Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION REPORT
FOR
HIGH MAST LIGHT FOUNDATIONS
WELLINGTON STREET AND
LANCASTER STREET INTERCHANGES
HIGHWAY 86
KITCHENER, ONTARIO

DISTRIBUTION:

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TABLE OF CONTENTS

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INTRODUCTION

This report summarizes the results of the foundation investigation conducted for installation of six High Mast Light (HML) poles at the Wellington Street interchange and two HML poles at the Lancaster Street ramps along Highway 86 in Kitchener, Ontario. The study was carried out at the request of Morrison Hershfield Limited.

The purpose of this investigation was to define the subsurface soil and groundwater conditions at the pole locations and based on this information, to provide geotechnical parameters for design of the HML pole foundations.

SITE DESCRIPTION

The proposed pole locations are situated within the existing ramps at the Wellington and Lancaster Street interchanges along Highway 86 in Kitchener, Ontario.

The area lies within the Waterloo Sand Hills physiographic region of Southern Ontario and comprises rolling hills and ridges formed during Wisconsin glaciation. In general, the overburden consists of outwash sand and sand and gravel overlying glacial tills. Undrained depressions (kettles) formed in the overburden during glaciation are typically infilled with organic deposits and seasonal water. (L.J. Chapman and D.F. Putnam, The Physiography of Southern Ontario, 3rd Edition, Ontario Research Foundation, 1984).

INVESTIGATION PROCEDURES

The fieldwork was carried out on August 30 and September 11, 2000 and comprised one borehole drilled to 8.1 m depth at each of the eight proposed pole locations. The locations of the boreholes are shown on Drawing 1, appended.

The locations of and elevation at the boreholes were established in the field by Peto MacCallum Ltd. The following temporary benchmarks (T.B.M.) were used for vertical reference:

T.B.M.: Top of bridge curb at northeast corner of westbound Wellington Street structure over Highway 86 (from spot elevation shown on plan provided by Morrison Hershfield Limited).

Elevation: 324.3 (metric)

B.M. Regional Municipality of Waterloo benchmark Ki-182-RMW-192-3. Tablet set in east face of bridge carrying Lancaster Street West over Highway 86.

Elevation: 327.26 (metric)

The boreholes were advanced using continuous flight solid stem augers, powered by truck-mounted CME-55 and track-mounted CME-75 drillrigs, 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.

The groundwater conditions in the boreholes were closely monitored during the course of the fieldwork. A piezometer was installed in borehole 107 to monitor water levels. The water level in the piezometer was measured on September 29, 2000.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Grain size distribution analyses and Atterberg Limit tests were carried out on selected samples.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test "N" values, groundwater observations, and the results of laboratory grain size distribution analyses and moisture content determinations.

The subsurface stratigraphy revealed in the boreholes generally comprised a surficial topsoil layer overlying discontinuous sand, sand and gravel, silt or clay layers, underlain by silty clay to silty sand till. Fill was revealed at one location. The strata encountered are summarized below:

Fill

Fill was identified surficially in borehole 106. The fill consisted of 200 mm of sandy silt topsoil over 250 mm of loose sand. All or a portion of the clayey silt topsoil revealed below the sand layer at this location may also be a fill. The topsoil/fill was penetrated at 1.2 m depth.

Topsoil

Topsoil was encountered as a fill in borehole 106 and as a surficial layer in the remaining boreholes. The surficial topsoil layer was typically 200 to 250 mm thick, locally 100 mm in borehole 104. The topsoil generally consisted of silty sand to sandy silt, becoming a clayey silt in borehole 108.

Discontinuous Layers of Sand, Silt and Clay

The topsoil was underlain by discontinuous layers of sand, silt and clay. The sand predominated and was encountered in each of the boreholes drilled at Wellington Street. The sand/silt layers were typically compact to dense, locally loose and possibly a fill to 2.6 m depth in borehole 105. Isolated cohesive layers encountered in boreholes 102 and 108 were stiff to very stiff.

The results of a grain size distribution analysis conducted on a sample of the sand are presented on Figure 1. Moisture contents ranged from 3 to 14% in the sand, 12 to 19% in the silt, and 22% in the clay.

The upper layers were penetrated at depths of 0.8 to 3.1 m.

Sand and Gravel

Very dense sand and gravel was encountered below the upper silt/sand layers in borehole 102 at 2.2 m depth. The sand and gravel layer was 0.5 m thick and was penetrated at 2.7 m depth.

A very dense layer of sand and gravel was contacted between depths of 2.2 to 2.6 m in borehole 108.

Moisture contents of about 3% were measured in the sand and gravel.

Till

A major till deposit was encountered at depths of 0.8 to 3.1 m in all boreholes. In general the till consisted of cohesive clayey silt/silty clay with zones/layers grading to cohesionless sandy silt and silty sand. The consistency of the till was typically very stiff, ranging from stiff/compact to hard/very dense. Moisture contents varied from 8 to 27% and were typically 12 to 22%.

Hard clayey silt was contacted at 7.5 m depth in borehole 102. This stratum likely comprises the till deposit as well.

The results of the grain size distribution analyses conducted on the till are presented on Figures 2 and 3. The Atterberg Limits determined from selected cohesive samples of the till are plotted on the Plasticity Chart, Figure 4. For three samples, the liquid limit ranged from 18 to 23 and the plastic limit from 11 to 14, indicating a low plastic soil. Liquid limits of 38 and 45, and plastic limits of 19 and 20 determined on two other samples indicate a medium plastic clay.

The boreholes were terminated in the till at 8.1 m depth.

Groundwater

Caving of wet borehole sidewalls and/or wetness of the sampler was observed during or upon completion of drilling in boreholes 101, 102, 106 and 107 at depths of 1.5 to 6.1 m. Upon completion of augering, free water was measured at depths of 2.4 and 3.2 m in boreholes 106 and 107, respectively.

Free water was not observed in boreholes 103, 104, 105 and 108 during the course of the fieldwork. The sidewalls of borehole 103 caved at 7.5 m depth upon completion.

On September 29, 2000, free water was detected at a depth of 0.7 m in the piezometer installed in borehole 107. However, this water level has likely been influenced by surface water infiltration into the borehole.

Observed groundwater levels are subject to seasonal variations and rainfall patterns.

CLOSURE

The fieldwork was carried out under the supervision of Ms. D. Jotham and direction of Mr. G. Mitchell, P.Eng. The equipment was supplied by Geo-Environmental Drilling Inc.

The report was prepared by Mr. M.R. Anderson, P.Eng., Senior Engineer and reviewed by Mr. G. Mitchell, P.Eng., Manager of Geotechnical Engineering, Kitchener.

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
PROVINCE OF ONTARIO

Yours very truly

PETO MacCALLUM LTD.

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Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

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MRA:cs

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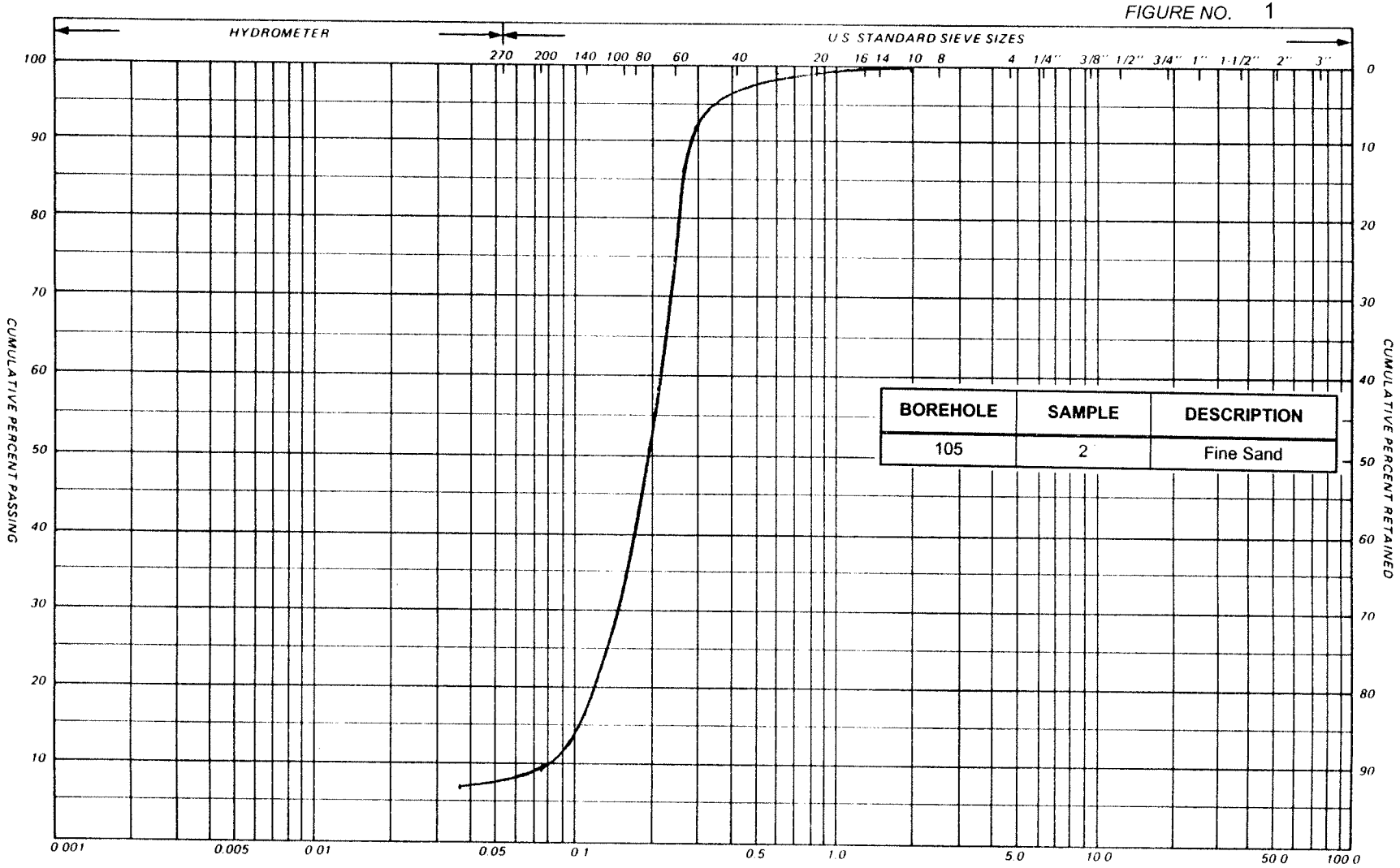
PARTICLE SIZE DISTRIBUTION CHART

PML REF. 99 KF 141B
FIGURE NO. 1



BOREHOLE	SAMPLE	DESCRIPTION
105	2	Fine Sand

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

REMARKS

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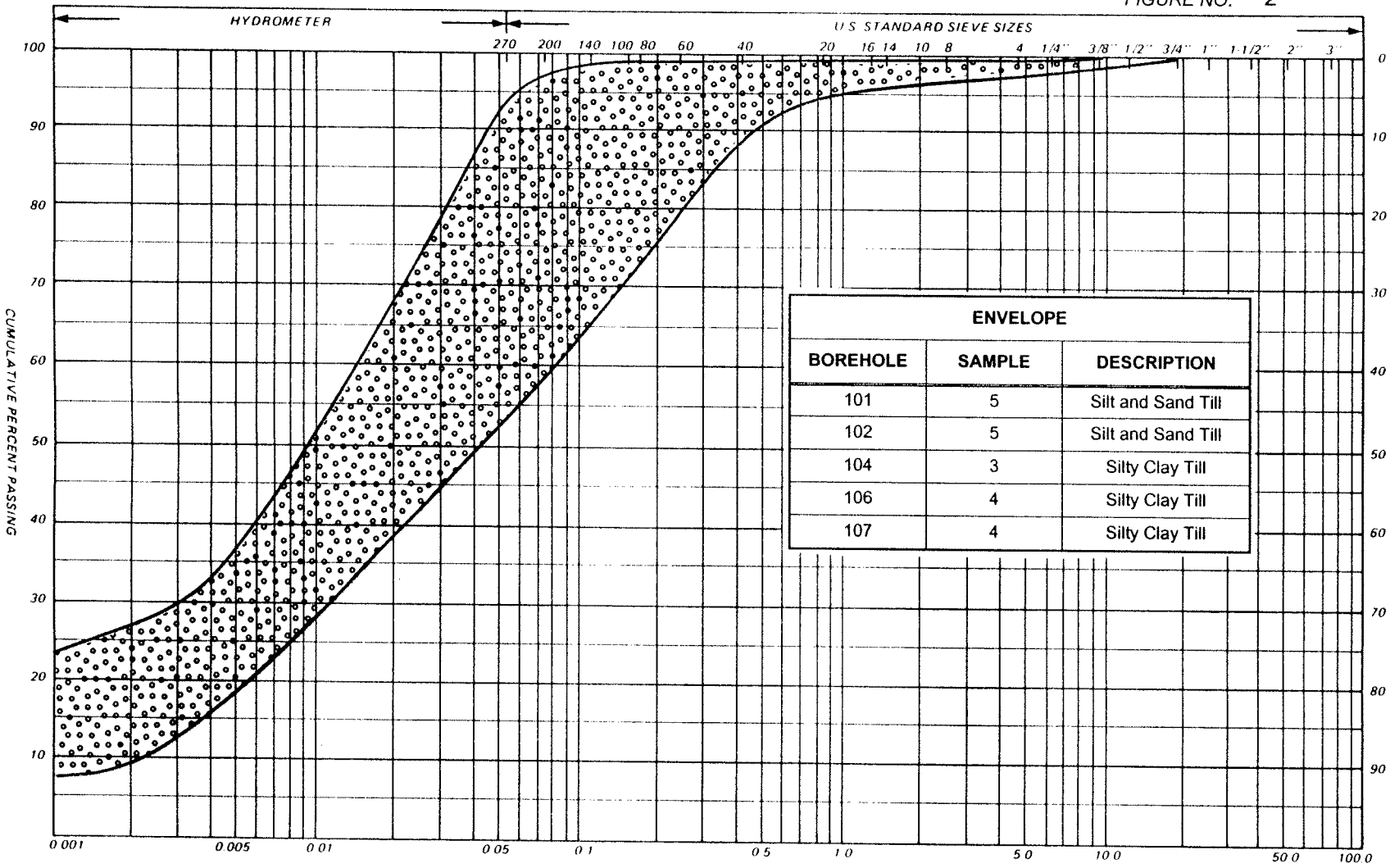
PARTICLE SIZE DISTRIBUTION CHART

PML REF. 99 KF 141B
FIGURE NO. 2



ENVELOPE		
BOREHOLE	**SAMPLE**	**DESCRIPTION**
101	5	Silt and Sand Till
102	5	Silt and Sand Till
104	3	Silty Clay Till
106	4	Silty Clay Till
107	4	Silty Clay Till

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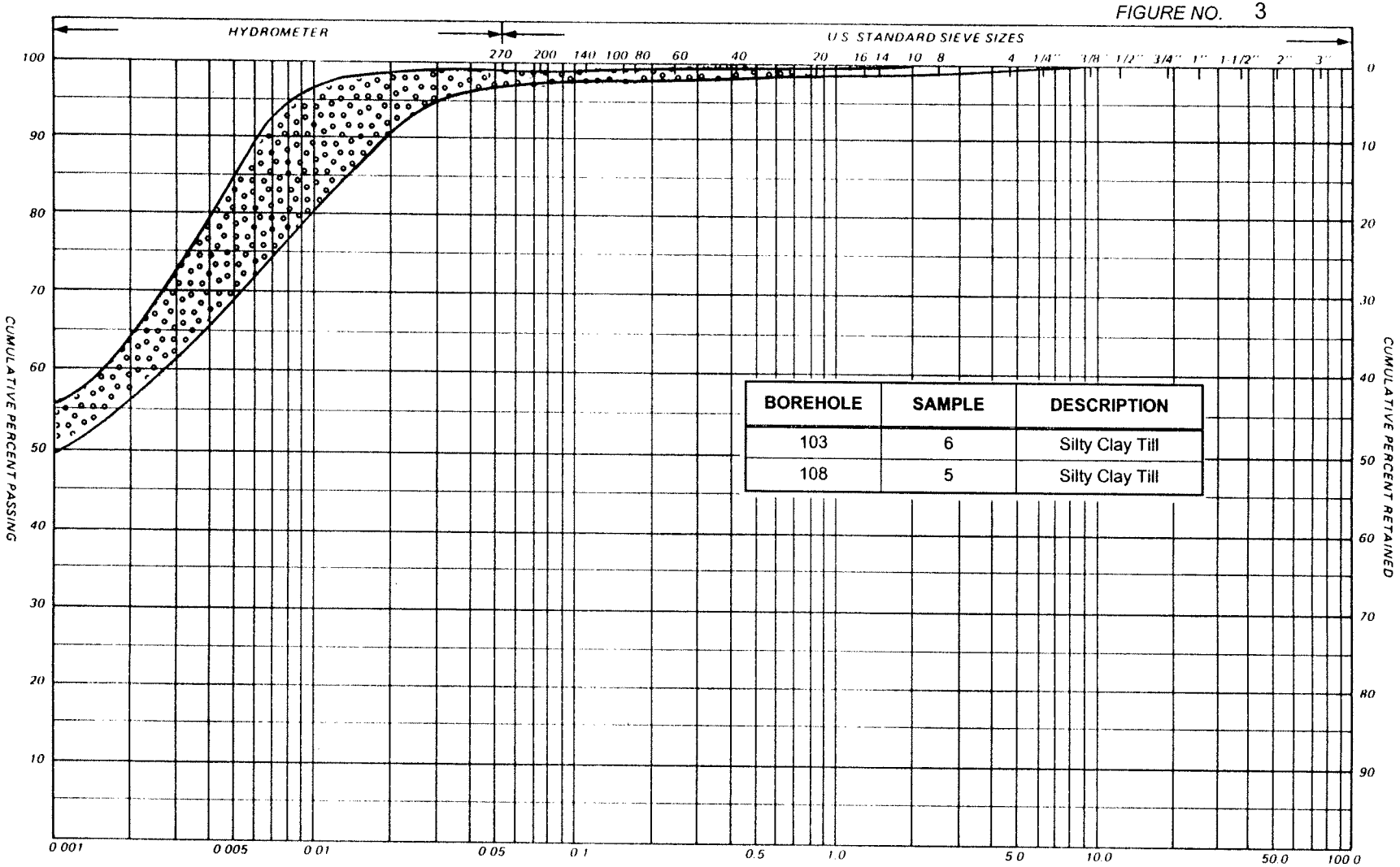
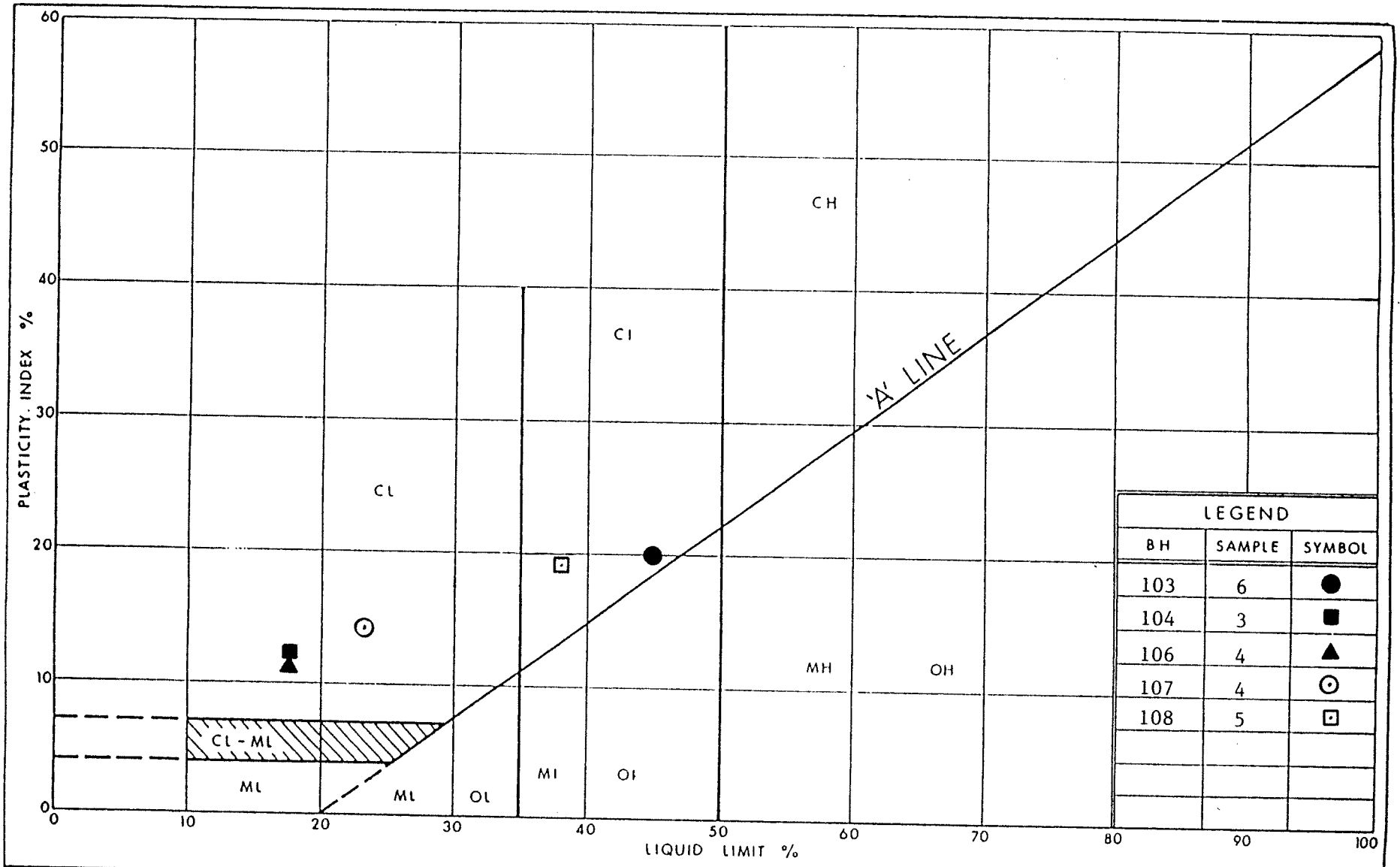
PARTICLE SIZE DISTRIBUTION CHART

PML REF. 99 KF 141B
FIGURE NO. 3



BOREHOLE	SAMPLE	DESCRIPTION
103	6	Silty Clay Till
108	5	Silty Clay Till



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Ontario

PLASTICITY CHART

FIG No 4

PML Ref. 99 KF 141A

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LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS: -

CONSISTENCY	'N' BLOWS/0.3m	c kPa
VERY SOFT	0 - 2	0 - 12
SOFT	2 - 4	12 - 25
FIRM	4 - 8	25 - 50
STIFF	8 - 15	50 - 100
VERY STIFF	15 - 30	100 - 200
HARD	> 30	> 200

DENSENESS	'N' BLOWS/0.3m
VERY LOOSE	0 - 4
LOOSE	4 - 10
COMPACT	10 - 30
DENSE	30 - 50
VERY DENSE	> 50

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

SOIL TESTS

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

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LOG OF BOREHOLE NO. 101

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO. 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
	GROUND ELEVATION 322.7					
0.20	TOPSOIL: Dark brown silty sand, trace gravel, rootlets and organics, moist		322			
	SAND: Dense brown fine to medium sand, trace silt, trace gravel, moist to saturated			1	SS	32
1.5						
1.80			321	2	SS	25
2.15	SANDY SILT TILL: Compact brown sandy silt, trace gravel, saturated					
	CLAYEY SILT TILL: Hard grey clayey silt, some sand and gravel, D.T.P.L.		320	3	SS	50/130 mm
3.0						
3.10				4	SS	50/100 mm
	SAND: Very dense brown fine to medium sand, some silt, some gravel, moist to wet		319			
3.95						
4.5	SILT AND SAND TILL: Very dense brown silt and sand, trace gravel, very moist		318			
				5	SS	50/80 mm
			317			
6.0						
6.10						
	SAND: Very dense grey fine to medium sand, trace silt, some rust staining, saturated			6	SS	72
			316			
7.5						
			315	7	SS	42
8.10	BOREHOLE TERMINATED AT 8.10 m					
9.0						

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M: 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT %: 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

After sample 2, sampler wet.

After sample 3, free water at 1.75 m.

GR	SA	SI	CL
3	39	48	10

Upon completion of drilling, borehole wet caved at 6.10 m.

NOTES:

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LOG OF BOREHOLE NO. 102

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Street Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO. 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

GROUND ELEVATION 319.0

DEPTH in METRES	DESCRIPTION	ELEVATION	SAMPLE NUMBER	SAMPLE TYPE	BLOWS/0.3m N-VALUES
0.20	TOPSOIL: Dark brown sandy silt topsoil, rootlets and organics, moist				
1.05	SILTY CLAY: Very stiff silty clay with silt seams, rootlets, A.P.L.	318	1	SS	16
1.35	SILT: Compact light brown silt, trace clay, trace gravel, very moist	317	2	SS	43
2.15	SAND: Dense brown fine to medium sand, some gravel, trace silt, moist		3	SS	76
2.70	SAND AND GRAVEL: Very dense brown fine to medium sand, some gravel, trace silt, moist	316	4	SS	65
		315			
	SILT AND SAND TILL: Very dense brown silt and sand, trace gravel, moist to saturated		5	SS	56
5.50	becoming grey, some rust staining	314			
		313	6	SS	50/150 mm*
		312			
7.45	CLAYEY SILT: Hard grey clayey silt, D.T.P.L.		7	SS	100
8.10	BOREHOLE TERMINATED AT 8.10 m	311			

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

GR	SA	SI	CL
0	39	59	11

After sample 5, borehole wet caved at 3.25 m.

Upon completion of drilling, borehole wet caved at 2.65 m.

NOTES * High "N" Value due to over-filled sampler.

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LOG OF BOREHOLE NO. 103

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

GROUND ELEVATION 317.9

DEPTH in METRES	DESCRIPTION	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
0.25	TOPSOIL: Dark brown sandy silt, rootlets and organics, moist				
0.75	SAND: Compact brown fine to medium sand, some silt, trace gravel, moist	317	1	SS	20
1.5	CLAYEY SILT TILL: Stiff to very stiff brown clayey silt, some sand and gravel, numerous silt seams to 2.00 m, D.T.P.L.	316	2	SS	14
2.00	becoming grey, A.P.L. to D.T.P.L.		3	SS	22
2.90	SILTY SAND TILL: Dense grey silty sand, some gravel, moist	315	4	SS	31
3.0					
3.65	SILTY CLAY TILL: Hard grey silty clay, trace sand and gravel, D.T.P.L.	314			
4.5		313	5	SS	32
6.0		312			
6.10	becoming A.P.L.		6	SS	33
		311			
7.45	SILTY SAND: Very dense grey silty sand, trace gravel, some rust staining, saturated	310	7	SS	68
8.10	BOREHOLE TERMINATED AT 8.10 m				
9.0					

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M
20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT %
10 20 30

45

GROUND WATER OBSERVATIONS AND REMARKS

GR	SA	SI	CL
0	1	35	64

Upon completion of drilling, borehole caved at 7.45 m with no free water.

NOTES:

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LOG OF BOREHOLE NO. 104

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

DEPTH IN METRES	DESCRIPTION	LEGEND	ELEVATION	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m N-VALUES
	GROUND ELEVATION 321.5					
0.10	TOPSOIL: Dark brown sandy silt, rootlets and organics, moist		321			
0.85	SAND: Compact reddish brown to brown fine to medium sand, trace silt, moist			1	SS	12
1.5 1.50	SILT: Compact light brown silt, trace sand and clay, moist		320	2	SS	12
	SILTY CLAY TILL: Stiff to very stiff grey silty clay , some sand and gravel, occasional wet sand seams, A.P.L. to D.T.P.L.		319	3	SS	24
3.0			318	4	SS	21
4.5			317	5	SS	26
			316			
6.0			315	6	SS	26
7.5 7.60	becoming A.P.L.		314	7	SS	20
8.10	BOREHOLE TERMINATED AT 8.10 m					
9.0						

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

GR	SA	SI	CL
2	20	54	24

Upon completion of drilling, borehole open with no free water.

NOTES

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LOG OF BOREHOLE NO. 105

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

DEPTH in METRES	DESCRIPTION	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
	GROUND ELEVATION 323.3				
0.20	TOPSOIL: Dark brown sandy silt, rootlets and organics, moist	323			
	SAND: Loose reddish brown fine to medium sand, trace silt, moist (Possible Fill)	322	1	SS	4
1.5			2	SS	1
		321			
2.60	becoming compact, light brown		3	SS	17
3.0 3.05	SILT TILL: Compact light brown silt, little sand and gravel, very moist	320	4	SS	16
		319			
4.5 4.55	CLAYEY SILT TILL: Very stiff grey clayey silt, some sand and gravel, D.T.P.L.		5	SS	23
		318			
6.0		317	6	SS	27
		316			
7.5 7.60	occasional silt seams		7	SS	23
8.10	BOREHOLE TERMINATED AT 8.10 m				
9.0					

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ——— W_L
PLASTIC LIMIT ——— W_P
WATER CONTENT ——— W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

GR	SA	SI	CL
0	91	(9)	

Upon completion of drilling, borehole open with no free water.

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LOG OF BOREHOLE NO. 106

PROJECT HIGH MAST LIGHT POLES
LOCATION Wellington Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 08 30
OUR PROJECT NO 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

DEPTH IN METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
	GROUND ELEVATION 322.9					
0.20	TOPSOIL: Dark brown sandy silt, rootlets and organics, moist					
0.45	SAND: Loose brown fine to medium sand, some gravel, trace silt, moist (fill)		322	1	SS	7
1.20	TOPSOIL: Dark brown and black clayey silt, some peat, rootlets and organics, moist		321	2	SS	11
1.90	SILTY SAND: Compact grey silty sand, trace gravel, some rust staining, very moist to saturated		320	3	SS	11
2.55	SAND: Compact brown fine to coarse sand, trace to some gravel, trace silt, saturated		319	4	SS	15
3.05	SILTY CLAY TILL: Very stiff light brown silty clay, some sand and gravel, A.P.L. to D.T.P.L.		318	5	SS	33
4.55	becoming grey		317	6	SS	25
6.10	becoming hard becoming very stiff, occasional wet sand seams		316			
7.15	SILTY SAND TILL: Very dense grey silty sand, trace gravel, occasional silt seams, saturated		315	7	SS	53
8.10	BOREHOLE TERMINATED AT 8.10 m					

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

After sample 2, sampler wet.

Upon completion of drilling, borehole caved at 4.25 m with free water at 2.45 m.

GR	SA	SI	CL
0	37	43	20

NOTES:

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LOG OF BOREHOLE NO. 107

PROJECT HIGH MAST LIGHT POLES
LOCATION Lancaster Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 09 11
OUR PROJECT NO 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

GROUND ELEVATION 321.0

DEPTH IN METRES	DESCRIPTION	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
0.25	TOPSOIL: Dark brown clayey silt, rootlets and organics, very moist				
0.90	SANDY SILT: Compact light brown sandy silt, little gravel, moist	320	1	SS	12
1.5	SILTY CLAY TILL: Stiff to very stiff grey silty clay, trace sand and gravel, A.P.L. to D.T.P.L.	319	2	SS	20
			3	SS	18
3.0	3.05 occasional silt seams	318	4	SS	27
4.5		317			
		316	5	SS	16
6.0	6.10 occasional saturated sand and gravel seams	315	6	SS	28
		314			
7.5	7.60 becoming hard		7	SS	43
	8.10 BOREHOLE TERMINATED AT 8.10 m	313			
9.0					

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

GR SA SI CL

Bentonite Seal
12 mm PVC Pipe
0 4 70 26
Native Backfill
Piezometer Tip
After sample 6, sampler wet.

Upon completion of drilling, borehole open with free water at 3.20 m.

PIEZOMETER READINGS:
Initial: 4.55 m
2000 09 29: 0.75 m

NOTES

CHECKED BY

PML/504A

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 108

PROJECT HIGH MAST LIGHT POLES
LOCATION Lancaster Ramps at Highway 86
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE 2000 09 11
OUR PROJECT NO. 99 KF 141A
ENGINEER G. Mitchell
TECHNICIAN D. Jotham

GROUND ELEVATION 318.6

DEPTH in METRES	DESCRIPTION	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N-VALUES
0.20	TOPSOIL: Dark brown clayey silt, rootlets and organics, moist	318			
1.35	CLAYEY SILT: Stiff grey clayey silt, little gravel, A.P.L. to D.T.P.L.	317	1	SS	12
1.5			2	SS	25
2.20	SILT: Dense grey silt, saturated, dilatent				
2.60	SAND AND GRAVEL: Very dense brown fine to medium sand and gravel, trace silt, numerous cobbles, moist	316	3	SS	50/80 mm
3.0			4	SS	20
	SILTY CLAY TILL: Very stiff grey silty clay, trace sand and gravel, D.T.P.L.	315			
4.5		314	5	SS	24
		313			
6.0	6.10 occasional silt seams	312	6	SS	24
7.5		311	7	SS	26
8.10	BOREHOLE TERMINATED AT 8.10 m				
9.0					

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

GROUND WATER OBSERVATIONS AND REMARKS

GR	SA	SI	CL
0	4	38	58

Upon completion of drilling, borehole open with no free water.

NOTES:

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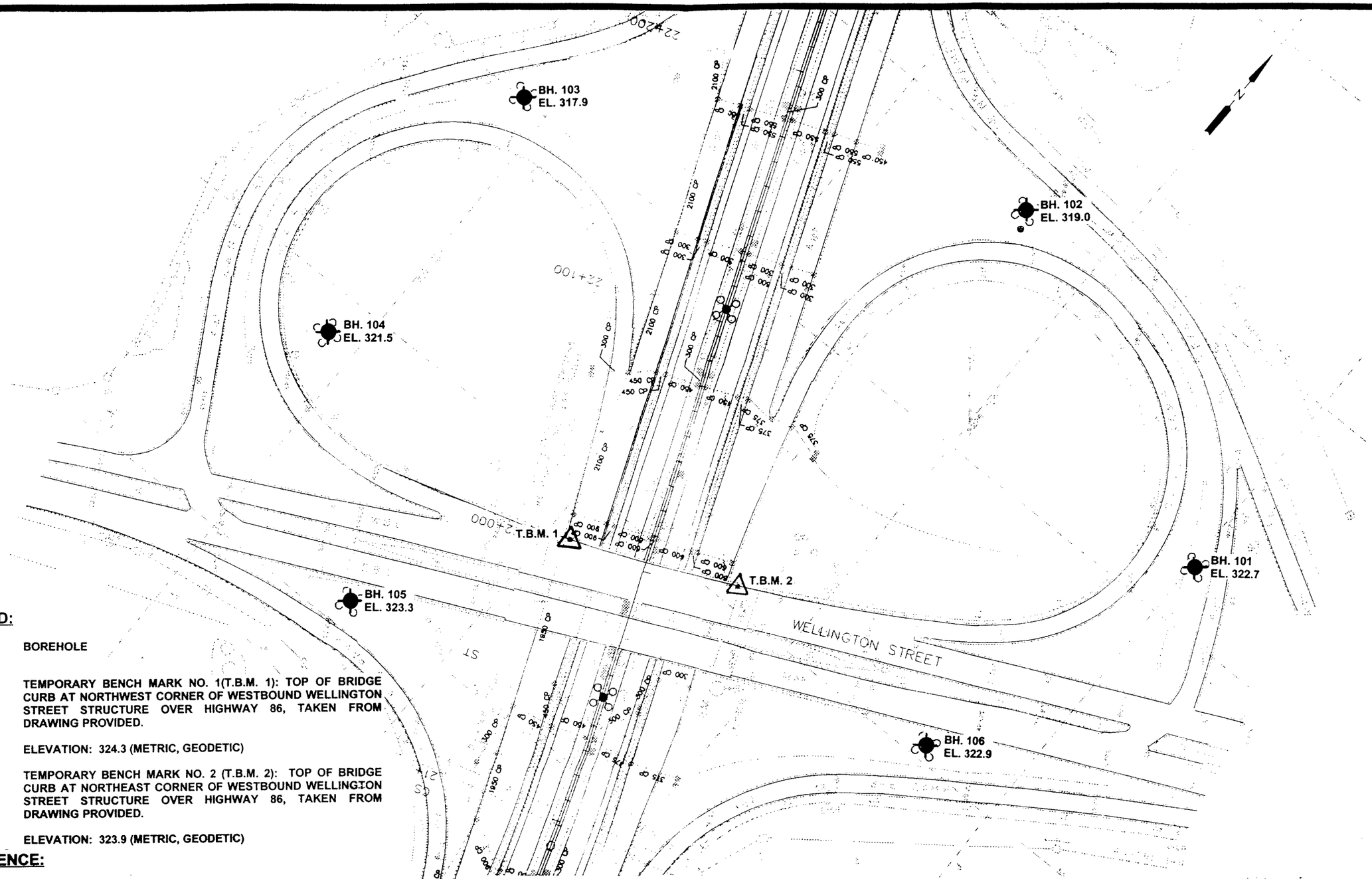
PML/504A



LEGEND:

BOREHOLE

TEMPORARY BENCH MARK NO. 1(T.B.M. 1): TOP OF BRIDGE CURB AT NORTHWEST CORNER OF WESTBOUND WELLINGTON STREET STRUCTURE OVER HIGHWAY 86, TAKEN FROM DRAWING PROVIDED.

ELEVATION: 324.3 (METRIC, GEODETIC)

TEMPORARY BENCH MARK NO. 2 (T.B.M. 2): TOP OF BRIDGE CURB AT NORTHEAST CORNER OF WESTBOUND WELLINGTON STREET STRUCTURE OVER HIGHWAY 86, TAKEN FROM DRAWING PROVIDED.

ELEVATION: 323.9 (METRIC, GEODETIC)

REFERENCE:

BOREHOLE LOCATION PLAN REPRODUCED FROM DRAWING SUPPLIED BY CLIENT.

NOTE:

THE INFERRED STRATIGRAPHY REFERRED TO IN THE REPORT IS BASED ON THE DATA FROM THESE BOREHOLES SUPPLEMENTED BY GEOLOGICAL EVIDENCE. THE ACTUAL STRATIGRAPHY BETWEEN THE BOREHOLES MAY VARY.

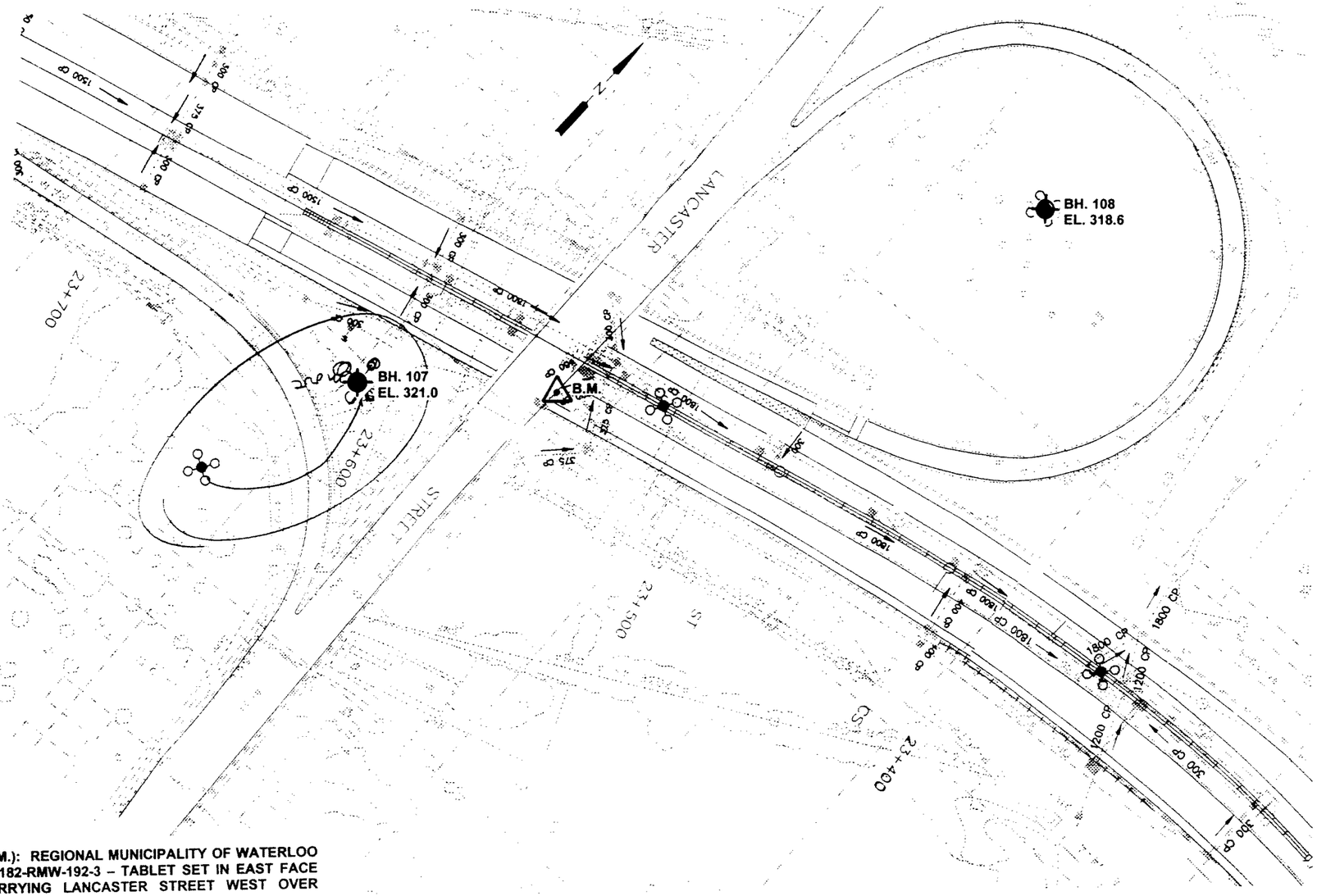
MORRISON HERSHFIELD LIMITED

HIGH MAST LIGHT POLES
WELLINGTON STREET AT HIGHWAY 86
KITCHENER, ONTARIO

BOREHOLE PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS

		DATE	SCALE	PML REF.	DRAWING NO.
DRAWN	D. JOTHAM	OCT., 2000	1 : 1500	99 KF 141A	1
CHECKED	M. ANDERSON				
APPROVED	G. MITCHELL				



LEGEND:

BOREHOLE

BENCHMARK (B.M.): REGIONAL MUNICIPALITY OF WATERLOO BENCHMARK KI-182-RMW-192-3 – TABLET SET IN EAST FACE OF BRIDGE CARRYING LANCASTER STREET WEST OVER HIGHWAY 86.

ELEVATION: 327.258 (METRIC, GEODETIC)

REFERENCE:

BOREHOLE LOCATION PLAN REPRODUCED FROM DRAWING SUPPLIED BY CLIENT.

NOTE:

THE INFERRED STRATIGRAPHY REFERRED TO IN THE REPORT IS BASED ON THE DATA FROM THESE BOREHOLES SUPPLEMENTED BY GEOLOGICAL EVIDENCE. THE ACTUAL STRATIGRAPHY BETWEEN THE BOREHOLES MAY VARY.

MORRISON HERSHFIELD LIMITED

HIGH MAST LIGHT POLES
LANCASTER STREET AT HIGHWAY 86
KITCHENER, ONTARIO

BOREHOLE PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS

		DATE	SCALE	PML REF.	DRAWING NO.
DRAWN	D. JOTHAM	OCT., 2000	1 : 1500	99 KF 141A	2
CHECKED	M. ANDERSON				
APPROVED	G. MITCHELL				

Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT
FOR
HIGH MAST LIGHT FOUNDATIONS
WELLINGTON STREET AND
LANCASTER STREET INTERCHANGES
HIGHWAY 86
KITCHENER, ONTARIO

DISTRIBUTION:

6 cc: Morrison Hershfield Limited + Electronic
1 cc: PML Kitchener
1 cc: PML Toronto

PML Ref. 99 KF 141A

October, 2000

Peto MacCallum Ltd.
CONSULTING ENGINEERS

TABLE OF CONTENTS

INTRODUCTION

Installation of six High Mast Light (HML) poles at the Wellington Street interchange and two HML poles at the Lancaster Street ramps along Highway 86 in Kitchener, Ontario is planned.

This report provides geotechnical parameters for design of the HML pole foundations as well as comments and recommendations regarding construction of the foundations.

The subsurface stratigraphy revealed in boreholes drilled at the pole locations generally comprised a surficial topsoil layer overlying discontinuous sand, sand and gravel, silt or clay layers, underlain by silt clay to silty sand till. Fill was revealed at one location.

ENGINEERING DISCUSSION AND RECOMMENDATIONS

The borehole information indicates that the HML pole foundations will generally extend through a topsoil layer, sand, silt or clay layers, and into silty clay to silty sand till.

Geotechnical parameters governing the design of HML pole foundations are as follows:

For Cohesive Soil:

q_u = unconfined compressive strength (kPa)

For Cohesionless Soil:

ϕ = angle of internal friction (degree)

n_h = coefficient of horizontal subgrade reaction (kN/m^3)

γ = unit weight of soil (kN/m^3); use submerged unit weight below the water table (submerged unit weight equals unit weight minus 9.8 kN/m^3)

The geotechnical parameters recommended for design of the proposed foundation units are provided on Table I, appended. A design groundwater table level inferred from the borehole observations, soil colouring, and moisture content profile are also provided on Table I.

The caissons should be designed in accordance with the MTO "Procedures for the Design of High Mast Pole Foundations", June 1994. The lateral earth pressure, p, developed along the length of caisson, may be computed using the equations provided below. A resistance factor of 0.5 should be applied to the computed earth pressure to calculate the ULS resistance.

For Cohesive Soil

$p = 4.5\, q_u D$

where D = caisson diameter (m)

* resistance to a depth of 1.5 D or the frost depth, whichever is greater is to be ignored

For Cohesionless Soil

$p = 2K_p \gamma z D$

where K_p = lateral earth pressure coefficient

$= \frac{1 + \sin\phi}{1 - \sin\phi}$ for horizontal ground surface, or

$= \left[\frac{\cos\phi}{1 - \sqrt{\sin\phi\,(\sin\phi - \cos\phi \tan\beta)}}\right]^2$ for sloping ground surface

z = depth below grade (m)

β = slope inclination

* resistance to frost depth is to be ignored

For HML pole foundations on or near slopes in cohesive soil or fill, use the attached Figure 1 to determine the percentage of calculated lateral resistance.

A frost penetration depth in soil of 1.4 m is recommended for design.

If required, the following soil parameters should be used for design of HML poles constructed in well compacted engineered fill:

Cohesive Fill

q_u = 100 kPa
γ = 18 kN/m^3

Non-Cohesive Fill

ϕ = 30 degrees
n_h = 3.0 MN/m^3
γ = 18 kN/m^3

The foundations for high mast lighting poles are expected to comprise drilled cast-in place concrete caissons. The manual specifies the minimum caisson diameter as listed in the following table:

Minimum Allowable Foundation Diameters

POLE HEIGHT (m)	DIAMETER (m)
25	1.22
30	1.22
35	1.37
40	1.52
45	1.52

These values are the minimum sizes, allowing for the size of the base plate, anchorage and foundation reinforcement. Larger available caisson sizes are 1.83 m and 2.13 m, which should be used only if the smaller sizes are not adequate.

In general, installation of the foundations is expected to be relatively straightforward using conventional augering procedures and sump pumping techniques. Comments regarding potential construction concerns at each borehole location are presented on Table I.

The following potential construction concerns are noted:

- The groundwater level was interpreted to range from 1.7 to 7.4 m depth in boreholes 101, 102, 103, 106 and 107. Free water was not observed in boreholes 104, 105 and 108 during drilling. Considering the relatively low permeability of the predominant clayey silt / silty clay till as well as the typically very dense nature of the non-cohesive soils, pumping should be adequate to handle seepage which enters the excavation, subject to subsequent comments regarding cave.

- Cave of the sidewalls of boreholes 101, 102, 103 and 106 was observed at depths of 2.7 to 7.4 m. A suitable caisson liner should be available on-site to support the sidewalls of the auger hole where required and minimize the potential for sloughing and groundwater inflow.

- Cobbles were encountered in the sand and gravel layer revealed in borehole 108. The rate of auger advance may decrease or rock coring methods may be required if numerous or large cobbles are encountered during foundation installation at this and other locations.

All foundation excavation operations should be observed by qualified geotechnical personnel to verify that soil conditions at the pole locations are consistent with the recommended parameters and ensure that the geotechnical requirements presented in this report are properly implemented.

All work should be carried out in accordance with the Occupational Health and Safety Act (Ontario Regulation 213/91) and with local regulations.

CLOSURE

The report was prepared by Mr. M.R. Anderson, P. Eng., Senior Engineer. It was reviewed by Mr. G. Mitchell, P.Eng., Manager of Geotechnical Engineering, Kitchener.

Yours very truly

PETO MacCALLUM LTD.

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

Gerry Mitchell, M.Eng., P.Eng.
Manager, Geotechnical Engineering
Kitchener

Brian R. Gray, M.Eng., P.Eng.
Vice President
Geotechnical Engineering and
Geo-Environmental Services

MRA:cs

PML Ref. 99 KF 141A
October, 2000

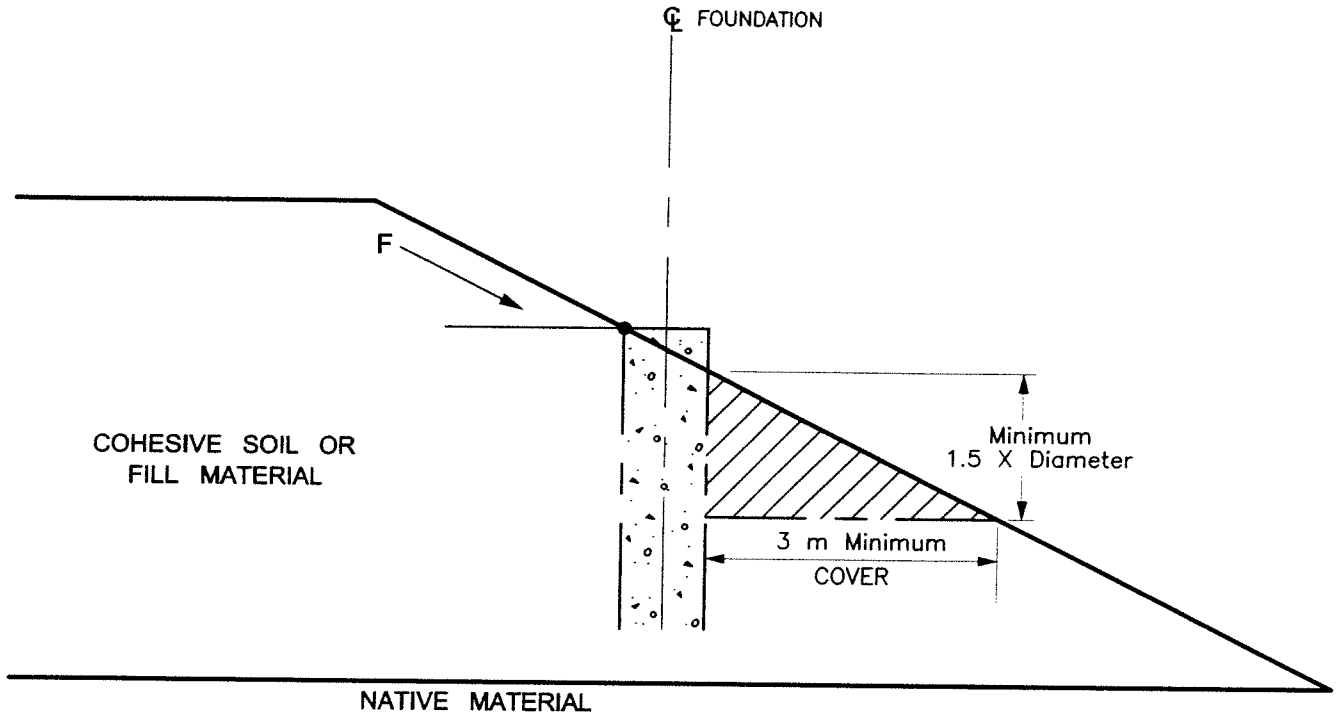
TABLE I

SUMMARY OF GEOTECHNICAL CONDITIONS AND DESIGN PARAMETERS

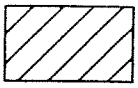
HIGH MAST LIGHT FOUNDATIONS
WELLINGTON STREET AND LANCASTER STREET INTERCHANGES
HIGHWAY 86
KITCHENER, ONTARIO

Pole No.	BOREHOLE		SUMMARIZED STRATIGRAPHY							Design Water table Level (m)	Comments
	No.	Elevation	Depth (m)	Soil Type	Consistency or Denseness	q_u (kPa)	$\phi°$	n_h (MN/m^3)	γ (kN/m^3)		
P13	101	322.7	0.2 – 2.2 2.2 – 3.1 3.1 – 8.1	Non Cohesive Sand/Till Cohesive Silt Till Non Cohesive Sand/Till	Compact to Dense Hard V. Dense	- 400 -	35 - 38	6 - 10	21 21 21	1.7	Potential for cave in augerhole.
P12	102	319.0	0.2 – 1.4 1.4 – 8.1	Cohesive Clay/Silt Non Cohesive Sand/Till	V. Stiff/Compact V. Dense	200 -	- 38	- 10	20 21	3.3	Potential for cave in augerhole.
P10	103	317.9	0.3 – 2.9 2.9 – 8.1	Cohesive Silt Till Cohesive Clay Till	Stiff to V. Stiff Hard	200 400	- -	- -	20 21	3.5	-
P8	104	321.5	0.1 – 1.5 1.5 – 8.1	Non Cohesive Sand/Silt Cohesive Clay Till	Compact V. Stiff	- 300	30 -	3 -	20 21	3.0	-
P7	105	323.3	0.2 – 2.6 2.6 – 4.6 4.6 – 8.1	Non Cohesive Sand Non Cohesive Sand/Silt Till Cohesive Silt Till	Loose Compact V. Stiff	- - 300	28 32 -	1.5 5 -	19 20 20	4.0	Potential for cave in upper loose sand.
P11	106	322.9	1.2 – 2.6 2.6 – 4.6 4.6 – 7.2 7.2 – 8.1	Non Cohesive Sand Cohesive Clay Till Cohesive Clay Till Non Cohesive Sand Till	Compact V. Stiff Hard V Dense	- 200 350 -	32 - - 38	3 - - 10	20 20 21 21	1.9	Potential for cave in augerhole.
-	107	321.0	0.3 – 0.9 0.9 – 8.1	Non Cohesive Silt Cohesive Clay Till	Compact V. Stiff	- 250	30 -	3 -	20 20	3.0	Potential for cave in augerhole.
P23	108	318.6	0.2 – 1.4 1.4 – 2.6 2.6 – 8.1	Cohesive Silt Non Cohesive Silt to Gravel Cohesive Clay Till	Stiff Dense to V. Dense V. Stiff	150 - 300	- 35 -	- 10 -	20 21 20	3.0	Cobbles in sand and gravel layer.

HIGH MAST POLE FOUNDATION ON SLOPE



LEGEND

F	ADDITIONAL EARTH PRESSURE FROM SLOPING SURFACE
	ASSUME NO PASSIVE RESISTANCE DEVELOPED IN THIS ZONE

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45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3C6
Tel: (905) 561-2231 Fax (905) 561-6383

DATE	SCALE	JOB NO.	FIGURE NO.
OCT. 2000	NTS	99KF141A	1