FOUNDATION INVESTIGATION AND DESIGN REPORT

for

HIGH MAST LIGHT POLES AND PYLON SIGN
COMMUTER CARPOOL LOT
HIGHWAY 404 AND MAJOR MACKENZIE DRIVE
TOWN OF RICHMOND HILL, YORK REGION, ONTARIO
AGREEMENT NO. 2015-E-0011
GWP 2227-09-00

PETO MacCALLUM LTD.
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1 cc: PML Toronto

PML Ref.: 16TF018A
Index No.: 026FIR and 027FDR
GEOCRES No.: 30M14-456
December 20, 2016

<u>PART A</u> - FOUNDATION INVESTIGATION REPORT

for

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PART A – FOUNDATION INVESTIGATION REPORT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A - FOUNDATION INVESTIGATION REPORT
for
High Mast Light Poles and Pylon Sign
Commuter Carpool Lot
Highway 404 and Major Mackenzie Drive
Town of Richmond Hill, York Region, Ontario
Agreement No. 2015-E-0011
GWP 2227-09-00

1. INTRODUCTION

This Foundation Investigation Report addresses the geotechnical aspects of the conceptual design proposed for the High Mast Light (HML) poles and Pylon Sign (PS) structures within the New Carpool Parking Lot located in the southwest quadrant of the intersection of Highway 404 and Major Mackenzie Drive, as shown on Drawings HMP-1.

The field work was carried out on October 18 and 19, 2016. The purpose of this investigation was to explore the subsurface conditions at this site expected to influence the design and installation of the HML Poles and Pylon Sign.

AECOM Canada Ltd. (AECOM) has retained Peto MacCallum Ltd. (PML) on behalf of the Ministry of Transportation of Ontario (MTO) to carry out the foundation investigation and prepare this report as part of the Retainer Assignment task No. 2015-E-0011. The terms of reference and scope of work for the foundation engineering services are outlined in MTO's Request for Proposal under Work Item no. 2015-E-0011-002, dated June 2016.

2. SITE DESCRIPTION

The topography of the project area is generally flat to gently undulating, except for Highway 404 underpass structure (embankment fill) and ramps. Land use in the vicinity of the site comprises agricultural and public services. The York Region Southeast District Road Maintenance Facility is located to the north side of the proposed carpool location.

This section of Highway 404 is located in the Physiographic Region known as the Peel Plain. The soils in the "Peel Plain" consist of a till sheet generally following the topography of the region. The till is typically comprised of silts and clays with occasional sand and gravel zones. Coarse grained

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granular deposits of variable thickness are interbedded in the till at random locations. Upper Ordovician shale bedrock of Georgian Bay Formation underlies the overburden in the area.

3. FIELD INVESTIGATION PROCEDURES

The investigation included advancing three (3) boreholes numbered HMLP-1, HMLP-2 and PS1 to a maximum depth of 10.0 m. Borehole locations are shown on the attached Drawing No. HMP-1.

The underground services at the borehole locations were cleared by the respective utility companies. Subsequently, the borehole locations were established in the field by Callon Dietz Inc. retained by AECOM.

Boreholes were strategically located in the vicinity of the proposed structure. Callon Dietz Inc. carried out the survey of the borehole locations and elevations, and provided the co-ordinates for locations in MTM NAD 83 northing and easting. All elevations reported in this report are referred to Geodetic and expressed in metres.

Boreholes were advanced using continuous flight solid stem augers, powered by a track-mounted CME-55 drill rig. The drill rig used for drilling was owned and operated by Tri-Phase of Mississauga, Ontario. Tri-Phase is a specialist drilling contractor, was working under the full-time supervision of a member of PML's engineering staff.

Representative soil samples were recovered from the boreholes at 0.75 m intervals to a depth of 3.0 m and at 1.5 m intervals below 3.0 m, using a conventional 51 mm O.D split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

Boreholes were found to be dry at the time of termination of drilling. Groundwater was not observed during and after completing of drilling. Upon completion of drilling, the boreholes were backfilled with bentonite/cement grout in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures.

The recovered soil samples were returned to our laboratory for detailed visual examination, and index tests.

4. LABORATORY TEST PROCEDURES

Laboratory tests on representative Standard Penetration Test (SPT) samples recovered during the fieldwork were conducted by the laboratory owned by PML, located in Toronto. The laboratory testing program included the following:

- Natural moisture content determinations (20)
- Grain size distribution analysis (6)
- Atterberg limit tests (6)

All laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow the American Society for Testing Materials (ASTM) standards, with the exception of hydrometer tests (LS-702). The results of the grain size distribution analyses are presented in Figures CP-GS-1 and CP-GS-2. The results of the Atterberg Limit tests are presented in Figures CP-PC-1 and CP-PC-2. All of the test results are summarized on the attached Record of Borehole Logs appended in the report.

5. SUBSURFACE CONDITION

The underlying subsoil in the project area consist of 100 mm to 300 mm topsoil, which is followed by 1.2 m to 2.3 m thick, stiff to hard clayey silt fill (Embankment Fill) with varying proportions of sand and gravel. Hard clayey silt till deposit was encountered immediately below the fill layer and extends to maximum investigation depth of 10.0 m. For classification purposes, the soils encountered at this site can be divided into three distinct zones.

a) Topsoil
b) Embankment Fill
c) Clayey Silt, with Sand, Trace Gravel (Till)

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the attached Record of Borehole Sheets.

5.1 Topsoil

A 100 mm to 300 mm thick topsoil was observed in borehole HMLP-1, HMLP-2 and PS-1, which extends to elevation 215.9 to El. 207.4.

5.2 Embankment Fill

The topsoil is immediately followed by fill materials in all three boreholes. The fill layer ranges in thickness from 1.2 m to 2.3 m and extends to a depth ranging from 1.4 m to 2.5 m (El. 213.7 to El. 206.2) below the existing ground surface. The fill layer consists of stiff to hard clayey silt. Sand and gravel lenses were encountered within clayey fill in borehole HMLP-1 and PS-1.

The "N"-values measured within this deposit ranged from 13 blows/300 mm to 43 blows/300 mm, indicating a stiff to hard state of consistency. High "N"-value of 50 blows/100 mm recorded in borehole HMLP-1 resulted from presence of cobbles within the fill material.

The moisture content of five samples tested varied from 6.2% to 18.2%. The results of the sieve analysis test performed on a representative sample from this deposit is provided on Figure CP-GS-1. The test results indicate that this deposit consists of 2% gravel, 21% sand, 40% silt and 37% clay. Atterberg limit test was performed on a sample and the results are provided on Figure CP-PC-1. Based on the Atterberg limit values, the soil may be classified as clays of low plasticity (CL) in the Unified Soil Classification System (USCS).

5.3 Clayey Silt, With Sand, Trace Gravel (Till)

The fill layer is underlain by clayey silt (till) deposit in all three boreholes. This clayey silt (till) deposit extends to the maximum depths of investigation ranging from 9.7 m to 10 m (El. 206.2 to El. 197.9). The SPT values in this deposit range from 32 blows/300 mm to 50 blows/50 mm, indicating hard consistency.

The moisture content of samples tested varied from 5.9% to 8.6%. The results of the sieve analysis test performed on five representative samples from this deposit are provided on Figure CP-GS-2. The test results indicate that this deposit consists of 2% to 4% gravel, 31% to 34% sand, 44% to 49% silt and 18% to 20% clay. Atterberg limit test was performed on five samples and the results are provided on Figure CP-PC-2. Based on the Atterberg limit values, the soil may be classified as silts of low plasticity (CL-ML) in the Unified Soil Classification System (USCS).

5.4 Groundwater

All of the boreholes were observed to be dry during and upon completion of drilling. The groundwater level may be expected to fluctuate due to the influence of precipitation and seasonal changes.

6. CLOSURE

Mr. S. Aziz carried out the field investigation for this study under the supervision of Mr. M. Khorsand, BSc, E.I.T., and Mr. C. M. P. Nascimento, P. Eng., Project Manager. Tri-Phase Drilling Inc. supplied the drill rig for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto.

This report was prepared by Mr. M. Khorsand, BSc, E.I.T., and reviewed by Mr. M. Vasavithasan, M.Sc.Eng., P.Eng.. Senior Engineer, Geotechnical Services, Mr. C. M. P. Nascimento, P. Eng., MTO Designated Principal Contact, conducted an independent review of the report.

Yours very truly

Peto MacCallum Ltd.

Mansoor

LICENSED PROFESSIONAL ENGINEER
M. VASAVITHASAN
Dec. 20, 2016
PROVINCE OF ONTARIO

Mansoor Khorsand, BSc, EIT
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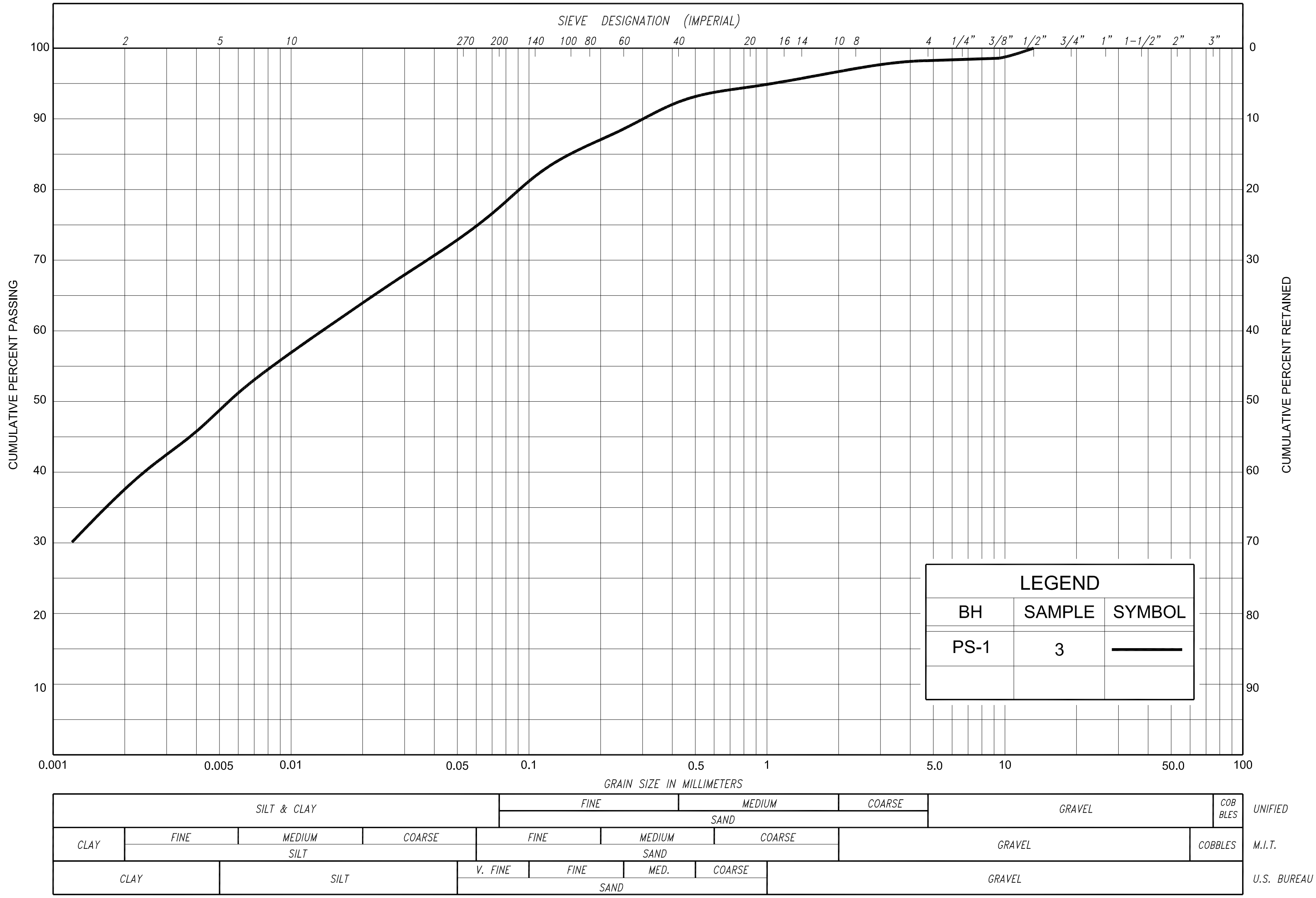
Dec 20/2016
PROVINCE OF ONTARIO

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

MK/MV/CN:nk

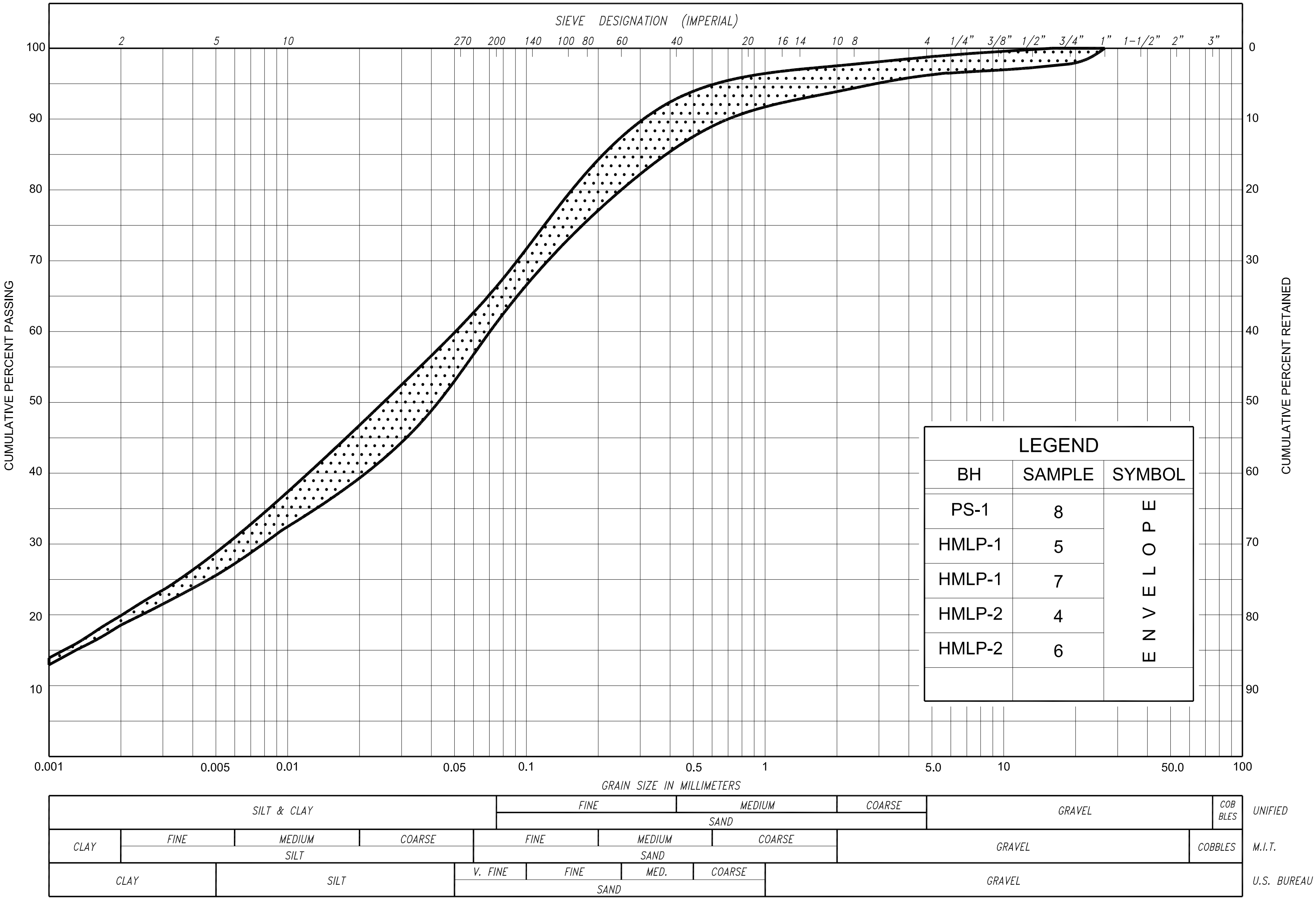


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, sandy, trace gravel (CL)
(FILL)

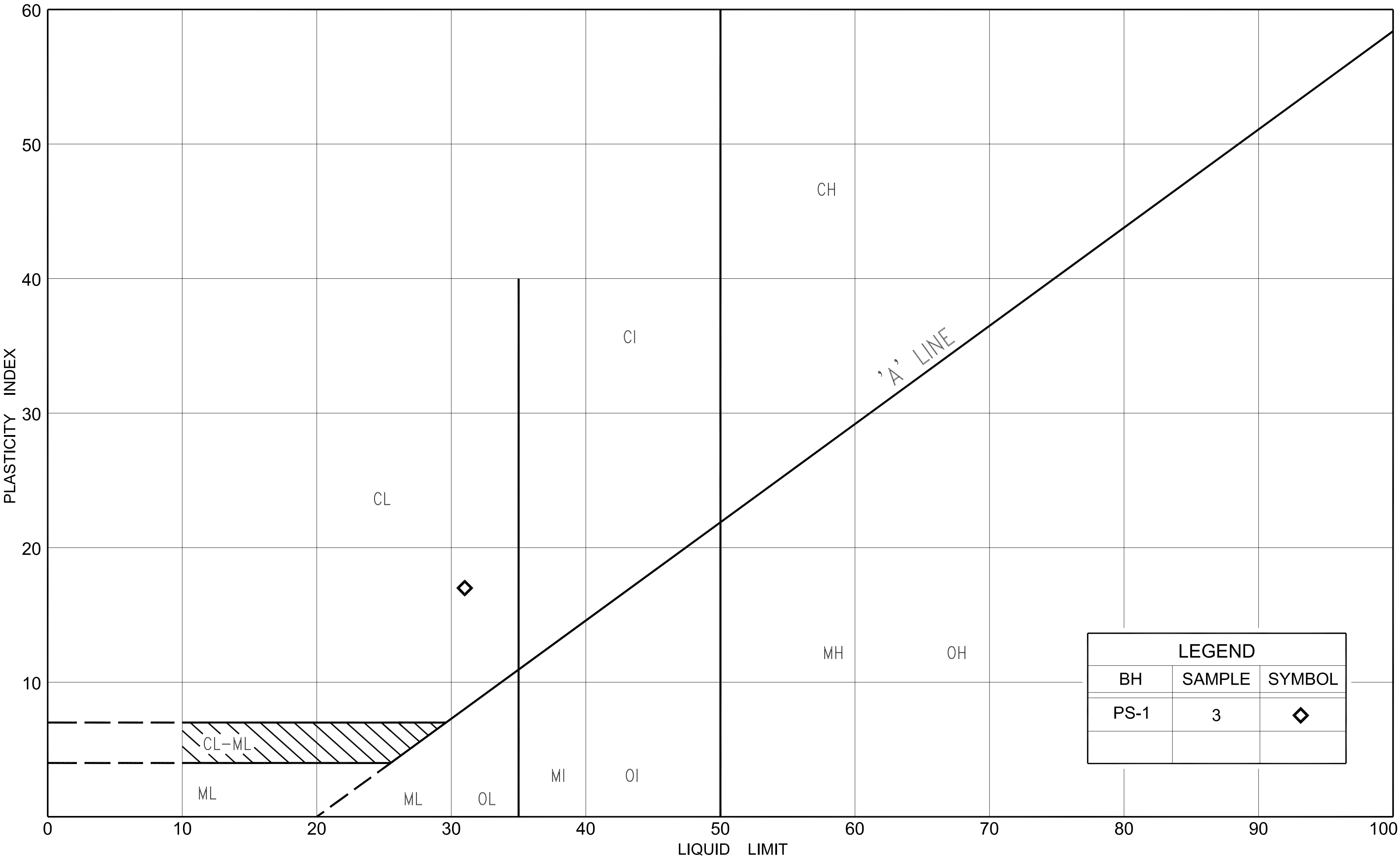
FIG No.	CP-GS-1
HWY	404
TASK #	2015-E-0011 - 002



GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand, trace gravel (CL-ML)

FIG No.	CP-GS-2
HWY	404
TASK #	2015-E-0011 - 002



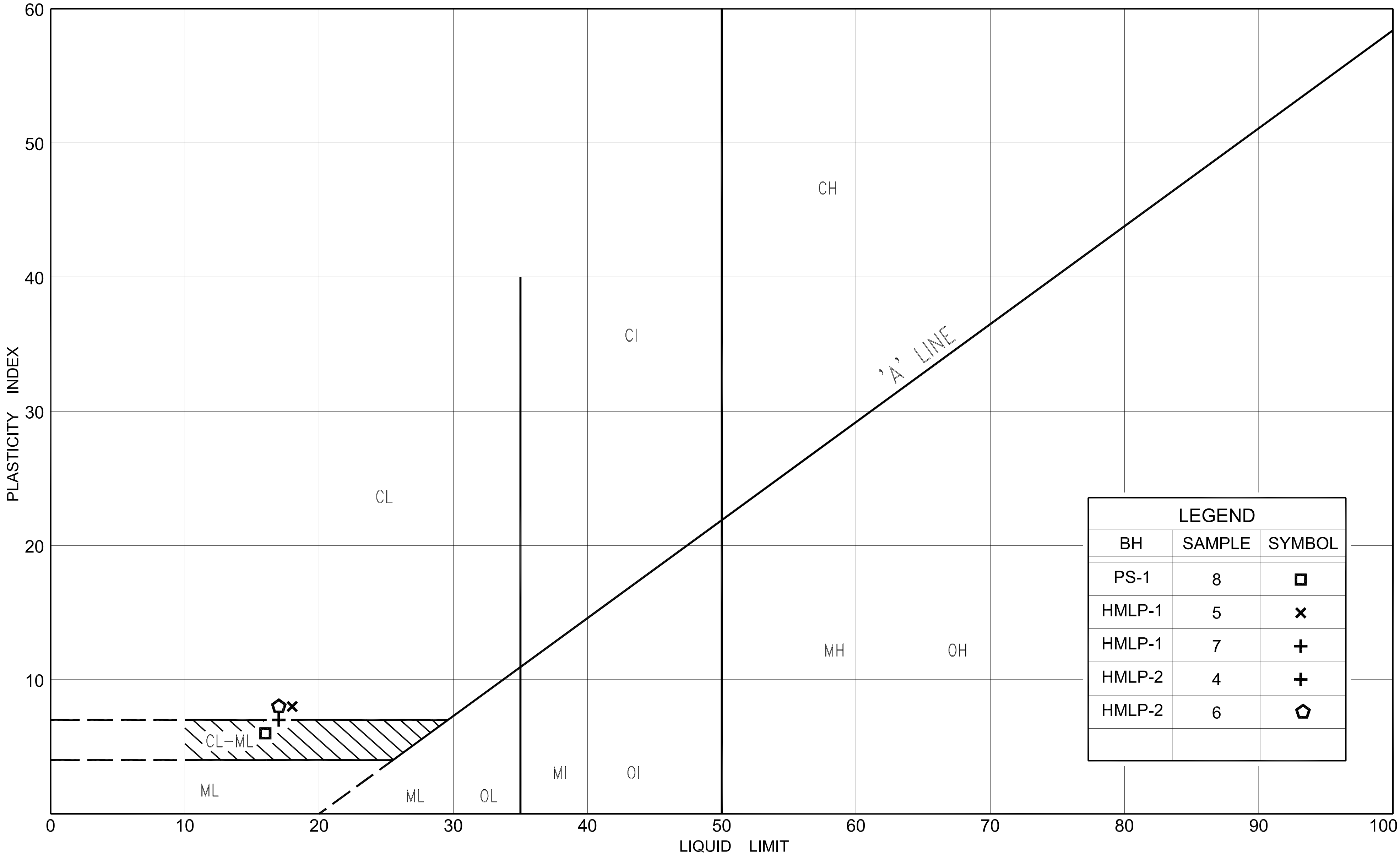
BH	SAMPLE	SYMBOL
PS-1	3	◇

Ontario

PLASTICITY CHART

CLAYEY SILT, sandy, trace gravel (CL)
(FILL)

FIG No.	CP-PC-1
HWY	404
TASK #	2015-E-0011 - 002



LEGEND		
BH	SAMPLE	SYMBOL
PS-1	8	□
HMLP-1	5	×
HMLP-1	7	+
HMLP-2	4	+
HMLP-2	6	⬠

Ontario

PLASTICITY CHART

CLAYEY SILT, with sand, trace gravel (CL-ML)

FIG No.	CP-PC-2
HWY	404
TASK #	2015-E-0011 - 002

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

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

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

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

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

JOINTING AND BEDDING:

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
r_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'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY $= \frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

Ontario

Peto MacCallum Ltd.
CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No HMLP-1

METRIC

TASK No. 2015-E-0011 002 LOCATION Co-ords: 4 860 262.0 N ; 314 426.0 E ORIGINATED BY S.A.

DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh.

DATUM Geodetic DATE October 18, 2016 CHECKED BY M.V.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
212.0	Ground Surface				*			
211.9 / 0.1	Topsoil; Clayey silt with sand, some gravel; Very stiff Brown/grey Moist; cobbles (FILL)	1	SS	28				
		2	SS	16				
		3	SS	50/13cm		○		
209.6 / 2.4	Clayey silt with sand, trace gravel; Hard Brown/grey Moist; Grey; cobbles (TILL)	4	SS	50/10cm				
		5	SS	53		○├┤		4 34 44 18
		6	SS	38		○		
		7	SS	35		○├┤		2 34 46 18
		8	SS	40		○		
		9	SS	66		○		
202.0 / 10.0	End of borehole							

Elevation scale: 211, 210, 209, 208, 207, 206, 205, 204, 203, 202

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

* Borehole dry upon completion of drilling

Upon completion of drilling, no cave-in

5 Numbers refer to Sensitivity

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No HMLP-2

METRIC

TASK No. 2015-E-0011 002 LOCATION Co-ords: 4 860 155.6 N ; 314 460.3 E ORIGINATED BY S.A.

DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.Kh.

DATUM Geodetic DATE October 19, 2016 CHECKED BY M.V.

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
207.6	Ground Surface						
207.4 / 0.2	Topsoil						
206.2 / 1.4	Clayey silt with sand, some gravel. Very stiff to hard, Grey/brown, Moist (FILL)	1	SS	16			
		2	SS	43		○	
197.9 / 9.7	Clayey silt with sand, trace gravel cobbles. Hard, Grey, Moist (TILL)	3	SS	89/23cm		○	
		4	SS	50/13cm		○ (with plastic/liquid limit range)	2 31 49 18
		5	SS	50/13cm			
		6	SS	50/8cm		○ (with plastic/liquid limit range)	3 31 46 20
		7	SS	50/5cm		○	
		8	SS	50/13cm		○	
		9	SS	50/13cm		○	
	End of borehole						

* Borehole dry upon completion of drilling

Upon completion of drilling, no cave-in

Chart headings: 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; ELEVATION SCALE 207 206 205 204 203 202 201 200 199 198.

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

Ontario

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CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No PS-1

METRIC

TASK No. 2015-E-0011 002	LOCATION Co-ords: 4 860 311.4 N ; 314 361.5 E		ORIGINATED BY S.A.
DIST Central	HWY 404	BOREHOLE TYPE Continuous Flight Solid Stem Augers	COMPILED BY M.Kh.
DATUM Geodetic	DATE October 18, 2016		CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.2	Ground Surface						
0.0 / 215.9	Topsoil	1	SS	13	216		
0.3	Clayey silt with sand, trace gravel. Stiff to very stiff. Brown/ dark brown. Moist. Mottled grey/brown, Moist (FILL)	2	SS	13	215		
		3	SS	23	214		2 21 40 37
213.7 / 2.5	Clayey silt with sand, trace gravel oxidized partings. Hard. Grey/ brown. Moist	4	SS	32			
		5	SS	50/13cm	213		
		6	SS	50/8cm	212, 211		
		7	SS	83/23cm	210, 209		
	cobbles (TILL)	8	SS	50/5cm	208, 207		3 33 46 18
		9	SS	89/28cm			
206.2 / 10.0	End of borehole						

* Borehole dry upon completion of drilling

Upon completion of drilling, no cave-in

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS *; 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

5 Numbers refer to Sensitivity

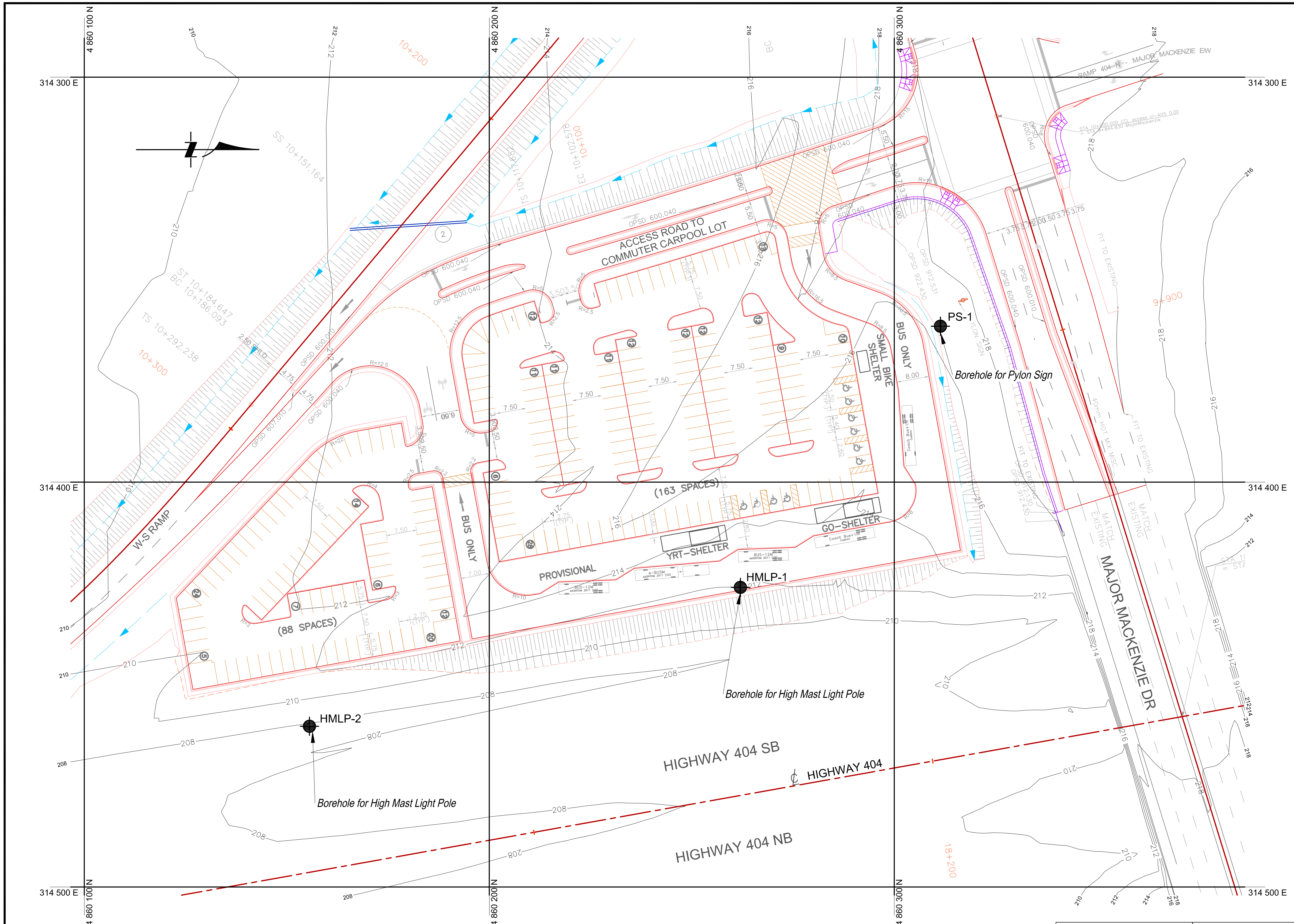
20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

RETAINER ASSIGNMENT :
CA 2015-E-0011 - 002
G.W.P. 2227-09-00

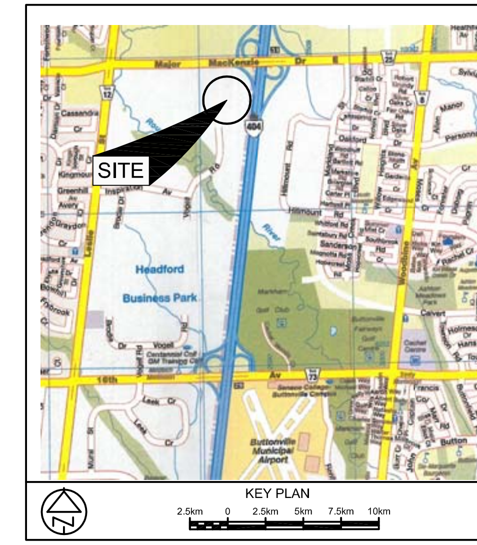
HIGH MAST LIGHT POLES AND PYLON SIGN
COMMUTER CARPOOL LOT
HIGHWAY 404 AND MAJOR MCKENZIE DRIVE
TOWN OF RICHMOND HILL, ONTARIO
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN
SCALE
10 0 10 20m



LEGEND

- Borehole
- Cone
- Borehole and Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation October 2016
- WH Penetration due to weight of hammer and rod
- * Water level not established
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	NORTHINGS	EASTINGS
HMLP-1	212.0	4 860 262.0	314 426.0
HMLP-2	207.6	4 860 155.6	314 460.3
PS-1	216.2	4 860 311.4	314 361.5

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

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

REF AECOM Drawings: ACAD-404 MM CCL_plan.dwg and ACAD-404-MM CCL_add BHs_foundations.dwg updated

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 30M14-456

HWY No 404			DIST CENTRAL
SUBM'D NA	CHECKED M.Kh.	DATE DEC 20, 2016	SITE
DRAWN NA	CHECKED MV	APPROVED CN	DWG HMP-1

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART B - FOUNDATION DESIGN REPORT

for

HIGH MAST LIGHT POLES AND PYLON SIGN
COMMUTER CARPOOL LOT
HIGHWAY 404 AND MAJOR MACKENZIE DRIVE
TOWN OF RICHMOND HILL, YORK REGION, ONTARIO
AGREEMENT NO. 2015-E-0011
GWP 2227-09-00

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PML Ref.: 16TF018A
Index No.: 027FDR
GEOCRES No.: 30M14-456
December 20, 2016

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PART B – FOUNDATION DESIGN REPORT

PART B - FOUNDATION DESIGN REPORT
for
High Mast Light Poles and Pylon Sign
Commuter Carpool Lot
Highway 404 and Major Mackenzie Drive
Town of Richmond Hill, York Region, Ontario
Agreement No. 2015-E-0011
GWP 2227-09-00

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7. ENGINEERING RECOMMENDATIONS

7.1 Project Description

This section of the report provides recommendations for the foundation design of the proposed two (2) High Mast Lights (HMLs) and one Pylon Sign (PS) to be located on southwest quadrant of the intersection of Highway 404 and Major Mackenzie Drive in the town of Richmond Hill, York Region, Ontario. This report was prepared by Peto MacCallum Ltd. (PML) for AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation of Ontario (MTO).

It is proposed to install two High Mast Light Poles and install one Pylon Sign, as a result of realignment of W-S Ramp and to construct a New Commuter Carpool Lot at the intersection of Highway 404 and Major Mackenzie Drive.

7.2 Design of HML Pole and Pylon Sign Foundations

The HML pole foundations should be designed in accordance with MTO's *Guidelines for the Design of High Mast Pole Foundations*, 4th Edition, dated May 2004. The PS structure foundations should be designed in accordance with MTO's *Sign Support Manual*, dated 2015. It is anticipated that each of the proposed HML poles and PS structures will be supported on a single caisson meeting the requirements for "short piles" as described in MTO's *Guidelines for the Design of High Mast Pole Foundations*.

The subsurface conditions at specific HML and PS locations can be inferred from the respective borehole of the structure.

The equation provided below for cohesive soils should be used to calculate the coefficient of lateral subgrade reaction, k_s, and the unfactored passive lateral earth pressure, P_p (kPa), distributed along the length of the caisson, based on the stratigraphy and geotechnical parameters given in Table 1 at the end of this report.

$k_s = 67\ C_u / D$ (kN/m3)

Where: C_u = undrained shear strength (kPa)
D = pile width or diameter (m);

The passive resistance within the upper 1.4 m below final ground surface should be neglected to account for frost action. In accordance with MTO's *Guidelines for the Design of High Mast Pole Foundations,* the ultimate passive pressure can be taken as 2 times of the passive lateral earth pressure.

Where an undrained shear strength, C_u, and effective angle of internal friction, Φ', are provided for a cohesive soil strata in Table 1, the length of caisson may be calculated using the appropriate undrained shear strength value assuming an internal angle of friction, Φ' = 0. A resistance factor of 0.5 should be applied to the calculated ultimate lateral resistance in order to obtain the factored lateral geotechnical resistance at ULS, in accordance with Table 6.2 of the Canadian Highway Bridge Design Code, 2014 version (CHBDC, 2014).

7.3 Construction Considerations

Construction of HML poles and PS foundations should be in accordance with *Ontario Provincial Standard Specification*, OPSS 915 (Sign Support Structures) and OPSS 631 (Concrete Footings and Maintenance Platforms for High Mast Lighting Poles), respectively.

Glacial till deposit encountered at this site may contain occasional cobbles or boulders. Consideration should be given to presence of cobbles and/or boulders at the proposed location of HML poles and PS. Appropriate equipment and procedures may be required to penetrate these obstructions during the excavations, particularly for the installation of caisson.

The Non-Standard Special Provision presented in Appendix A should be included in the Contract Documents to alert the contractor for the potential presence of cobbles and boulders within the subsoil deposits, which may affect the installation of caisson and spread footing foundations.

8. TOE WALL AT HML POLE LOCATIONS

It is proposed to construct a toe wall at the HML pole locations. The following recommendation may be considered for the design and construction of the toe wall.

8.1 Foundation Preparation

The subsurface soil conditions encountered at the HML pole locations consist of very stiff clayey silt fill underlain by very stiff to hard clayey silt till. The existing fill to elevations recommended in the table below should be removed and replaced with engineered fill consisting of granular material. The founding subgrade of the engineered fill should be inspected by a professional geotechnical engineer to confirm that the subsoil conditions are consistent with those encountered in the boreholes and free of any deleterious materials. Any loose or deleterious areas encountered should be subexcavated and replaced with approved, compacted granular material under the direction of a geotechnical engineer. The base of the proposed toe wall may be placed at least a minimum of 0.5 m below the finished grade.

The foundations for the high mast poles are expected to be placed at a lower elevation than the toe wall. There may be interaction between the toe wall and the foundation for the high mast poles, depending on the location of each structural elements. Loading from the toe wall should be taken into consideration if both structures are within the influence zone of each other.

8.2 Bearing Resistance

The recommended founding elevation of toe wall should be at or below the elevation indicated in the following table.

BOREHOLE NAME	FOUNDING ELEVATION	SUBGRADE SOIL
HMLP-1	209.6	Hard Clayey Silt Sandy Till
HMLP-2	206.2	Hard Clayey Silt Sandy Till

The geotechnical resistance values at Ultimate Limit State (ULS) and Serviceability Limit State (SLS) provided below may be used for minimum of 1.0 m wide footing placed on engineered fill. The geotechnical resistance at ULS provided is based on a factor of 0.5 as recommended in the Canadian Highway Bridge Design Code (CHBDC 2014). Estimated total settlement for the geotechnical resistance at SLS recommended will be in the range of 20 to 25 mm. Most of the settlement is expected to take place immediately and continuing settlement will be minimal to cause any differential settlement.

Factored Geotechnical Bearing Resistance at ULS = 450 kPa

Geotechnical Bearing Resistance at SLS = 300 kPa

The global stability of wall and the embankment should be checked once the geometry of the wall is finalized.

8.3 Sliding and Base Friction

The following parameters may be used for calculation of sliding resistance of precast concrete toe wall placed on engineered fill.

PARAMETER	ENGINEERED FILL
Friction Angle, degrees	30
Cohesion, kPa	0
Unit Weight, kN/m^3	20.0

An equivalent unfactored friction angle of 28 degrees at the interface of the precast concrete toe wall and engineered fill may be assumed for the calculation of sliding resistance. The structural designer should use appropriate factors on the angle of friction values provided on the table, for the computation of sliding resistance. If additional sliding resistance is required, base of the wall could be keyed or doweled into the engineered fill.

8.4 Toe Wall Backfill

The backfill behind the toe walls should consist of suitable free draining granular materials such as Granular A, Granular B Type I or Type II and the backfill geometry shall be according to OPSD 3121.150. The backfill shall be placed and compacted to at least 95% of the standard Proctor maximum dry density determined in accordance with MTO LS-706. Backfilling adjacent to concrete toe wall should be carried out in conformance with OPSS 501 and SP105S10. Operation of compaction equipment adjacent to toe wall should be restricted to limit the compaction pressure noted in clause 6.9.3 of the CHBDC. Refer to SP 105S10 for additional information with regards to compaction of fill material adjacent to a structure.

A subdrain system (SP 405F03) and weep holes (OPSD-3190.100) should be installed to minimize the build-up of hydrostatic pressure behind and below the precast/cast-in-place concrete walls. The subdrains should be surrounded by a properly designed granular filter or non-woven Class II geotextile with a Filtration Opening Size (FOS) of 75 – 100 μm as specified in OPSS 1860 to prevent migration of fines into the drainage system. The drainage pipes should be installed on a positive grade and drain excessive water from the granular pad.

9. CLOSURE

This Foundation Investigation and Design Report was prepared by Mr. M. Khorsand, EIT and was reviewed by Mark Vasavithasan, M.Sc.Eng., P.Eng., Senior Engineer, Geotechnical Services. Mr. C. Nascimento, P.Eng., Principal Designate MTO Contact conducted an independent review of the report.

Sincerely

Peto MacCallum Ltd

Mansoor

LICENSED PROFESSIONAL ENGINEER
M. VASAVITHASAN
Dec. 20, 2016
PROVINCE OF ONTARIO

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Dec. 20, 2016
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Carlos M.P. Nascimento, P.Eng.
Project Manager and
MTO Designated Principal Contact

MK/MV/CN:nk

TABLE 1

Geotechnical Design Parameters for High Mast Light Poles and Pylon Sign

TYPE OF STRUCTURE	ELEVATIONS		SOIL TYPE	DESIGN PARAMETERS			DEPTH (m)
	FROM	TO		BULK UNIT WEIGHT kN/m^3	SHEAR STRENGTH (C_u), kPa	INTERNAL FRICTION ANGLE	
HML-P1	212.0	209.6	Very Stiff Clayey Silt (Fill)	19	100	26	0 to 2.4 m
	209.6	202.0	Hard Clayey Silt with Sand (Till)	20	200	30	Below 2.4 m
HML-P2	207.6	206.2	Very Stiff Clayey Silt (Fill)	19	100	26	0 to 1.4
	206.2	197.9	Hard Clayey Silt with sand (Till)	20	200	30	Below 1.4 m
PS-1	216.2	213.7	Very Stiff Clayey Silt (Fill)	19	100	26	0 to 2.5 m
	213.7	206.2	Hard Clayey Silt with sand (Till)	20	200	30	Below 2.5 m

APPENDIX A

NSSP - Obstruction During Caisson Construction

APPENDIX A

Non-Standard Special Provisions (Nssp)

NSSP – Obstructions During Caisson Construction

The Contractor shall be advised that cobbles and boulders are present within the embankment fill and native soils. The Contractor shall be responsible for selecting construction methods and equipment that will enable operations to advance through the embankment fill and/or native soils including zones where cobbles and boulders are encountered.