA SI CL
0.0	SILTY CLAY																
	Very Stiff		1	SS	21												0 4 45 51
	To Hard																
471.4			2	SS	116/15"												0 7 63 30
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/12"		470										0 3 71 26
	Red To Grey Red																
	Fine Texture		4	BXL Core	98% Rec		460										RQD = 50
	Soft And Fissile																
	With Thin Bedding																
	Including A Few																
	Shaly Limestone Beds		5	BXL Core	100% Rec		450										RQD = 67
	Shaly Limestone 15'8"-16'0"																
	Shaly Limestone 40'8"-41'0"																
	Shaly Limestone 43'5"-44'5"		6	BXL Core	100% Rec		440										RQD = 54
434.4																	
45.0	End Of Borehole																
	Note: W.L. Not Established																

RECORD OF BOREHOLE No 8

W P 159-75-06 LOCATION N 15 805 601 E 954 015 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 21, 1977 CHECKED BY R.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			20	40	60	80	100					
481.3	Ground Level																GR SA SI CL
0.0	SILTY CLAY						480										
	Very Stiff		1	SS	16												
	To Hard																
473.3			2	SS	56												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/7"		470										
	Red To Grey Red		4	SS	100/5"												
			5	SS	75/3"												
463.6			6	SS	75/3"												
17.7	End Of Borehole																

+3, x5: Numbers refer to 20
 Sensitivity 15-20 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 13-27

1 OF 1

METRIC

W.P. _____ LOCATION N 4 817 672.3 E 290 767.7 ORIGINATED BY GA
 HWY 403/0EW BOREHOLE TYPE Solid Stem Augers/140 Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.05.21 - 2013.05.22 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ N/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	W _u VALUES			20	40	60	80	100		
144.4 0.0	ASPHALT (150mm)													
0.2 143.5	Gravelly SAND, some silt Compact Brown Damp (FILL)		1	SS	26		144							34 44 22 (SI+CL)
0.8 142.8	Silty CLAY trace sand trace gravel Very Stiff Reddish Brown		2	SS	23		143							
1.6 142.8	SHALE highly weathered, thinly bedded, reddish brown		3	SS	34		142							
			4	SS	36		141							
	Start coring at 3.0m Highly to slightly weathered, thinly bedded, occasional limestone interbeds Frequent clay seams from 3.1m to 3.4m Horizontal fractures at 3.4m, 3.5m, 3.6m, 3.7m, 3.8m Limestone interbeds (25mm) at 3.2m, 4.0m and (75mm) at 3.6m		1	RUN			140							RUN #1 TCR=100% SCR=57% ROD=20% UCS=1MPa (Average)
	Highly broken zone 225mm at 3.7 330mm at 4.5m 100mm at 5.7m Horizontal fracture from 4.9m to 5.5m		2	RUN			139							RUN #2 TCR=100% SCR=70% ROD=48% UCS=5MPa (Average)
138.3 6.1	END OF BOREHOLE AT 6.1m. BOREHOLE OPEN TO 8.1m AND WATER LEVEL AT 2.1m UPON COMPLETION OF CORING. BOREHOLE BACK FILLED WITH BENTONITE HOLEPLUG TO 0.3m. CONCRETE TO 0.15m THEN ASPHALT PATCH TO SURFACE													

ONTARIO 1184-GPJ 2012 TEMPLATE(MTO) GDT 8/8/13

+ 3 x 3 Numbers refer to
Sensitivity

23
15
12

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13-28

1 OF 2

METRIC

WP _____ LOCATION N 4 817 778 0 E 390 789 7 ORIGINATED BY GA
 HWY 403/CEW BOREHOLE TYPE Solid Stem Augers/NO Coring COMPILED BY AN
 DATUM Geodetic DATE 2013 05 22 - 2013 05 22 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNPT WEIGHT 7 kg/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"I" VALUES		20	40	60	80	100					
147.0	ASPHALT (300mm)															
146.7																
0.3	Gravelly SAND some silt Compact to Very Dense Reddish Brown Comp (FILL)		1	SS	30											
			2	SS	55											33 47 20 (SI+CL)
			3	SS	16											
144.7																
2.3	Silty CLAY, trace to some sand, trace gravel Very Silty to Silty Brown to Reddish Brown		4	SS	18											
			5	SS	12											0 12 45 43
142.4																
4.6	SHALE highly weathered, reddish brown		6	SS	45											
	Start coring at 6.1m Slightly weathered to fresh, thinly bedded, reddish brown, occasional limestone interbeds 175mm soft zone at 6.1m		1	RUN												
	Highly broken zone (100mm) at 6.2m, 6.5m															
	Limestone interbeds (25mm) at 6.4m and (150mm) at 6.8m and 7.3m															
	Horizontal fractures at 6.2m, 6.4m, 6.5m, 6.8m, 6.9m, 7.0m, 7.4m, 7.7m, 7.8m, 7.9m, 8.1m, 8.2m, 8.5m, 8.9m and (150mm) at 8.6m 50mm highly broken zone at 7.6m		2	RUN												
	Limestone interbeds (25mm) at 7.7m, 7.9m, 8.1m, 8.2m, 8.3m, 8.5m, 8.7m															
137.9																
9.1	END OF BOREHOLE AT 9.1m BOREHOLE OPEN TO 9.1m AND WATER LEVEL AT 4.9m UPON COMPLETION OF CORING BOREHOLE BACKFILLED WITH BENTONITE HOLE PLUG TO 0.3m															

OHT/MTS 1184 QPJ 2012/EMPLATE(MTO) GDT 88/13

Continued Next Page

+ 1 x 2

Numbers refer to
Sensitivity

23
11-5
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13-28

2 OF 2

METRIC

W.P. _____ LOCATION N 4 817 778.0 E 290 786.7 ORIGINATED BY GA
 HWY 403/GEW BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.05.22 - 2013.05.22 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION/SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT γ _w M/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			1" VALUES	20	40	60	80	100	W _p	W _L		
	Continued From Previous Page CONCRETE TO 0.15m THEN ASPHALT PATCH TO SURFACE															

OKT111145 1184.GPJ 2012TEMPLATE[M10].GDT 06/13



APPENDIX FIR-B

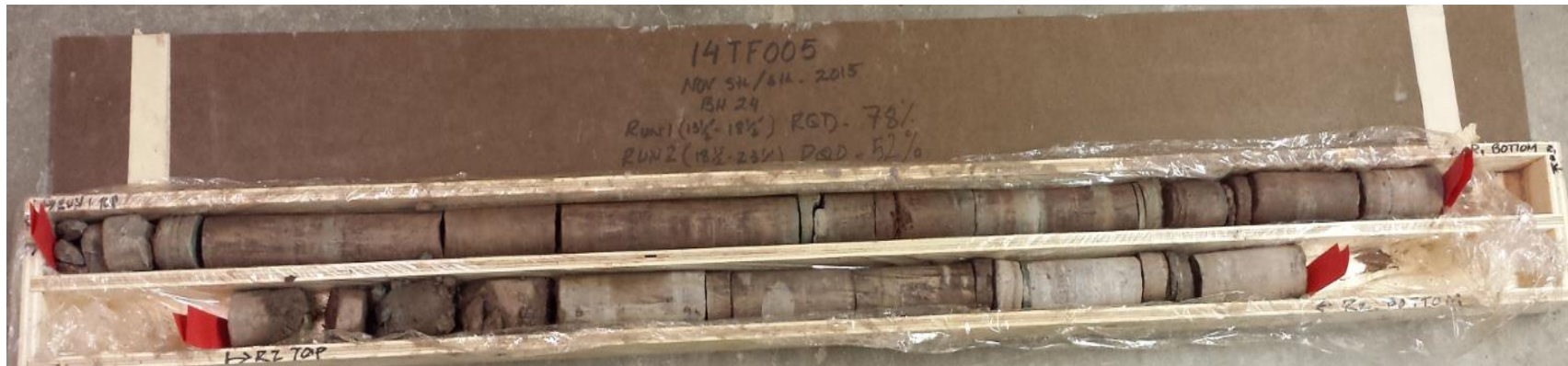
Rock Core Photographs



Photograph 1: Cores retrieved from borehole 20. Cores 8 and 9 from 4.7 to 7.8 m depth. RQD values were 73 and 82%, indicating fair to good rock quality.



Photograph 2: Cores retrieved from borehole 22. Cores 4 and 5 from 1.6 to 4.6 m depth. RQD values were 32 and 50%, indicating poor to fair rock quality.



Photograph 3: Cores retrieved from borehole 24. Cores 6 and 7 from 4.1 to 7.2 m depth. RQD values were 72 and 52% respectively, indicating good to fair rock quality.