

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-192
~~80M12-186~~

DIST. 6 REGION

W.P. No. 54-82-04/108

CONT. No. 86-67

W. O. No.

STR. SITE No. 214-81-188

HWY. No. 401

LOCATION First Line East

High Mast Lighting

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-67



Ministry of
Transportation and
Communications

I N D E XPAGE NO.

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NOTE: For the purposes of this contract, these reports supersede all other foundation reports prepared by or for the Ministry in connection with the above-noted projects.

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 (R Q D), 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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_a	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 = $\frac{c_u}{\tau_r}$

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

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^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

FOR

W.P. 54-82-04; Site N/A

High Mast Lighting (Hwy. 10 to Hwy. 410)

Hwy. 401, District 6, TorontoINTRODUCTION

This report summarizes the foundation investigation required for the above-noted high mast lighting.

The fieldwork was conducted between 85 11 15 and 85 11 21 utilizing a continuous flight auger machine equipped with solid-stem augers, N casing and B core barrels.

This work consisted of advancing sampled boreholes at or near all proposed high mast light locations (C1 to C10).

SITE DESCRIPTION

These high mast lights are located along Hwy. 401 between Hwy. 410 and Hwy. 10.

According to Chapman and Putnam (1984), the site lies within the 'Peel Plain' physiographic area. In this area it is characterized by a relatively level area of shallow overburden overlying shale bedrock.

SUBSURFACE CONDITIONSGeneral

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations (refer to BH #C1 to BH #C10). The general locations of the high mast lights C1 to C10 are illustrated on Figures 1A & 1B while specific locations are indicated in Table 1.

STRATIGRAPHYOverburden

The overburden is generally silty clay of low plasticity, containing variable amounts of sand and gravel and occasional shaly zones.

Based on 'N' values, the material varies from very soft to hard but is generally stiff to hard.

The thickness of the overburden is variable ranging from 0.6 m to 4.6 m.

Bedrock

Detailed descriptions of the bedrock core samples are provided in Tables 2A and 2B.

At locations C1, C2, C3 and C4, the bedrock is shale of the Queenston Formation.

At locations C5, C6, C7, C8, C9 and C10, the bedrock is shale and limestone of the Georgian Bay Formation.

Groundwater Conditions

At the time of the field investigation, the groundwater elevation at the borehole locations was at or near the surface.



D. H. Dundas

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

M. Devata

M. Devata, P. Eng.,
Chief Foundations Engineer
(East)

APPENDIX

FIGURE 1B W.P. 54-82-04

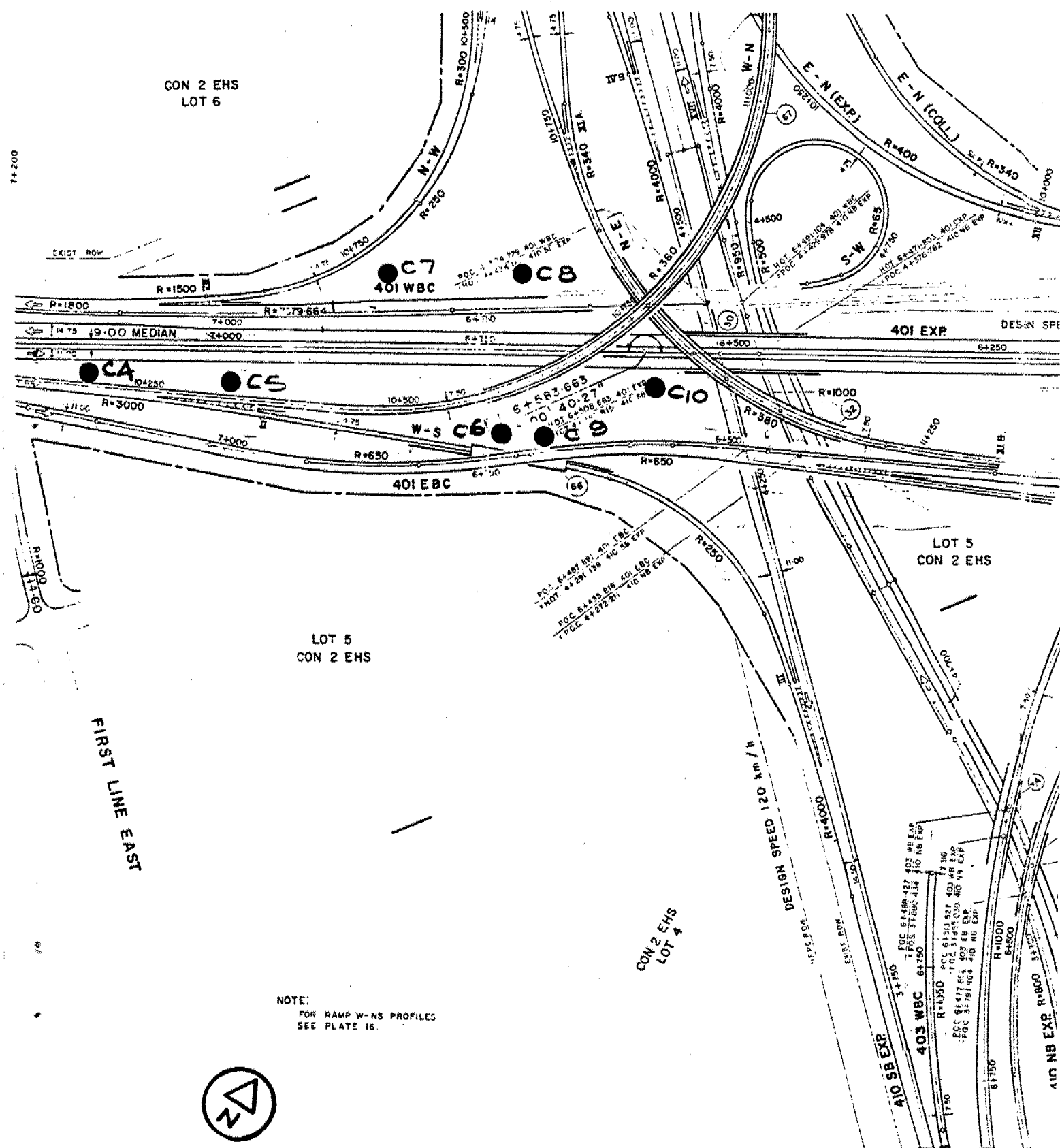


TABLE 1

W.P. 54-82-04

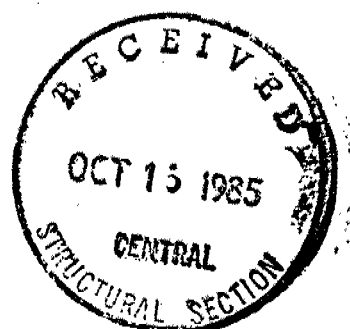


HIGHWAY 401 HIGH-MAST POLE ELEVATIONS

<u>Pole No.</u>	<u>Coordinates</u>		<u>Existing Elevation</u>	<u>Ultimate* Elevation</u>
	<u>Northing</u>	<u>Easting</u>		
C1	4832488.9	290713.7	192.5	192.5
C2	4832563.7	290880.1	193.7	193.7
C3	4832611.2	291080.5	191.3	191.3
C4	4832699.5	291263.5	188.8	188.1
** C5	4832765.6	291411.9	185.8	185.8
C6	4832794.2	291574.8	183.9	183.9
C7	4832930.4	291504.9	184.5	184.5
C8	4833007.7	291623.4	184.2	184.2
C9	4832873.5	291696.8	184.6	184.1
C10	4832979.3	291781.8	184.0	184.0

* Ultimate elevations are based on Preliminary Design Report and are, therefore, subject to change during detailed design stage.

** Location of Pole #C5 has been revised.



W.P. 54-82-04
File: 16-82100

October 15, 1985

SWA:jg

DESCRIPTION OF ROCK CORE - W.P.

54-82-04

TABLE 2A

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
C1	4.98-6.50	93	0	4.98-6.50	SHALE (95%) red and green, moderately weathered, very closely spaced joints, with SILTSTONE (5%) in 3cm-5cm layers. SHALE (95%) red and green, unweathered, closely spaced joints with SILTSTONE (5%) in 3cm-5cm layers.
	-8.03	95	68	6.50-8.03	
C2	1.68-3.07	44	0	1.68-6.40	SHALE (95%) red and green, moderately to highly weathered, very high core losses, with SILTSTONE (5%) in 2.5cm-10.2cm layers. SHALE (95%) red and green, slightly weathered, closely spaced joints, with SILTSTONE in 3cm-5cm layers.
	-4.70	36	0		
	-6.07	28	0	6.40-7.49	
	-7.49	88	39		
C3	5.21-6.73	48	10	5.21-6.25	SHALE (95%) red and green, highly weathered, high core loss. SHALE (50%) red and green, unweathered, closely spaced joints with limestone (50%) in 5cm-20cm layers.
	-8.26	95	48	6.25-8.26	

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 54-82-04 TABLE 2B

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
C5	4.11-5.64m	74	67	4.11-4.62	SHALE with limestone pieces, highly weathered; very high core loss
	-7.16m	100	75	4.62-7.16m	SHALE (50%) grey, unweathered, medium spaced joints with LIMESTONE (50%) grey, unweathered up tp 45cm thick
C7	1.98-3.01	43	0	1.98-2.67	SHALE and LIMESTONE moderately weathered becoming slightly weathered with depth very high core loss zone
	-4.37	60	12		
	-5.89	83	28	2.67-5.89	SHALE (50%) grey, slightly weathered with moderately weathered zones, with LIMESTONE (50%), unweathered, in up to 23cm layers
C9	2.92-4.44	78	0	2.92-3.73	SHALE, moderately to highly weathered (high core loss) with limestone in up to 10cm layers
	-6.10	98	35	3.73-6.10	SHALE (80%) slightly weathered to unweathered, closely spaced joints with LIMESTONE (20%) in up to 15cm layers.

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

RECORD OF BOREHOLE No C-1

METRIC 11

W P 54-82-04 LOCATION Co-ords: N 4832488.9; E 290713.7 ORIGINATED BY BD
 DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY DD
 DATUM GEODETIC DATE 85 11 21-22 CHECKED BY DD

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					
192.5	GROUND SURFACE													
0.0						*								
	trace organics		1	SS	11									
			2	SS	25									
	Silty Clay (CL) trace/some sand trace gravel occ. shaly zones firm to hard		3	SS	65									
			4	SS	129/20cm									
			5	SS	85/10cm									
187.9			6	SS	85/8cm									
4.6														
	weathered sound		7	RC	REC 92%									
	Bedrock Shale Queenston Formation		8	RC	REC 97%									
184.4														
8.1	END OF BOREHOLE													
	*groundwater elevation not determined													



RECORD OF BOREHOLE No C-2

METRIC

12

W P 54-82-04 LOCATION Co-ords: N 4832563.7; E 290880.1 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 18 CHECKED BY DD

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								
193.7	GROUND SURFACE												
0.0	Probable Silty Clay (CL) **												
193.1													
0.6			1	SS	84								
			2	SS	106/	20cm							
			3	RC	REC 51%								
			4	RC	REC 38%								
	Bedrock Shale Queenston Formation		5	RC	REC 30%								
			6	RC	REC 86%								
	Weathered Sand												
186.2													
7.5	END OF BOREHOLE												
	*Groundwater elevation not determined												
	**trace/some sand trace gravel soft to firm												



RECORD OF BOREHOLE No C-3

METRIC 13

W P 54-82-04 LOCATION Co-ords: N 4832611.2; E 291080.5 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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							
191.3	GROUND SURFACE											
0.0						*	191					
	With Organics		1	SS	11		190					
	Silty Clay (CL) Trace/Some Sand Occ. Shaly Zones Trace Gravel Stiff to Hard		2	SS	26		189					
188.7			3	SS	88	10cm	188					
2.6			4	SS	100	15cm	187					
			5	SS	106	15cm	186					
			6	SS	110	15cm	185					
			7	RC	REC 50%		184					
	Weathered Sound											
	Bedrock Shale Queenston Formation		8	RC	REC 95%							
183.0												
8.3	END OF BOREHOLE											
	*Groundwater elevation not determined											

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-4

METRIC 14

W P 54-82-04 LOCATION Co-ords: N 4832699.5; E 291263.5 ORIGINATED BY BD
 DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
 DATUM GEODETIC DATE 85 11 20 CHECKED BY BD

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					
188.8	GROUND SURFACE													
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Very Stiff to Hard		1	SS	85/15	cm								
			2	SS	125	23cm								
186.4			3	SS	90	13cm								
2.4	Probable Bedrock Shale, Weathered Queenston Formation													
185.8														
3.0	END OF BOREHOLE													

+3, x5: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No C-5

METRIC 15

W P 54-82-04 LOCATION Co-ords: N 4832765.6; E 291411.9 ORIGINATED BY BD
 DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
 DATUM CEODETIC DATE 85 11 20 CHECKED BY BD

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									
185.8	GROUND SURFACE													
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Occ. Shaly Zones Very Stiff to Hard		1	SS	33									
			2	SS	43									
			3	SS	100	8cm								
182.9			4	SS	100	10cm								
2.9	Weathered Sound Bedrock Shale and Limestone Georgian Bay Formation		5	RC	REC 70%									
			6	RC	REC 98%									
178.6	END OF BOREHOLE													
7.2	*Groundwater elevation not determined													



RECORD OF BOREHOLE No C-6

METRIC

16

W P 54-82-04 LOCATION Co-Order: N 4832794.2; E 291574.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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								
183.9 0.0	GROUND SURFACE					*							
	Silty Clay (CL) Some Sand Trace Gravel Hard		1	SS	54		183						
182.5 1.4	END OF BOREHOLE *Groundwater elevation not determined Probable bedrock at 1.4 m Shale and Limestone Georgian Bay Formation Weathered												

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No C-7

METRIC 17

W P 54-82-04 LOCATION Co-ords: N 4832930.4; E 291504.9 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
184.5	GROUND SURFACE										
0.0											
	Silty Clay (CL) Trace/Some Sand Trace Gravel Hard		1	SS	51						
182.5			2	SS	39						
2.0			3	RC	REC 48%						
	Bedrock Shale and Limestone Georgian Bay Formation		4	RC	REC 69%						
			5	RC	REC 90%						
178.6	Weathered Sound										
5.9	END OF BOREHOLE										



RECORD OF BOREHOLE No C-8

METRIC 18

W P 54-82-04 LOCATION Co-ords: N 4833007.7; E 291623.4 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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						
184.2	GROUND SURFACE										
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Soft to Hard Occ. Shaly Zones		1	SS	7		184				
			2	SS	5		183				
			3	SS	100	8cm	182				
181.3	END OF BOREHOLE										
2.9	*Groundwater elevation not determined Probable Bedrock at 2.9 m depth Georgian Bay Formation Weathered										

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-9

METRIC 19

W P 54-82-04 LOCATION Co-ords: N 4832873.5; E 291696.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 20/21 CHECKED BY BD

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					
184.6	GROUND SURFACE													
0.0														
	Silty Clay (CL) with Sand and Gravel Very soft to firm		1	SS	4									
			2	SS	10									
182.6			3	SS	70	/10cm								
2.0			4	RC	Rec 90%									
	weathered sound													
	Bedrock Shale and Limestone Georgian Bay Formation		5	RC	Rec 95%									
178.5														
6.1	END OF BOREHOLE													
	*Groundwater elevation not determined													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No C-10

METRIC 20

W P 54-82-04 LOCATION Co-ords: N 4832979.3; E 291781.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 21 CHECKED BY BD

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						
184.0 0.0	GROUND SURFACE										
	Silty Clay (CL) Some sand Trace gravel Firm		1	SS	7		183				
	Silty Sand Trace Gravel Loose to Very Dense		2	SS	96	28cm	182				
181.7 2.3	END OF BOREHOLE Probable Bedrock Shale and Limestone Georgian Bay Formation Weathered										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

FOUNDATION INVESTIGATION REPORT

For

W. P. 54-82-05; Site: 81-181
Hwy. #401 Underpass at First Line East
Hwy. #401, District 6, Toronto

INTRODUCTION

Dominion Soil Investigation Inc., Consulting Geotechnical Engineers, were retained by the Ontario Ministry of Transportation and Communications to conduct a foundation investigation at the site of a proposed bridge replacement at Highway 401 and First Line East (Kennedy Road) intersection in Mississauga, Ontario. Authorization to carry out the work was received from Mr. M.S. Devata, Senior Foundations Engineer, Pavement and Foundation Design Section of the Ministry.

The purpose of the investigation was to determine the subsoil conditions at the site; to define the engineering properties of the substrata; to make recommendations pertaining to the design of the foundations of the proposed structure and to comment on the anticipated construction conditions.

The field work was carried out during the period of August 29 to September 7, 1983, and consisted of drilling twelve boreholes to depths ranging between 1.6 and 8.5 m. The location of the boreholes are shown on Drawing No. 548205-A* and the subsurface conditions encountered are presented on the Record of Borehole Sheets.

* NOTE: Refer to Drawing No. 2 and No. 2A of the Contract Drawings.

SUMMARIZED SUBSOIL CONDITIONS

The boreholes that were drilled through the shoulder of the existing road encountered up to 6 m of fill. Below the fill and/or topsoil the subsoil generally consists of silty clay till changing to 'till-shale' complex and is underlain by a reddish highly weathered bedrock at relatively shallow depths.

Details of the subsurface conditions encountered in the boreholes are given on the individual Record of Boreholes, and inferred subsoil profiles are presented on Drawing No. 548205-A. *

The relevant index and engineering properties of the principal strata are briefly discussed in the following paragraphs.

Fill

Boreholes 5 and 6 were drilled from the median of Highway 401 and encountered below an asphalt and concrete layer, granular fill extending to about 0.8 m below the ground surface.

Boreholes 1, 3, 7, 9 and 11 were drilled through the shoulder of the existing Kennedy Road embankment and encountered fill extending 3.0 (B.H. 11) to 6.1 m (B.H. 3) below the ground surface. The composition of the fill generally consists of silty clay with some sand and gravel and is similar in composition to the indigenous till. The grain size distribution of a sample from the fill is presented on Figure 1 indicating 5% gravel, 56% sand, 25% silt and 14% clay size particles.

* NOTE: Refer to Drawing No. 2 and 2A of the Contract Drawings.

The following index properties were measured in the laboratory:

Liquid Limit	25 - 35%
Plastic Limit	11 - 15%
Plasticity Index	14 - 20
Moisture Content	13 - 21%

These values are characteristics of clayey soils of low plasticity.*

Pockets or zones of organic material were also found included in the fill.

From 'N'-values ranging between 5 and 32 blows/0.3 m the fill is considered to be firm to hard and unevenly compacted.

Organic Silty Clay

Underlying the embankment fill in Boreholes 1, 7 and 9 a 0.4 to 0.7 m thick organic silty clay layer was encountered. Due to the organic content this material could be expected to be relatively weak and compressible but the recorded Standard Penetration Indices of 21 and 38 and the relatively low moisture contents of 22%, indicate that the material has already been considerably compressed under the weight of the embankment fill.

Silty Clay Till

The natural subsoil below the fill or a thin veneer of topsoil is a reddish brown silty clay till. The till is a well graded mixture of a wide range of particle sizes and as shown on Figure 2, it consists of 6 to 9% gravel, 35 to 38% sand, 38 to 40% silt and 13 to 21% clay size particles.

*NOTE: Refer to Figure 4, Appendix.

An Atterberg Test gave the following values:

Liquid Limit	25%
Plastic Limit	15%
Plasticity Index	10
Moisture Content	13 to 16%

These values indicate clayey soils of low plasticity and the fact that the natural moisture contents are generally at or below the Plastic Limit suggests high strength and low compressibility.* From 'N'-values of 32 blows/0.3 m and greater, the till is considered to be hard.

At the borehole locations the till is generally 1 to 2.5 m thick and with increasing depth the frequency of shale content in the till increases. The material at greater depths resembles a highly weathered shale with pockets of till material. This zone can be best described as a 'till-shale complex' and is indicated on the borehole log sheets as zones with "frequent shale fragments". The grain size distribution of a sample from this material is given in Figure 3, indicating 12% gravel, 46% sand, 31% silt and 11% clay size particles. Laboratory tests showed a Liquid Limit of 28 - 34%, Plastic Limit of 15 - 19% with a corresponding plasticity index of 13 - 15 indicating a clayey soil of low plasticity. The measured moisture contents ranged from 8 - 14%.

From 'N'-values of 36 to generally more than 100 blows/0.3 m, the consistency of the 'till-shale complex' is described as hard. Some

*NOTE: Refer to Figure 5, Appendix.

of the boreholes were terminated within this material after penetrating it a short distance. At the boreholes where this zone was fully penetrated, it was 0.5 to 2 m thick and was underlain by the shale bedrock.

Shale Bedrock

The site is located close to the interface of reddish Queenston and greyish Dundas shale formations and the depth to the surface of the bedrock in the area is known to be generally shallow.

In the majority of the boreholes shale bedrock was encountered at a depth of 1.5 to 8.0 m below the ground surface between Elevations 191.1 and 189.2 m. In some of the boreholes, the rock was penetrated a short distance by augering and in six of the boreholes NXL size cores were recovered by diamond drilling. In these boreholes the rock was penetrated for a vertical distance of 1.9 to 4.0 m. The core recovery ranged from 86 to 100% and the examination of the recovered samples and cores indicates that the bedrock within the depths explored, is a weathered to highly weathered, closely bedded, reddish shale. The shale, identified as belonging to the Queenston Formation, contains some grey limestone and frequent greyish shale bands. R.Q.D. values ranging from 0 to 85% (generally less than 50%) indicate a rock of generally poor quality.

GROUNDWATER CONDITIONS

The groundwater conditions in the boreholes were observed during the drilling. After their completion, where feasible, the boreholes were left open and water levels in the open boreholes were re-checked approximately three weeks thereafter. The recorded values are presented on the individual Record of Borehole Sheets.

Based on these observations, it is our opinion that the groundwater level at the time of the investigation was generally between Elevations 191 and 190 m.

NOTE: The preceding report is a copy of the factual information from the Foundation Investigation Report prepared by Dominion Soil Investigation Inc. (consulting geotechnical engineers for this project), under the technical supervision of the MTC Foundation Design Section.



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



M. Devata, P. Eng.,
Chief Foundations Engineer
(East)

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,735N; 291,132E ORIGINATED BY H.C.
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
DATUM GEODETTIC DATE 1983.09.01 CHECKED BY I.P.L.

[illegible]

+3, x5: Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,746N; 291,149E ORIGINATED BY H.C.
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER AND NXL ROCK CORE COMPILED BY F.L.
DATUM GEODETIC DATE 1983.08.29 CHECKED BY I.P.L.

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
192.6	Ground Level																
0.0	0.23 m Topsoil																
	Brown, hard Silty clay till		1	SS	46		192										
			2	SS	75/ 0.5 m		191										
	----- Frequent shale fragments Reddish		3	SS	70/ 0.15m		190										
189.9																	
2.7	Reddish Shale, some greyish shale and limestone seams		4	RC NXL	100%		189										
			5	RC NXL	100%		188										
187.0																	
5.6	End of Borehole																

Augering
↓
Diamond
Drilling

Borehole dry
on complet-
ion of
augering.
Wet cave @
1.6 m Sept.
20/83.

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

METRIC

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity



RECORD OF BOREHOLE No 4

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,723N; 291,175E
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER AND NXL ROCK CORE
DATUM GEODETIC DATE 1983.08.29 and 1983.09.01
ORIGINATED BY H.C.
COMPILED BY F.L.
CHECKED BY I.P.L.

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					
191.5	Ground Level																
0.0	0.12 m Topsoil																
	Reddish Silty clay till		1	SS	34		191										
	Stiff to Hard																
	Hard		2	SS	75	0.10m	190										
	Frequent Shale fragments																
189.4			3	SS	70	0.10m	189										
2.1	Reddish Shale some greyish shale and limestone seams		4	RC NXL	90%		188										
			5	RC NXL	100%		187										
185.9							186										
5.6	End of Borehole																

Augering
↑
↓
Diamond
Drilling

Borehole dry
on complet-
ion of
augering.

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,692N; 291,181E ORIGINATED BY H.C.
 DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
 DATUM GEODETIC DATE 1983.09.07 CHECKED BY I.P.L.

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					
190.9	Ground Level																
0.0	75 mm Asphalt 175 mm Concrete Sandy gravel (Fill)																
190.1																	
0.8	Reddish, hard Silty clay till, with shale fragments		1	SS	70		190										
			2	SS	50/	0.12m											
189.3																	
1.8	Reddish Shale some greyish shale and limestone seams						189										
			3	RC NXL	93%		188										
			4	RC NXL	86%		187										
			5	RC NXL	100%		186										
185.1																	
5.8	End of Borehole																

Augering

↓
Diamond
Drilling

Borehole dry
on complet-
ion of
augering.

+3, x⁴: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

METRIC

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 7

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,663N; 291,203E
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER
DATUM GEODETIC DATE 1983.08.30
ORIGINATED BY H.C.
COMPILED BY F.L.
CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
197.5	Ground Level													
0.0	0.1 m Topsoil						197							
			1	SS	11									
	Sandy		2	SS	15		196							
	Grey/brown/dk.grey Silty clay, with some gravel, traces of organic pockets (Fill)		3	SS	5		195							
			4	SS	5									
							194							
			5	SS	17									
							193							
			6	SS	24									
							192							
191.7			7	SS	49									
5.8	Dark grey/black Organic silty clay													
191.0	V.stiff		8	SS	38		191							
6.5	Reddish, hard Silty clay till with traces of organics													
190.1	Frequent shale frag- ments		9	SS	126	0.12m								Borehole dry on complet- ion
7.4	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,675N; 291,224E
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER AND NXL ROCK CORE
DATUM GEODETIC DATE 1893.08.29 and 1983.08.31
ORIGINATED BY H.C.
COMPILED BY F.L.
CHECKED BY I.P.L.

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					
192.0	Ground Level																
0.0	0.05 m Topsoil																
	Reddish, hard Silty clay till, with shale fragments		1	SS	106		191										
			2	SS	50/	0.15m											
190.0							190										
2.0	Reddish Shale, some greyish shale and limestone seams		3	SS	75/	0.07m											
	Very highly weathered zone		4	RC NXL	93%		189										
			5	RC NXL	90%		188										
							187										
186.3																	
5.7	End of Borehole																

Augering
↑
Diamond
Drilling

Borehole dry
on complet-
ion of aug-
ering.
W.L. @ 1.8m
& hole caved
in @ 2.7m
Sept.20/83

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 9

METRIC

W P 54-82-05 LOCATION CO.ORDS. 4,832,637N; 291,227E
 DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER
 DATUM GEODETIC DATE 1983.08.30
 ORIGINATED BY H.C.
 COMPILED BY F.L.
 CHECKED BY I.P.L.

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					
196.3	Ground Level																
0.0	Gravelly sand (Fill)						196										Encountered boulder at 1.1 m. Borehole re- located 1.5m north and re-drilled
195.7																	
0.6	Sandy		1	SS	5/	0.15m											
	Red/brown/dk.brown Silty clay, with some sand and gravel (Fill)		2	SS	12		195										
			3	SS	22		194										
			4	SS	18		193										
192.6																	
3.7	Dark grey/black Stiff Organic silty clay		5	SS	21		192										
192.2																	
4.1	Some organics																
	Greyish, hard Silty clay till		6	SS	60		191										6 36 38 20
	Frequent shale frag- ments Reddish		7	SS	89												Borehole dry on complet- ion. Water level @ 3.5m & B.H. caved in @ 3.8 m Sept. 20/83
190.1			8	SS	80/	0.10m											
6.2	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 10

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,645N; 291,251E ORIGINATED BY H.C.
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER AND NXL ROCK CORE COMPILED BY F.L.
DATUM GEODETIC DATE 1983.08.29 and 1983.08.31 CHECKED BY I.P.L.

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			SHEAR STRENGTH									
								○ UNCONFINED	+ FIELD VANE								
						● QUICK TRIAXIAL	x LAB VANE	WATER CONTENT (%)									
194.7	Ground Level																
0.0	0.15 m Topsoil																
	V.stiff Hard		1	SS	32		194										
	Reddish Silty clay till		2	SS	56		193										
	Frequent shale frag- ments		3	SS	86		192										
			4	RC NXL	59%												
191.1																	
3.6	Very highly weathered		5	RC NXL	92%		191										
	Reddish shale, some greyish shale & limestone seams		6	RC NXL	100%		190										
189.2																	
5.5	End of Borehole																

Augering

Diamond
Drilling

Borehole dry
on complet-
ion of
augering.
W.L. @ 4.3m
& borehole
caved-in @
4.9 m

Sept.20/83

Augering

Diamond
Drilling

Borehole dry
on complet-
ion of
augering.
W.L. @ 4.3m
& borehole
caved-in @
4.9 m
Sept. 20/83

+3, x5: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 11

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,609N; 291,254E ORIGINATED BY H.C.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.08.30 CHECKED BY I.P.L.

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
194.5	Ground Level																
0.0	0.05m Topsoil																
194.0	Gravelly sand (Fill)						194										
0.5	Reddish/brown/dry Silty clay, with some sand and gravel (Fill)		1	SS	9												
			2	SS	8		193										
			3	SS	11		192										
191.5	Layered Silty clay V. stiff Hard		4	SS	42												
			5	SS	75		191										
	Greyish Silty clay till																
	Frequent shale frag- ments																
189.9	Reddish		6	SS	70/	0.15m	190										Borehole dry on complet- ion.
4.6	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No 12

METRIC

W P 54-82-05 LOCATION CO-ORDS. 4,832,616N; 291,268E ORIGINATED BY H.C.
 DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER AND NXL ROCK CORE COMPILED BY F.L.
 DATUM GEODETIC DATE 1983.08.29 and 1983.08.31 CHECKED BY I.P.L.

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					
193.3	Ground Level															GR SA SI CL
0.0	0.15 m Topsoil															
	Reddish, hard Silty clay till, with shale fragments		1	SS	36											
			2	SS	39											
			3	SS	95/	0.23m										
190.4																
2.9	Reddish Shale, some greyish shale and limestone seams		4	RC NXL	100%											
			5	RC NXL	100%											
187.5																
5.8	End of Borehole															

Augering

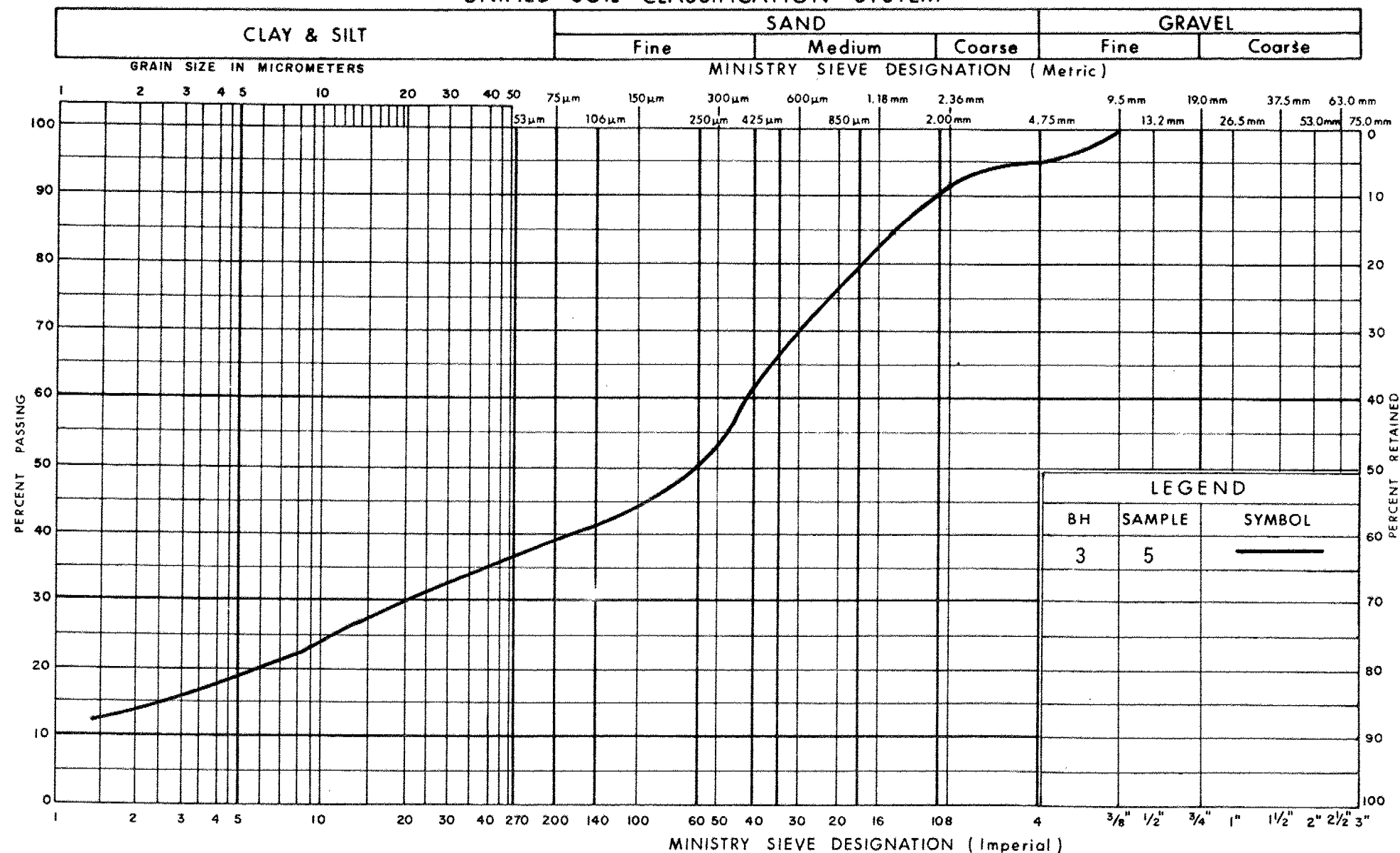
 Diamond
Drilling

Borehole dry
on complet-
ion of
augering.

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

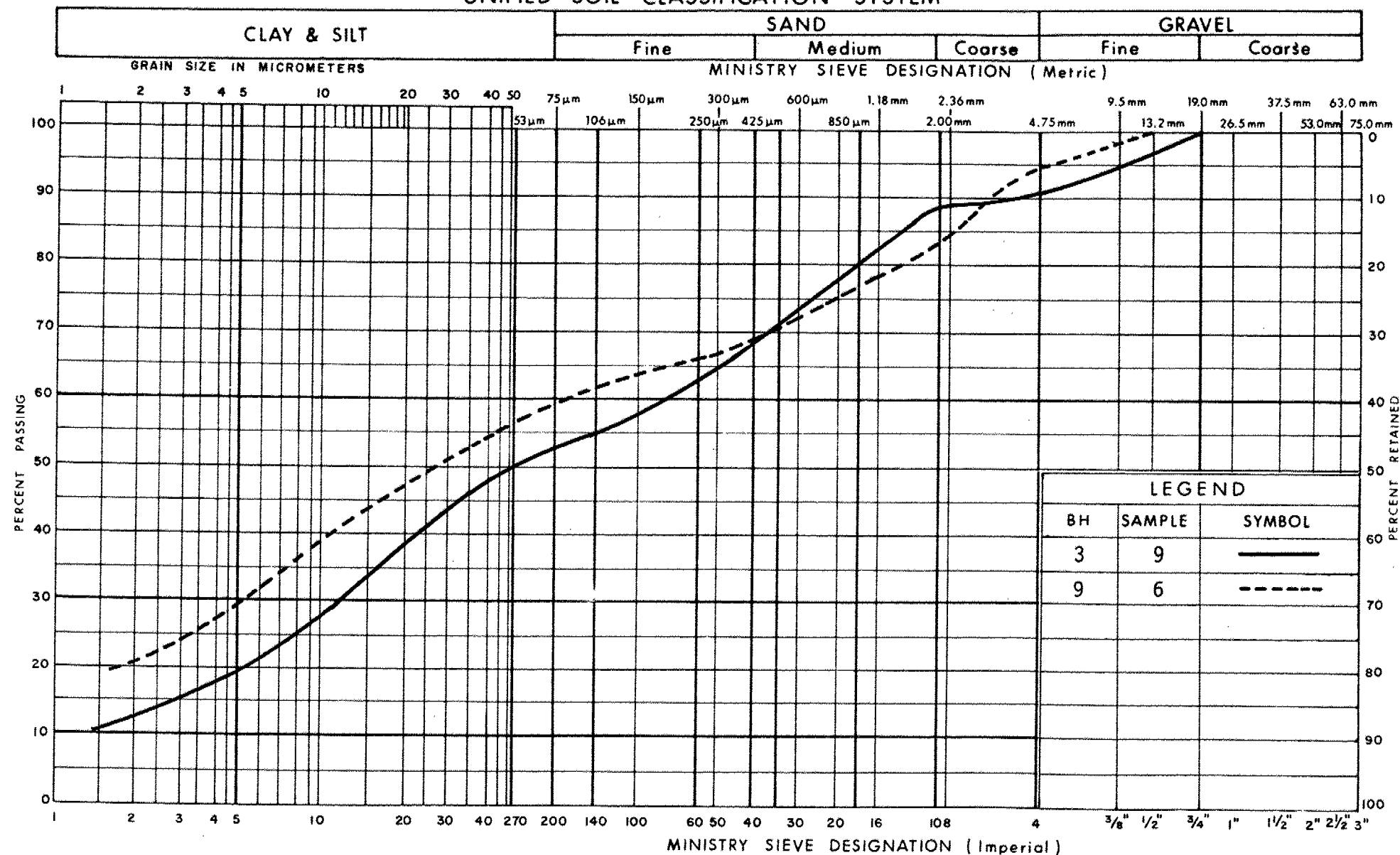
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
 SILTY CLAY with some Sand & traces of gravel (FILL)

FIG No 1

W P 54-82-05

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

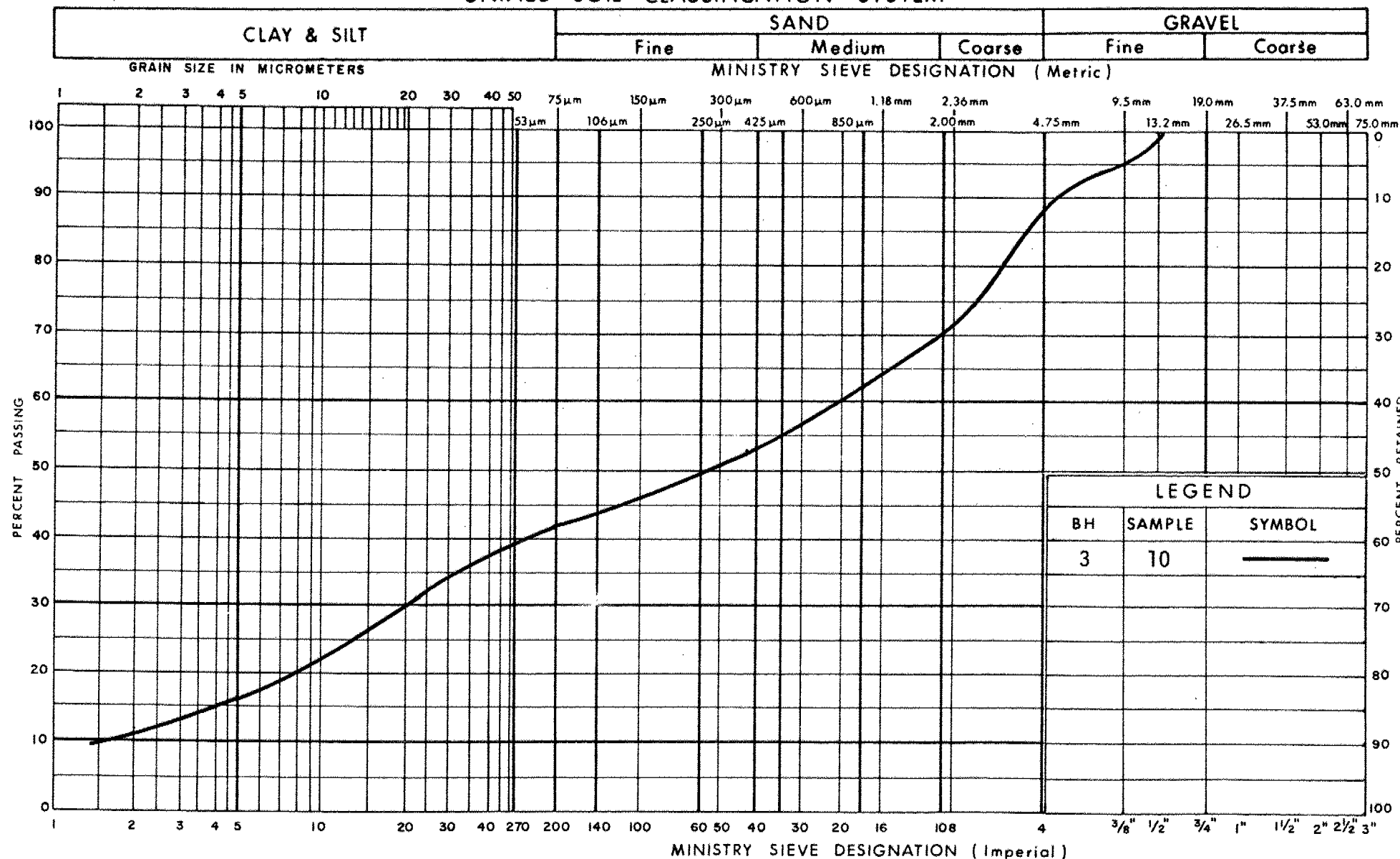
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL

FIG No 2

W P 54-82-05

UNIFIED SOIL CLASSIFICATION SYSTEM

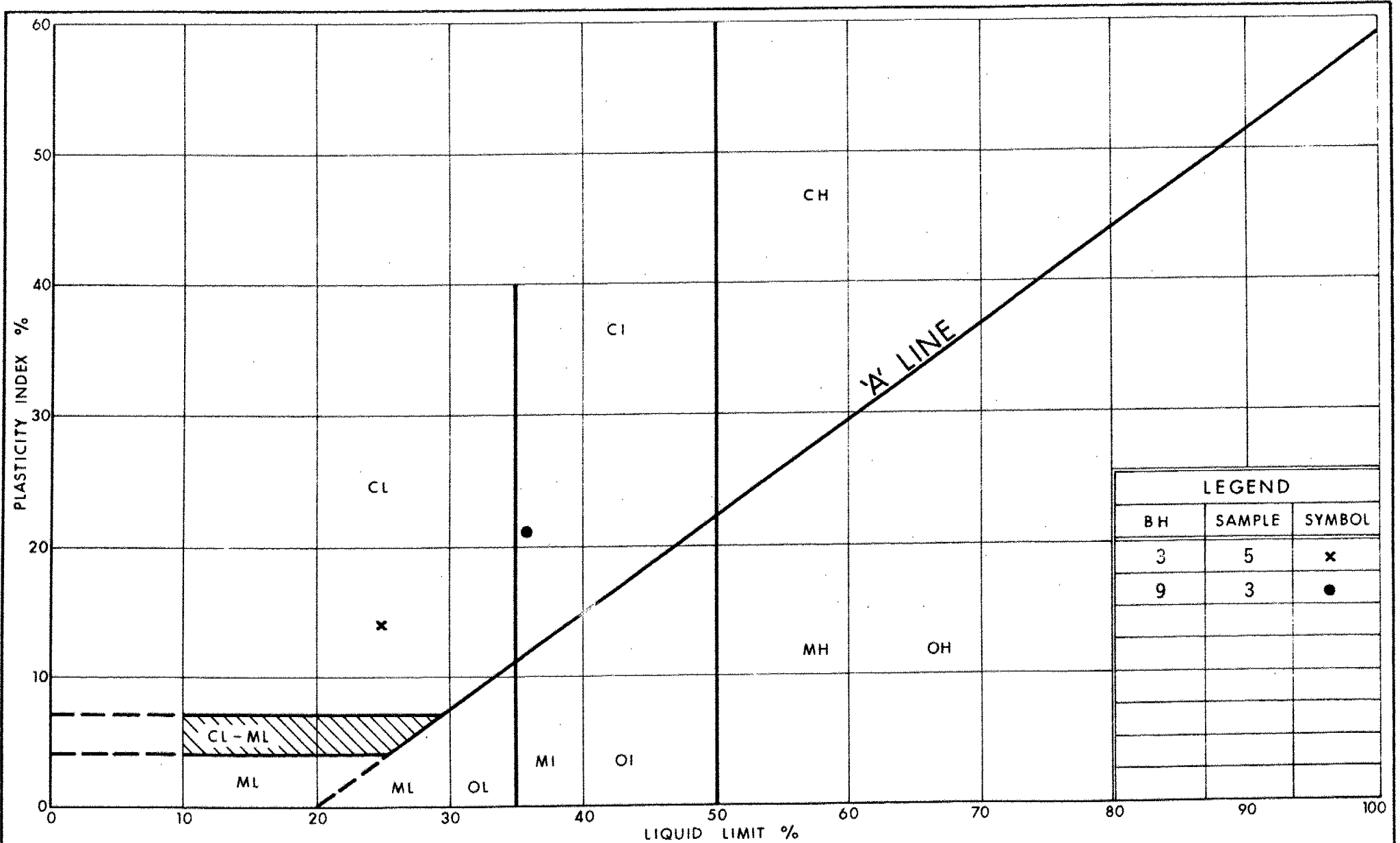


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY TILL with shale fragments

FIG No 3

W P 54-82-05

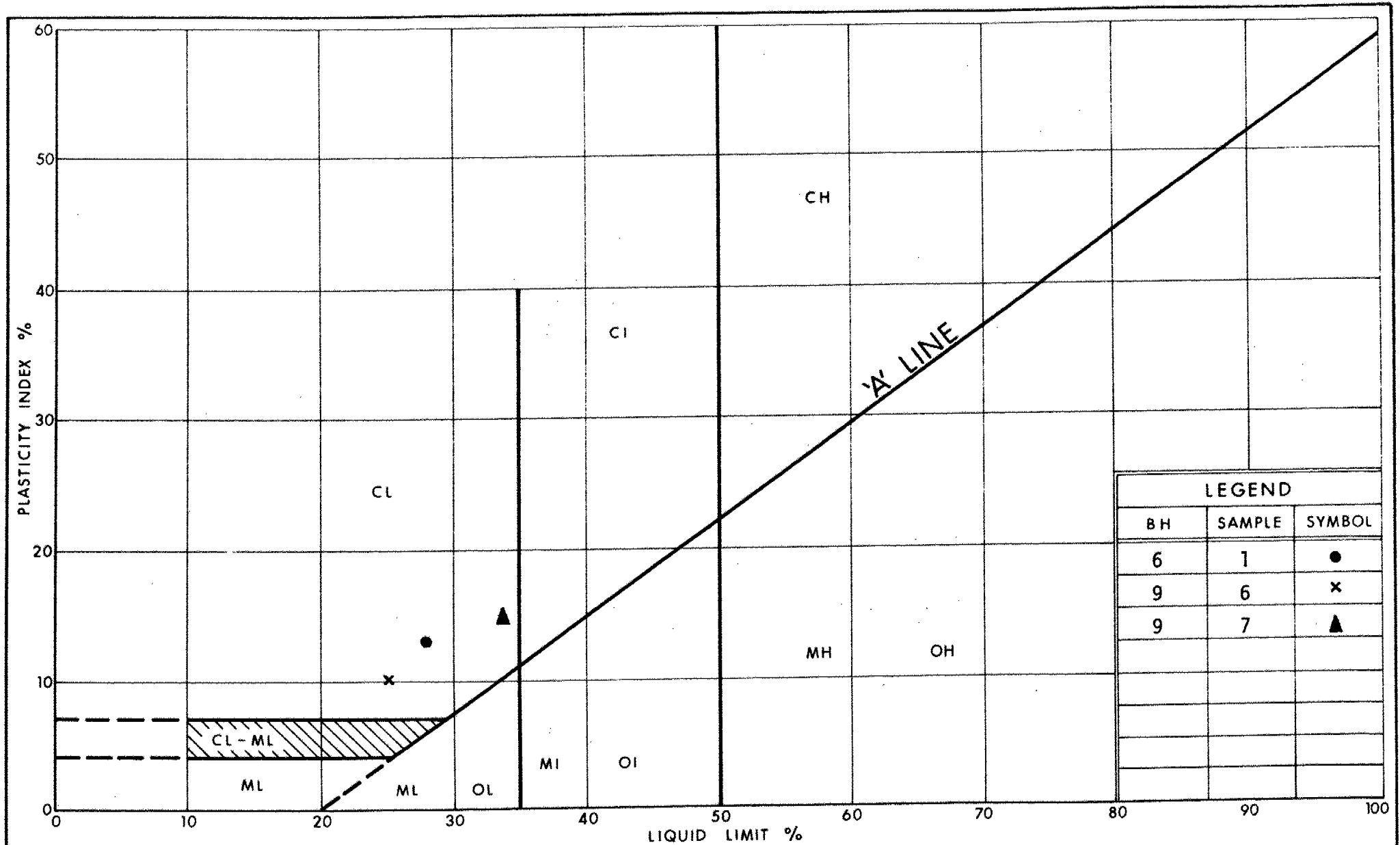


Ministry of
Transportation and
Communications
Ontario

PLASTICITY CHART
SILTY CLAY with some Sand & Gravel (Fill)

FIG No 4

W P 54-82-05



Ministry of
Transportation and
Communications

PLASTICITY CHART SILTY CLAY TILL

FIG No 5

W P 54-82-25

Foundation Investigation Report Addendum
For

W.P. 54-82-05, Site 24-81-181
Hwy. 401 Underpass at First Line East
Hwy. 401, District 6, Toronto

INTRODUCTION

This addendum summarizes the results of additional foundation investigations required at this site as a result of a revision in the horizontal alignment of First Line East Road. It is intended to supplement the Foundation Investigation Report prepared for this project by Dominion Soil Investigation Inc.

The fieldwork for the addendum was conducted between 85 03 13 and 85 03 15 utilizing a continuous flight auger machine equipped with 82 mm I.D. hollow-stem augers, N casing and a B core barrel.

This work consisted of 5 sampled boreholes.

SUBSURFACE CONDITIONS

The Record of Borehole Sheets (Appendix B.H. #101 to B.H. #105) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes and stratigraphical profiles based on the borehole data have been added to Drawing No. 548205-A&B. *

At the locations of the boreholes completed for this addendum, up to 2.9 m of silty clay till overlies the shale bedrock. Refer to the original Foundation Investigation Report for a typical description of the silty clay till. For a description of the rock core samples from the addendum boreholes, refer to Table 1-Addendum (Appendix).

* NOTE: Refer to Drawing No. 2 and No. 2A of the Contract Drawings.



D. H. Dundas

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

M. Devata

M. Devata, P. Eng.,
Chief Foundations Engineer
(East)

APPENDIX


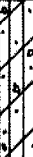


DESCRIPTION OF ROCK CORE - W.P. 54-82-05

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
101	3.58 - 3.78	50	0	3.58 - 4.34	Shale (70%), red, highly weathered, high core loss with limestone (30%), green, moderately weathered
	3.78 - 4.90	82	14	4.34 - 4.90	Shale (95%), red, slightly weathered, closely spaced joints, with siltstone (5%), green, unweathered
102	3.43 - 3.68	80	0	3.43 - 3.68	Shale, highly weathered
	3.68 - 4.98	100	24	3.68 - 4.22	Shale (80%), red, moderately weathered, closely spaced joints, with limestone (20%), green to light grey
				4.22 - 4.98	Shale (100%), red, unweathered, medium spaced joints
103	3.58 - 5.18	90	41	3.58 - 5.54	Shale (60%), red, slightly weathered becoming unweathered, closely spaced joints, with limestone (40%), green and light grey, unweathered, closely spaced joints
	5.18 - 5.54	100	0		
104	2.08 - 2.59	100	0	2.08 - 2.59	Shale (95%), red, highly weathered to clayey with limestone (5%), slightly weathered
	2.59 - 3.89	75	0	2.59 - 3.81	Shale (100%), red, moderately weathered, very closely spaced joints
	3.89 - 4.67	90	32		
				3.81 - 4.67	Limestone (80%), light grey to green, unweathered, closely spaced joints with shale (20%), slightly weathered
105	1.80 - 2.84	100	15	1.80 - 2.79	Shale (100%), red, highly to moderately weathered, very closely spaced joints
	2.84 - 3.84	77	31	2.79 - 3.84	Limestone (80%), light green, unweathered, closely spaced joints with shale (20%), red, unweathered

RECORD OF BOREHOLE No 101

METRIC

W P 54-82-05 LOCATION Co-Ords N 4832 601.8; E 291 235.2 ORIGINATED BY IW
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger; B Core COMPILED BY HS
 DATUM Geodetic DATE 85 03 13 CHECKED BY DD

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					
192.0	Ground Surface																
0.0	Silty Clay (Till) trace sand trace gravel very stiff to hard		1	SS	21		191										
			2	SS	70		190										
			3	SS	114												
189.1																	
2.9	Bedrock Shale		4	SS	129		189										
			5	RC	Rec =50%												
	weathered sound		6	RC	Rec =82%		188										
187.1																	
4.9	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 102

METRIC

W P 54-82-05 LOCATION Co-Ords: N 4 832 619.0; E 291 213.6 ORIGINATED BY IW
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem, B Core COMPILED BY HS
 DATUM Geodetic DATE 85 03 14 CHECKED BY DD

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					
192.0	Ground Surface																
0.0	Silty Clay (Till) trace Sand trace Gravel very stiff to hard		1	SS	22		191										
			2	SS	43		190										
			3	SS	126												
189.1																	
2.9	Bedrock Shale		4	SS	120	0.20m	189										
			5	RC	Rec =80%												
			6	RC	Rec =100%		188										
187.0																	
5.0	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 103

METRIC

W P 54-82-05 LOCATION Co-Ords: N 4 832 662.3; E 291 171.4 ORIGINATED BY IW
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger, B Core COMPILED BY HS
DATUM Geodetic DATE 85 03 14 CHECKED BY DD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
190.7	Ground Surface																GR SA SI CL
0.0	Silty Clay (Till) trace Sand trace Gravel Very Stiff to Hard		1	SS	15		190										
			2	SS	18		189										
			3	SS	95		188										
187.8	Bedrock		4	SS	77		187										
2.9	Shale weathered sound		5	RC BXL	Rec 90%		186										RQD 41%
	Occasional limestone seams		6	RC BXL	Rec 100%												RQD 0%
185.2	End of Borehole																
5.5																	

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 104

METRIC

W P 54-82-05 LOCATION Co-Ords: N 4 832 697.3; E 291 127.8 ORIGINATED BY IW
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger, B Core COMPILED BY HS
DATUM Geodetic DATE 85 03 15 CHECKED BY DD

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			SHEAR STRENGTH										WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE							
190.6	Ground Surface																	
0.0	Silty Clay (Till)						190											
	trace Sand																	
	trace Gravel																	
	very stiff		1	SS	17													
189.2																		
1.4	Bedrock Shale		2	SS	65		189											
	Occasional limestone seams																	
			3	RC BXL	Rec 100%		188										RQD 0%	
			4	RC BXL	Rec 75%		187										RQD 0%	
	weathered sound																	
	Limestone occasional shale seams		5	RC BXL	Rec 90%		186										RQD 32%	
185.9																		
4.7	End of Borehole																	

+³, x⁵: Numbers refer to Sensitivity
20
15 $\frac{1}{2}$ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 105

METRIC

W P 54-82-05 LOCATION Co-Ords: N 4 832 718.4; E 291 104.9
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger, B Core
DATUM Geodetic DATE 85 03 15
ORIGINATED BY IW
COMPILED BY HS
CHECKED BY DD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
189.5	Ground Surface																
0.0	Silty Clay (Till) trace Sand trace Gravel						189										
	hard		1	SS	66												
188.1																	
1.4	Bedrock		2	SS	100	0.10m	188										
			3	RC BXL	Rec 100%												RQD 15%
	shale weathered						187										
	Limestone sound		4	RC BXL	Rec 77%												RQD 31%
185.6							186										
3.9	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications

CONT 86-67

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 54-82-04

DIST #6

HWY #401

STR SITE N/A

High Mast Lighting
(Hwy.#10 to Hwy.#410)

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FOUNDATION INVESTIGATION REPORT

FOR

W.P. 54-82-04; Site N/A

High Mast Lighting (Hwy. 10 to Hwy. 410)

Hwy. 401, District 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation required for the above-noted high mast lighting.

The fieldwork was conducted between 85 11 15 and 85 11 21 utilizing a continuous flight auger machine equipped with solid-stem augers, N casing and B core barrels.

This work consisted of advancing sampled boreholes at or near all proposed high mast light locations (C1 to C10).

SITE DESCRIPTION

These high mast lights are located along Hwy. 401 between Hwy. 410 and Hwy. 10.

According to Chapman and Putnam (1984), the site lies within the 'Peel Plain' physiographic area. In this area it is characterized by a relatively level area of shallow overburden overlying shale bedrock.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations (refer to BH #C1 to BH #C10). The general locations of the high mast lights C1 to C10 are illustrated on Figures 1A & 1B while specific locations are indicated in Table 1.

STRATIGRAPHY

Overburden

The overburden is generally silty clay of low plasticity, containing variable amounts of sand and gravel and occasional shaly zones.

Based on 'N' values, the material varies from very soft to hard but is generally stiff to hard.

The thickness of the overburden is variable ranging from 0.6 m to 4.6 m.

Bedrock

Detailed descriptions of the bedrock core samples are provided in Tables 2A and 2B.

At locations C1, C2, C3 and C4, the bedrock is shale of the Queenston Formation.

At locations C5, C6, C7, C8, C9 and C10, the bedrock is shale and limestone of the Georgian Bay Formation.

Groundwater Conditions

At the time of the field investigation, the groundwater elevation at the borehole locations was at or near the surface.

DISCUSSION AND RECOMMENDATIONS

It is proposed to install 10 high mast lights along Hwy. 410 and Hwy. 10.

Foundation design will be by Broms method as described 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.

Design

It should be assumed that existing or proposed fill does not provide any lateral resistance unless it is constructed of compacted Granular 'A'.

However, if an engineering fill, consisting of compacted Granular 'A' within a 4 m radius of the C/L of the high mast light is used, the following design parameters may be applied:

$$\begin{aligned}\phi &= 30^\circ \\ \gamma &= 140 \text{ pcf}\end{aligned}$$

Also, it should be assumed that 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. For design purposes, the most critical surface elevations should be assumed so that the required frost penetration cover is provided at all times.

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 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 caissons:

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

q_u = unconfined compressive strength in psi

γ = unit weight in pcf

<u>Light Pole</u>	<u>Elev. (m) From-To</u>	<u>Material Type</u>	<u>ϕ degrees</u>	<u>q_u (psi)</u>	<u>γ (pcf)</u>
C1	192.5-191.5	Cohesive	0	5	115
	191.5-191.0	Cohesive	0	15	115
	191.0-190.0	Cohesive	0	30	115
	190.0-187.9	Cohesive	0	75	120
	187.9-187.0	Bedrock	0	125	130
	187.0-	Bedrock	0	1000	140
C2	193.7-193.1	Cohesive	0	5	115
	193.1-192.0	Bedrock	0	105	130
	192.0-187.0	Bedrock	0	125	130
	187.0-	Bedrock	0	1000	140
C3	191.3-190.0	Cohesive	0	5	115
	190.0-189.5	Cohesive	0	30	115
	189.5-188.7	Cohesive	0	100	120
	188.7-185.0	Bedrock	0	125	130
	185.0-	Bedrock	0	1000	140
C4	188.8-188.0	Cohesive	0	5	115
	188.0-186.4	Cohesive	0	100	120
	186.4-184.4	Bedrock	0	125	130
	184.4-	Bedrock	0	1000	140

<u>Light Pole</u>	<u>Elev. (m) From-To</u>	<u>Material Type</u>	<u>ϕ degrees</u>	<u>q_u (psi)</u>	<u>δ (pcf)</u>
C5	185.8-185.0	Cohesive	0	5	115
	185.0-184.5	Cohesive	0	40	115
	184.5-183.5	Cohesive	0	55	115
	183.5-182.9	Cohesive	0	100	120
	182.9-181.0	Bedrock	0	125	130
	181.0-	Be rock	0	1000	140
C6	183.9-183.0	Cohesive	0	5	115
	183.0-182.5	Cohesive	0	65	120
	182.5-180.5	Bedrock	0	125	130
	180.5-	Bedrock	0	1000	140
C7	184.5-184.0	Cohesive	0	5	115
	184.0-182.5	Cohesive	0	50	115
	182.5-179.0	Bedrock	0	125	130
	179.0-	Bedrock	0	1000	140
C8	184.2-182.0	Cohesive	0	5	115
	182.0-181.3	Cohesive	0	100	120
	181.3-179.3	Bedrock	0	125	130
	179.3-	Bedrock	0	1000	140
C9	184.6-183.0	Cohesive	0	5	115
	183.0-182.6	Cohesive	0	10	115
	182.6-181.0	Bedrock	0	125	130
	181.0-	Bedrock	0	1000	140
C10	184.0-182.5	Cohesive	0	5	115
	182.5-181.7	Granular	25	0	115
	181.7-179.7	Bedrock	0	125	130
	179.7-	Bedrock	0	1000	140

Rock anchors may be used to provide additional resistance. For design estimation purposes the allowable bond stress between the anchor and the sound bedrock may be assumed to be 40 psi. However, if rock anchors are considered, it is recommended that a test program should be carried out to determine the allowable bond stress. Please contact this office for details regarding suggested testing.



D. H. Dundas

D. H. Dundas, P.Eng.

Senior Foundations Engineer

M. Devata

M. Devata, P.Eng.

Chief Foundations Engineer

APPENDIX

W.P. 54-82-04



TABLE 1

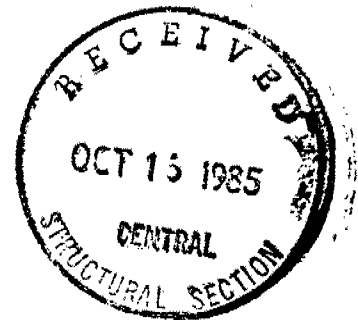
W.P. 54-82-04

HIGHWAY 401 HIGH-MAST POLE ELEVATIONS

<u>Pole No.</u>	<u>Coordinates</u>		<u>Existing Elevation</u>	<u>Ultimate* Elevation</u>
	<u>Northing</u>	<u>Easting</u>		
C1	4832488.9	290713.7	192.5	192.5
C2	4832563.7	290880.1	193.7	193.7
C3	4832611.2	291080.5	191.3	191.3
C4	4832699.5	291263.5	188.8	188.1
** C5	4832765.6	291411.9	185.8	185.8
C6	4832794.2	291574.8	183.9	183.9
C7	4832930.4	291504.9	184.5	184.5
C8	4833007.7	291623.4	184.2	184.2
C9	4832873.5	291696.8	184.6	184.1
C10	4832979.3	291781.8	184.0	184.0

* Ultimate elevations are based on Preliminary Design Report and are, therefore, subject to change during detailed design stage.

** Location of Pole #C5 has been revised.



W.P. 54-82-04
File: 16-82100

October 15, 1985

SWA:jg

DESCRIPTION OF ROCK CORE - W.P.

54-82-04

TABLE 2A

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
C1	4.98-6.50	93	0	4.98-6.50	SHALE (95%) red and green, moderately weathered, very closely spaced joints, with SILTSTONE (5%) in 3cm-5cm layers. SHALE (95%) red and green, unweathered, closely spaced joints with SILTSTONE (5%) in 3cm-5cm layers.
	-8.03	95	68	6.50-8.03	
C2	1.68-3.07	44	0	1.68-6.40	SHALE (95%) red and green, moderately to highly weathered, very high core losses, with SILTSTONE (5%) in 2.5cm-10.2cm layers. SHALE (95%) red and green, slightly weathered, closely spaced joints, with SILTSTONE in 3cm-5cm layers.
	-4.70	36	0		
	-6.07	28	0	6.40-7.49	
	-7.49	88	39		
C3	5.21-6.73	48	10	5.21-6.25	SHALE (95%) red and green, highly weathered, high core loss. SHALE (50%) red and green, unweathered, closely spaced joints with limestone (50%) in 5cm-20cm layers.
	-8.26	95	48	6.25-8.26	

* CR= CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 54-82-04

TABLE 2B

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C5	4.11-5.64m	74	67	4.11-4.62	SHALE with limestone pieces, highly weathered; very high core loss
	-7.16m	100	75	4.62-7.16m	SHALE (50%) grey, unweathered, medium spaced joints with LIMESTONE (50%) grey, unweathered up tp 45cm thick
C7	1.98-3.01	43	0	1.98-2.67	SHALE and LIMESTONE moderately weathered becoming slightly weathered with depth very high core loss zone
	-4.37	60	12		
	-5.89	83	28	2.67-5.89	SHALE (50%) grey, slightly weathered with moderately weathered zones, with LIMESTONE (50%), unweathered, in up to 23cm layers
C9	2.92-4.44	78	0	2.92-3.73	SHALE, moderately to highly weathered (high core loss) with limestone in up to 10cm layers
	-6.10	98	35	3.73-6.10	SHALE (80%) slightly weathered to unweathered, closely spaced joints with LIMESTONE (20%) in up to 15cm layers.

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

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'_{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_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 C-1

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832488.9; E 290713.7 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY DD
DATUM GEODETIC DATE 85 11 21-22 CHECKED BY DD

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							
192.5 0.0	GROUND SURFACE					*						
	trace organics		1	SS	11							
			2	SS	25							
	Silty Clay (CL) trace/some sand trace gravel occ. shaly zones firm to hard		3	SS	65							
			4	SS	129/20cm							
			5	SS	85/10cm							
187.9 4.6			6	SS	85/8cm							
	weathered sound		7	RC	REC 92%							
	Bedrock Shale Queenston Formation		8	RC	REC 97%							
184.4 8.1	END OF BOREHOLE *groundwater elevation not determined											

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-2

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832563.7; E 290880.1 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GRODENTIC DATE 85 11 18 CHECKED BY DD

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								
193.7	GROUND SURFACE												
0.0	Probable Silty Clay (CL) **												
193.1													
0.6			1	SS	84								
			2	SS	106/	20cm							
			3	RC	REC 51%								
			4	RC	REC 38%								
	Bedrock Shale Queenston Formation												
			5	RC	REC 30%								
	Weathered Sound												
			6	RC	REC 86%								
186.2													
7.5	END OF BOREHOLE												
	*Groundwater elevation not determined												
	**trace/some sand trace gravel soft to firm												

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-3

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832611.2; E 291080.5 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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							
191.3 0.0	GROUND SURFACE					*	191					
	With Organics		1	SS	11		190					
	Silty Clay (CL) Trace/Some Sand Occ. Shaly Zones Trace Gravel Stiff to Hard		2	SS	26		189					
188.7 2.6			3	SS	88/10cm		188					
			4	SS	100/15cm		187					
			5	SS	106/15cm		186					
			6	SS	110/15cm		185					
	Weathered Sound		7	RC	REC 50%		184					
	Bedrock Shale Queenston Formation		8	RC	REC 95%							
183.0 8.3	END OF BOREHOLE *Groundwater elevation not determined											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C-4

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832699.5; E 291263.5 ORIGINATED BY BD
 DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
 DATUM GEODETIC DATE 85 11 20 CHECKED BY BD

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									
188.8	GROUND SURFACE													
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Very Stiff to Hard		1	SS	85/15cm		188							
			2	SS	125	23cm		187						
186.4			3	SS	90	13cm		186						
2.4	Probable Bedrock Shale, Weathered													
185.8	Queenston Formation													
3.0	END OF BOREHOLE													

+³, x⁵: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No C-5

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832765.6; E 291411.9 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM CRODATIC DATE 85 11 20 CHECKED BY BD

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						
185.8	GROUND SURFACE					*					
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Occ. Shaly Zones Very Stiff to Hard		1	SS	33		185				
			2	SS	43		184				
182.9			3	SS	100	8cm	183				
2.9			4	SS	100	10cm	182				
	Weathered Sound		5	RC	REC 70%		181				
	Bedrock Shale and Limestone Georgian Bay Formation		6	RC	REC 98%		180				
178.6							179				
7.2	END OF BOREHOLE *Groundwater elevation not determined										

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-6

METRIC

W P 54-82-04 LOCATION Co-Ords: N 4832794.2; E 291574.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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						
183.9	GROUND SURFACE										
0.0	Silty Clay (CL) Some Sand Trace Gravel Hard		1	SS	54	*	183				
182.5											
1.4	END OF BOREHOLE *Groundwater elevation not determined Probable bedrock at 1.4 m Shale and Limestone Georgian Bay Formation Weathered										



RECORD OF BOREHOLE No C-7

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832930.4; E 291504.9 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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						
184.5	GROUND SURFACE										
0.0											
	Silty Clay (CL) Trace/Some Sand Trace Gravel Hard		1	SS	51						
182.5			2	SS	39						
2.0			3	RC	REC 48%						
	Bedrock Shale and Limestone Georgian Bay Formation		4	RC	REC 69%						
			5	RC	REC 90%						
178.6	Weathered Sound										
5.9	END OF BOREHOLE										

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-8

METRIC

W P 54-82-04 LOCATION Co-ords: N 4833007.7; E 291623.4 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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								
184.2	GROUND SURFACE											
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Soft to Hard Occ. Shaly Zones		1	SS	7							
			2	SS	5							
			3	SS	100	8cm						
181.3	END OF BOREHOLE											
2.9	*Groundwater elevation not determined Probable Bedrock at 2.9 m depth Georgian Bay Formation Weathered											

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-9

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832873.5; E 291696.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 20/21 CHECKED BY BD

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						
184.6	GROUND SURFACE													
0.0						*								
	Silty Clay (CL) with Sand and Gravel Very soft to firm		1	SS	4		184							
182.6			2	SS	10		183							
2.0			3	SS	70	/10cm	182							
	weathered sound		4	RC	Rec 90%		181							
	Bedrock Shale and Limestone Georgian Bay Formation		5	RC	Rec 95%		180							
178.5							179							
6.1	END OF BOREHOLE													
	*Groundwater elevation not determined													

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No C-10

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832979.3; E 291781.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 21 CHECKED BY BD

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						
184.0	GROUND SURFACE										
0.0	Silty Clay (CL) Some sand Trace gravel Firm		1	SS	7		183				
	Silty Sand Trace Gravel Loose to Very Dense		2	SS	96	/28cm	182				
181.7	END OF BOREHOLE										
2.3	Probable Bedrock Shale and Limestone Georgian Bay Formation Weathered										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 54-82-04

DIST #6

HWY #401

STR SITE N/A

High Mast Lighting
(Hwy.#10 to Hwy.#410)

DISTRIBUTION

G. C. E. BURKHARDT (3)

R. D. GUNTER

A. WITTENBERG

J. SMRCKA (2)

K. BASSI

J. H. PEER

T. YAKUTCHUK

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GEOCRES 30M12-192

DATE

FOUNDATION INVESTIGATION REPORT

FOR

W.P. 54-82-04; Site N/A

High Mast Lighting (Hwy. 10 to Hwy. 410)

Hwy. 401, District 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation required for the above-noted high mast lighting.

The fieldwork was conducted between 85 11 15 and 85 11 21 utilizing a continuous flight auger machine equipped with solid-stem augers, N casing and B core barrels.

This work consisted of advancing sampled boreholes at or near all proposed high mast light locations (C1 to C10).

SITE DESCRIPTION

These high mast lights are located along Hwy. 401 between Hwy. 410 and Hwy. 10.

According to Chapman and Putnam (1984), the site lies within the 'Peel Plain' physiographic area. In this area it is characterized by a relatively level area of shallow overburden overlying shale bedrock.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations (refer to BH #C1 to BH #C10). The general locations of the high mast lights C1 to C10 are illustrated on Figures 1A & 1B while specific locations are indicated in Table 1.

STRATIGRAPHY

Overburden

The overburden is generally silty clay of low plasticity, containing variable amounts of sand and gravel and occasional shaly zones.

Based on 'N' values, the material varies from very soft to hard but is generally stiff to hard.

The thickness of the overburden is variable ranging from 0.6 m to 4.6 m.

Bedrock

Detailed descriptions of the bedrock core samples are provided in Tables 2A and 2B.

At locations C1, C2, C3 and C4, the bedrock is shale of the Queenston Formation.

At locations C5, C6, C7, C8, C9 and C10, the bedrock is shale and limestone of the Georgian Bay Formation.

Groundwater Conditions

At the time of the field investigation, the groundwater elevation at the borehole locations was at or near the surface.

DISCUSSION AND RECOMMENDATIONS

It is proposed to install 10 high mast lights along Hwy. 410 and Hwy. 10.

Foundation design will be by Broms method as described 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.

Design

It should be assumed that existing or proposed fill does not provide any lateral resistance unless it is constructed of compacted Granular 'A'.

However, if an engineering fill, consisting of compacted Granular 'A' within a 4 m radius of the C/L of the high mast light is used, the following design parameters may be applied:

$$\phi = 30^\circ$$

$$\gamma = 140 \text{ pcf}$$

Also, it should be assumed that 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. For design purposes, the most critical surface elevations should be assumed so that the required frost penetration cover is provided at all times.

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 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 caissons:

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

q_u = unconfined compressive strength in psi

γ = unit weight in pcf

<u>Light Pole</u>	<u>Elev. (m) From-To</u>	<u>Material Type</u>	<u>ϕ degrees</u>	<u>q_u (psi)</u>	<u>γ (pcf)</u>
C1	192.5-191.5	Cohesive	0	5	115
	191.5-191.0	Cohesive	0	15	115
	191.0-190.0	Cohesive	0	30	115
	190.0-187.9	Cohesive	0	75	120
	187.9-187.0	Bedrock	0	125	130
	187.0-	Bedrock	0	1000	140
C2	193.7-193.1	Cohesive	0	5	115
	193.1-192.0	Bedrock	0	105	130
	192.0-187.0	Bedrock	0	125	130
	187.0-	Bedrock	0	1000	140
C3	191.3-190.0	Cohesive	0	5	115
	190.0-189.5	Cohesive	0	30	115
	189.5-188.7	Cohesive	0	100	120
	188.7-185.0	Bedrock	0	125	130
	185.0-	Bedrock	0	1000	140
C4	188.8-188.0	Cohesive	0	5	115
	188.0-186.4	Cohesive	0	100	120
	186.4-184.4	Bedrock	0	125	130
	184.4-	Bedrock	0	1000	140

<u>Light Pole</u>	<u>Elev. (m) From-To</u>	<u>Material Type</u>	<u>ϕ degrees</u>	<u>q_u (psi)</u>	<u>δ (pcf)</u>
C5	185.8-185.0	Cohesive	0	5	115
	185.0-184.5	Cohesive	0	40	115
	184.5-183.5	Cohesive	0	55	115
	183.5-182.9	Cohesive	0	100	120
	182.9-181.0	Bedrock	0	125	130
	181.0-	Be rock	0	1000	140
C6	183.9-183.0	Cohesive	0	5	115
	183.0-182.5	Cohesive	0	65	120
	182.5-180.5	Bedrock	0	125	130
	180.5-	Bedrock	0	1000	140
C7	184.5-184.0	Cohesive	0	5	115
	184.0-182.5	Cohesive	0	50	115
	182.5-179.0	Bedrock	0	125	130
	179.0-	Bedrock	0	1000	140
C8	184.2-182.0	Cohesive	0	5	115
	182.0-181.3	Cohesive	0	100	120
	181.3-179.3	Bedrock	0	125	130
	179.3-	Bedrock	0	1000	140
C9	184.6-183.0	Cohesive	0	5	115
	183.0-182.6	Cohesive	0	10	115
	182.6-181.0	Bedrock	0	125	130
	181.0-	Bedrock	0	1000	140
C10	184.0-182.5	Cohesive	0	5	115
	182.5-181.7	Granular	25	0	115
	181.7-179.7	Bedrock	0	125	130
	179.7-	Bedrock	0	1000	140

Rock anchors may be used to provide additional resistance. For design estimation purposes the allowable bond stress between the anchor and the sound bedrock may be assumed to be 40 psi. However, if rock anchors are considered, it is recommended that a test program should be carried out to determine the allowable bond stress. Please contact this office for details regarding suggested testing.



D. H. Dundas

D. H. Dundas, P.Eng.

Senior Foundations Engineer

M. Devata

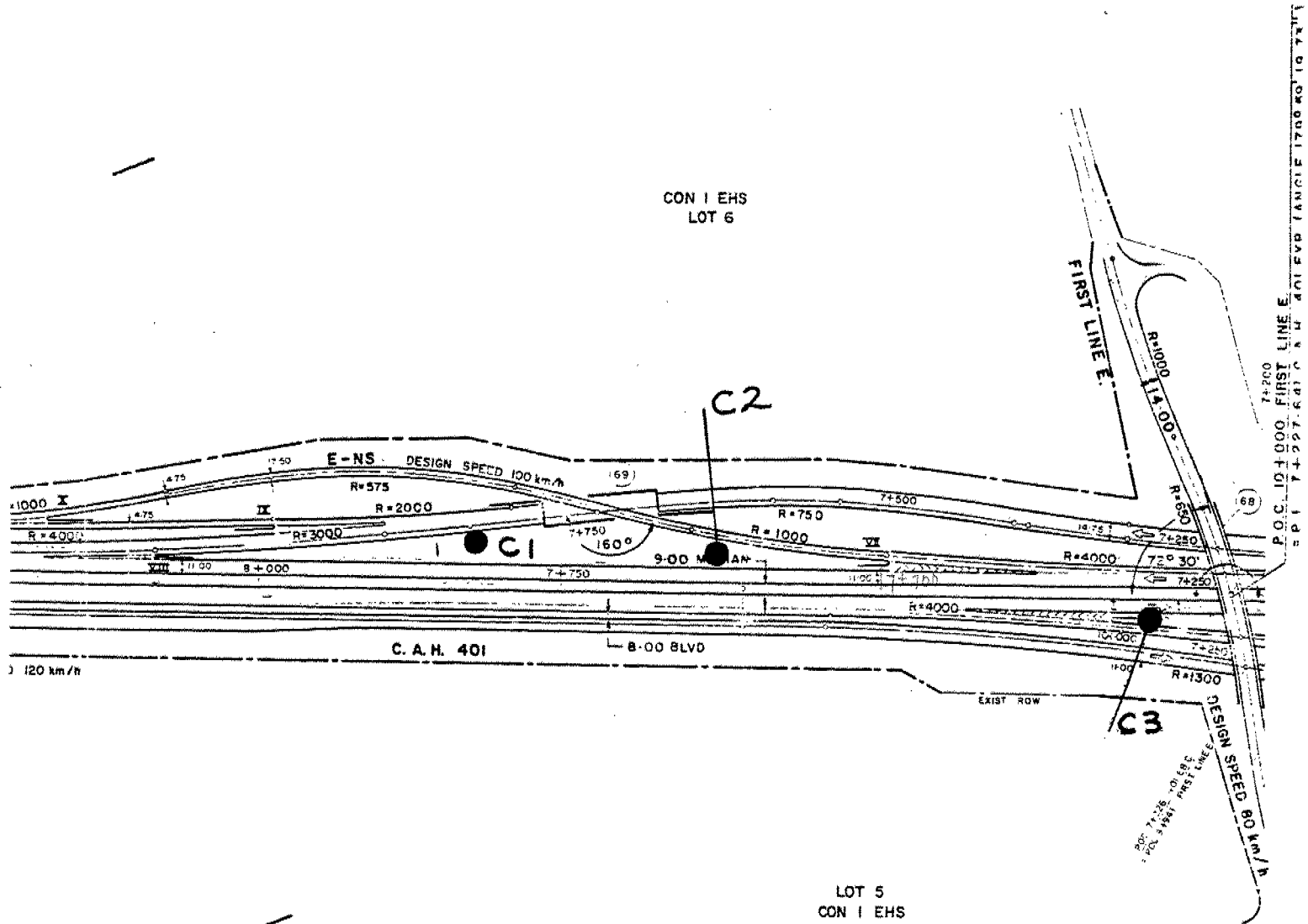
M. Devata, P.Eng.

Chief Foundations Engineer

A P P E N D I X

FIGURE 1A

W.P. 54-82-04



W.P. 54-82-04

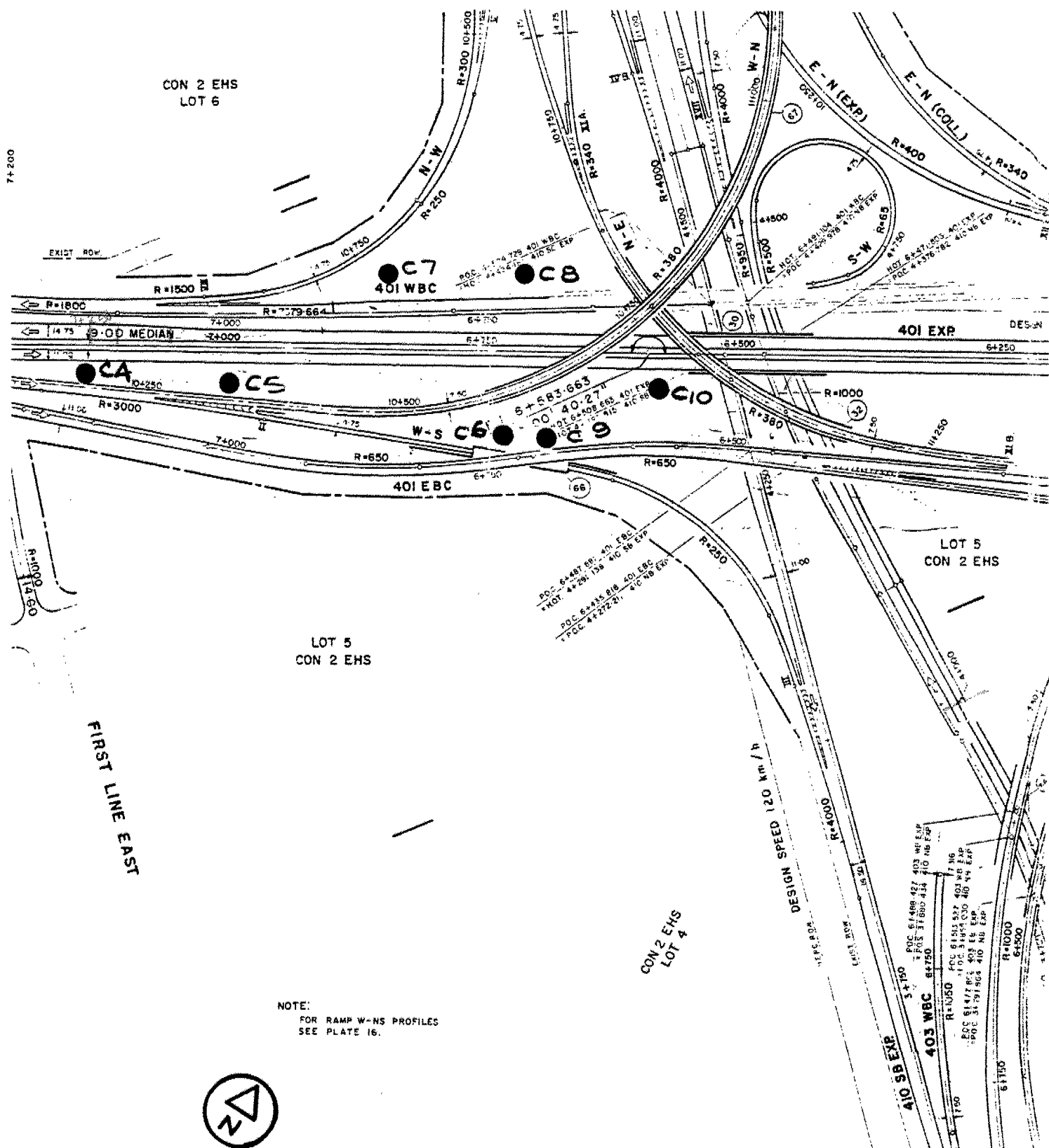


TABLE 1

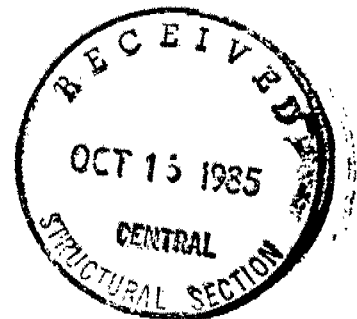
W.P. 54-82-04

**HIGHWAY 401 HIGH-MAST POLE ELEVATIONS**

<u>Pole No.</u>	<u>Coordinates</u>		<u>Existing Elevation</u>	<u>Ultimate* Elevation</u>
	<u>Northing</u>	<u>Easting</u>		
C1	4832488.9	290713.7	192.5	192.5
C2	4832563.7	290880.1	193.7	193.7
C3	4832611.2	291080.5	191.3	191.3
C4	4832699.5	291263.5	188.8	188.1
** C5	4832765.6	291411.9	185.8	185.8
C6	4832794.2	291574.8	183.9	183.9
C7	4832930.4	291504.9	184.5	184.5
C8	4833007.7	291623.4	184.2	184.2
C9	4832873.5	291696.8	184.6	184.1
C10	4832979.3	291781.8	184.0	184.0

* Ultimate elevations are based on Preliminary Design Report and are, therefore, subject to change during detailed design stage.

** Location of Pole #C5 has been revised.



W.P. 54-82-04
File: 16-82100

October 15, 1985

SWA:jg

DESCRIPTION OF ROCK CORE - W.P.

54-82-04

TABLE 2A

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
C1	4.98-6.50	93	0	4.98-6.50	SHALE (95%) red and green, moderately weathered, very closely spaced joints, with SILTSTONE (5%) in 3cm-5cm layers. SHALE (95%) red and green, unweathered, closely spaced joints with SILTSTONE (5%) in 3cm-5cm layers.
	-8.03	95	68	6.50-8.03	
C2	1.68-3.07	44	0	1.68-6.40	SHALE (95%) red and green, moderately to highly weathered, very high core losses, with SILTSTONE (5%) in 2.5cm-10.2cm layers. SHALE (95%) red and green, slightly weathered, closely spaced joints, with SILTSTONE in 3cm-5cm layers.
	-4.70	36	0		
	-6.07	28	0	6.40-7.49	
	-7.49	88	39		
C3	5.21-6.73	48	10	5.21-6.25	SHALE (95%) red and green, highly weathered, high core loss. SHALE (50%) red and green, unweathered, closely spaced joints with limestone (50%) in 5cm-20cm layers.
	-8.26	95	48	6.25-8.26	

* CR= CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 54-82-04

TABLE 2B

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C5	4.11-5.64m	74	67	4.11-4.62	SHALE with limestone pieces, highly weathered, very high core loss
	-7.16m	100	75	4.62-7.16m	SHALE (50%) grey, unweathered, medium spaced joints with LIMESTONE (50%) grey, unweathered up tp 45cm thick
C7	1.98-3.01	43	0	1.98-2.67	SHALE and LIMESTONE moderately weathered becoming slightly weathered with depth very high core loss zone
	-4.37	60	12		
	-5.89	83	28	2.67-5.89	SHALE (50%) grey, slightly weathered with moderately weathered zones, with LIMESTONE (50%), unweathered, in up to 23cm layers
C9	2.92-4.44	78	0	2.92-3.73	SHALE, moderately to highly weathered (high core loss) with limestone in up to 10cm layers
	-6.10	98	35	3.73-6.10	SHALE (80%) slightly weathered to unweathered, closely spaced joints with LIMESTONE (20%) in up to 15cm layers.

* CR= CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

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/0.3 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

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 = $\frac{c_u}{\tau_r}$

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

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 C-1

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832488.9; E 290713.7 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY DD
DATUM GEODETIC DATE 85 11 21-22 CHECKED BY DD

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						
192.5	GROUND SURFACE										
0.0						*					
	trace organics		1	SS	11						
			2	SS	25						
	Silty Clay (CL) trace/some sand trace gravel occ. shaly zones firm to hard		3	SS	65						
			4	SS	129	20cm					
			5	SS	85	10cm					
187.9			6	SS	85	8cm					
4.6											
	weathered sound		7	RC	REC 92%						
	Bedrock Shale Queenston Formation		8	RC	REC 97%						
184.4											
8.1	END OF BOREHOLE										
	*groundwater elevation not determined										

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No C-2

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832563.7; E 290880.1 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 18 CHECKED BY DD

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						
193.7	GROUND SURFACE										
0.0	Probable Silty Clay (CL) **					*					
193.1											
0.6			1	SS	84						
			2	SS	106	20cm					
			3	RC	REC 51%						
			4	RC	REC 38%						
	Bedrock Shale Queenston Formation		5	RC	REC 30%						
			6	RC	REC 86%						
	Weathered Sand										
186.2											
7.5	END OF BOREHOLE										
	*Groundwater elevation not determined										
	**trace/some sand trace gravel soft to firm										

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-3

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832611.2; E 291080.5 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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							
191.3	GROUND SURFACE					*	191					
0.0			1	SS	11		190					
	With Organics		2	SS	26		189					
	Silty Clay (CL) Trace/Some Sand Occ. Shaly Zones Trace Gravel Stiff to Hard		3	SS	88/10cm		188					
188.7			4	SS	100/15cm		187					
2.6			5	SS	106/15cm		186					
			6	SS	110/15cm		185					
			7	RC	REC 50%		184					
	Weathered Sound		8	RC	REC 95%							
	Bedrock Shale Queenston Formation											
183.0	END OF BOREHOLE											
8.3	*Groundwater elevation not determined											



RECORD OF BOREHOLE No C-4

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832699.5; E 291263.5 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 20 CHECKED BY BD

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						
188.8	GROUND SURFACE									
0.0										
	Silty Clay (CL) Trace/Some Sand Trace Gravel Very Stiff to Hard		1	SS	85/15cm	188				
			2	SS	125	23cm	187			
186.4			3	SS	90	13cm				
2.4	Probable Bedrock Shale, Weathered									
185.8	Queenston Formation					186				
3.0	END OF BOREHOLE									

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-5

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832765.6; E 291411.9 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM CGOBTIC DATE 85 11 20 CHECKED BY BD

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						
185.8	GROUND SURFACE										
0.0	Silty Clay (CL) Trace/Some Sand Trace Gravel Occ. Shaly Zones Very Stiff to Hard		1	SS	33						
			2	SS	43						
182.9			3	SS	100	8cm					
2.9			4	SS	100	10cm					
	Weathered Sound		5	RC	REC 70%						
	Bedrock Shale and Limestone Georgian Bay Formation		6	RC	REC 98%						
178.6											
7.2	END OF BOREHOLE *Groundwater elevation not determined										



RECORD OF BOREHOLE No C-6

METRIC

W P 54-82-04 LOCATION Co-Ords: N 4832794.2; E 291574.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 19 CHECKED BY BD

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 × 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								
183.9	GROUND SURFACE												
0.0	Silty Clay (CL) Some Sand Trace Gravel Hard					*	183						
182.5			1	SS	54								
1.4	END OF BOREHOLE *Groundwater elevation not determined Probable bedrock at 1.4 m Shale and Limestone Georgian Bay Formation Weathered												

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No C-7

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832930.4; E 291504.9 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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						
184.5	GROUND SURFACE										
0.0											
	Silty Clay (CL) Trace/Some Sand Trace Gravel Hard		1	SS	51		184				
			2	SS	39		183				
182.5			3	RC	REC 48%		182				
2.0			4	RC	REC 69%		181				
	Bedrock Shale and Limestone Georgian Bay Formation		5	RC	REC 90%		180				
							179				
	Weathered Sound										
178.6											
5.9	END OF BOREHOLE										

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-8

METRIC

W P 54-82-04 LOCATION Co-ords: N 4833007.7; E 291623.4 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 15 CHECKED BY BD

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							
184.2 0.0	GROUND SURFACE					*	184					
	Silty Clay (CL) Trace/Some Sand Trace Gravel Soft to Hard Occ. Shaly Zones		1	SS	7		183					
			2	SS	5		182					
			3	SS	100	8cm						
181.3 2.9	END OF BOREHOLE *Groundwater elevation not determined Probable Bedrock at 2.9 m depth Georgian Bay Formation Weathered											

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No C-9

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832873.5; E 291696.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GRODITIC DATE 85 11 20/21 CHECKED BY BD

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						
184.6	GROUND SURFACE										
0.0						*					
	Silty Clay (CL) with Sand and Gravel Very soft to firm		1	SS	4						
182.6			2	SS	10						
2.0			3	SS	70	/10cm					
	weathered sound		4	RC	Rec 90%						
	Bedrock Shale and Limestone Georgian Bay Formation		5	RC	Rec 95%						
178.5											
6.1	END OF BOREHOLE										
	*Groundwater elevation not determined										

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No C-10

METRIC

W P 54-82-04 LOCATION Co-ords: N 4832979.3; E 291781.8 ORIGINATED BY BD
DIST 6 HWY 401 BOREHOLE TYPE SS Auger, B Core & Cone Test COMPILED BY BD
DATUM GEODETIC DATE 85 11 21 CHECKED BY BD

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								
184.0	GROUND SURFACE												
0.0	Silty Clay (CL) Some sand Trace gravel Firm		1	SS	7		183						
	Silty Sand Trace Gravel Loose to Very Dense		2	SS	96	28cm	182						
181.7													
2.3	END OF BOREHOLE												
	Probable Bedrock Shale and Limestone Georgian Bay Formation Weathered												

OFFICE REPORT ON SOIL EXPLORATION

memorandum



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

Date: 1989 04 11

Attn: R. Barsalou
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Bldg.

RE: High Mast Lighting (HML)
W.P. 54-82-12, Site N/A
Hwy. 410/401/403, District 6, Toronto


Further to your memo dated 89 04 11, we have reviewed the foundation requirements for the proposed 30 m HML located at Co-ordinates N 4 832 726.0, E 292 194.5.

As discussed in our telephone conversation of April 11/89, we normally would conduct foundation investigations to provide parameters for the design of the required caisson foundation. However, since this will be a relatively routine bedrock installation, and in order to meet the scheduling requirements for this project, we will base our recommendations on existing data.

It is our understanding that this HML will be founded entirely within shale bedrock and that the foundations for other HML's in the area consist of 1+ m diameter caissons socketed 3 to 5 m into the shale bedrock.

Based on this information, we recommend that the foundation for this HML should consist of a 1+ m diameter caisson socketed 5 m into the shale bedrock.

If there are any questions, please advise.


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

DHD/jb

memorandum



Tel: 3731

To: G.C.E. Burkhardt
Head, Structural Section
4th Floor, Atrium Tower

Date: 1989 09 25

Atten: R. Barsalou
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: High Mast Lighting (HML)
W.P. 54-82-12, Site N/A
Hwy. 410/401/403, District 6, Toronto

Further to your memo dated 89 04 11, we have reviewed the foundation requirements for the proposed 30 m HML located at Co-ordinates N 4 832 824.0, E 292 089.4.

It is our understanding that the elevation of the existing ground surface is 184.3 m while the elevation of the regraded ground surface will be 174.5 m. Based on boreholes advanced for W.P. 54-82-09, (specifically B.H. #C-11), we assume that the caisson for this proposed HML will be founded entirely in sound shale bedrock. In this case the existing design consisting of a 1.22 diameter caisson socketed 5 m into shale bedrock will be adequate.

If there are any questions, please advise.

DHD/mmj

A handwritten signature in dark ink, appearing to read "D.H. Dundas".

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

RECORD OF BOREHOLE No 101

METRIC

W.P. 04-02-04 LOCATION Garage 1 N. 400000 5791 130 ORIGINATED BY BD
 DIST 6 HWY 401 BOREHOLE TYPE SS AUCED COMPILED BY BD
 DATUM Geodetic DATE 80-11-10 CHECKED BY BD

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE (PIOT) Z 20 40 60 80 100	PLASTIC LIMIT W _p	LIQUID LIMIT W _L	SHRINKAGE W _s	WATER CONTENT (%) W _p W W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PIOT NUMBER	TYPE VALUES									
100.0	GROUND SURFACE											
9	Silty Clay (CL) Some trace sand Trace gravel Stiff to Hard Red interbedded with clay											
5.0												
10.0												
15.0												
20.0												
25.0												
30.0												
35.0												
40.0												
45.0												
50.0												
55.0												
60.0												
65.0												
70.0												
75.0												
80.0												
85.0												
90.0												
95.0												
100.0												

OFFICE REPORT ON SOIL EXPLORATION

x¹, x²: Numbers refer to
Sensitivity

20
15 0.5 [% STRAIN AT FAILURE]
10