PetoMacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION REPORT
FOR
HIGHWAY 77 UNDERPASS
G.W.P. 60-00-00, SITE 6-104
HIGHWAY 401
COMBER, ONTARIO

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FOUNDATION INVESTIGATION REPORT
for
Highway 77 Underpass
G.W.P. 60-00-00, Site 6-104
Highway 401
Comber, Ontario

INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed replacement of the existing underpass structure at Highway 77 and Highway 401 in Comber, Ontario. The investigation was conducted for the Southwestern Region Structural Section of the Ontario Ministry of Transportation.

Highway 401 will pass under Highway 77 at approximate Station 13+928, Highway 401 chainage, in the Town of Lakeshore (Township of Tilbury West).

The report pertains to the proposed underpass structure and approaches within about 20 m of the abutments.

SITE DESCRIPTION

The site is situated at the intersection of the existing Highways 77 and 401. The proposed structure will carry Highway 77 traffic over Highway 401. At the location of the structure, Highway 401 runs in the east-west direction. The existing approaches comprise fill embankments with heights of approximately 7 to 8 m.

The site is located in the Town of Lakeshore in Essex County (Southwestern Ontario), east of Windsor along Highway 401. The surrounding lands are mainly level and used for agricultural purposes.

The area is part of the Essex Clay Plain physiographic sub-region. It is essentially a till plain smoothed by deposits of lacustrine clay which settled in the depressions while the knolls were being lowered by wave action. In general, the overburden in the sub-region consists of silty clays and/or clayey silts. The bedrock belonging to the Dundee Formation and anticipated at a depth of about 40 m is largely composed of Middle Devonian limestone, dolostone and shale.

INVESTIGATION PROCEDURES

The field work was carried out during the period January 20 to 25, 2002 and comprised six boreholes advanced to depths of 5.0 to 44.8 m, as summarized in the following table, at the locations indicated on Drawing 1 (Appendix B).

Location	Borehole No.	Depth (m)		
		Auger	Rock Core (1)	Total
North Approach	104-1	5.0	-	5.0
North Abutment, West Side	104-2	12.6	-	12.6
North Abutment, East Side	104-3	41.8	3.0	44.8
South Abutment, West Side	104-4	41.9	2.2	44.1
South Abutment, East Side	104-5	14.2	-	14.2
South Approach	104-6	5.0	-	5.0

(1) NXL diamond rock coring equipment

The coring in borehole 104-4 was terminated before the programmed 3.0 m of core was recovered to avoid further difficulties as pressurized natural gas was encountered in the bedrock at this location.

The locations of and ground surface elevations at the boreholes were established in the field by Peto MacCallum Ltd. The following benchmark (BM) was used for vertical reference:

BM 207: Cut cross on southeast corner of concrete footing for handrail
28.2 RT 13+919.1
Elevation 190.663 (geodetic)

The boreholes were advanced using continuous flight solid and hollow stem augers, powered by a truck-mounted CME-75 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In situ vane shear and pocket penetrometer tests were also performed to further assess the shear strength of the cohesive soils.

NW casing was extended to the bedrock surface and NXL diamond rock coring equipment used to recover two rock cores from each of the deep holes – boreholes 104-3 and 104-4.

The groundwater conditions in the boreholes were closely monitored during the course of the field work. Upon completion of augering, boreholes 104-1, 104-2, 104-5 and 104-6 were backfilled with auger cuttings to the ground surface. Boreholes 104-3 and 104-4 were grouted upon completion of rock coring.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Atterberg Limits tests and grain size distribution analyses were carried out on selected samples, their results being presented in Figures 1 to 3 (Appendix A) and on the Record of Borehole sheets (Appendix B).

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, boundary elevations, standard penetration and in situ vane shear/pocket penetrometer test results, rock core descriptions, groundwater observations, the results of laboratory grain size distribution analyses, Atterberg Limits tests and moisture content determinations. Samples submitted for laboratory testing are also shown on the borehole logs.

The borehole locations and stratigraphic profiles prepared from the borehole data are presented on Drawings 1 and 2.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised a surficial pavement structure over fill underlain by topsoil, silty clay and clay till. Limestone bedrock was contacted below the clay overburden at an approximate depth of 41.8 m (elevation 148.6). The strata encountered are summarized below.

Pavement Structure

A pavement structure of 750 mm in thickness (910 mm in borehole 104-3) was present surficially in all the boreholes. It consisted of 210 to 280 mm of asphaltic concrete and 470 to 660 mm of sand and gravel.

Fill

The fill below the surficial pavement structure was represented by silty clay in the approach boreholes and fine to coarse sand over silty clay in boreholes 104-2 to 104-5. The sand was very loose to compact and 1.5 to 5.5 m thick, its moisture content ranging from 5 to 8%, locally 23% (at 6.2 m depth in borehole 104-5).

The silty clay was encountered at depths of 0.8 to 6.3 m (elevation 184.3 to 189.6). The confirmed thickness of this layer varied between 1.7 and 4.7 m. The clay was typically stiff to very stiff with a localized firm zone in borehole 104-5 and had a moisture content of 16 to 22%.

The fill was not penetrated in boreholes 104-1 and 104-6 which were terminated at 5 m depth (elevation 184.8 and 185.3 respectively).

Topsoil

Consisting of silty clay, the topsoil was revealed at depths of 7.1 to 7.9 m (elevation 182.6 to 183.2). Assessed at one location as being very stiff, this unit was 300 to 700 mm thick and had a moisture content of 23 to 27%.

Silty Clay

Directly beneath the topsoil at elevation 182.3 to 182.5 was a 0.8 to 1.9 m thick layer of silty clay. This unit was not identified in borehole 104-5. The silty clay was stiff to very stiff in consistency, its moisture content being about 25%. Pocket penetrometer testing conducted within the unit gave the values of unconfined strength in a range of 70 to 125 kPa.

Clay Till

The silty clay till was encountered at depths of 8.6 to 10.1 m (elevation 180.4 to 182.0). Its consistency was stiff to hard in the upper portion of the unit, becoming firm with depth. The results of vane shear testing carried out in this stratum at 22 m depth indicate that the undisturbed and remolded shear strength values are 85 and 70 kPa respectively (soil sensitivity is 1.2). A number of pocket penetrometer tests conducted within the unit gave the values of unconfined strength varying broadly between 40 and 250 kPa, typically decreasing with depth. The moisture content of the clay till ranged from 18 to 23% in the upper portion of the unit, reaching 21 to 29% at depth.

The deposit was 31.7 to 32.8 m in thickness, in borehole 104-4 containing an approximately 6 m thick layer of loose to dense silt and sand till that was revealed at 32.2 m depth (elevation 158.3). The clay till was not penetrated in boreholes 104-2 and 104-5 which were terminated at respective depths of 12.6 and 14.2 m (elevation 177.5 and 176.4).

The results of the Atterberg Limits tests are presented in Figure 1 (Appendix A). The clay till plots as a silty clay of medium plasticity. The results of particle size distribution analyses conducted on the clay till and local silt/sand deposit are presented in Figures 2 and 3 (Appendix A).

Bedrock

Limestone bedrock, confirmed by rock coring, was contacted below the clay till overburden at the following depths and elevations:

Location	Depth to Rock (m)	Bedrock Elevation
North Abutment, East Side	41.8	148.5
South Abutment, West Side	41.9	148.6

Rock core description is provided in Table I (Appendix A). The measured core recovery varied between 90 and 100%. The RQD determined from the rock cores was in a range of 80 to 93%, indicating a good to excellent quality rock. Loss of drill water circulation was experienced shortly after the start of coring – at depths of 43.2 m (elevation 147.1) in borehole 104-3 and 42.0 m (elevation 148.5) in borehole 104-4. A small void was detected in the core in borehole 104.3 about 1.4 m below the rock surface. It is worth noting that a natural gas deposit with trace of oil under pressure was discovered in the latter borehole at 42.5 m depth (elevation 148.0).

The unconfined compressive strength of the rock determined on two representative samples corresponding to depths of 41.9 and 44.4 m (elevation 148.4 and 145.9 respectively) was about 90 MPa.

Groundwater

No water was observed in any of the boreholes during or upon completion of drilling in the overburden.

Groundwater was not observed in the boreholes drilled at this site during the field investigation. Based on visual examination of the samples retrieved during drilling and water level observations/measurements during the field investigations conducted for other structures throughout the study corridor, it is expected that the stabilized water level at this site is near elevation 179.5, 2.5 m below the original ground surface elevation.

CLOSURE

The field work was carried out under the supervision of Mr. M. Rapsey and direction of Mr. M.R. Anderson, P.Eng., Senior Geotechnical Engineer. The equipment was supplied by Elite Drilling.

The report was prepared by Mr. G.O. Degil, Ph.D., Senior Project Supervisor, and Mr. M.R. Anderson, M. Eng., P.Eng. It was reviewed by Mr. D.W. Kerr, M. Eng., P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, M. Eng., P.Eng., carried out an independent review of the report.

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
PROVINCE OF ONTARIO

Yours very truly

Peto MacCallum Ltd.

Murray R. Anderson, M.Eng., P.Eng
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
D. W. KERR
PROVINCE OF ONTARIO

Dennis W. Kerr, M.Eng., P.Eng.
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President

GD:lad

APPENDIX A

TABLE I	–	ROCK CORE DESCRIPTION
FIGURE 1	–	PLASTICITY CHART
FIGURES 2 and 3	–	PARTICLE SIZE DISTRIBUTION CHARTS

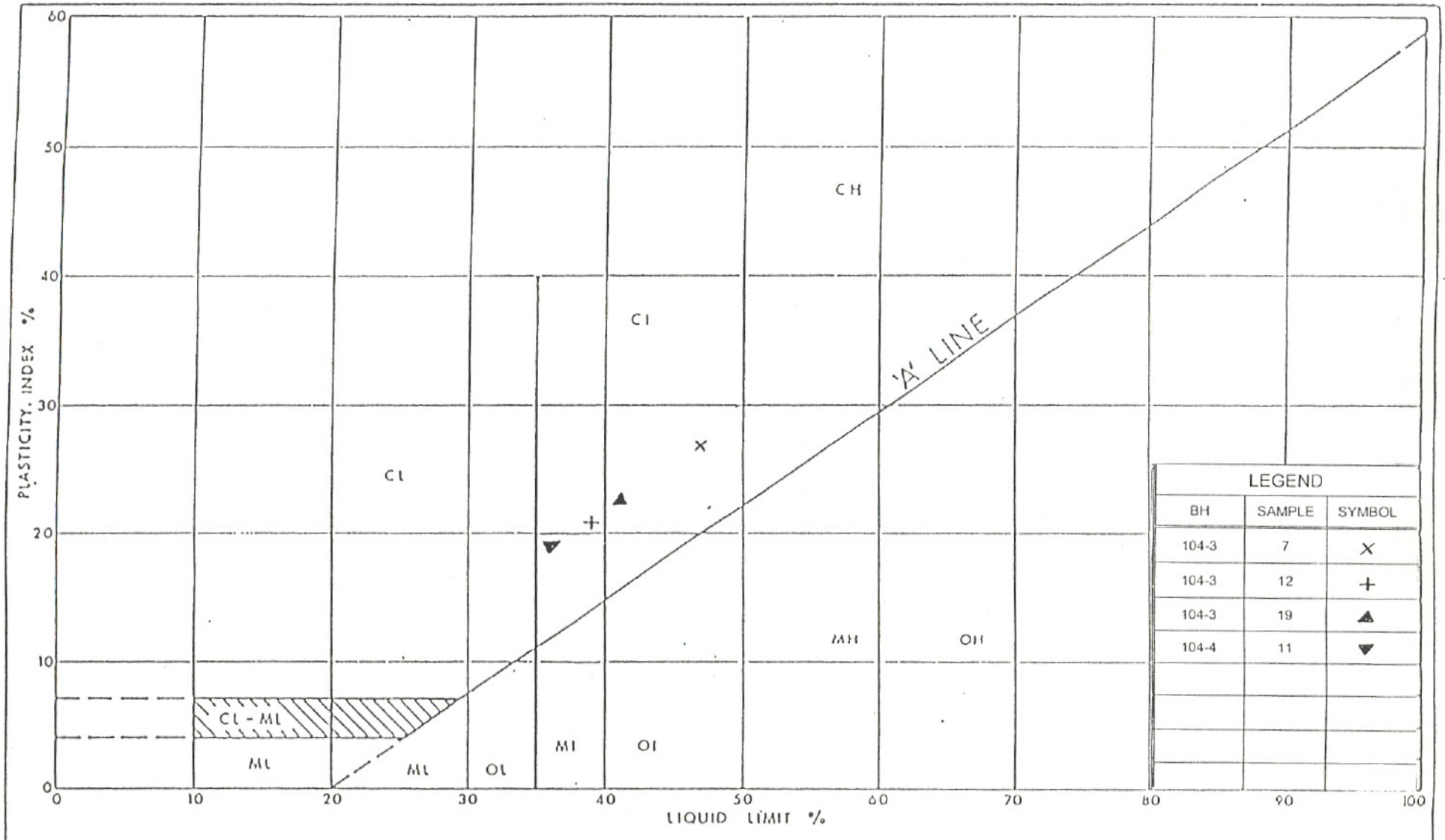
TABLE I

ROCK CORE DESCRIPTION
HIGHWAY 77 UNDERPASS
G.W.P. 60-00-00, SITE 6-104
HIGHWAY 401
WINDSOR, ONTARIO

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	RUN NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
104-3	20	41.75 – 43.30	100	85	41.75 – 44.80	**LIMESTONE:** grey, fine grained, occ. white mottling, occ. styolitic partings; medium to high strength; unweathered; closely to moderately spaced discontinuities; fracture index 3; good quality (Dundee Formation)
	21	43.30 – 44.80	100	93		
104-4	21	41.90 – 42.50	100	90	41.90 – 44.05	**LIMESTONE:** buff to grey, fine grained, with irregular shaley parting at 42.50 m (gas); medium to high strength; unweathered; closely to moderately spaced discontinuities; fracture index 4; good quality (Dundee Formation)
	22	42.50 – 44.05	90	80		

Logged by J.F. Wright using the Provincial Highways "A Guide to the Description of Rock for Engineering Purposes" Dated October, 1982.

RQD = Rock Quality Designation



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PLASTICITY CHART

SILTY CLAY, some sand, trace of gravel (CI)

FIG No 1
HIGHWAY 401
G.W.P. No. 60-00-00

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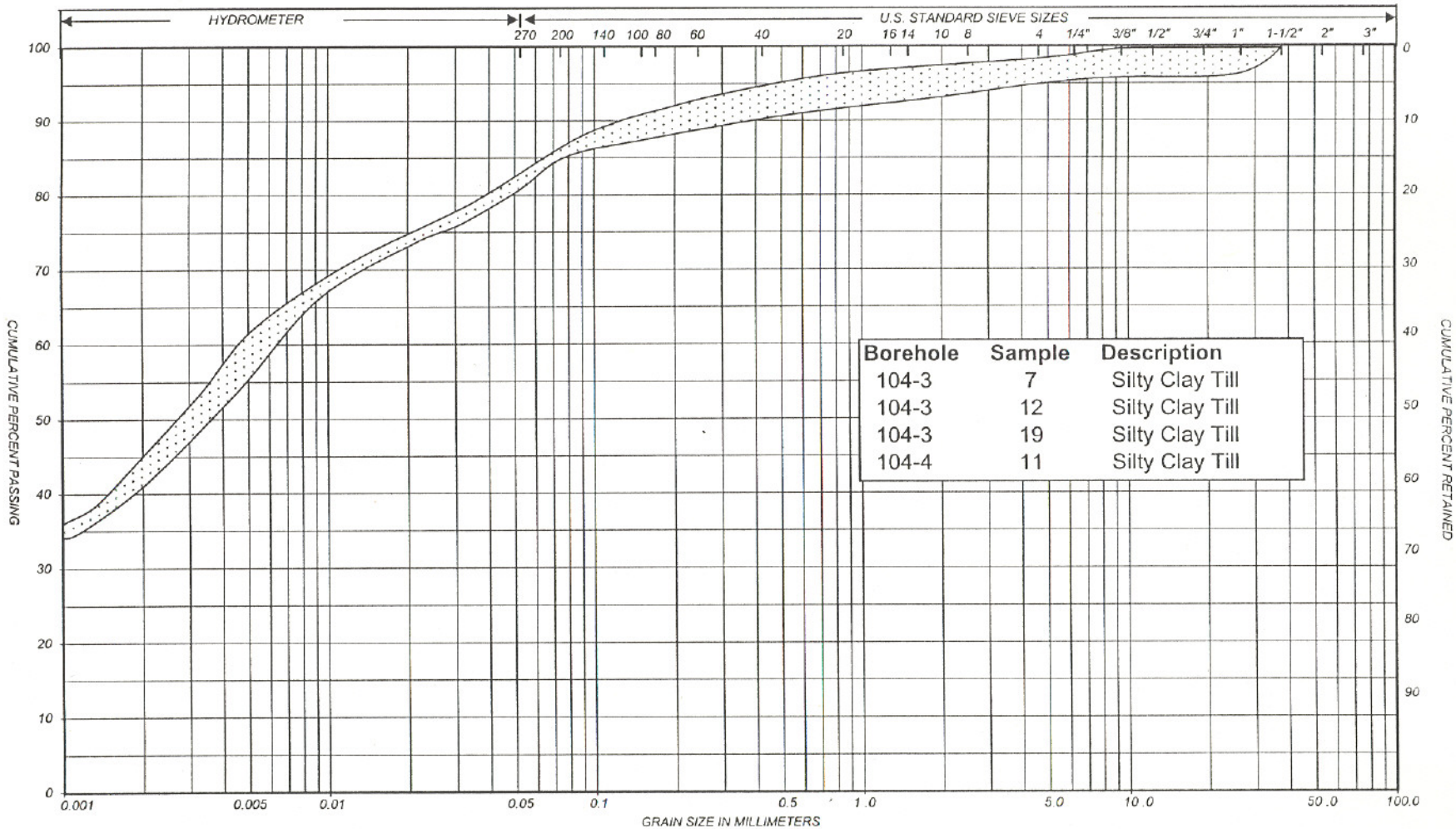
PARTICLE SIZE DISTRIBUTION CHART

PML REF. 01TF072E
REPORT NO. 1
FIGURE 2



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

REMARKS SILTY CLAY TILL

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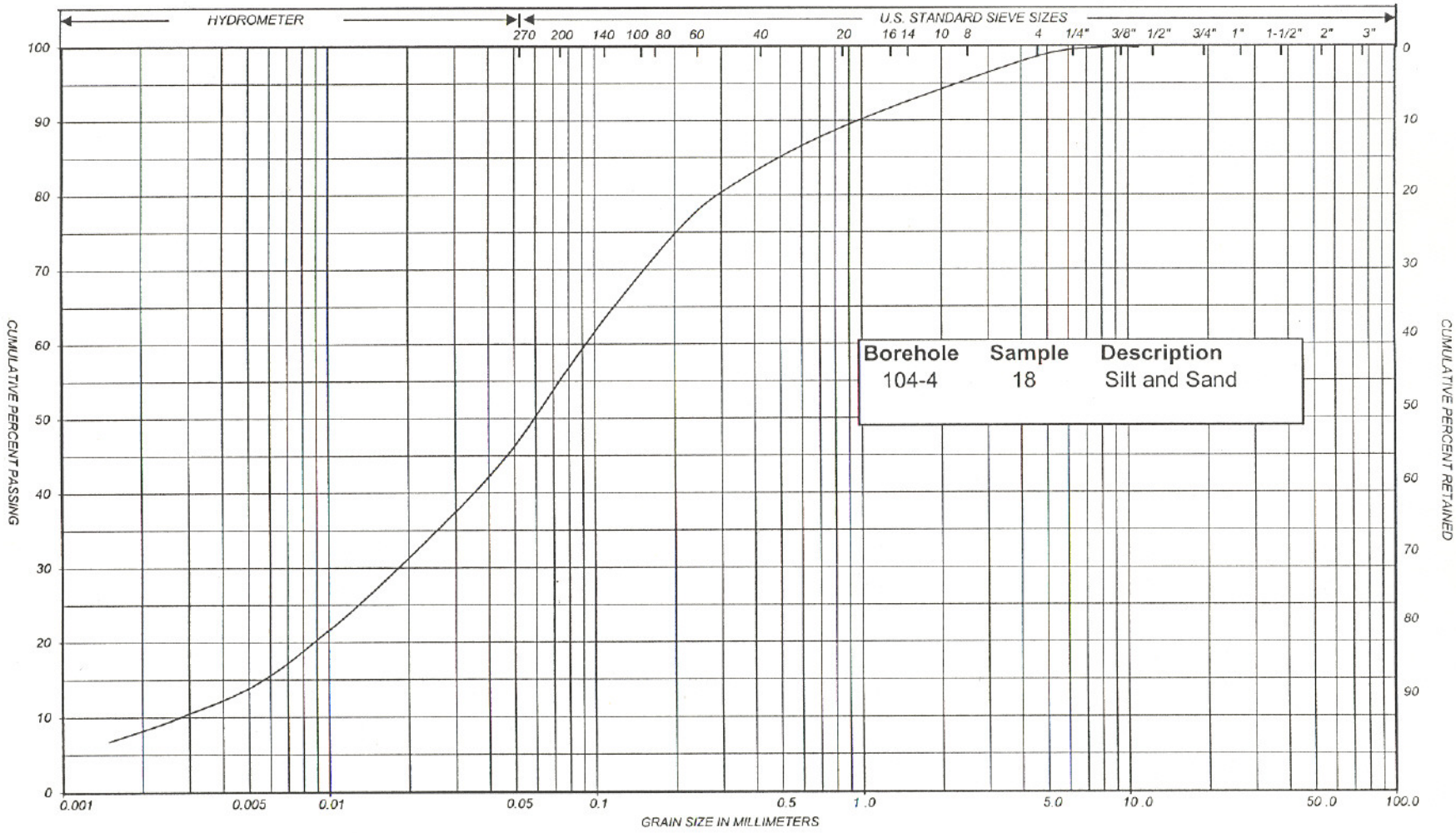
PML REF. 00TF072E
REPORT NO. 1
FIGURE 3

PARTICLE SIZE DISTRIBUTION CHART



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

REMARKS SILT AND SAND

APPENDIX B

RECORD OF BOREHOLE SHEETS

DRAWINGS 1 AND 2

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LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N', - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SP
0.3 m INTO THE SUBSOIL. DRIVEN BY MEANS OF A 63.5 kg HAMMER FALLING FREELY A DISTANCE OF 0.76 m.

DYNAMIC PENETRATION RESISTANCE: - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51 mm, 60 DEGREE CONE,
END OF DRILL RODS. 0.3 m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE D
THE FOLLOWING TERMS:

CONSISTENCY	'N' BLOWS/0.3 m	c kPa	DENSENESS	'N' BLOWS/0.3 m
VERY SOFT	0 – 2	0 – 12	VERY LOOSE	0 – 4
SOFT	2 – 4	12 – 25	LOOSE	4 – 10
FIRM	4 – 8	25 – 50	COMPACT	10 – 30
STIFF	8 – 15	50 – 100	DENSE	30 – 50
VERY STIFF	15 – 30	100 – 200	VERY DENSE	> 50
HARD	> 30	> 200		

W.T.P.L. WETTER THAN PLASTIC LIMIT D.T.P.L. DRIER THAN PLASTIC LIMIT

A.P.L. ABOUT PLASTIC LIMIT

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

▲,△ - UNDISTURBED AND REMOULDED SHEAR STRENGTH DETERMINED FROM IN SITU VANE TEST.

■ - UNDRAINED SHEAR STRENGTH DETERMINED FROM POCKET PENETROMETER TEST.

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RECORD OF BOREHOLE No 104-1 1 of 1 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 144 N; 300 508 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY MRA

DATUM Geodetic DATE January 24, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.86	Ground Surface										
0.00	Pavement, 280mm asphaltic concrete over 470mm sand and gravel										
189.11											
0.75	Silty clay, trace of sand Stiff to Very Stiff Brown (Fill)		1	SS	13		189				
			2	SS	12		188				
	occ. small pockets of dark brown silty clay topsoil		3	SS	17		187				
			4	SS	18		186				
184.81			5	SS	20		185				
5.05	End of Borehole 2002-01-24 Borehole dry on completion of drilling										

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$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 104-2 1 of 1 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 125 N; 300 496 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY MRA

DATUM Geodetic DATE January 24, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
190.19	Ground Surface						190
0.00	Pavement, 230mm asphaltic concrete over 520mm sand and gravel						
189.44							189
0.75	Sand, fine to coarse, some silt, some gravel Loose Brown Moist (Fill)		1	AS	-		
			2	SS	6		
187.69							188
2.50	Silty clay, trace of sand Stiff to Very Stiff Brown (Fill)		3	SS	11		187
			4	SS	18		186
			5	SS	23		185
183.09							184
7.10	Topsoil, silty clay, trace of sand						
182.39	Dark Brown		6	SS	28		183
7.80	Silty clay, trace of sand Very Stiff						
181.59	Brown						182
8.60	Silty clay, trace of sand and gravel, with blueish grey fissures (Till) Hard Brown		7	SS	46		181
	Grey		8	SS	36		180
							179
177.54			9	SS	30		178
12.65	End of Borehole 2002-01-24 Borehole dry on completion of drilling						

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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20
15 — 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 104-3 1 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 124 N; 300 508 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA

DATUM Geodetic DATE January 20, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.26	Ground Surface										
0.00 / 189.35	Pavement, 250mm asphaltic concrete over 660mm sand and gravel										
0.91 / 187.86	Gravelly sand, fine to coarse, with silt Loose Brown Damp (Fill)		1	SS	5				○		
2.40	Silty clay, trace of sand and gravel Stiff to Very Stiff Brown (Fill)		2	SS	10				○		
			3	SS	24				○		
			4	SS	17				○		
183.16											
7.10 / 182.46	Topsoil, silty clay, trace of sand Dark Brown		5	SS	23				○		
7.80	Silty clay, trace of sand Very Stiff to Stiff Brown		6	SS	14			■	○		
181.26											
9.00	Silty clay, some sand, trace of gravel, with blueish grey fissures (Till) Very Stiff Brown Grey		7	SS	18				225 ○		2 13 43 42
			8	SS	32				○		
			9	SS	22			■	○		
			10	SS	15				■ ○		
	Cont'd										

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(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 104-3 2 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 124 N; 300 508 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA

DATUM Geodetic DATE January 20, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, X LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.26	Ground Surface										
	Silty clay, some sand, trace of gravel, with blueish grey fissures (Till) *(Cont'd)*		11	SS	17		175	■	o		
							174				
	Firm						173				
			12	SS	7		172		o		5 10 40 45
							171				
							170				
			13	SS	7		169		o		
							168				
							167				
			14	SS	5		166		o		
							165				
							164				
							163				
			15	SS	4				o		
							162				
							161				
	Cont'd										

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$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

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Ontario

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RECORD OF BOREHOLE No 104-3 3 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 124 N; 300 508 E. ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 20, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.26	Ground Surface						160				
	Silty clay, some sand, trace of gravel, with blueish grey fissures (Till) *(Cont'd)*		16	SS	4		159		o		
							158				
			17	SS	3		157		o		
							156				
			18	SS	0		155		o		
							154				
							153				
			19	SS	7		152				4 10 41 45
148.51							151		o		
41.75	Bedrock Unweathered, strong limestone Grey		20	RC	REC 100%		150				RQD = 85%
							149				
			21	RC	REC 100%		148				RQD = 93%
145.46							147				
44.80	Cont'd						146				

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+7, ×5: Numbers refer to Sensitivity

20
15 — 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-3 4 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 124 N; 300 508 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA

DATUM Geodetic DATE January 20, 2002 CHECKED BY DWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
190.26	Ground Surface										
	End of Borehole										
	2002-01-20 Borehole dry on completion of drilling										
	■ Penetrometer Test										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:39:46 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-4 1 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 496 E. ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 22 to 24, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.53	Ground Surface										
0.00 / 189.78	Pavement, 250mm asphaltic concrete over 500mm sand and gravel						190				
0.75	Sand, fine to coarse, some gravel, trace of silt Very Loose Brown Damp (Fill)		1	AS	-						
			2	SS	4		189				
			3	SS	3		188				
			4	SS	4		187				
185.03							186				
5.50	Silty clay, trace of sand Stiff Brown (Fill)		5	SS	8		185				
182.63							184				
7.90 / 182.33	Topsoil, silty clay, trace of sand		6	SS	26		183				
8.20	Silty clay, trace of sand and gravel, with blueish grey fissures Stiff to Very Stiff Brown		7	SS	18		182		125		
			8	SS	13		181				
180.38							180		250		
10.15	Silty clay, some sand, trace of gravel (Till) Hard Brown Grey Very Stiff		9	SS	43		179				
			10	SS	20		178		137.5		
	Stiff						177				
			11	SS	13		176				2 13 40 45
	Cont'd										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:17 AM

+7, ×5: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-4 2 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 496 E. ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 22 to 24, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.53	Ground Surface										
	Silty clay, some sand, trace of gravel (Till) *(Cont'd)*		12	SS	13		175				
							174				
							173				
	Firm		13	TW	PH		172				
							171				
							170				
			14	SS	4		169				
				FV				+1.2			
							168				
							167				
			15	SS	5		166				
							165				
							164				
			16	SS	3		163				
							162				
							161				
	Cont'd										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:18 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 — 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-4 3 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 496 E. ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 22 to 24, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.53	Ground Surface										
	Silty clay, some sand, trace of gravel (Till) *(Cont'd)*		17	SS	11		160				
	Sandy						159				
159.33											
32.20	Silt and sand, trace of clay and gravel Dense Grey (Till)		18	SS	38		158 157				2 42 48 8
	with zones and lenses of silty clay, some sand Loose		19	SS	8		156 155 154				
152.23							153				
38.30	Silty clay, some sand to sandy, trace of gravel Firm Grey (Till)		20	SS	7		152 151				
148.63							150 149				
41.90	Bedrock Unweathered, strong limestone Buff to Grey		21	RC	REC 100%		148				RQD = 90%
			22	RC	REC 90%		147				Natural gas encountered RQD = 80%
146.48											
44.05	End of Borehole Cont'd										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:19 AM

+7, ×5: Numbers refer to Sensitivity 20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-4 4 of 4 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 496 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A. & NXL Rock Coring COMPILED BY MRA

DATUM Geodetic DATE January 22 to 24, 2002 CHECKED BY DWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
190.53	Ground Surface										
	2002-01-25 Borehole dry on completion of drilling										
	■ Penetrometer Test										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:20 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-5 1 of 2 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 507 E. ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY MRA
DATUM Geodetic DATE January 25, 2002 CHECKED BY DWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.58	Ground Surface										
0.00	Pavement, 255mm asphaltic concrete over 495mm sand and gravel										
189.83							190				
0.75	Sand, fine to coarse, some gravel, trace of silt Loose Brown Damp (Fill)		1	SS	6		189		o		
			2	SS	5		188		o		
	Compact		3	SS	11		187		o		
	Wet						186				
184.33			4	SS	6		185		o		
6.25	Silty clay, trace of sand Firm Mottled Brown (Fill)						184				
182.63	Very Stiff		5	SS	24		183		o		
7.95	Topsoil, silty clay, trace of sand										
181.98							182				
8.60	Very Stiff Dark Brown Silty clay, some sand Stiff Mottled Brown/ Fissured Grey (Till)		6	SS	8		181		o		
	Hard		7	SS	52		180		o		
	Very Stiff		8	SS	22		179		125 o		
	Grey		9	SS	15		178		■ o		
176.38							177				
14.20	End of Borehole Cont'd										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:33 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 — ○ — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-5 2 of 2 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 075 N; 300 507 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY MRA

DATUM Geodetic DATE January 25, 2002 CHECKED BY DWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
190.58	Ground Surface										
	2002-01-25 Borehole dry on completion of drilling										
	■ Penetrometer Test										

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 — 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 104-6 1 of 1 METRIC

G.W.P. 60-00-00 LOCATION Co-ords. 4 678 055 N; 300 507 E. ORIGINATED BY MR

DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY MRA

DATUM Geodetic DATE January 24, 2002 CHECKED BY DWR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
190.35	Ground Surface										
0.00	Pavement, 210mm asphaltic concrete over 540mm sand and gravel						190				
189.60											
0.75	Silty clay, trace of sand Stiff to Very Stiff Brown (Fill)		1	SS	15		189				
			2	SS	13						
	occ. topsoil lenses		3	SS	12		188				
			4	SS	15		187				
							186				
185.30			5	SS	20						
5.05	End of Borehole 2002-01-24 Borehole dry on completion of drilling										

ON_MOT 01TF072E.GPJ ON_MOT.GDT 09/18/2002 11:33:42 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

METRIC

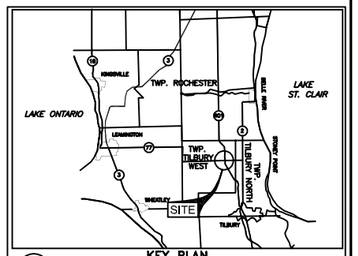
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 60-00-00

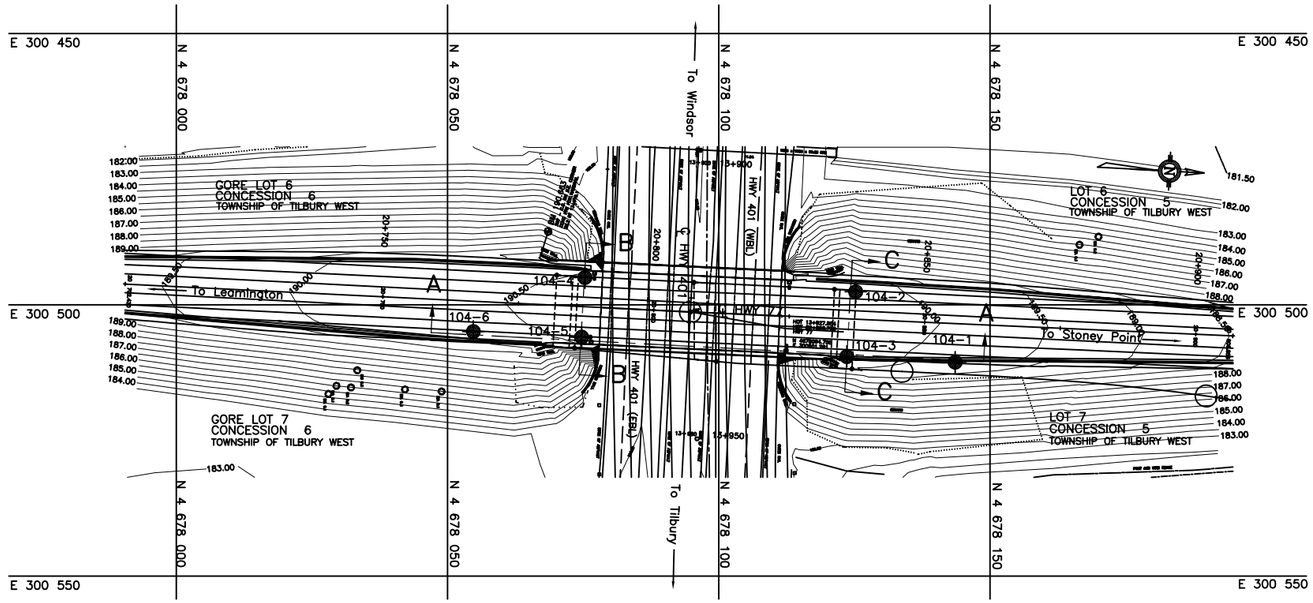
HIGHWAY 401
HIGHWAY 77 UNDERPASS
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

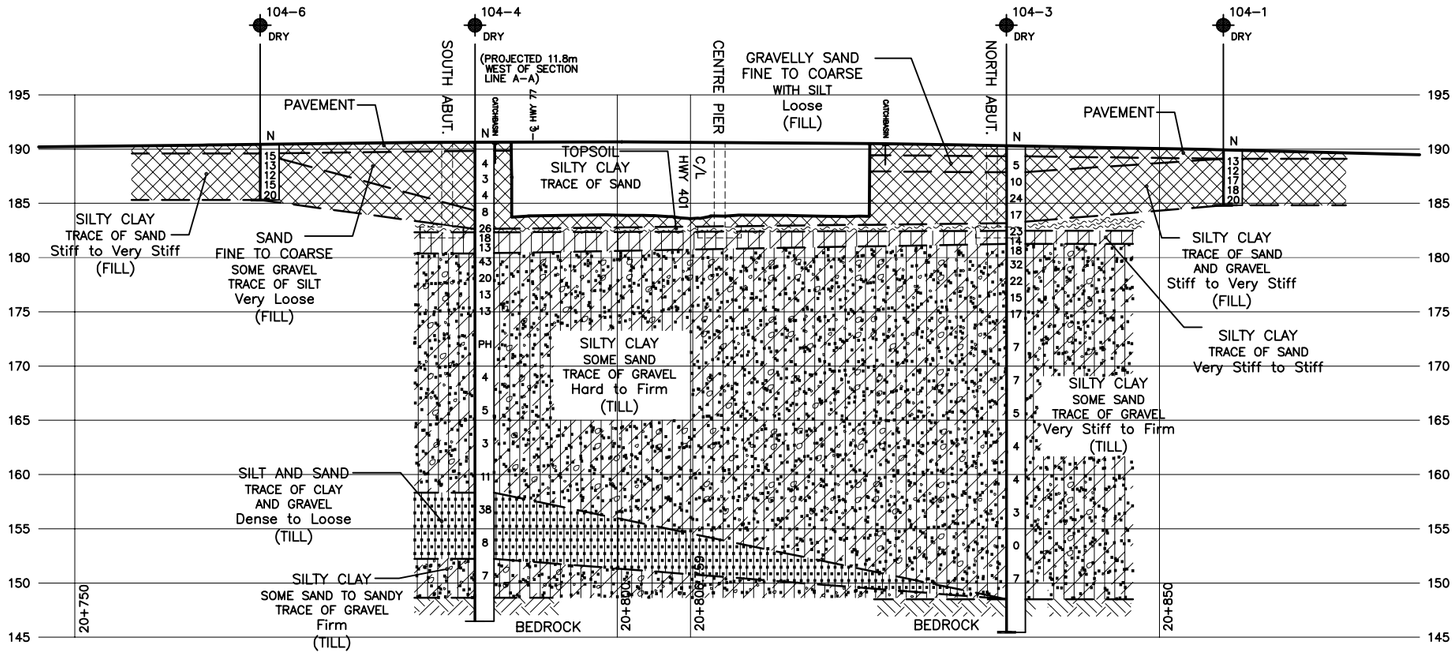
Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
5 0 10 15km



PLAN
SCALE
10 5 0 10 20m



A-A
SECTION
SCALE
5 2.5 0 5 10m

NOTES:

1. REFER TO DRAWING 2 FOR SECTIONS B-B AND C-C.
2. SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

REF No E-Plan401Hwy 77-StJoachim.dwg; Jan 2002

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N — Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE — Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation Jan 2002
- Head
- ARTESIAN WATER Encountered

BH No	ELEVATION	CO-ORDINATES NORTH	EAST
104-1	189.86	4 678 144	300 508
104-2	190.19	4 678 125	300 496
104-3	190.26	4 678 124	300 508
104-4	190.53	4 678 075	300 496
104-5	190.58	4 678 075	300 507
104-6	190.35	4 678 055	300 507

- 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.

HWY No	401			DIST	31
SUBM'D	GD	CHECKED	MRA	DATE SEP 18, 2002	SITE 6-104
DRAWN	MM/TK	CHECKED	BRG	APPROVED DWK	DWG 1

METRIC

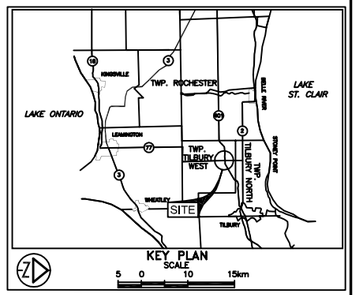
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

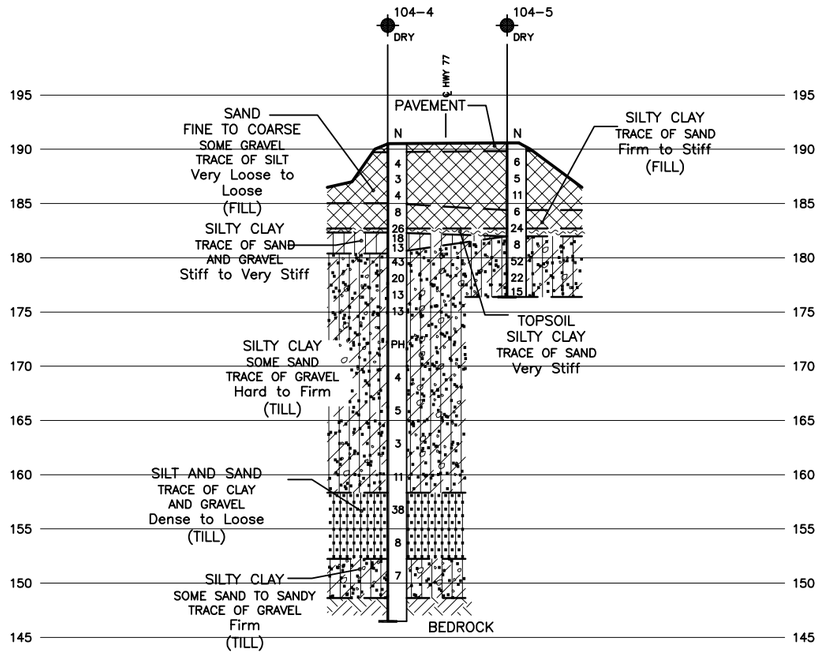
CONT No
GWP No 60-00-00

HIGHWAY 401
HIGHWAY 77 UNDERPASS
BOREHOLE LOCATIONS & SOIL STRATA

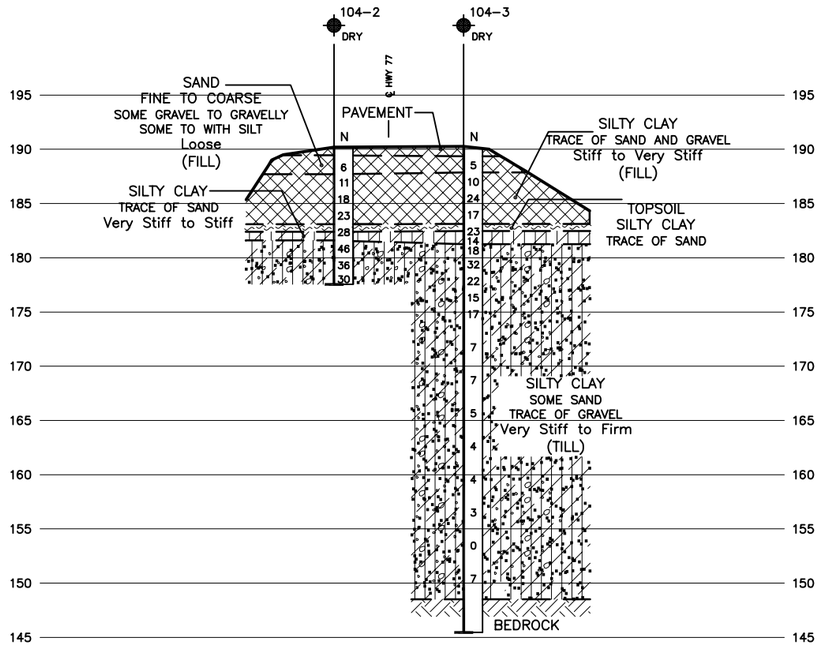
SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS





B-B



C-C

SECTIONS

SCALE
5 2.5 0 5 10m

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation Jan 2002
- Head
- ARTESIAN WATER Encountered

BH No	ELEVATION	CO-ORDINATES NORTH	EAST

(Refer to drawing 1 for co-ordinates)

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

NOTES:

1. REFER TO DRAWING 1 FOR PLAN AND SECTION A-A.
2. SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

REF No E-Plan401Hwy 77-StJoachim.dwg; Jan 2002

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.

HWY No	401					DIST	31
SUBM'D	GD	CHECKED	MRA	DATE	SEP 18, 2002	SITE	6-104
DRAWN	MM/TK	CHECKED	BRG	APPROVED	DWK	DWG	2