

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-226

DIST. 6 REGION

W.P. No. 595-90-00

CONT. No. 96-01

W. O. No.

STR. SITE No.

HWY. No. 41b

LOCATION HML, 401 to N of
Steeles Ave

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 96-01



Ontario

**Ministry of
Transportation**

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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above-mentioned project.

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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	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						

FOUNDATION INVESTIGATION REPORT
 For
 High Mast Lighting Poles
 Hwy 410, From Hwy 401 Northerly to North of Steeles Ave.
 W.P. 595-90-00, Hwy. 410, Central Region

INTRODUCTION

This report presents soil information for the proposed 32 high mast light poles (P1 through P32) at the above mentioned site. Soil information was obtained from previous subsurface investigations in the area (Geocres 30M12-187, 189, 193, 194 and 204). This report is produced at the request of Central Region Structural Section.

SUBSURFACE CONDITIONS

The appended seven Record of Borehole sheets (details below) have been selected from previous projects to represent the soil conditions for this project. The locations of the boreholes are shown on Figure 1. The native soil in general is a competent cohesive glacial till. The consistency of the material in general is very firm to hard but on average hard (N-values ranging from 5 blows to more than 100 blows/0.3m, with an average N-value of more than 30 blows/0.3m). The closest boreholes (listed below) should be referred for the soil condition at the HML locations. The glacial till is underlain by shale bedrock. Generally, the bedrock elevation at the site is lower at the north end. At the south end, near Hwy 401 the bedrock elevation is higher and can be encountered within few metres below the ground surface. The bedrock elevation at the site varies from 174.2m to 190.0m

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
BH 2	N 4,833,058.8; E 291,687.5	30M12-189
BH 3	N 4,834,474.4; E 290,498.2	30M12-204
BH 6	N 4,834,433.6; E 290,448.2	30M12-204
BH 8	N 4,835,522.5; E 289,437.5	30M12-193
BH 101	N 4,836,970.8; E 288,281.7	30M12-194
BH 3	N 4,838,214.5; E 287,746.8	30M12-187
BH 4	N 4,838,214.3; E 287,693.0	30M12-187

MISCELLANEOUS

The soil information for this project was obtained from previous Foundation Investigation in this area (Geocres 30M12-187, 189, 193, 194 and 204). This report was prepared by K.S.Q. Ahmad, Foundation Engineer, reviewed and approved by D. Dundas, Senior Foundation Engineer.



for Tae Chul Kim
D. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

WP 595-90-00			RECORD OF BOREHOLE No 2			METRIC						
W P 54-82-11 (FORMERLY)			LOCATION Co-ords. N 4 833 058.8; E 291 687.5			ORIGINATED BY DT						
DIST 6 HWY 410/401			BOREHOLE TYPE Wash Bore BX Casing, BQ Rock Core			COMPILED BY HS						
DATUM Geodetic			DATE 84 10 03			CHECKED BY						
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					
183.9	Ground Surface											
0.0	Heterogeneous Mixture of Silty Clay some sand											
183.0	Occasional shale slabs											
0.9												
	Grey Shale Bedrock with Limestone Bands		1	RC BQ		183	REC	RQD	Weathering			
			2	RC BQ		182	25%	0	Highly			
			3	RC BQ		181	63%	26%				
	Grey Limestone Bedrock with Shale Bands		4	RC BQ		180	65%	16%	Slightly to Unweathered			
			5	RC		179	100%	0				
			6	RC BQ			93%	0				
178.7												
3.2	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION



WP 595-90-00

RECORD OF BOREHOLE No 3

METRIC

W P 103-69-19 (FORMERLY) LOCATION Co-ords. N 4 834 474.4; E 290 498.2

ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY TS

DATUM Geodetic DATE 87 12 02 and 03

CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
186.5	Ground Surface													
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	70		186						22.8	
	Brown-Grey		2	SS	37		184	120/20 cm					23.1	3 32 40 25
	Hard		3	SS	41		182							
			4	SS	23		180						23.2	5 35 48 12
	Very Stiff		5	SS	80	15 cm	178							
			6	SS	60	7 cm								
	Hard		7	SS	120	7 cm	176						22.7	3 45 44 8
174.2			8	SS	100	15 cm								
12.3	End of Borehole Probable Bedrock													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

WP 595-90-00			RECORD OF BOREHOLE No 6			METRIC			
W P 103-69-19 (FORMERLY)			LOCATION Co-ords. N 4 834 433.6; E 290 448.2			ORIGINATED BY TS			
DIST 6 HWY 410			BOREHOLE TYPE Solid Stem Auger, Cone Test			COMPILED BY TS			
DATUM Geodetic			DATE 87 12 04			CHECKED BY			
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER						
187.0	Ground Surface								
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55			23.1	12 23 41 24
	Brown Grey	Hard	2	SS	50				
			3	SS	24				
			4	SS	29			23.6	8 32 44 16
			5	SS	30				
		Very Stiff	6	SS	18				
			7	SS	55				
			8	SS	75				13 30 32 25
		Silt Very Dense	9	SS	70				
			10	SS	100				
		Hard	11	SS	100	15 cm			
173.2			12	SS	100	7 cm			
13.8	End of Borehole Probable Bedrock								

OFFICE REPORT ON SOIL EXPLORATION

WP 595-90-00 RECORD OF BOREHOLE No 8 METRIC

W P 103-69-15 (FORMERLY) LOCATION Co-ords. 4 835 522.5 N; 289 437.5 E. ORIGINATED BY IW

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers; BX Rock Core COMPILED BY APT

DATUM Geodetic DATE 1983 12 06-09 CHECKED BY 161

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100				PLASTIC LIMIT W _p	W	LIQUID LIMIT W _L		
186.6	Ground Level															
0.0	Topsoil		1	SS	8		186									
186.3			2	SS	28		185									
0.3	Very stiff		3	SS	45		184									
	Hard		4	SS	68		183									
	Heterogeneous mixture of silty clay, sand & gravel (Glacial Till)		5	SS	64		182									
			6	SS	74		181									
			7	SS	100/ 0.15		180									
			8	SS	74		179									
			9	SS	83		178									
			10	SS	70		177									
			11	SS	80/ 0.15		176									
174.3	Shale bedrock		12	RC BX	94%		175									
12.3	Weathered		13	RC BX	92%		174									
	Dark Grey						173									
171.4							172									
15.2	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION



WP 595-90-00			RECORD OF BOREHOLE No 101				METRIC							
W P 103-69-16 (FORMERLY)			LOCATION CO-ORDS: N 4 836 970.8; E 288 281.7				ORIGINATED BY DY							
DIST 6 HWY 410			BOREHOLE TYPE Solid Stem Auger				COMPILED BY DY							
DATUM Geodetic			DATE 85 12 11				CHECKED BY SP							
SOIL PROFILE			SAMPLES			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					
197.2	Ground Surface													
0.0	Topsoil				*	197								
	Sand with Silt, Changing to Silt with depth		1	SS	8	196								
195.1	Loose to Compact		2	SS	19									
2.1	Silty Clay, Trace Sand		3	SS	14	195								
			4	SS	11	194								
192.8	Firm to Stiff		5	SS	5	193								0 5 56 39
4.4	Heterogeneous Mixture Silty Clay, Sand Gravel (Glacial Till)		6	SS	68/23 cm	192								5 27 48 20
	Hard		7	SS	65/18 cm									
			8	SS	78/13 cm	191								
190.0														
7.2	Auger Grinding Probable Bedrock End of Borehole													
	* Groundwater Level not established													

WP 595-90-00

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-18 (FORMERLY) LOCATION Co-ords. N 4 838 214.5; E 287 746.8

ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test

COMPILED BY JA

DATUM Geodetic DATE 84 08 07

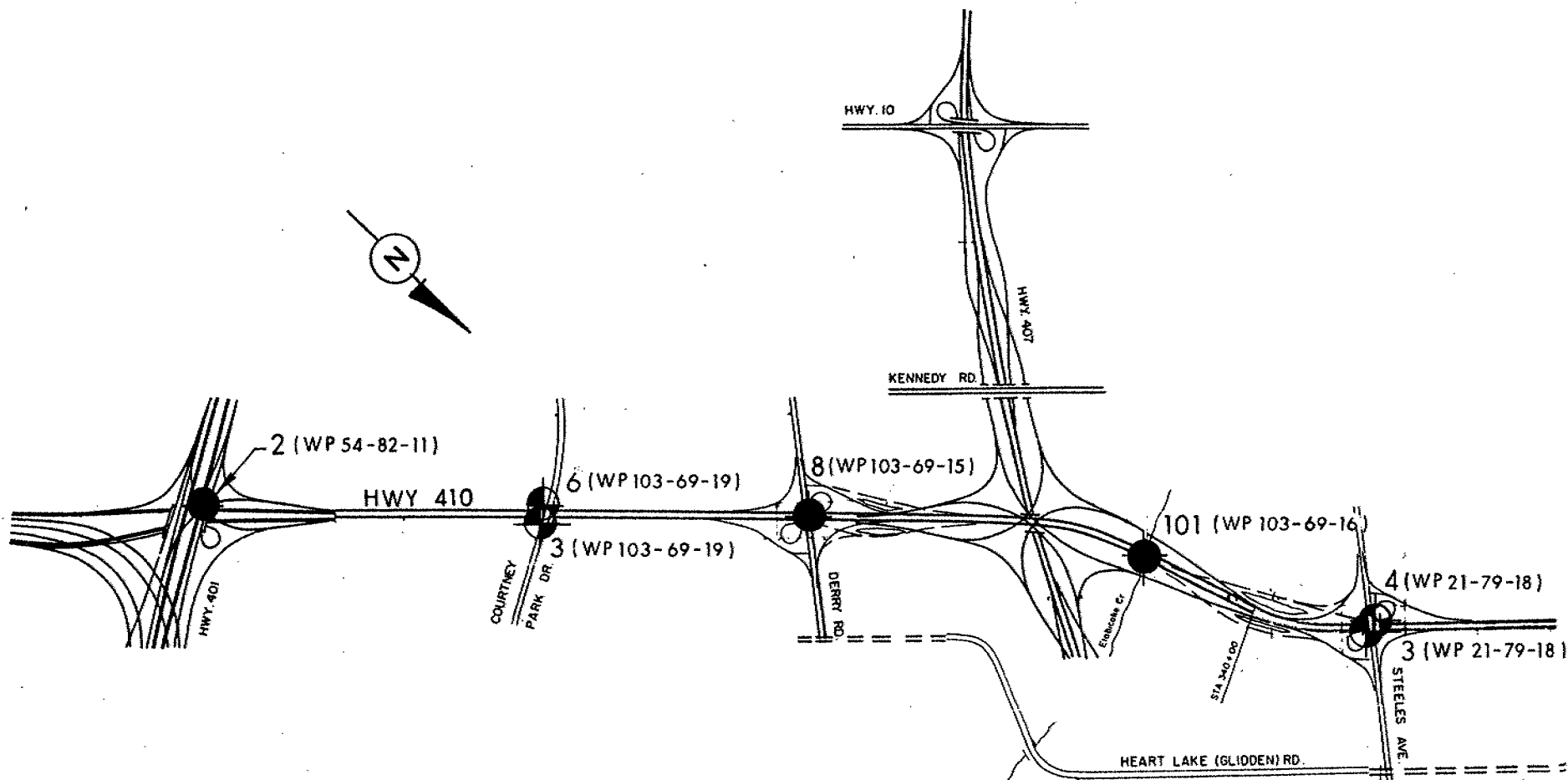
CHECKED BY AS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		PLASTIC LIMIT W _p	W	LIQUID LIMIT W _L		
197.5	Ground Surface							SHEAR STRENGTH		WATER CONTENT (%)				GR SA SI CL
0.0	Sand and Gravel (shoulder)						197	○ UNCONFINED + FIELD VANE						
196.8							196	● QUICK TRIAXIAL x LAB VANE						
0.7	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	9		195							
	Hard		2	SS	27		194							12 30 41 17
			3	SS	32		193							
			4	SS	64		192							23 30 34 13
			5	SS	42		191							
			6	SS	72		190							
			7	SS	82		189							
			8	SS	128									
			9	SS	90	10 cm								
			10	SS	100	18 cm								
			11	SS	100	13 cm								
			12	SS	100	18 cm								
188.2	End of Borehole													
9.3	* W.L. not established													



+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

WP 595-90-00				RECORD OF BOREHOLE No 4				METRIC						
W P 21-79-18 (FORMERLY)				LOCATION Co-ords. N 4 838 214.3; E 287 693.0				ORIGINATED BY JA						
DIST 6 HWY 410				BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test				COMPILED BY JA						
DATUM Geodetic				DATE 84 08 08				CHECKED BY PS						
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	WATER CONTENT (%) 10 20 30					
197.8	Ground Surface													
0.0	Topsoil, Fill													
196.6														
0.9	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	49									
	Hard		2	SS	67									
			3	SS	61									
	Brown Grey		4	SS	75									
			5	SS	132/25	B								9 33 48 10
			6	SS	136									
			7	SS	100/15	B								28 26 33 13
			8	SS	100/13	B								
189.6			9	SS	100/15	B								
7.9	End of Borehole													
	* W.L. not established													



LEGEND

-  Bore Hole
-  Bore Hole & Cone

NOTE

FOR SUBSOIL INFORMATION REFER
TO RECORD OF BOREHOLE SHEETS.

PLAN
NOT TO SCALE

HWY 410 HIGH MAST LIGHTING POLES (From Hwy 401 northerly to north of Steeles Ave)

HWY 410

CENTRAL REGION

WP 595-90-00

GEOCRES No 30M12-226

DATE 1995 06 15

Figure No 1



FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 96-01

WP	595-90-00	REGION	Central
HWY	410	STR SITE	-

High Mast Lighting Poles
Hwy. 410, From Hwy. 401 Northerly to
North of Steeles Avenue

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GEOCRES 30M12-226

DATE JUN 26 1995

FOUNDATION INVESTIGATION REPORT
For
High Mast Lighting Poles
Hwy 410, From Hwy 401 Northerly to North of Steeles Ave.
W.P. 595-90-00, Hwy. 410, Central Region

INTRODUCTION

This report presents soil information for the proposed 32 high mast light poles (P1 through P32) at the above mentioned site. Soil information was obtained from previous subsurface investigations in the area (Geocres 30M12-187, 189, 193, 194, 195 and 204). This report is produced at the request of Central Region Structural Section.

SUBSURFACE CONDITIONS

The appended seven Record of Borehole sheets (details below) have been selected from previous projects to represent the soil conditions for this project. The locations of the boreholes are shown on Figure 1. The native soil in general is a competent cohesive glacial till. The consistency of the material in general is very firm to hard but on average hard (N-values ranging from 5 blows to more than 100 blows/0.3m, with an average N-value of more than 30 blows/0.3m). The closest boreholes (listed below) should be referred for the soil condition at the HML locations. The glacial till is underlain by shale bedrock. Generally, the bedrock elevation at the site is lower at the north end. At the south end, near Hwy 401 the bedrock elevation is higher and can be encountered within few metres below the ground surface. The bedrock elevation at the site varies from 174.2m to 190.0m

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
BH 2	N 4,833,058.8; E 291,687.5	30M12-189
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BH 101	N 4,836,970.8; E 288,281.7	30M12-194
BH 3	N 4,838,214.5; E 287,746.8	30M12-187
BH 4	N 4,838,214.3; E 287,693.0	30M12-187

DISCUSSION AND RECOMMENDATIONS

It is proposed to install 32 high mast lighting poles (P1 through P32) on Hwy 410 from north of Hwy 401 to north of Steeles Avenue.

The High Mast Lighting poles will be founded on single reinforced concrete caissons. The foundations for HML should be designed in accordance with the methods described by B.B. Broms in the following two 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.

Broms, B.B.; Lateral Resistance of Piles in Cohesionless Soils,
Journal of the Soil Mechanics and Foundations Division,
ASCE, Vol.90, No.SM3, Paper 3909, May 1964.

There will be some grade changes at the HML pole locations. At all HML locations, except P27 the existing grade will be raised. The fill height will range from 0.2m to 2.7m with an average fill height of 1.4m. At P27 the grade will be lowered by 0.9m.

There are two options for the design of the HML foundations:

Option 1 (Preferred)

Assume that the soil condition at any HML pole location is similar to the soil condition in the borehole logs closest to the proposed HML location. The closest boreholes to be used for design are as follows:

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
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BH 4	N 4,838,214.3; E 287,693.0	30M12-187

Use the following soil parameters for design:

In Glacial Till

Q_u	= Unconfined Compressive Strength = 250 kPa
γ	= Unit Weight = 21.2 kN/m ³
Water Level	= As shown on the log sheet closest to the HML location.

In Shale Bedrock

Q_u	= Unconfined Compressive Strength = 750 Kpa
γ	= Unit Weight = 22.5 Kn/m ³
Water Level	= As shown on the log sheet closest to the HML location.

For any existing fill overlying the native soil following parameters should be used taking into consideration that only half of the fill height would provide lateral support:

ϕ	= 30°
γ	= 20 kN/m ³

It should be assumed that soil in the zone of frost penetration does not provide any lateral resistance. The depth of frost penetration at this site is 1.2m.

Option 2

If the project schedule does not permit for a detailed design of the foundation using these parameters, then all the caisson foundations within glacial till should be 8m deep. If the caisson foundation is to be constructed entirely in the shale bedrock then the caisson foundation should be 4m deep.

Construction Consideration:

Since, the recommendation for the HML foundation design is provided without any detailed Foundation investigation, it is recommended that the caissons should be inspected at the time of construction to verify that the soil condition is similar to the soil condition encountered in previous investigations. We suggest that the inspection could be accomplished by a contract employee recommended by the Foundation Design office and retained by the Construction office for the duration of the construction project. This approach has been used effectively for previous projects.

It is recommended that a non-standard special provision for the construction of HML foundations, should be incorporated in the contract. A copy of the latest NSSP is attached to this report for reference. The contractor should be advised that variable types of subsurface material may be encountered at the high mast light pole locations; and that the soil descriptions in this report are generalized and not site specific. For construction planning purposes it may be assumed that;

- Groundwater is at or near the surface.
- Cohesionless material may be encountered and it would be susceptible to disturbance under conditions of unbalanced hydrostatic head.
- Glacial deposits are anticipated and there is a probability that occasional cobbles and boulders may be encountered within the deposit.
- In some areas bedrock is present at shallow depth. It is possible that in some areas caisson drilling will take place partially or entirely in the bedrock.

The Contractor is responsible for constructing the high mast pole foundations without disturbing the material at the sides or bases of the foundations. His proposal should be capable of dealing with the above-noted site condition. The Contractor shall submit his proposed construction method to the Engineer for review a minimum of 15 working days prior to the commencement of construction of these foundation elements.

Miscellaneous

The soil information for this project was obtained from previous Foundation Investigation in this area (Geocres 30M12-187, 189, 193, 194, 195 and 204). This report was prepared by K.S.Q. Ahmad, Foundation Engineer, reviewed and approved by D. Dundas, Senior Foundation Engineer.



A handwritten signature in cursive script, appearing to read "K.S.Q. Ahmad", positioned above the printed name and title.

K.S.Q. Ahmad, P. Eng.
Foundation Engineer



A handwritten signature in cursive script, appearing to read "D. Dundas", positioned above the printed name and title.

D. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

GEOCRES 30M12-189

RECORD OF BOREHOLE No 2

METRIC

W P 54-82-11 LOCATION Co-ords. N 4 833 058.8; E 291 687.5 ORIGINATED BY DT
DIST 6 HWY 410/401 BOREHOLE TYPE Wash Bore BX Casing, BQ Rock Core COMPILED BY HS
DATUM Geodetic DATE 84 10 03 CHECKED BY [Signature]

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			20	40	60	80	100					
183.9	Ground Surface															
0.0	Heterogeneous Mixture of Silty Clay some sand															
183.0	Occasional shale slabs															
0.9																
	Gray Shale Bedrock with Limestone Bands		1	RC BQ		183	REC	BQD	Weathering							
			2	RC BQ		182	25%	0	Highly							
			3	RC BQ		181	63%	26%								
	Gray Limestone Bedrock with Shale Bands		4	RC BQ		180	65%	16%	Slightly to Unweathered							
			5	RC		179	100%	0								
			6	BQ			93%	0								
178.7																
5.2	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 474.4; E 290 498.2
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test
 DATUM Geodetic DATE 87 12 02 and 03
 ORIGINATED BY TS
 COMPILED BY TS
 CHECKED BY TS

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						
186.5	Ground Surface							○ UNCONFINED * FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	70		186								
	Brown Grey		2	SS	37		184	120/20 cm						22.8	
	Hard		3	SS	41		182							23.1	3 32 40 25
	Very Stiff		4	SS	23		180							23.2	5 35 48 12
	Hard		5	SS	80/15 cm		178								
			6	SS	60/7 cm		176								
			7	SS	120/7 cm										
174.2			8	SS	100/15 cm									22.7	3 45 44 8
12.3	End of Borehole Probable Bedrock														

RECORD OF BOREHOLE No 6

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 433.6; E 290 448.2
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test
 DATUM Geodetic DATE 87 12 04
 ORIGINATED BY TS
 COMPILED BY TS
 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W WL	Wp W WL	Wp W WL		
187.0	Ground Surface												
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55		186					23.1	12 23 41 24
	Brown Grey	Hard	2	SS	50		184						
			3	SS	24								
			4	SS	29								
			5	SS	30		182					23.6	8 32 44 16
		Very Stiff	6	SS	18		180						
			7	SS	55								
			8	SS	75								
			9	SS	70		178						13 30 32 25
	Silt Very Dense		10	SS	100		176						
	Hard		11	SS	100	15 cm	174						
173.2			12	SS	100	7 cm							
13.8	End of Borehole Probable Bedrock												

RECORD OF BOREHOLE No 8

METRIC

W P 103-69-15 LOCATION Co-ords. 4 835 522.5 N; 289.437.5 E. ORIGINATED BY TR
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers; BX Rock Core COMPILED BY AT
DATUM Geodetic DATE 1985 12 06-09 CHECKED BY 14

[illegible]

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE

GEOCRES 30M12-187

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 214.5; E 287 746.8
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test
DATUM Geodetic DATE 84 08 07
ORIGINATED BY JA
COMPILED BY JA
CHECKED BY AS

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 (%) 10 20 30	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.5	Ground Surface										
0.0	Sand and Gravel (shoulder)										
196.8											
0.7	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	9						
	Hard		2	SS	27						
			3	SS	32						
			4	SS	64						
	- Brown Gray		5	SS	42						
			6	SS	72						
			7	SS	82						
			8	SS	128						
			9	SS	90	10 cm					
			10	SS	100	18 cm					
			11	SS	100	13 cm					
			12	SS	100	18 cm					
188.2	End of Borehole										
9.3	* W.L. not established										

OFFICE REPORT ON SOIL EXPLORATION

GEOCRES 30M12-187

RECORD OF BOREHOLE No 4										METRIC			
W P 21-79-18		LOCATION Co-ords. N 4 838 214.3; E 287 693.0				ORIGINATED BY JA							
DIST 6 HWY 410		BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test				COMPILED BY JA							
DATUM Geodetic		DATE 84 08 08				CHECKED BY PS							
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			VALUES	20 40 60 80 100					
197.5	Ground Surface												
0.0	Topsail, Fill												
196.6													
0.9	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	49								
	Hard		2	SS	67								
	Brown Gray		3	SS	61								
			4	SS	75								
			5	SS	132/25 cm								9 33 48 10
			6	SS	136								
			7	SS	100/15 cm								28 26 33 13
			8	SS	100/13 cm								
189.6			9	SS	100/15 cm								
7.9	End of Borehole												
	* W.L. not established												

NON STANDARD SPECIAL PROVISION

Sheet _____ of _____
Date _____

WP NO _____ Contract No _____
Location _____

District No _____ Hwy No _____
Type of Work _____

This SP in new (✓) []
This SP replaces No _____
Remarks:

Explanation of Intent: To define High Mast Pole construction

Item No	Spec No	Title or Item Description
		CONCRETE FOOTING FOR HIGH MAST POLES

CONSTRUCTION

The Contractor is advised that variable types of subsurface material may be encountered at the high mast light pole locations; for addition information regarding soil conditions the Contractor is referred to the Foundation Investigation Report.

For bidding purposes it may be assumed that:

- Ground water is at or near the surface.
- If cohesionless material is encountered, it would be susceptible to disturbance under conditions of unbalanced hydrostatic head.
- If glacial deposits are encountered, there is a probability that occasional cobbles and boulders may be encountered within the deposit.
- Bedrock will be encountered within the caisson limits at locations that can be interpolated from the Foundation Investigation Report.

The Contractor is responsible for constructing the high mast pole foundations without disturbing the material at the sides or bases of the foundations. The Contractor shall submit eight copies of the proposed construction method to the Engineer for review a minimum of 15 working days prior to the commencement of construction of these foundation elements.

BASIS OF PAYMENT

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment and materials required to do the work.

Initiated by _____

Detailed by _____

Approved by _____

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 TUBF 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

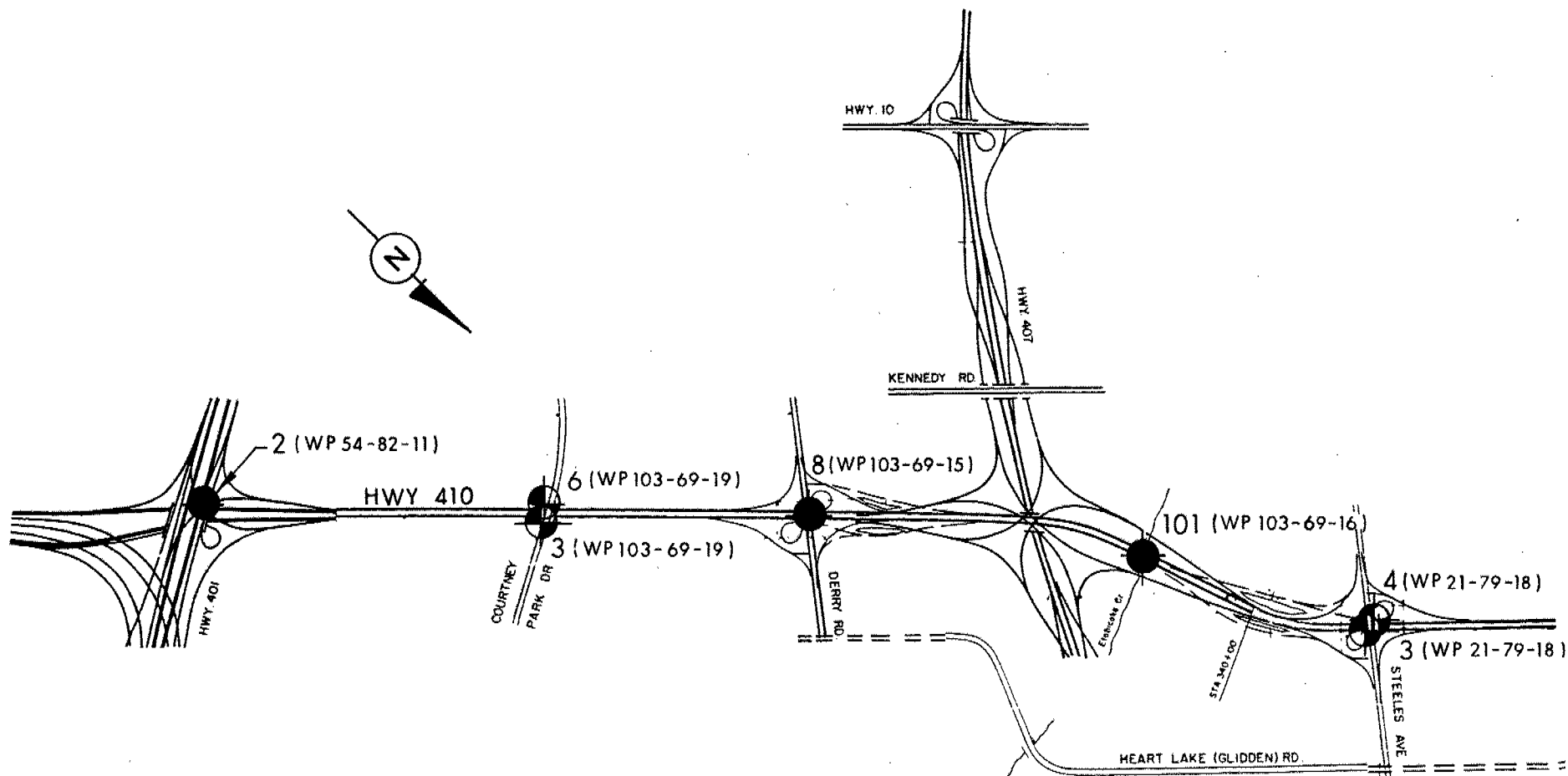
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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						



LEGEND

-  Bore Hole
-  Bore Hole & Cone

NOTE

FOR SUBSOIL INFORMATION REFER
TO RECORD OF BOREHOLE SHEETS.

PLAN
NOT TO SCALE

HWY 410 HIGH MAST LIGHTING POLES (From Hwy 401 northerly to north of Steeles Ave)

HWY 410

CENTRAL REGION

WP 595-90-00

GEOCREs No 30M12-226

DATE 1995 06 15

Figure No 1

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-226

DIST. 6 REGION

W.P. No. 595-90-00

CONT. No. 96-01

W. O. No.

STR. SITE No.

HWY. No. 41b

LOCATION HML, 401 to N of
 Steekles Are

No of PAGES -

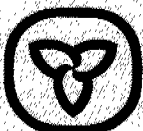
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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 96-01



Ontario

**Ministry of
Transportation**

INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 13	Foundation Investigation Report for High Mast Lighting Poles Hwy 410, from Hwy. 401 Northerly to North of Steeles Avenue W.P. 595-90-00 Hwy. 410, Central Region

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above-mentioned project.

EXPLANATION OF TERMS USED IN REPORT

2

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.

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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.

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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'	$^\circ$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	$^\circ$	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						

FOUNDATION INVESTIGATION REPORT
 For
 High Mast Lighting Poles
 Hwy 410, From Hwy 401 Northerly to North of Steeles Ave.
 W.P. 595-90-00, Hwy. 410, Central Region

INTRODUCTION

This report presents soil information for the proposed 32 high mast light poles (P1 through P32) at the above mentioned site. Soil information was obtained from previous subsurface investigations in the area (Geocres 30M12-187, 189, 193, 194 and 204). This report is produced at the request of Central Region Structural Section.

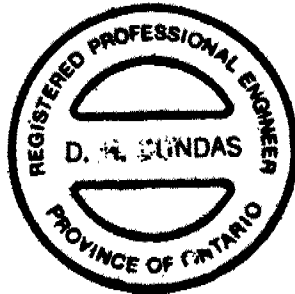
SUBSURFACE CONDITIONS

The appended seven Record of Borehole sheets (details below) have been selected from previous projects to represent the soil conditions for this project. The locations of the boreholes are shown on Figure 1. The native soil in general is a competent cohesive glacial till. The consistency of the material in general is very firm to hard but on average hard (N-values ranging from 5 blows to more than 100 blows/0.3m, with an average N-value of more than 30 blows/0.3m). The closest boreholes (listed below) should be referred for the soil condition at the HML locations. The glacial till is underlain by shale bedrock. Generally, the bedrock elevation at the site is lower at the north end. At the south end, near Hwy 401 the bedrock elevation is higher and can be encountered within few metres below the ground surface. The bedrock elevation at the site varies from 174.2m to 190.0m

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
BH 2	N 4,833,058.8; E 291,687.5	30M12-189
BH 3	N 4,834,474.4; E 290,498.2	30M12-204
BH 6	N 4,834,433.6; E 290,448.2	30M12-204
BH 8	N 4,835,522.5; E 289,437.5	30M12-193
BH 101	N 4,836,970.8; E 288,281.7	30M12-194
BH 3	N 4,838,214.5; E 287,746.8	30M12-187
BH 4	N 4,838,214.3; E 287,693.0	30M12-187

MISCELLANEOUS

The soil information for this project was obtained from previous Foundation Investigation in this area (Geocres 30M12-187, 189, 193, 194 and 204). This report was prepared by K.S.Q. Ahmad, Foundation Engineer, reviewed and approved by D. Dundas, Senior Foundation Engineer.



for Tae Chul Kim
D. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

WP595-90-00 RECORD OF BOREHOLE No 2 METRIC

W P 54-82-11 (FORMERLY) LOCATION Co-ords. N 4 833 058.8; E 291 687.5 ORIGINATED BY DT

DIST 6 HWY 410/401 BOREHOLE TYPE Wash Bore BX Casing, BQ Rock Core COMPILED BY BS

DATUM Geodetic DATE 84 10 03 CHECKED BY *EP*

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					
183.9	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay some sand																
183.0	Occasional shale slabs																
0.9																	
	Grey Shale Bedrock with Limestone Bands		1	RC BQ			183	REC	RQD	Weathering							
			2	RC BQ			182	25%	0	Highly							
			3	RC BQ			181	63%	26%								
	Grey Limestone Bedrock with Shale Bands		4	RC BQ			180	65%	16%	Slightly to Unweathered							
			5	RC			179	100%	0								
178.7			6	RC BQ				93%	0								
3.2	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



WP 595-90-00

RECORD OF BOREHOLE No 3

METRIC

W P 103-69-19 (FORMERLY) LOCATION Co-ords. N 4 834 474.4; E 290 498.2

ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test

COMPILED BY TS

DATUM Geodetic DATE 87 12 02 and 03

CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y KN/m ³	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						

186.5	Ground Surface													
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)						186							
	Brown- Grey		1	SS	70		184	120/20 cm					22.8	
			2	SS	37								23.1	3 32 40 25
			3	SS	41		182							
			4	SS	23		180						23.2	5 35 48 12
			5	SS	80	15 cm	178							
			6	SS	60	7 cm	176							
			7	SS	120	7 cm							22.7	3 45 44 8
174.2			8	SS	100	15 cm								
12.3	End of Borehole Probable Bedrock													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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 (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
187.0	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55		186			23.1	12 23 41 24
	Brown Grey	Hard	2	SS	50		184				
			3	SS	24						
			4	SS	29						
			5	SS	30		182			23.6	8 32 44 16
		Very Stiff	6	SS	18						
			7	SS	55		180				
			8	SS	75						
			9	SS	70		178				13 30 32 25
	Silt Very Dense		10	SS	100		176				
	Hard		11	SS	100	15 cm					
173.2			12	SS	100	7 cm	174				
13.8	End of Borehole Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

WP 595-90-00			RECORD OF BOREHOLE No 8			METRIC						
W P 103-69-15 (FORMERLY)			LOCATION Co-ords. 4 835 522.5 N; 289 437.5 E.			ORIGINATED BY IW						
DIST 6 HWY 410			BOREHOLE TYPE Hollow Stem Augers: BX Rock Core			COMPILED BY AET						
DATUM Geodetic			DATE 1983 12 06-09			CHECKED BY /						
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					
186.6	Ground Level											
0.0	Topsoil		1	SS	8							
186.3			2	SS	28							
0.3	Very stiff		3	SS	45							
	Hard		4	SS	68							
	Heterogeneous mixture of silty clay, sand & gravel		5	SS	64							
	(Glacial Till)		6	SS	74							
			7	SS	100/0.15							
			8	SS	74							
			9	SS	83							
			10	SS	70							
			11	SS	80/0.15							
			12	RC BX	94%							
			13	RC BX	92%							
174.3	Shale bedrock											
172.3	Weathered											
	Dark Grey											
171.4												
15.2	End of Borehole											

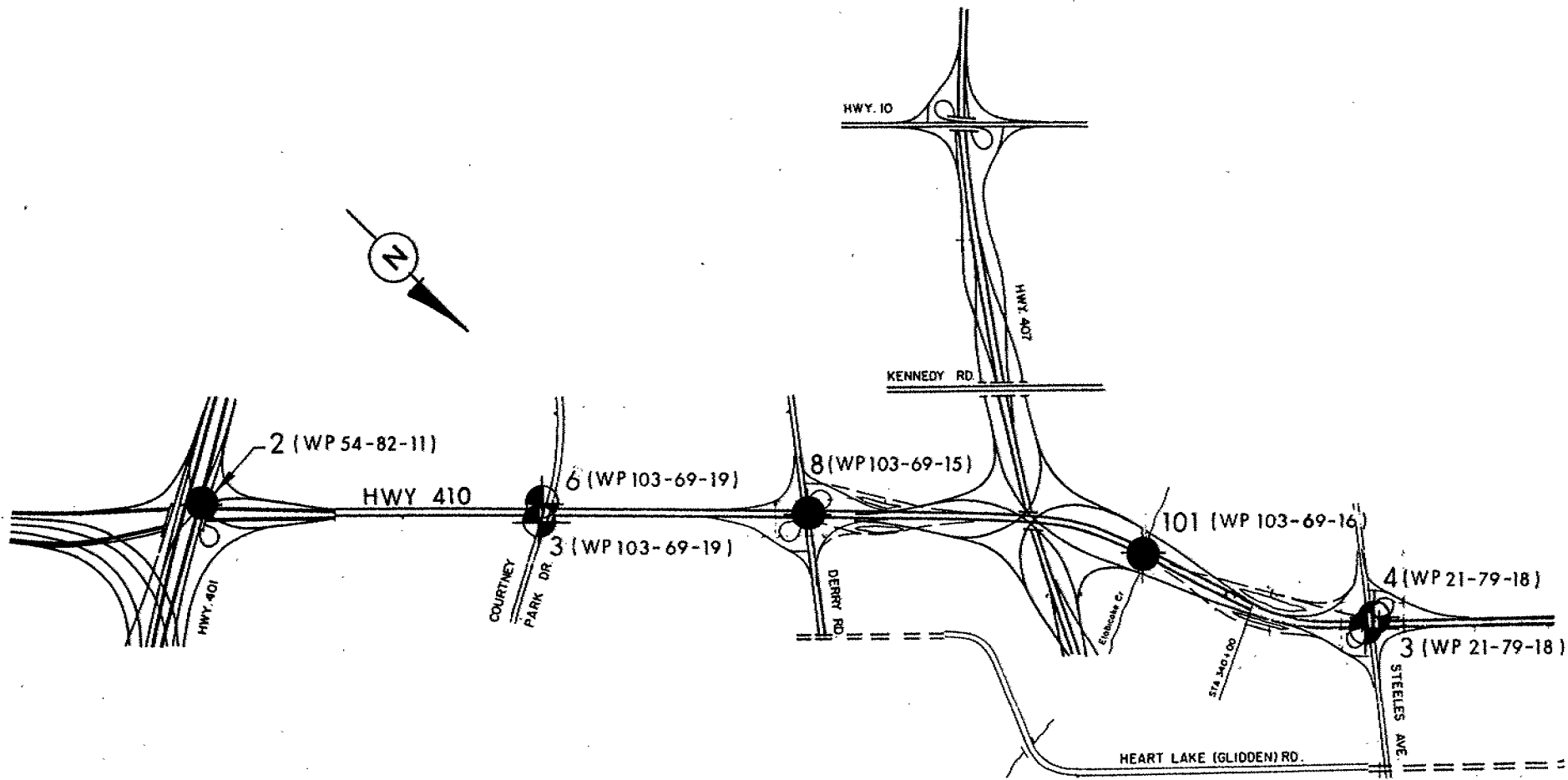
OFFICE REPORT ON SOIL EXPLORATION





WP 595-90-00			RECORD OF BOREHOLE No 101			METRIC						
W P 103-69-16 (FORMERLY)			LOCATION CO-ORDS: N 4 836 970.8; E 288 281.7			ORIGINATED BY DY						
DIST 6 HWY 410			BOREHOLE TYPE Solid Stem Auger			COMPILED BY DY						
DATUM Geodetic			DATE 85 12 11			CHECKED BY [Signature]						
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					
197.2	Ground Surface											
0.0	Topsoil											
	Sand with Silt, Changing to Silt with depth		1	SS	8							
			2	SS	19							
195.1	Loose to Compact											
2.1	Silty Clay, Trace Sand		3	SS	14							
			4	SS	11							
			5	SS	5							
192.8	Firm to Stiff											
4.4	Heterogeneous Mixture Silty Clay, Sand Gravel (Glacial Till)		6	SS	68/23 cm							0 5 56 39
	Hard		7	SS	65/18 cm							5 27 48 20
			8	SS	78/13 cm							
190.0												
7.2	Auger Grinding Probable Bedrock End of Borehole											
	* Groundwater Level not established											

WP 595-90-00				RECORD OF BOREHOLE No 3				METRIC						
W P 21-79-18 (FORMERLY)		LOCATION Co-ords. N 4 838 214.5; E 287 746.8		ORIGINATED BY JA										
DIST 6 HWY 410		BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test		COMPILED BY JA										
DATUM Geodetic		DATE 84 08 07		CHECKED BY AS										
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	WATER CONTENT (%) 10 20 30					
197.5	Ground Surface													
0.0	Sand and Gravel (shoulder)													
196.8														
0.7	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	9									
	Hard		2	SS	27									
			3	SS	32									
			4	SS	64									
	Brown Gray		5	SS	42									
			6	SS	72									
			7	SS	82									
			8	SS	128									
			9	SS	907	10 cm								
			10	SS	1007	18 cm								
			11	SS	1007	13 cm								
188.2			12	SS	1007	18 cm								
9.3	End of Borehole													
	* W.L. not established													

WP 595-90-00				RECORD OF BOREHOLE No 4				METRIC				
W P 21-79-18 (FORMERLY)		LOCATION Co-ords. N 4 838 214.3; E 287 693.0		ORIGINATED BY JA								
DIST 6 HWY 410		BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test		COMPILED BY JA								
DATUM Geodetic		DATE 84 08 08		CHECKED BY PS								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W_p	NATURAL MOISTURE CONTENT W		
197.8	Ground Surface											
0.0	Topsoil, Fill											
196.6	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)											
0.9	Hard											
	Brown Grey											
			1	SS	49							
			2	SS	67							
			3	SS	61							
			4	SS	75							
			5	SS	132/25	cm						9 33 48 10
			6	SS	136							
			7	SS	100/15	cm						28 26 33 13
			8	SS	100/13	cm						
189.6	End of Borehole		9	SS	100/15	cm						
7.9	* W.L. not established											



LEGEND

-  Bore Hole
-  Bore Hole & Cone

NOTE

FOR SUBSOIL INFORMATION REFER
TO RECORD OF BOREHOLE SHEETS.

PLAN
NOT TO SCALE

HWY 410 HIGH MAST LIGHTING POLES

(From Hwy 401 northerly to north of Steeles Ave)

HWY 410

CENTRAL REGION

WP 595-90-00

GEOCREs No 30M12-226

DATE 1995 06 15

Figure No 1



FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 96-01

WP	595-90-00	REGION	Central
HWY	410	STR SITE	-

High Mast Lighting Poles
Hwy. 410, From Hwy. 401 Northerly to
North of Steeles Avenue

DISTRIBUTION

V.F. Boehnke (3)
D. Billings
W. Peck (2)
B. Peltier (3)
M. Holowka
J. Robinson
E.A. Joseph
F. Bacchus (Cover Only)
✓ File

GEOCRES 30M12-226

DATE JUN 26 1995

FOUNDATION INVESTIGATION REPORT
For
High Mast Lighting Poles
Hwy 410, From Hwy 401 Northerly to North of Steeles Ave.
W.P. 595-90-00, Hwy. 410, Central Region

INTRODUCTION

This report presents soil information for the proposed 32 high mast light poles (P1 through P32) at the above mentioned site. Soil information was obtained from previous subsurface investigations in the area (Geocres 30M12-187, 189, 193, 194, 195 and 204). This report is produced at the request of Central Region Structural Section.

SUBSURFACE CONDITIONS

The appended seven Record of Borehole sheets (details below) have been selected from previous projects to represent the soil conditions for this project. The locations of the boreholes are shown on Figure 1. The native soil in general is a competent cohesive glacial till. The consistency of the material in general is very firm to hard but on average hard (N-values ranging from 5 blows to more than 100 blows/0.3m, with an average N-value of more than 30 blows/0.3m). The closest boreholes (listed below) should be referred for the soil condition at the HML locations. The glacial till is underlain by shale bedrock. Generally, the bedrock elevation at the site is lower at the north end. At the south end, near Hwy 401 the bedrock elevation is higher and can be encountered within few metres below the ground surface. The bedrock elevation at the site varies from 174.2m to 190.0m

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
BH 2	N 4,833,058.8; E 291,687.5	30M12-189
BH 3	N 4,834,474.4; E 290,498.2	30M12-204
BH 6	N 4,834,433.6; E 290,448.2	30M12-204
BH 8	N 4,835,522.5; E 289,437.5	30M12-193
BH 101	N 4,836,970.8; E 288,281.7	30M12-194
BH 3	N 4,838,214.5; E 287,746.8	30M12-187
BH 4	N 4,838,214.3; E 287,693.0	30M12-187

DISCUSSION AND RECOMMENDATIONS

It is proposed to install 32 high mast lighting poles (P1 through P32) on Hwy 410 from north of Hwy 401 to north of Steeles Avenue.

The High Mast Lighting poles will be founded on single reinforced concrete caissons. The foundations for HML should be designed in accordance with the methods described by B.B. Broms in the following two 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.

Broms, B.B.; Lateral Resistance of Piles in Cohesionless Soils,
Journal of the Soil Mechanics and Foundations Division,
ASCE, Vol.90, No.SM3, Paper 3909, May 1964.

There will be some grade changes at the HML pole locations. At all HML locations, except P27 the existing grade will be raised. The fill height will range from 0.2m to 2.7m with an average fill height of 1.4m. At P27 the grade will be lowered by 0.9m.

There are two options for the design of the HML foundations:

Option 1 (Preferred)

Assume that the soil condition at any HML pole location is similar to the soil condition in the borehole logs closest to the proposed HML location. The closest boreholes to be used for design are as follows:

<u>Boreholes</u>	<u>Co-ordinates</u>	<u>Geocres No</u>
BH 2	N 4,833,058.8; E 291,687.5	30M12-189
BH 3	N 4,834,474.4; E 290,498.2	30M12-204
BH 6	N 4,834,433.6; E 290,448.2	30M12-204
BH 8	N 4,835,522.5; E 289,437.5	30M12-193
BH 101	N 4,836,970.8; E 288,281.7	30M12-194
BH 3	N 4,838,214.5; E 287,746.8	30M12-187
BH 4	N 4,838,214.3; E 287,693.0	30M12-187

Use the following soil parameters for design:

In Glacial Till

Q_u	= Unconfined Compressive Strength = 250 kPa
γ	= Unit Weight = 21.2 kN/m ³
Water Level	= As shown on the log sheet closest to the HML location.

In Shale Bedrock

Q_u	= Unconfined Compressive Strength = 750 Kpa
γ	= Unit Weight = 22.5 Kn/m ³
Water Level	= As shown on the log sheet closest to the HML location.

For any existing fill overlying the native soil following parameters should be used taking into consideration that only half of the fill height would provide lateral support:

ϕ	= 30°
γ	= 20 kN/m ³

It should be assumed that soil in the zone of frost penetration does not provide any lateral resistance. The depth of frost penetration at this site is 1.2m.

Option 2

If the project schedule does not permit for a detailed design of the foundation using these parameters, then all the caisson foundations within glacial till should be 8m deep. If the caisson foundation is to be constructed entirely in the shale bedrock then the caisson foundation should be 4m deep.

Construction Consideration:

Since, the recommendation for the HML foundation design is provided without any detailed Foundation investigation, it is recommended that the caissons should be inspected at the time of construction to verify that the soil condition is similar to the soil condition encountered in previous investigations. We suggest that the inspection could be accomplished by a contract employee recommended by the Foundation Design office and retained by the Construction office for the duration of the construction project. This approach has been used effectively for previous projects.

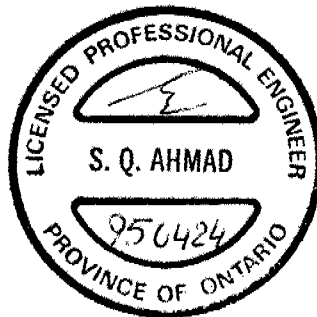
It is recommended that a non-standard special provision for the construction of HML foundations, should be incorporated in the contract. A copy of the latest NSSP is attached to this report for reference. The contractor should be advised that variable types of subsurface material may be encountered at the high mast light pole locations; and that the soil descriptions in this report are generalized and not site specific. For construction planning purposes it may be assumed that;

- Groundwater is at or near the surface.
- Cohesionless material may be encountered and it would be susceptible to disturbance under conditions of unbalanced hydrostatic head.
- Glacial deposits are anticipated and there is a probability that occasional cobbles and boulders may be encountered within the deposit.
- In some areas bedrock is present at shallow depth. It is possible that in some areas caisson drilling will take place partially or entirely in the bedrock.

The Contractor is responsible for constructing the high mast pole foundations without disturbing the material at the sides or bases of the foundations. His proposal should be capable of dealing with the above-noted site condition. The Contractor shall submit his proposed construction method to the Engineer for review a minimum of 15 working days prior to the commencement of construction of these foundation elements.

Miscellaneous

The soil information for this project was obtained from previous Foundation Investigation in this area (Geocres 30M12-187, 189, 193, 194, 195 and 204). This report was prepared by K.S.Q. Ahmad, Foundation Engineer, reviewed and approved by D. Dundas, Senior Foundation Engineer.



A handwritten signature in cursive script, appearing to read "K.S.Q. Ahmad", positioned above the printed name and title.

K.S.Q. Ahmad, P. Eng.
Foundation Engineer



A handwritten signature in cursive script, appearing to read "D. Dundas", positioned above the printed name and title.

D. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

GEOCRES 30M12-189

RECORD OF BOREHOLE No 2

METRIC

W P 54-82-11 LOCATION Co-ords. N 4 833 058.8; E 291 687.5 ORIGINATED BY DT
DIST 6 HWY 410/401 BOREHOLE TYPE Wash Bore BX Casing, BQ Rock Core COMPILED BY BS
DATUM Geodetic DATE 84 10 03 CHECKED BY EP

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					
183.9	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay some sand																
183.0	Occasional shale slabs																
0.9																	
	Gray Shale Bedrock with Limestone Bands		1	RC BQ			183	REC	BQD	Weathering							
			2	RC BQ			182	25%	0	Highly							
			3	RC BQ			181	63%	26%								
	Gray Limestone Bedrock with Shale Bands		4	RC BQ			180	65%	16%	Slightly to Unweathered							
			5	RC			179	100%	0								
			6	BQ				93%	0								
178.7																	
5.2	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 474.4; E 290 498.2
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test
 DATUM Geodetic DATE 87 12 02 and 03
 ORIGINATED BY TS
 COMPILED BY TS
 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)			
186.5	Ground Surface									10 20 30			
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	70		186					22.8	
	Brown Grey		2	SS	37		184	120/20 cm				23.1	3 32 40 25
	Hard		3	SS	41		182						
			4	SS	23		180					23.2	5 35 48 12
	Very Stiff		5	SS	80/15 cm		178						
			6	SS	60/7 cm		176					22.7	3 45 44 8
	Hard		7	SS	120/7 cm								
174.2			8	SS	100/15 cm								
12.3	End of Borehole Probable Bedrock												

RECORD OF BOREHOLE No 6

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 433.6; E 290 448.2
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test
 DATUM Geodetic DATE 87 12 04
 ORIGINATED BY TS
 COMPILED BY TS
 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
187.0	Ground Surface													
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55		186						23.1	12 23 41 24
	Brown Grey		2	SS	50		184							
	Hard		3	SS	24									
			4	SS	29									
			5	SS	30		182						23.6	8 32 44 16
	Very Stiff		6	SS	18		180							
			7	SS	55									
			8	SS	75									
	Silt Very Dense		9	SS	70		178							13 30 32 25
			10	SS	100		176							
	Hard		11	SS	100	15 cm								
173.2			12	SS	100	7 cm	174							
13.8	End of Borehole Probable Bedrock													

RECORD OF BOREHOLE No 8

METRIC

W P 103-69-15 LOCATION Co-ords. 4 835 522.5 N; 289 437.5 E. ORIGINATED BY JH
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers; BX Rock Core COMPILED BY JH
DATUM Geodetic DATE 1985 12 06-09 CHECKED BY JH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	Wp	W	Wl		
186.6	Ground Level															
0.0	Topsoil		1	SS	8											
186.3																
0.3	Very stiff		2	SS	28											
	Hard		3	SS	45											
	Heterogeneous mixture of silty clay, sand & gravel		4	SS	68											
	(Glacial Till)		5	SS	64											
	Brown Grey		6	SS	74											
			7	SS	100/ 0.15											
			8	SS	74											
			9	SS	83											
			10	SS	70											
174.3			11	SS	80/ 0.1											
12.3	Shale bedrock															
	Weathered															
	Dark Grey		12	RC BX	94%											
			13	RC BX	92%											
171.4																
15.2	End of Borehole															

RECORD OF BOREHOLE No 101

METRIC

W P 103-69-16

LOCATION CO-ORDS: N 4 836 970.8; E 288 281.7

ORIGINATED BY DY

DIST 6 HWY 410

BOREHOLE TYPE Solid Stem Auger

COMPILED BY DY

DATUM Geodetic

DATE 85 12 11

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	Wl					
197.2	Ground Surface						197									
0.0	Topsoil					*										
	Sand with Silt, Changing to Silt with depth		1	SS	8		196									
195.1	Loose to Compact		2	SS	19		195									
2.1	Silty Clay, Trace Sand		3	SS	14		194									
			4	SS	11		193									
192.8	Firm to Stiff		5	SS	5		192									
4.4	Heterogeneous Mixture Silty Clay, Sand Gravel (Glacial Till)		6	SS	68/ 23 cm		191									
	Hard		7	SS	65/ 18 cm											
			8	SS	78/ 13 cm											
190.0	Auger Grinding Probable Bedrock End of Borehole															
	* Groundwater Level not established															

+3, x5: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

GEOCRES 30M12-187

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 214.5; E 287 746.8
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test
DATUM Geodetic DATE 84 08 07
ORIGINATED BY JA
COMPILED BY JA
CHECKED BY AS

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								
197.5	Ground Surface												
0.0	Sand and Gravel (shoulder)												
196.8													
0.7	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till)		1	SS	9								
	Hard		2	SS	27								
			3	SS	32								
			4	SS	64								
	- Brown Gray		5	SS	42								
			6	SS	72								
			7	SS	82								
			8	SS	128								
			9	SS	907	10 cm							
			10	SS	1007	18 cm							
			11	SS	1007	13 cm							
			12	SS	1007	18 cm							
188.2	End of Borehole												
9.3	* W.L. not established												

OFFICE REPORT ON SOIL EXPLORATION

GEOCRE 30M12-187

RECORD OF BOREHOLE No 4

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 214.3; E 287 693.0 ORIGINATED BY JA
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test COMPILED BY JA
DATUM Geodetic DATE 84 08 08 CHECKED BY PS

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 (%) 10 20 30	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.5	Ground Surface										
0.0	Topsoil, Fill										
196.6	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till) Hard		1	SS	49						
0.9			2	SS	67						
			3	SS	61						
			4	SS	75						
			5	SS	132/25 cm						9 33 48 10
			6	SS	136						
			7	SS	100/15 cm						28 26 33 13
			8	SS	100/13 cm						
189.6			9	SS	100/15 cm						
7.9	End of Borehole * W.L. not established										

NON STANDARD SPECIAL PROVISION

Sheet _____ of _____
Date _____

WP NO _____ Contract No _____
Location _____

District No _____ Hwy No _____
Type of Work _____

This SP in new (✓) []
This SP replaces No _____
Remarks:

Explanation of Intent: To define High Mast Pole construction

Item No	Spec No	Title or Item Description
		CONCRETE FOOTING FOR HIGH MAST POLES

CONSTRUCTION

The Contractor is advised that variable types of subsurface material may be encountered at the high mast light pole locations; for addition information regarding soil conditions the Contractor is referred to the Foundation Investigation Report.

For bidding purposes it may be assumed that:

- Ground water is at or near the surface.
- If cohesionless material is encountered, it would be susceptible to disturbance under conditions of unbalanced hydrostatic head.
- If glacial deposits are encountered, there is a probability that occasional cobbles and boulders may be encountered within the deposit.
- Bedrock will be encountered within the caisson limits at locations that can be interpolated from the Foundation Investigation Report.

The Contractor is responsible for constructing the high mast pole foundations without disturbing the material at the sides or bases of the foundations. The Contractor shall submit eight copies of the proposed construction method to the Engineer for review a minimum of 15 working days prior to the commencement of construction of these foundation elements.

BASIS OF PAYMENT

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment, and materials required to do the work.

Initiated by _____

Detailed by _____

Approved by _____

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

MECHANICAL PROPERTIES OF SOIL

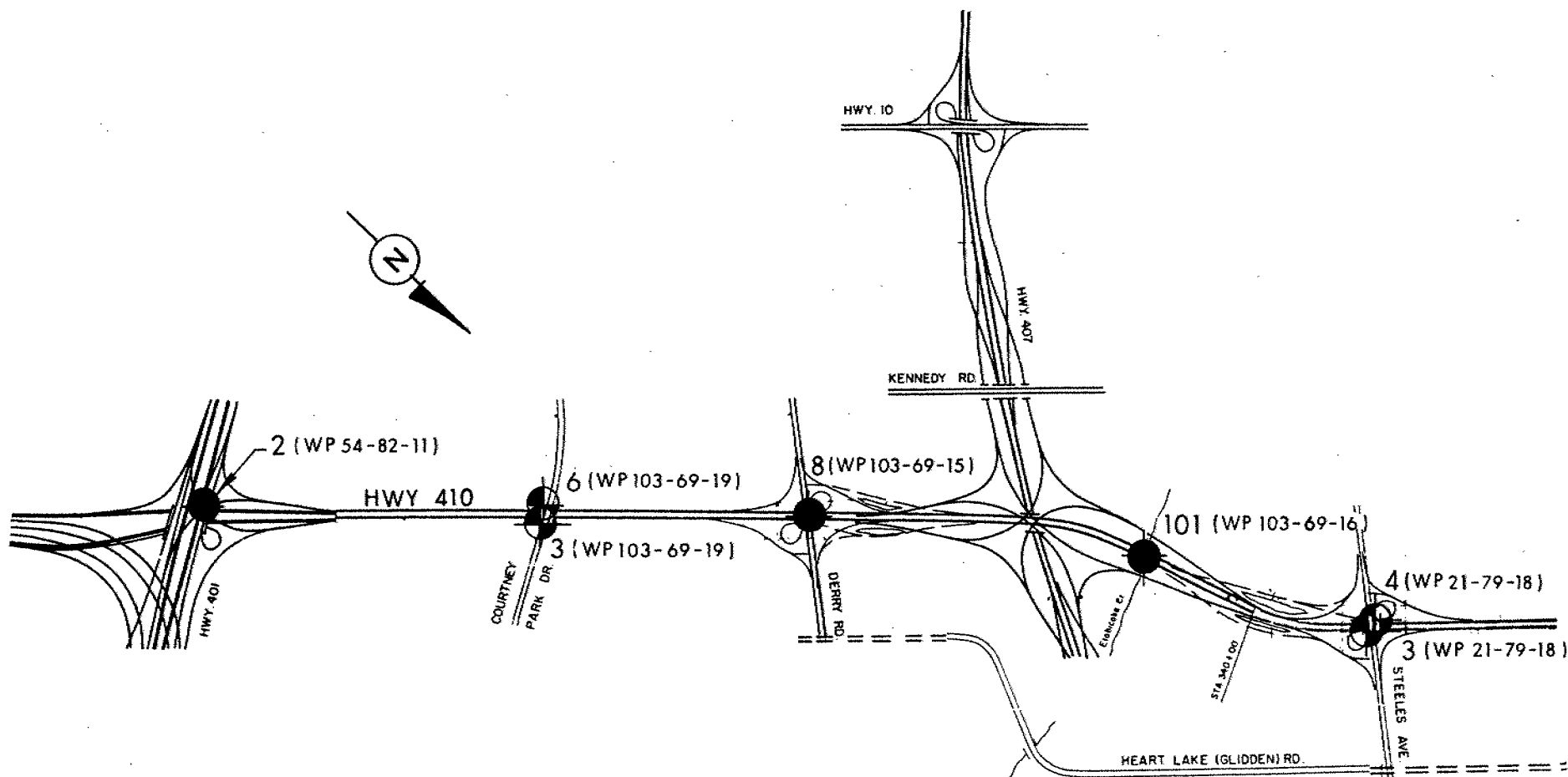
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{VO}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



LEGEND

-  Bore Hole
-  Bore Hole & Cone

NOTE

FOR SUBSOIL INFORMATION REFER
TO RECORD OF BOREHOLE SHEETS.

PLAN
NOT TO SCALE

HWY 410 HIGH MAST LIGHTING POLES (From Hwy 401 northerly to north of Steeles Ave)

HWY 410

CENTRAL REGION

WP 595-90-00

GEOCREs No 30M12-226

DATE 1995 06 15

Figure No 1