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W.P. No. 164-79-04/05

CONT. No. 87-60

W. O. No.

STR. SITE No. 37

HWY. No. 400/7

LOCATION High Mast Lighting
Hwy 400/7

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 164-79-04/05

DIST 6

HWY 400/7

STR SITE 37

High Mast Lighting

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FOUNDATION INVESTIGATION REPORT

For

Hwy 400 and Hwy 7, High Mast Lighting

W.P. 164-79-04/05, Site 37

District 6, Central Region

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation performed at the above-mentioned site between 1985-06-10 and 1985-06-14. The fieldwork consisted of advancing one borehole at each high mast lighting location. The boreholes included sampling the overburden at 0.75 m intervals down to 3.5 m and at 1.5 m intervals from 3.5 m down to the end of the borehole. Boreholes ranged from 6.2 m to 12.6 m in depth and all 18 boreholes were accompanied by cone penetration tests.

SITE DESCRIPTION

The site is in the area of the existing Hwy. 400 and Hwy 7 intersection in the Regional Municipality of York. The ground surface tends to slope to the South.

The site is located in the physiographic region known as the Peel Plain; which is described as "a level - to - undulating tract of clay soils".¹

SUBSURFACE CONDITIONS

General

In general, reasonably uniform subsurface conditions with varying insitu consistency/denseness were encountered across the site. The surficial deposit of silty clay, trace to with sand, trace gravel with silty sand to sandy silt seams was encountered across the site. At the south end of the site this cohesive deposit was proven to be at least 12.6 m thick. At the north end of the site the silty clay was underlain by a non-cohesive deposit of sand some silt, trace clay, trace gravel in a very dense state. The boundaries between the soil types, insitu and laboratory tests results, and groundwater levels, are shown on the attached Record of Borehole Sheets. The locations of the borings are shown on Drawing 164790405-A.

The various soil types encountered are briefly described in the following paragraphs.

¹The Physiography of Southern Ontario 3rd Ed.

Silty Clay, trace to with Sand, trace Gravel

This cohesive material was encountered in all boreholes as the surficial deposit. At the South end of the site the deposit was shown to be up to 12.6 m thick. At the North end of the site the deposit was approximately 9 m thick and was underlain by a non-cohesive sand deposit.

The results of Atterberg Limits testing carried out on 12 samples of this material are plotted on Figure 1 in the appendix and can be summarized as follows:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
w	8 to 20%	13%	12.5%
w _L	17 to 43.5%	25%	23%
w _p	10.5 to 19.5%	14 %	14%
I _p	6.5 to 25%	11%	10%

This information indicates that this material is primarily a silty clay of low plasticity, (CL Group).

The results of grain size distribution testing are shown in envelope form on Figure 2. These results can be summarized as follows:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Gravel	0- 8%	3%	3%
Sand	1-34%	18%	18%
Silt	41-73%	52%	52%
Clay	15-56%	27%	25%

Based on this information this material is described as a silty clay, trace to with sand, trace gravel.

Interpretation of Standard Penetration test 'N' values indicates that this material has a firm to hard consistency. The material tends to become stiffer with depth and in general, the material becomes hard at 2 to 4 m below the ground surface.

Thin seams of silty sand to sandy silt were encountered within the silty clay, trace to with sand, trace gravel. The upper seam was encountered across the site in all holes with the exception of C-5, C-6, C-11, C-15, and C-17. In general this non-cohesive seam slopes to the south and thus it is approximately

parallel to the ground surface. At the north end of the site this seam is encountered at approximately Elev. 192 m and at the south end it is at approximately Elev. 187 m.

The result of one grain size distribution test done on a sample of this material is shown on Figure 3 and can be summarized as follows:

Gravel	0
Sand	1
Silt	97
Clay	2

Based on this information along with visual identification of other samples of this material this seam is made up of silty sand to sandy silt.

Interpretation of Standard Penetration Test 'N' values indicate this material is in a loose to very dense state.

Sand some Silt, trace Clay, Gravel

This material was encountered below the silty clay described above in 2 holes, C-7 and C-8, towards the northern end of the site.

No tests were carried out on this non-cohesive material.

Interpretation of Standard Penetration Test 'N' values ranging from 185 to 242 for 25 cm indicates this material to be in a very dense state.

Groundwater Conditions

Groundwater levels were determined by measuring in open boreholes. The groundwater elevation ranges from 189.7 m in borehole C-3 to 199.6 m in borehole C-11. In seven holes the stabilized water level was not established. In these cases the groundwater level may be assumed to be at ground surface.

Discussion and Recommendations

In the area around the Hwy 400 and Hwy 7 intersection it is proposed to install 18 high mast lights.

The following table indicates the location and the pole height of each installation as well as the existing and proposed ground elevations and the existing ground water level at each location.

POLE CO-ORDINATES		PROPOSED AT GROUND ELEVATION	EXISTING GROUND ELEVATION	GROUND WATER LEVEL	CUT (C) POLE FILL(F) HEIGHT(m)	
C1	N4,849,466;E 301,738	190.8	190.7	190.1	0.1m(F)	30
C2	N4,849,591;E 301,641	192.2	191.3	190.7	0.9m(F)	30
C3	N4,849,710;E 301,612	194.0	192.1	189.7	1.9m(F)	30
C4	N4,849,754;E 301,763	196.2	196.1	*196.1	0.1m(F)	30
C5	N4,849,857;E 301,597	196.3	195.7	193.6	0.6m(F)	30
C6	N4,849,995;E 301,695	199.3	198.9	*198.9	0.4m(F)	30
C7	N4,850,052;E 301,554	197.4	197.3	*197.3	0.1m(F)	30
C8	N4,850,173;E 301,521	198.3	198.1	*198.1	0.2m(F)	30
C9	N4,850,146;E 301,637	199.0	198.4	*198.4	0.6m(F)	30
C10	N4,850,297;E 301,587	199.8	200.0	*200.0	0.2m(C)	30
C11	N4,850,432;E 301,498	201.8	199.9	199.6	1.9m(F)	30
C12	N4,849,773;E 301,323	193.3	193.2	192.0	0.1m(F)	30
C13	N4,849,678;E 301,516	195.9	191.9	190.9	4.0m(F)	30
C14	N4,849,793;E 301,459	197.9	192.2	191.0	5.7m(F)	30
C15	N4,849,945;E 301,492	196.4	196.2	195.5	0.2m(F)	30
C16	N4,849,882;E 301,774	197.0	197.0	197.0	—	30
C17	N4,850,028;E 301,885	198.4	198.2	196.7	0.2m(F)	30
C18	N4,850,045;E 301,462	195.4	195.2	*195.2	0.2m(F)	30

*In cases where groundwater level was not established it is assumed to be at the original ground surface.

Conventional spread footings for these light poles would likely be quite expensive. However, high mast light poles have been installed economically in many areas of North America and Europe using a design method proposed by B.B. Broms and others in which the poles are supported on a concrete caisson pile. The Structural Office has decided to adopt this same method described by Broms

in two separate papers; Broms B.B. "Lateral Resistance of Piles in Cohesive Soils", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, No. SM2, Paper 3825, March 1964.; and "Lateral Resistance of Piles in Cohesionless Soils", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, No. SM3, Paper 3909, May, 1964.

In the following paragraphs, the feasibility of constructing concrete caissons at the site is discussed and the various parameters to be used in the caisson design are provided.

Design

It should be assumed that existing or proposed fill does not provide any lateral resistance. Similarly material, (fill or native soil), in the zone of frost penetration does not provide any lateral resistance. At this site the depth of frost penetration is 1.2 m . It should be noted, that all elevations and soil parameters given in the memo are based on the assumption that fill is placed at the time of construction.

For the cohesive soils located at this site, the coefficient of horizontal subgrade reaction should be computed in accordance with the following formula: (The design parameters are presented in Imperial Units, since the design example provided by the Structural Office used Imperial Units throughout.)

$$K_h = \frac{n_1 n_2 80 q_u}{D}$$

Where:

K_h - coefficient of horizontal subgrade reaction (lb/in³)

D - Diameter of concrete caisson pile (in)

n_1 - coefficient as defined below:

Coefficient n_1

Unconfined Compressive Strength q_u (psi)	n_1
Less than 7	0.32
7 to 28	0.36
Greater than 28	0.40

n_2 - coefficient based on pile material = 1.15 for concrete

q_u - unconfined compressive strength (psi)

For the non-cohesive soils, K_h should be computed from the following formula:

$$K_h = n_h \frac{z}{D}$$

K_h - coefficient of horizontal subgrade reaction (tons/ft³)

z - depth below ground surface (ft.)

D - diameter of caisson (ft)

n_h - Coefficient evaluated as follows:

Coefficient n_h in tons/ft³

Relative Density	Loose	Compact	Dense
Above Groundwater table	7	21	56
Below Groundwater table	4	14	34

The following soil parameters are recommended for the design of the high-mast light caisson:

(note: ϕ = apparent angle of internal friction for non-cohesive soils

q_u = unconfined compressive strength in psi

($q_u = 2c_u$)

γ = unit weight in pcf

Pole	Elev.(m) From-to	Type of Soil	ϕ	q_u psi	q_u t/ft ²	γ pcf
C-1	190.8-190.7	fill	0	0	0	-
	190.7-189.6	cohesive	0	0	0	-
	189.6-189.3	cohesive	0	6	0.43	115
	189.3-187.0	cohesive	0	25	1.8	120
	187.0-181.1*	cohesive	0	60	4.32	130
C-2	192.2-191.3	fill	0	0	0	-
	191.3-191.0	cohesive	0	0	0	-
	191.0-187.6	cohesive	0	25	1.8	120
	187.6-181.7*	cohesive	0	60	4.32	130
C-3	194.0-192.1	fill	0	0	0	-
	192.1-188.5	cohesive	0	12	0.86	115
	188.5-179.5*	cohesive	0	60	4.32	130
C-4	196.2-196.1	fill	0	0	0	-
	196.1-195.0	cohesive	0	0	0	-
	195.0-192.5	cohesive	0	42	3.02	125
	192.5-188.4*	cohesive	0	60	4.32	130
C-5	196.3-195.7	fill	0	0	0	-
	195.7-195.1	cohesive	0	0	0	-
	195.1-194.4	cohesive	0	12	0.86	115
	194.4-192.8	cohesive	0	42	3.02	125
	192.8-187.6*	cohesive	0	70	5.04	130

<u>Pole</u>	<u>Elev.(m) From-to</u>	<u>Type of Soil</u>	<u>ϕ</u>	<u>q_u psi</u>	<u>q_u t/ft²</u>	<u>γ pcf</u>
C-6	199.3-198.9	fill	0	0	0	-
	198.9-198.1	cohesive	0	0	0	-
	198.1-195.2	cohesive	0	12	0.86	115
	195.2-191.2*	cohesive	0	53	3.82	130
C-7	197.4-197.3	fill	0	0	0	-
	197.3-196.2	cohesive	0	0	0	-
	196.2-193.3	cohesive	0	33	2.38	125
	193.3-191.3	cohesive	0	51	3.67	130
	191.3-186.4*	non-cohesive	35°	0	0	130
C-8	198.3-198.1	fill	0	0	0	-
	198.1-197.1	cohesive	0	0	0	-
	197.1-195.2	cohesive	0	42	3.02	125
	195.2-189.1	cohesive	0	54	3.89	130
	189.1-188.5*	non-cohesive	35°	0	0	130
C-9	199.0-198.4	fill	0	0	0	-
	198.4-197.8	cohesive	0	0	0	-
	197.8-194.8	cohesive	0	33	2.38	125
	194.8-188.8*	cohesive	0	55	3.96	130
C-10	200.0-199.8	cut	-	-	-	-
	199.8-198.6	cohesive	0	0	0	-
	198.6-197.9	cohesive	0	12	0.86	115
	197.9-192.2*	cohesive	0	56	4.03	130
C-11	201.8-199.9	fill	0	0	0	-
	199.9-198.5	cohesive	0	28	2.02	120
	198.5-192.4*	cohesive	0	61	4.39	130
C-12	193.3-193.2	fill	0	0	0	-
	193.2-192.1	cohesive	0	0	0	-
	192.1-189.6	cohesive	0	33	2.38	125
	189.6-185.1*	cohesive	0	70	5.04	130

<u>Pole</u>	<u>Elev.(m) From-to</u>	<u>Type of Soil</u>	<u>ϕ</u>	<u>q_u psi</u>	<u>q_u t/ft²</u>	<u>γ pcf</u>
C-13	195.9-191.9	fill	0	0	0	-
	191.9-188.2	cohesive	0	25	1.8	120
	188.2-183.8*	cohesive	0	61	4.39	130
C-14	197.9-192.2	fill	0	0	0	-
	192.2-189.4	cohesive	0	25	1.8	120
	189.4-184.4*	cohesive	0	70	5.04	130
C-15	196.4-196.2	fill	0	0	0	-
	196.2-195.2	cohesive	0	0	0	-
	195.2-194.9	cohesive	0	6	0.43	115
	194.9-192.2	cohesive	0	33	2.38	125
	192.2-186.9*	cohesive	0	70	5.04	130
C-16	197.0-195.8	cohesive	0	0	0	-
	195.8-195.6	cohesive	0	33	2.38	125
	195.6-190.8*	cohesive	0	52	3.74	130
C-17	198.4-198.2	fill	0	0	0	-
	198.2-197.2	cohesive	0	0	0	-
	197.2-196.1	cohesive	0	12	0.86	115
	196.1-194.1	cohesive	0	42	3.02	125
	194.1-185.6*	cohesive	0	61	4.39	130
C-18	195.4-195.2	fill	0	0	0	-
	195.2-194.2	cohesive	0	0	0	-
	194.2-192.3	cohesive	0	25	1.8	120
	192.3-182.6	cohesive	0	54	3.89	130

*If deeper caissons are required please contact the Foundation Design Section.

Miscellaneous

The field work for this project was carried out under the supervision of Mr. F. Saccon, Project Foundations Engineer.

The report was written by Mr. I. Richardson Student Engineer, under the supervision of Mr. D. Dundas, Foundations Engineer and reviewed by Mr. M. Devata, Chief Foundations Engineer (East).

The drilling equipment used was owned and operated by Atcost Soil Drilling Inc.

I. K. Richardson

I.K. Richardson
Student Engineer



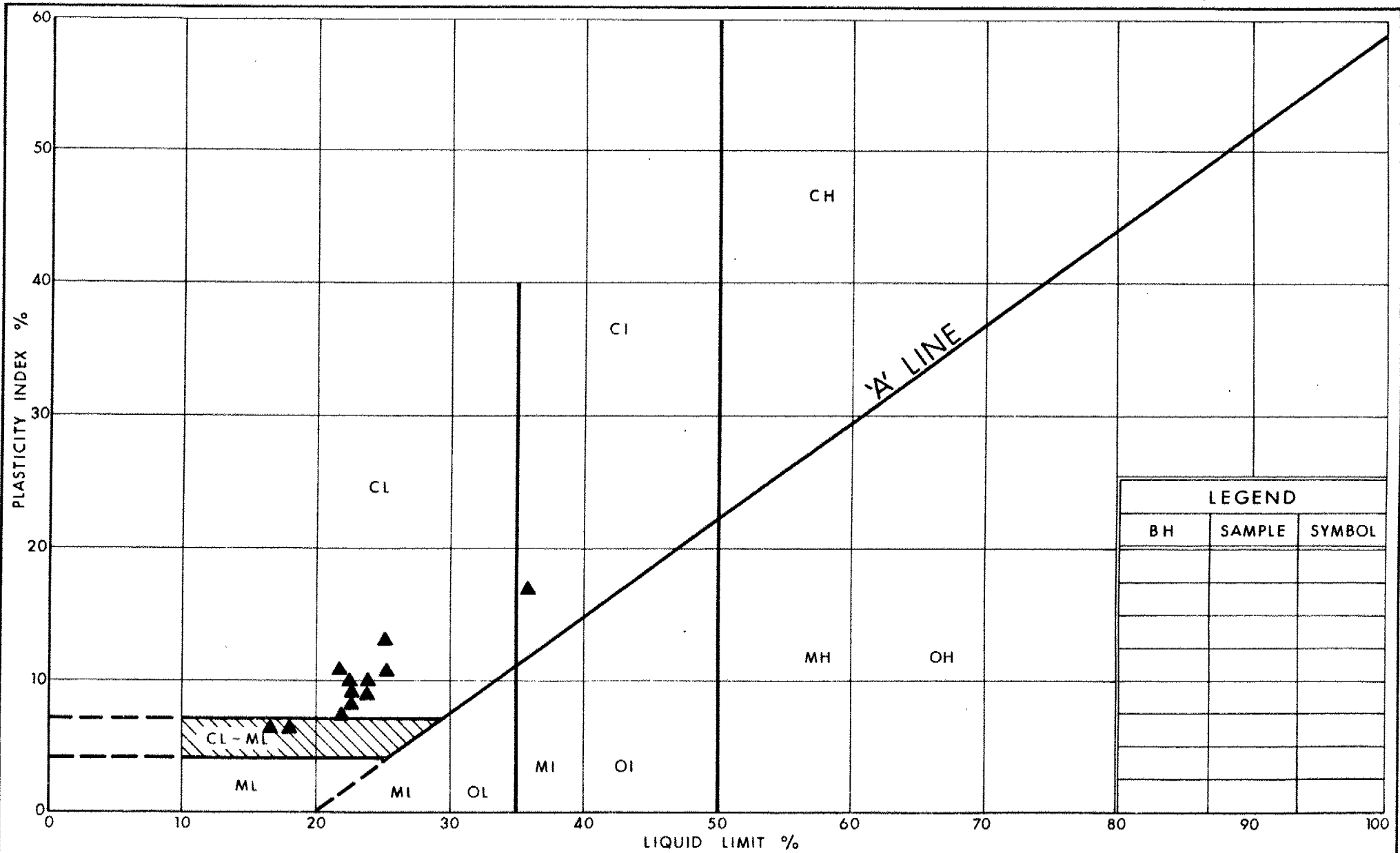
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APPENDIX



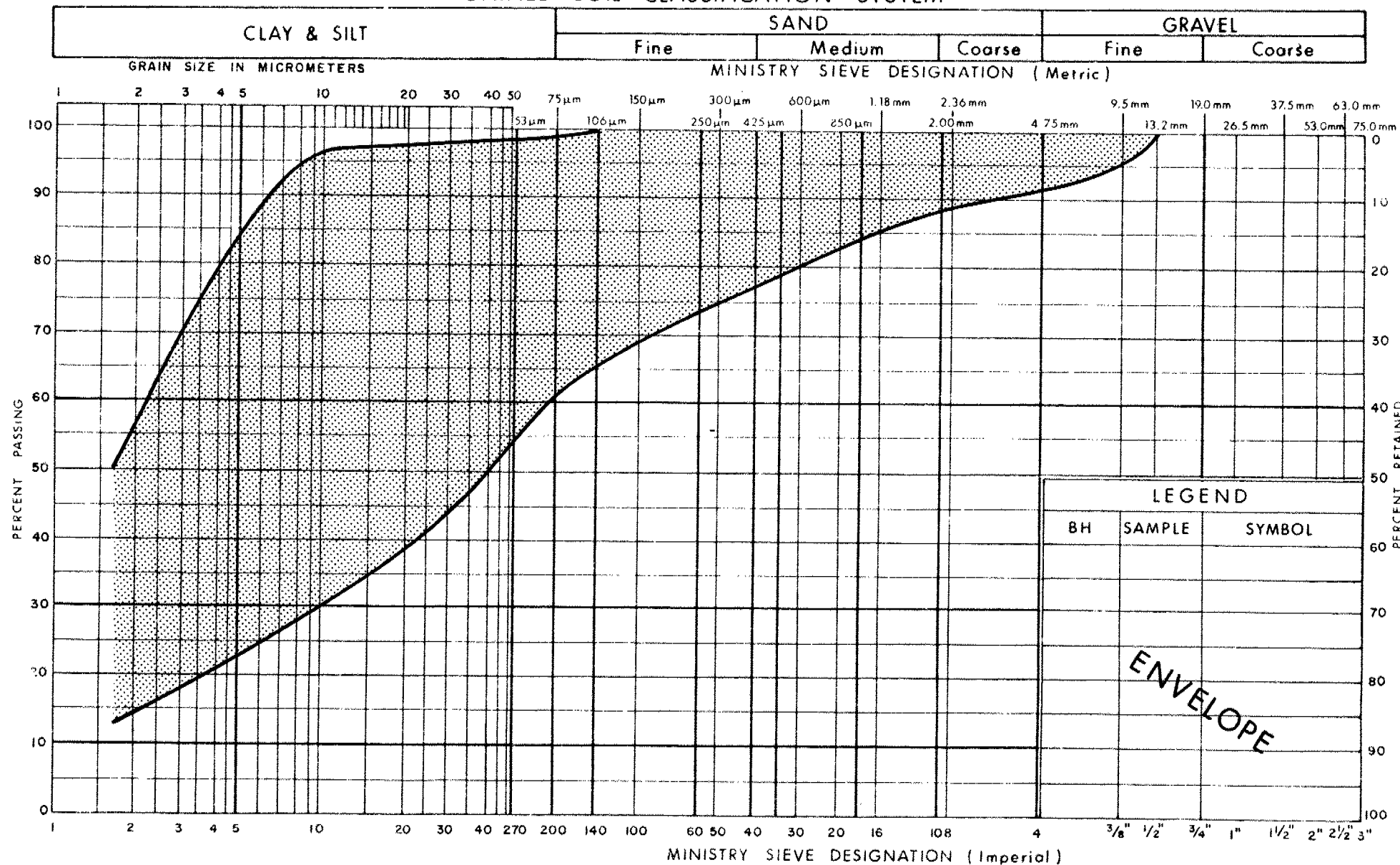
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PLASTICITY CHART SILTY CLAY TRACE TO WITH SAND TRACE OF GRAVEL

FIG No 1

W P 164-79-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

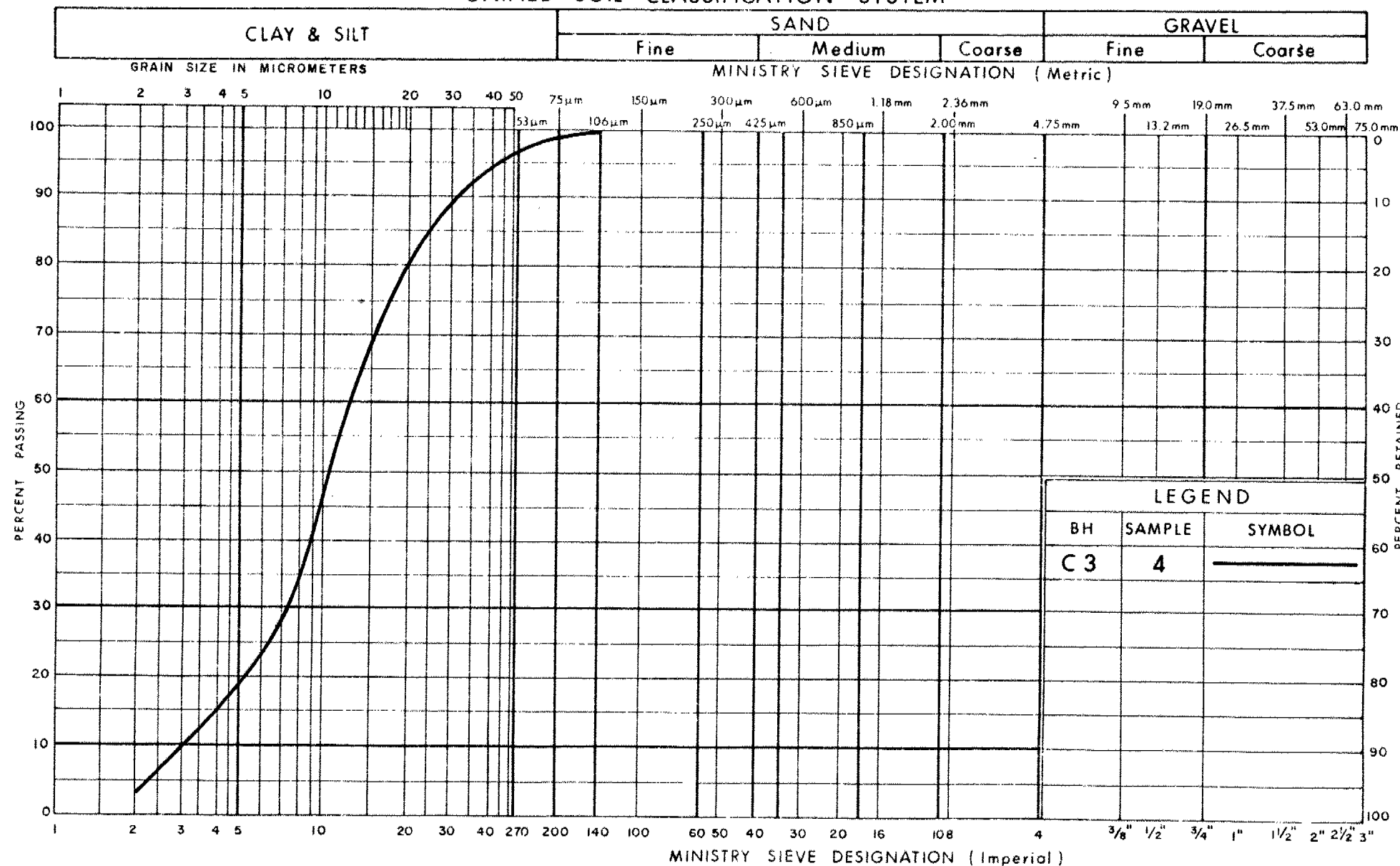
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Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
 TRACE TO WITH SAND TRACE OF GRAVEL

FIG No 2

W P 164-79-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

SAND, SOME SILT TRACE OF GRAVEL & CLAY

FIG No 3

W P 164-79-04/05

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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

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

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

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

JOINTING AND BEDDING:

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

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'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_r	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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



RECORD OF BOREHOLE No C1

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 466; E 301 738

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 12

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
190.7	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Firm												
	Very Stiff		1	SS	4								
			2	SS	19								
			3	SS	15								
	Silty Sand to Sandy Silt Compact		4	SS	13								
	Hard												
			5	SS	81								
			6	SS	80								
			7	SS	128								
181.1			8	SS	53								
9.6	End of Broehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C 2

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 591; E 301 641

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 12

CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
191.3	Ground Surface													
0.0	Silty Clay trace to with Sand trace Gravel Stiff to Very Stiff		1	SS	10		191							
			2	SS	22		190							
			3	SS	21		189							
	Silty Sand to Sandy Silt Loose		4	SS	5		188							
	Hard		5	SS	68		187							
			6	SS	128		186							
			7	SS	95		185							
			8	SS	102		184							
181.7							183							
9.6	End of Borehole						182							

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 \pm 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No C3

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 710; E 301 612

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 12

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
192.1	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Stiff to Very Stiff		1	SS	8		192						
			2	TW	PH		191						
			3	SS	18		190						7 34 41 18
	Silty Sand to Sandy Silt Compact		4	SS	15		189						0 1 97 2
	Hard		5	SS	55		188						
			6	SS	143		187						0 8 73 19
			7	SS	91		186						
			8	SS	65		185						0 1 50 49
			9	SS	70		184						
							183						
							182						
							181						
179.5			10	SS	68		180						0 1 43 56
12.6	End of Borehole												

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No C4

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 754; E 301 763

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 13

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
196.1	Ground Surface													
0.0	Silty Clay trace to with sand trace Gravel Very Stiff		1	SS	26		196							
			2	SS	28		195							
			3	SS	27		194							
			4	SS	49		193							
	Silty Sand to Sandy Silt Dense		5	SS	60		192							
	Hard		6	SS	126		191							
			7	SS	80		190							
188.4							189							
7.7	End of Borehole *groundwater level not established													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C 5

METRIC

W P 164-79-04/05 LOCATION Co-ords. N 4 849 857; E 301 597 ORIGINATED BY FS
 DIST 6 HWY 400 BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY FS
 DATUM Geodetic DATE 85 06 11 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
195.7	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Stiff		1	SS	8		195						
	Very Stiff		2	SS	25		194						
			3	SS	27		193						
	Hard		4	SS	99		192						
			5	SS	160		191						
			6	SS	38		190						
			7	SS	198		189						
187.6	End of Borehole						188						

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No C 6

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 995; E 301 695

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 13

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40					
198.9	Ground Surface													
0.0	Silty Clay trace to with Sand trace Gravel		1	SS	6									
			2	TW	PH									
			3	SS	10									
	Firm to Stiff		4	SS	13									
	Hard		5	SS	34									
			6	SS	65									
191.2	End of Borehole		7	SS	100	10cm								
7.7	*groundwater level not established													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C 7

METRIC

W P 164-79-04/05 LOCATION Co-ords. N 4 850 052; E 301 554 ORIGINATED BY FS
DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Augers, Cone Test COMPILED BY FS
DATUM Geodetic DATE 85 06 10 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
197.3	Ground Surface															
0.0	Silty Clay trace to with Sand trace Gravel Firm to Very Stiff		1	SS	7	*	197									
			2	SS	15		196									
			3	SS	22		195									
			4	SS	26		194									
	Hard		5	SS	35		193									
							192									
	Silty Sand to Sandy Silt		6	SS	131		191									
							190									
	Very Dense		7	SS	68		189									
188.3							188									
9.0	Sand some Silt trace Clay, Gravel Very Dense		8	SS	203		187									
186.4			9	SS	242 / 25cm											
10.9	End of Borehole *groundwater level not established															

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C 8

METRIC

W P 164-79-04/05 LOCATION Co-ords. N 4 850 173; E 301 521 ORIGINATED BY FS
DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Augers, Cone Test COMPILED BY FS
DATUM Geodetic DATE 85 06 10 CHECKED BY *OP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
198.1	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Very Stiff		1	SS	17		198						
			2	SS	25		197						
			3	SS	30		196						
	Hard		4	SS	34		195						
			5	SS	72		194						
			6	SS	189 / 15 cm		193						
	Silty Sand to Sandy Silt Very Dense		7	SS	120		192						
			8	SS	185		191						
189.1							190						
9.0	Sand some Silt trace Clay, Gravel						189						
188.5	Very Dense												
9.6	End of Borehole *groundwater level not established												

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No C 9

METRIC

W P 164-79-04/05 LOCATION Co-ords. N 4 850 146; E 301 637 ORIGINATED BY FS
DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY FS
DATUM Geodetic DATE 85 06 14 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						
							○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)						
							● QUICK TRIAXIAL	x LAB VANE							
198.4	Ground Surface													GR SA SI CL	
0.0	Silty Clay trace to with Sand trace Gravel Very Stiff		1	SS	19	*									
			2	SS	19										
			3	SS	25										
	Silty Sand to Sandy Silt Dense		4	SS	30										
	Hard		5	SS	40										
			6	SS	72										
			7	SS	98										
188.8			8	SS	112										
9.6	End of Borehole														
	*groundwater level not established														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C 10

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 850 297; E 301 587

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 14

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
200.0	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Firm		1	SS	7	*	199						
			2	TW	PH		198						5 29 41 25
	Hard		3	SS	37		197						
			4	SS	69		196						4 17 54 25
			5	SS	126		195						
			6	SS	105		194						1 19 55 25
							193						
192.2	Silty Sand to Sandy Silt Very Dense		7	SS	80	/15cm							
7.8	End of Borehole *groundwater level not established												


OFFICE REPORT ON SOIL EXPLORATION


+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C 11

METRIC

W P 164-79-04/05 LOCATION Co-ords N 4 850 432; E 301 498 ORIGINATED BY FS
 DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Augers, Cone Test COMPILED BY FS
 DATUM Geodetic DATE 85 06 10 CHECKED BY 

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
199.9	Ground Surface									
0.0	Silty Clay trace to with Sand trace Gravel Very Stiff ----- Hard		1	SS	17					
			2	SS	60					
			3	SS	90					
			4	SS	100					
			5	SS	88					
			6	SS	100	/15cm				
192.4	Refusal due to probable boulder End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No C 12

METRIC

W P 164-79-04/05

LOCATION N 4 849 773; E 301 323

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 10

CHECKED BY *EP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
193.2	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Very Stiff		1	SS	21		193						
			2	SS	18		192						
			3	TW	PH		191						
	Silty Sand to Sandy Silt Compact		4	SS	21		190						
	Hard		5	SS	99		189						
			6	SS	162		188						
	Silty Sand to Sandy Silt Very Dense		7	SS	224		187						
185.1	End of Borehole						186						

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No C 13

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 678; E 301 516

ORIGINATED BY FS


DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 11

CHECKED BY 

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
191.9	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Stiff to Very Stiff		1	SS	11		191						
			2	SS	28		190						
			3	TW	PH		189						
	Silty Sand to Sandy Silt Compact		4	SS	13		188						
	Hard		5	SS	54		187						
			6	SS	135		186						
			7	SS	95		185						
183.8							184						
8.1	End of Borehole												

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C 14

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 793; E 301 459

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 11

CHECKED BY

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+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No C 15

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 945; E 301 492

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 10

CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
196.2	Ground Surface														
0.0	Silty Clay trace to with Sand trace Gravel														
	Firm		1	SS	4										
			2	SS	25										
			3	TW	PH										
			4	SS	13										
	Stiff to Very Stiff														
	Hard		5	SS	110										
			6	SS	100										
			7	SS	85										
186.9			8	SS	60	/15cm									
9.3	End of Borehole														

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No C 16

METRIC

W P 164-79-04/05

LOCATION Co-ords. N 4 849 882; E 301 774

ORIGINATED BY FS

DIST 6 HWY 400

BOREHOLE TYPE Solid Stem Augers, Cone Test

COMPILED BY FS

DATUM Geodetic

DATE 85 06 13

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
197.0	Ground Surface											
0.0	Silty Clay trace to with Sand trace Gravel Very Stiff		1	SS	22		196					
	Hard		2	SS	40		195					
			3	SS	34		194					
			4	SS	68		193					
	Silty Sand to Sandy Silt Very Dense		5	SS	220	/33cm	192					
190.8			6	SS	100	/15cm	191					
6.2	End of Borehole *groundwater level not established											

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C 17

METRIC

W P 164-79-04/05 LOCATION N 4 850 028; E 301 885 ORIGINATED BY FS
 DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY FS
 DATUM Geodetic DATE 85 06 14 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
198.2	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Stiff		1	SS	8		198						
			2	SS	8		197						
	Very Stiff		3	SS	20		196						
			4	SS	28		195						
	Hard		5	SS	93		194						
			6	SS	53		193						
			7	SS	73		192						
			8	SS	42		191						
			9	SS	77		190						
185.6			10	SS	82		189						
12.6	End of Borehole						188						
							187						
							186						

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No C 18

METRIC

W P 164-79-04/05 LOCATION Co-ords. N 4 850 045; E 301 462 ORIGINATED BY FS
DIST 6 HWY 400 BOREHOLE TYPE Solid Stem Augers, Cone Test COMPILED BY FS
DATUM Geodetic DATE 85 06 10 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
195.2	Ground Surface												
0.0	Silty Clay trace to with Sand trace Gravel Stiff to Very Stiff		1	SS	12	*	195						
			2	SS	24		194						2 20 52 26
	Silty Sand to Sandy Silt Very Dense		3	SS	70		193						
	Hard		4	SS	108		192						8 16 54 22
			5	SS	46		191						
			6	SS	36		190						
			7	SS	29		189						1 11 65 23
	Silty Sand to Sandy Silt Compact		8	SS	74		188						
			9	SS	55		187						
			10	SS	70		186						4 32 49 15
182.6	End of Borehole						185						
12.6	*groundwater level not established						184						
							183						4 29 51 16

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

OFFICE REPORT ON SOIL EXPLORATION

WESTON ROAD

E 301 000

E 301 400

E 301 800

N 4 850 000

N 4 850 400

HWY 400 NBL

HWY 7

HWY 400 SBL

N 4 849 600

E 301 000

E 301 400

E 301 800

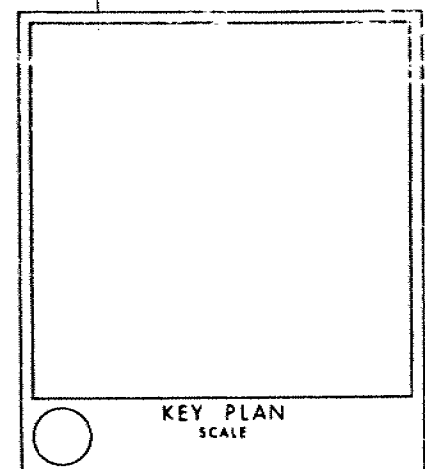
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 164-79-04/05

HWY 400 & 7
HIGH MAST LIGHTING
BORE HOLE LOCATIONS



SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & 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 85 06

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
C1	190.7	4 849 466	301 738
C2	191.3	4 849 591	301 641
C3	192.1	4 849 710	301 612
C4	196.1	4 849 754	301 763
C5	195.7	4 849 857	301 597
C6	198.9	4 849 995	301 695
C7	197.3	4 850 052	301 554
C8	198.1	4 850 173	301 521
C9	198.4	4 850 146	301 637
C10	200.0	4 850 297	301 587
C11	199.9	4 850 432	301 498
C12	193.2	4 849 773	301 323
C13	191.9	4 849 678	301 516
C14	192.2	4 849 793	301 459
C15	196.2	4 849 945	301 492
C16	197.0	4 849 882	301 774
C17	198.2	4 850 028	301 885
C18	195.2	4 850 045	301 462

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

NOTE
For Soil details refer to
Record of Borehole Sheets

PLAN
SCALE
400m 0 400m

REV	DATE	BY	DESCRIPTION

Geocres No 30M13-64

HWY No 400 & 7	DIST 6
SUBM'D D.D. CHECKED	DATE 1985 09 09
DRAWN	CHECKED

APPROVED DWG 164790405-A

memorandum



To: Mr. J. Castator
Project Supervisor
Construction Office
Central Region

Date: 1987-10-21
Central Region

RE: Contract 87-60 Hwy. 400/7 Interchange
District 6, Toronto

This will confirm the discussions we had with M. Devata and yourself at the job site on 87-10-20 with respect to the excavation for the Pier #4 footing.

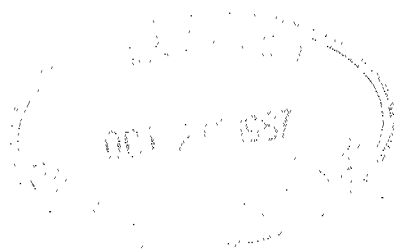
As noted in the field, the bottom of the excavation was wet and you were concerned about the placement of the reinforcing steel and subsequent concrete pour in this area. Pumping of the water from the excavation was recommended with the installation of a sump or sumps with perimeter ditching. Due to the sloughing at the north end of the excavation and seepage into the excavation, it was decided that a 3" concrete working slab may be required for a suitable working platform.

In any case, the working slab should be placed in the dry, and may have to be placed in stages because of the wetness in the area.

A handwritten signature in black ink, appearing to read "K. Pilgrim".

K. Pilgrim
Area Engineer - Structures
for:
G.C.E. Burkhardt
Head, Structural Section

KP/jf
c.c. M. Devata ✓



memorandum



Telephone: (416) 235-3731 [Ext.7102]

To: Mr. G. C. E. Burkhardt,
Head,
Structural Section,
1st floor, 5000 Yonge Street,
CENTRAL REGION

Date: 87 10 06

Att: Mr. R. Jeffries

From: Foundation Design Section,
Engineering Materials Office,
Central Building, Rm. 315

Re: High Mast Lighting
W.P. 164-79-04/05, Site 37
Hwy. #400/#7,
District #6, Toronto

Further to your request during our meeting of 87 10 06, this memo provides our recommendations for foundations for 3 re-located high mast lights at the Hwy. #400/Hwy. #7 interchange.

It is our understanding that the HML locations have been revised, during the contract, and that recommendations are urgently required in order to prevent delays to the contractor. As discussed in our meeting, in order to meet this time constraint it will be required to base our recommendations on existing borehole data.

We have reviewed the existing borehole data and in our opinion it is reasonable to apply the recommendations from the original foundation report to the new locations. However, in view of the uncertainties in the subsurface conditions, we recommend that the specified caisson depth should be 1 m deeper than the design depth.

Following is a Table illustrating the proposed HML locations and their respective original locations, also illustrated on attached Figure 1.

<u>HML #</u>	<u>Proposed Location</u>	<u>Original Location</u>
13	N 4 849 668 E 301 500	N 4 849 678 E 301 516
14	N 4 849 796 E 301 463	N 4 849 793 E 301 459
17	N 4 850 019 E 301 881	N 4 850 028 E 301 885

If there are any questions, please contact this office.

D. H. Dundas

D. H. Dundas, P. Eng.,
Sr. Foundations Engineer

memorandum



To: Mr. G. C. E. Burkhardt,
Head, Structural Section,
3rd floor, 5000 Yonge St.,
Central Region

Date: 85 11 07

Att: B. Jeffries

From: Foundation Design Section,
Room 315, Central Building,

Re: W. P. 164-79-04/05
High Mast Lighting
Engineered Fill Recommendations

Further to your conversation with L. Politano of this Section, regarding design parameters for high mast lighting in engineered fill, this memo confirms the following recommendations:

- 1) The engineered fill should consist of Granular 'A' material (95% minimum compaction).
- 2) The engineered fill should extend a minimum of 4 m from c/L of H M L base.
- 3) Design parameters for the engineered fill are:

$$\phi = 30^\circ$$
$$\gamma = 22 \text{ kN/m}^3$$

- 4) The fill above the required frost cover (1.2 m in this case) should be disregarded for calculation purposes.

If there are any questions, please contact this Section.

D. H. Dundas

D. H. Dundas, P. Eng.,
Senior Foundations Engineer

DHD:ma

memorandum

FILE



To: G.C.E. Burkhardt
Head Structural Section
Central Building

Date: 1985 07 11

Attn: R.A. Jeffries

From: Foundation Design Section
Room 315, Central Building
Downsview

Re: W.P. 164-79-04/05, Hwy 400 & Hwy 7
High Mast Lighting
Preliminary Recommendations

The fieldwork for the above-noted project has been completed. The investigation was conducted between 85-06-10 and 85-06-14 and consisted of advancing one borehole at each high-mast lighting location. The boreholes included sampling the overburden at 0.75 m intervals down to 3.5 m and at 1.5 m intervals from 3.5 m down to the end of the borehole. Boreholes ranged from 6.2 m to 12.6 m in depth.

Our final foundation investigation report will be issued in the near future. This memo outlines the preliminary recommendations pertaining to the design and construction of the high-mast light foundations. It is intended to be sufficient to allow design to proceed.

Site Description and Subsurface Conditions

The site is in the area of the existing Hwy. 400 and Hwy 7 intersection in the Regional Municipality of York. The ground surface tends to slope to the South.

In general, reasonably uniform subsurface conditions with varying insitu consistency/denseness were encountered across the site. The surficial deposit of silty clay, trace to some sand, trace gravel with silty sand seams was encountered across the site. At the south end of the site this cohesive deposit was proven to be at least 12.6 m thick. At the north end of the site the silty clay was underlain by a non-cohesive deposit of sand some silt, trace clay, trace gravel in a very dense state.

.... /2

Discussion and Recommendations

In the area around the Hwy 400 and Hwy 7 intersection it is proposed to install 18 high mast lights.

The following table indicates the location and the pole height of each installation as well as the existing and proposed ground elevations and the existing ground water level at each location.

POLE CO-ORDINATES		PROPOSED	EXISTING	GROUND	CUT (C)	POLE
		AT GROUND	GROUND	WATER	FILL(F)	HEIGHT(m)
		ELEVATION	ELEVATION	LEVEL		
C1	N4,849,466;E 301,738	190.8	190.7	190.1	0.1m(F)	30
C2	N4,849,591;E 301,641	192.2	191.3	190.7	0.9m(F)	30
C3	N4,849,710;E 301,612	194.0	192.1	189.7	1.9m(F)	30
C4	N4,849,754;E 301,763	196.2	196.1	*196.1	0.1m(F)	30
C5	N4,849,857;E 301,597	196.3	195.7	193.6	0.6m(F)	30
C6	N4,849,995;E 301,695	199.3	198.9	*198.9	0.4m(F)	30
C7	N4,850,052;E 301,554	197.4	197.3	*197.3	0.1m(F)	30
C8	N4,850,173;E 301,521	198.3	198.1	*198.1	0.2m(F)	30
C9	N4,850,146;E 301,637	199.0	198.4	*198.4	0.6m(F)	30
C10	N4,850,297;E 301,587	199.8	200.0	*200.0	0.2m(C)	30
C11	N4,850,432;E 301,498	201.8	199.9	199.6	1.9m(F)	30
C12	N4,849,773;E 301,323	193.3	193.2	192.0	0.1m(F)	30
C13	N4,849,678;E 301,516	195.9	191.9	190.9	4.0m(F)	30
C14	N4,849,793;E 301,459	197.9	192.2	191.0	5.7m(F)	30
C15	N4,849,945;E 301,492	196.4	196.2	195.5	0.2m(F)	30
C16	N4,849,882;E 301,774	197.0	197.0	197.0	—	30
C17	N4,850,028;E 301,885	198.4	198.2	196.7	0.2m(F)	30
C18	N4,850,045;E 301,462	195.4	195.2	*195.2	0.2m(F)	30

*In cases where groundwater level was not established it is assumed to be at the original ground surface.

Conventional spread footings for these light poles would likely be quite expensive. However, high mast light poles have been installed economically in many areas of North America and Europe using a design method proposed by B.B. Broms and others in which the poles are supported on a concrete caisson pile. The Structural Office has decided to adopt this same method described

by Broms in two separate papers; Broms B.B. "Lateral Resistance of Piles in Cohesive Soils", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, No. SM2, Paper 3825, March 1964.; and "Lateral Resistance of Piles in Cohesionless Soils", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, No. SM3, Paper 3909, May, 1964.

In the following paragraphs, the feasibility of constructing concrete caissons at the site is discussed and the various parameters to be used in the caisson design are provided.

Design

It should be assumed that existing or proposed fill does not provide any lateral resistance. Similarly material, (fill or native soil), in the zone of frost penetration does not provide any lateral resistance. At this site the depth of frost penetration is 1.2 m . It should be noted that all elevations and soil parameters given in the memo are based on the assumption that fill is placed at the time of construction.

For the cohesive soils located at this site, the coefficient of horizontal subgrade reaction should be computed in accordance with the following formula: (The design parameters are presented in Imperial Units, since the design example provided by the Structural Office used Imperial Units throughout.)

$$K_h = \frac{n_1 n_2 80 q_u}{D}$$

Where:

- K_h - coefficient of horizontal subgrade reaction (lb/in³)
- D - Diameter of concrete caisson pile (in)
- n_1 - coefficient as defined below:

Coefficient n_1

Unconfined Compressive Strength q_u (psi)	n_1
Less than 7	0.32
7 to 28	0.36
Greater than 28	0.40

n_2 - coefficient based on pile material = 1.15 for concrete

q_u - unconfined compressive strength (psi)

For the non-cohesive soils, K_h should be computed from the following formula:

$$K_h = n_h \frac{z}{D}$$

K_h - coefficient of horizontal subgrade reaction (tons/ft³)

z - depth below ground surface (ft.)

D - diameter of caisson (ft)

n_h - Coefficient evaluated as follows:

Coefficient n_h in tons/ft³

Relative Density	Loose	Compact	Dense
Above Groundwater table	7	21	56
Below Groundwater table	4	14	34

The following soil parameters are recommended for the design of the high-mast light caisson:

(note: ϕ = apparent angle of internal friction for non-cohesive soils

q_u = unconfined compressive strength in psi

($q_u = 2c_u$)

= unit weight in pcf

Pole	Elev.(m) From-to	Type of Soil	ϕ	q_u psi	p_u t/ft ²	pcf
C-1	190.8-190.7	fill	0	0	0	-
	190.7-189.6	cohesive	0	0	0	-
	189.6-189.3	cohesive	0	6	0.43	115
	189.3-187.0	cohesive	0	25	1.8	120
	187.0-181.1*	cohesive	0	60	4.32	130
C-2	192.2-191.3	fill	0	0	0	-
	191.3-191.0	cohesive	0	0	0	-
	191.0-187.6	cohesive	0	25	1.8	120
	187.6-181.7*	cohesive	0	60	4.32	130
C-3	194.0-192.1	fill	0	0	0	-
	192.1-188.5	cohesive	0	12	0.86	115
	188.5-179.5*	cohesive	0	60	4.32	130
C-4	196.2-196.1	fill	0	0	0	-
	196.1-195.0	cohesive	0	0	0	-
	195.0-192.5	cohesive	0	42	3.02	125
	192.5-188.4*	cohesive	0	60	4.32	130
C-5	196.3-195.7	fill	0	0	0	-
	195.7-195.1	cohesive	0	0	0	-
	195.1-194.4	cohesive	0	12	0.86	115
	194.4-192.8	cohesive	0	42	3.02	125
	192.8-187.6*	cohesive	0	70	5.04	130

Pole	Elev.(m) From-to	Type of Soil	ϕ	q_u psi	p_u t/ft ²	pcf
C-6	199.3-198.9	fill	0	0	0	-
	198.9-198.1	cohesive	0	0	0	-
	198.1-195.2	cohesive	0	12	0.86	115
	195.2-191.2*	cohesive	0	53	3.82	130
C-7	197.4-197.3	fill	0	0	0	-
	197.3-196.2	cohesive	0	0	0	-
	196.2-193.3	cohesive	0	33	2.38	125
	193.3-191.3	cohesive	0	51	3.67	130
	191.3-186.4*	non-cohesive	35°	0	0	130
C-8	198.3-198.1	fill	0	0	0	-
	198.1-197.1	cohesive	0	0	0	-
	197.1-195.2	cohesive	0	42	3.02	125
	195.2-189.1	cohesive	0	54	3.89	130
	189.1-188.5*	non-cohesive	35°	0	0	130
C-9	199.0-198.4	fill	0	0	0	-
	198.4-197.8	cohesive	0	0	0	-
	197.8-194.8	cohesive	0	33	2.38	125
	194.8-188.8*	cohesive	0	55	3.96	130
C-10	200.0-199.8	cut	-	-	-	-
	199.8-198.6	cohesive	0	0	0	-
	198.6-197.9	cohesive	0	12	0.86	115
	197.9-192.2*	cohesive	0	56	4.03	130
C-11	201.8-199.9	fill	0	0	0	-
	199.9-198.5	cohesive	0	28	2.02	120
	198.5-192.4*	cohesive	0	61	4.39	130
C-12	193.3-193.2	fill	0	0	0	-
	193.2-192.1	cohesive	0	0	0	-
	192.1-189.6	cohesive	0	33	2.38	125
	189.6-185.1*	cohesive	0	70	5.04	130

Pole	Elev.(m) From-to	Type of Soil	ϕ	q_u psi	P_u t/ft ²	pcf
C-13	195.9-191.9	fill	0	0	0	-
	191.9-188.2	cohesive	0	25	1.8	120
	188.2-183.8*	cohesive	0	61	4.39	130
C-14	197.9-192.2	fill	0	0	0	-
	192.2-189.4	cohesive	0	25	1.8	120
	189.4-184.4*	cohesive	0	70	5.04	130
C-15	196.4-196.2	fill	0	0	0	-
	196.2-195.2	cohesive	0	0	0	-
	195.2-194.9	cohesive	0	6	0.43	115
	194.9-192.2	cohesive	0	33	2.38	125
	192.2-186.9*	cohesive	0	70	5.04	130
C-16	197.0-195.8	cohesive	0	0	0	-
	195.8-195.6	cohesive	0	33	2.38	125
	195.6-190.8*	cohesive	0	52	3.74	130
C-17	198.4-198.2	fill	0	0	0	-
	198.2-197.2	cohesive	0	0	0	-
	197.2-196.1	cohesive	0	12	0.86	115
	196.1-194.1	cohesive	0	42	3.02	125
	194.1-185.6*	cohesive	0	61	4.39	130
C-18	195.4-195.2	fill	0	0	0	-
	195.2-194.2	cohesive	0	0	0	-
	194.2-192.3	cohesive	0	25	1.8	120
	192.3-182.6	cohesive	0	54	3.89	130

*If deeper caissons are required please contact the Foundation Design Section.

If you have any questions regarding this matter please contact the undersigned.

D.H. Dundas

D.H. Dundas, P. Eng.

Foundation Engineer

for

M.S. Devata, P. Eng.

Chief Foundation Engineer

(East)

DHD/MD/pet