

G.I.-30 SEPT. 1976

GEOCRES No. 3165-187DIST. 9 REGION W.P. No. 127-87-00CONT. No. 94-22W. O. No. STR. SITE No. HWY. No. 416LOCATION Hwy 416 from S of Baseline Rd.
Northerly to Hwy 417 (H.M.L.)No of PAGES - OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

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Ministry
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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 94-22

WP 127-87-00 DIST 9

HWY 416 STR SITE -

Proposed High Mast Light Poles
Highway 416 From South of Baseline Rd.
Northerly to Highway 417

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FOUNDATION INVESTIGATION REPORT
For
Proposed High Mast Light Poles
Highway 416 From South of Baseline Road
Northerly to Highway 417
W.P. 127-87-00
District 9, Ottawa

INTRODUCTION

A request for foundation investigation was made by Eastern Region Structural Section for the design of high mast light poles for the proposed Highway 416 from south of Baseline Road northerly to Highway 417. A number of foundation investigations have been carried out in the area before. The existing information is considered adequate to estimate the subsurface conditions at the proposed pole locations for the purpose of the design.

A thorough desk study has been carried out to extract the relevant information. This report summarizes the information collected and includes the foundation recommendations pertaining to the design of the high mast light poles. Proposed pole locations are illustrated in Figures 1 and 2 in the Appendix.

DISCUSSION AND RECOMMENDATIONS

General

Reference borehole numbers for each HML pole are tabulated in Table 1. Subsurface conditions at the location of the reference boreholes are shown on the record of borehole sheets in the Appendix. Groundwater levels may vary from the elevations shown in the record sheets due to seasonal fluctuations. Based on the subsoil information, the geotechnical design parameters are summarized in Table 2.

Foundation

The design of caissons for HML foundations shall be as per the "Procedures for the Design of High Mast Pole Foundations" prepared by the Structural Office, Procedures Section, dated January 1993. Where bedrock is at or close to the finished ground surface, the HML foundation may be designed as spread footing/shallow caisson with dowels into bedrock. Recommendations for the design of dowels are also included in Table 2.

The soils within 1.8 m of the finished grade should be neglected in the calculation for lateral resistance due to frost penetration. The finished grades of some of the HML poles is different from the existing ground surface. In these cases, the HML poles will be founded in a fill or a cut. The design of HML poles located in fills or cuts shall be as per the general guidelines given in a memo from the Foundation Design Section dated 1990 04 02. A copy of this memo is attached to this report for easy reference. It is recommended that the construction be closely monitored and any unforeseen subsoil conditions be reported to this office so that design may be reviewed to suit actual site conditions.

Construction Considerations

For caisson construction, liners should be used to stabilize the sides during

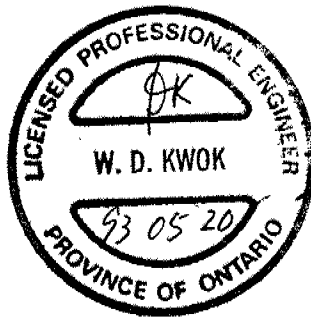
installation and concreting of the caissons, especially when excavation advances below the groundwater level in cohesionless materials. The founding base of the caisson should be pumped dry prior to concreting. Alternatively, tremie concrete may be used for underwater concreting.


It should be noted that the glacial till stratum contains occasional boulders. Installation of caissons through the glacial till stratum may encounter obstructions from boulders. Excavations for shallow footings are up to 3.4±m deep. Temporary cuts to the above mentioned depth can be made at a slope of 2H:1V or flatter. Dewatering in the form of sump pumping will be required to allow construction to be carried out under dry conditions.

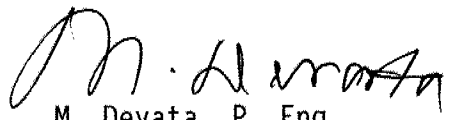
MISCELLANEOUS

This report was written by D. Kwok, Project Foundation Engineer, based on the investigation data extracted from various relevant foundation reports.

This report was reviewed by B. Iyer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.




D. Kwok, P.Eng
Project Foundation Engineer


M. Devata, P. Eng.
Chief Foundation Engineer

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

From: Foundation Design Section
Room 315, Central Building

Re: High Mast Lighting Foundations
on Cut and Fill Slopes

Date: 1990 04 02

Further to our meeting of February 26, 1990 and your subsequent minutes we have reviewed your proposal for high mast light foundations on slopes. Following are our comments on

- general implications for HML foundation on the slopes as opposed to in the median
- design implications for HML foundations on cut slopes

These comments are intended for planning purposes only. A foundation investigation would have to be initiated for each specific HML site. Since the foundation conditions will be variable, some refinement in foundation recommendations should be expected in the design phase of the project.

Slope Versus Median

There are a number of disadvantages in placing caisson foundations on slopes.

- The lateral resistance would be decreased due to the proximity of the caisson to the slope, inferior compaction near the slope and the reduction in passive resistance due to movement of the slope. These factors would contribute to deeper caissons.
- Access ramps would be required for caisson installation and permanent berms/benches would be required to increase lateral resistance and for maintenance access. These factors would increase property requirements and the complexity of grading.
- By not utilizing the full depth of the highway embankment and due to the implications for lateral resistance on slopes, caissons would be deeper thus increasing the risk of encountering artesian groundwater conditions. If artesian conditions are encountered, installation costs could be considerably higher and a drainage/filter system would have to be installed below frost level outletting to a permanent drain.

Cut Slopes

The design parameters for HML foundations at the toe of cut slopes will require investigation on a site specific basis. If the caissons are located on a bench a minimum of 3 m from the toe of slope as indicated in your proposal there would be no implication for the caisson design. Since the proposed toe wall at the base of the cut slope would have to retain a considerable earth pressure, it would be expensive. Therefore we recommend deleting it from the design and grading the slopes at 2:1.

Fill Slopes

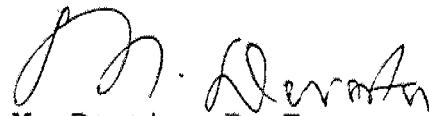
The implications for HML caissons on fill slopes are significant. The effects of settlement, slope movement, embankment compaction, and earth pressure on the caisson have been assessed resulting in the following recommendations.

Assuming that the proposed embankment geometry consists of an upper 4H:1V slope, 1.75 m high, then a 6 m berm, then 2H:1V slope:

- The design for caisson embedment can be calculated neglecting lateral resistance in the frost penetration zone but including lateral loads within the frost penetration zone.
- The caisson should be a minimum 3 m from the crest of the 2H:1V downslope.
- The properties of the fill will be site dependent but may involve a reduction of 10+% in strength parameters to account for uncertainties inherent in fill.
- The embankment should be preloaded prior to construction of the HML foundation in order to minimize settlement effects. The duration of the preload will be recommended on a site specific basis in the Foundation Report.
- The upper 60% of the embedment length within the fill (taken from frost penetration depth) should be disregarded for lateral resistance.

In conclusion, it is feasible to construct HML caissons on slopes as proposed. However, caissons would extend to a lower elevation and be more expensive. These costs should be compared to any savings that would result from locating HML's on the slopes instead of in the median.

If there are any questions, please advise.



M. Devata, P. Eng.
Chief Foundation Engineer

MD/BI/DD/mmj

cc: R. Dorton
B. Iyer
P. Payer
D. Dundas

APPENDIX

Table 1

REFERENCE BOREHOLE NUMBERS

HML Pole #	Ref. BH No.	Project No.	Orig. Grade	Final Grade
P13	10	120-87-04	66.5	68.4
	R4	120-87-01	68.5	
P12	12-4	121-87-04	66.7	74.3
	12-5	121-87-04	67.4	
P11	11-3	121-87-03	66.6	68.8
	11-4	121-87-03	67.3	
P10	R6	120-87-01	68.3	68.3
	15-3	121-87-05	67.9	
	15-4	121-87-05	69.4	
P9	15-4	121-87-05	69.4	68.8
	11-5	121-87-03	67.6	
P8	15-5	121-87-05	70.5	69.9
	10-7	127-87-03	72.3	
P7	15-5	121-87-05	70.5	68.0
	10-7	127-87-03	70.3	
P6	10-5	127-87-03	72.4	67.0
	10-6	127-87-03	71.7	
	10-4	127-87-03	72.9	
P5	89-8	127-87-00	76.8	70.2
	89-9	127-87-00	74.3	
P4	8-7	127-87-01	77.0	74.9
	89-8	127-87-00	76.8	
P3	8-7	127-87-01	77.0	72.7
	2	146-74-00	74.8	
P2	3	146-74-00	78.7	78.6
	9-5	127-87-02	78.8	
P1	9-8	127-87-02	80.7	77.2
	90-W1	126-87-01 (A)	85.5	
	88-3	146-74-00	81.0	

Table 2

GEOTECHNICAL DESIGN PARAMETERS

HML Pole #	Final Grade (m)	Elevation (m)	γ (kN/m ³)	ϕ (°)	(kPa)	Bond Capacity Bedrock/Grout (kPa)
P13	68.4	66.5-65 below 65	20 26	35 -	- -	- 500
P12	74.3	72.5-67 67-63 below 63	20 19 26	33 30 -	- - 20000	- - -
P11	68.9	67.0-65.2 65.2-62.2 below 62.2	19 20 26	- 35 -	40 - 20000	- - -
P10	68.3	below 67.9	26	-	-	500
P9	68.8	below 67.0	26	-	-	500
P8	69.9	below 69.9	26	-	-	500
P7	68.0	below 68.0	26	-	-	500
P6	67.0	below 67.0	26	-	-	500
P5	70.2	below 70.2	26	-	-	500
P4	74.9	73.1-71.5 below 71.5	21 26	38 -	- 20000	- 500
P3	72.7	below 72.7	26	-	-	500
P2	78.6 9-5	76.8-75.2 below 75.2	20 26	30 -	- 20000	500
P1	77.2	below 76.5	26	-	-	500

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 (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	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 = $\frac{w_L - w_p}{w - w_p}$	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						

FORMER		RECORD OF BOREHOLE No 88-3				METRIC			
W P 146-74-00		LOCATION Co-ords N 5 021 430; E 358 840		ORIGINATED BY PH					
DIST 9 HWY 416		BOREHOLE TYPE Hollow Stem Auger, NX & BXL Rock Core		COMPILED BY AC					
DATUM Geodetic		DATE October 19, 1988		CHECKED BY AC					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER						
81.0	Ground Surface								
0.0	Topsoil.								
0.2	Clayey silt and sandy silt, trace gravel, occasional sand layer.								
79.5	Loose Grey Brown		1	SS	5				
1.5	Silty clay and clayey silt, trace sand & gravel.		2	SS	3				
78.4	Very Stiff Grey Brown		3	SS	3				
2.6	Sandy silt to silty sand, some gravel, trace clay. (Glacial Till)		4	SS	5				
	Loose Grey Brown to Grey								
76.0			5	SS	10				
5.0	Dolostone bedrock, fresh, very thin to medium bedded grey, some sandy layers, occasional shale partings. (March Formation)		6	RC NX	REC= 100% RQD= 55%				
74.6			7	RC BXL	REC= 95% RQD= 84%				
6.4	Sandstone bedrock, fresh, thin to thickly bedded grey, occasional grey dolostone layer. (March Formation)		8	RC BXL	REC= 100% RQD= 98%				
			9	RC BXL	REC= 100% RQD= 100%				
70.6									
10.4	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION



W.P. 127-87-00

METRIC

ORIGINATED BY AC

COMPILED BY RN

CHECKED BY RW

+3, x5: Numbers refer to Sensitivity

FORMER		RECORD OF BOREHOLE No 9-8										METRIC			
W P 127-87-02		LOCATION Co-ords: N 5 021 452.9; E 358 794.0										ORIGINATED BY JW			
DIST 9 HWY 416		BOREHOLE TYPE H S Auger & Cone Test										COMPILED BY JW			
DATUM Geodetic		DATE 89 08 03										CHECKED BY			
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	W _p	W	W _L	WATER CONTENT (%)			
80.7	Ground Surface														
0.0	Silty Clay to Clayey Silt Some Sand, Occ. Sand Seams		1	SS	8										
	Brown Grey														
78.6	Firm		2	SS	6										
2.1	Het. Mixture of Silt, Sand & Gravel		3	SS	9										
	(Glacial Till)														
77.2			4	SS	24/28cm*										
3.5	End of Borehole Refusal to Auger (Probable Bedrock) *Sampler Bouncing														

OFFICE REPORT ON SOIL EXPLORATION

FORMER			RECORD OF BOREHOLE No 9-5				METRIC						
W P 127-87-02			LOCATION Co-ords: N 5 021 557.0; E 358 741.7				ORIGINATED BY AL						
DIST 9 HWY 416			BOREHOLE TYPE H S Auger, BW Casing, BXL Rock Core & Cone Test				COMPILED BY AL						
DATUM Geodetic			DATE 89 08 01				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			VALUES	SHEAR STRENGTH kPa					
78.8	Ground Surface												
0.0	Silty Clay to Clayey Silt												
	Some Sand, Occ. Sand Seams		1	SS	3								
	Grey, Firm to V. Stiff		2	TW	PH								8 38 33 21
76.5													
2.3	Het. Mixture of Silt, Sand & Gravel		3	SS	2								16 42 31 11
	(Glacial Till)		4	SS	4/27cm*								
75.3													
3.5	Bedrock Sandstone with Interbedded Sandy Dolostone Sound, Unweathered		5	BXL RC	REC 97%								RQD = 90%
73.8													
5.0	End of Borehole												
	*Sampler Bouncing												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



Ministry of
Transportation and
Communications
Ontario

POLE No P2

W.P. 127-87-00

FORMER			RECORD OF BOREHOLE No 3				METRIC									
W P 146-74-00		LOCATION Co-ords. N 5 021 561.5; E 358 735.7		ORIGINATED BY HS		DIST 9 HWY 416		BOREHOLE TYPE Hollow Stem Auger		COMPILED BY IR						
DATUM Geodetic		DATE 84 05 15		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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	15 30 45 60 75	15 30 45						
78.7	Ground Surface															
0.0	Silty Clay some sand Soft to Firm		1	SS	2											
77.2																
1.2	Heterogeneous Mixture Silty Clay with Sand some gravel Firm		2	SS	5											
			3	SS	5											
75.2			4	SS	2											
3.3	End of Borehole Refusal to Auger Probable Bedrock															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

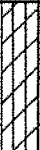

FORMER			RECORD OF BOREHOLE No 2				METRIC							
W P 146-74-00			LOCATION Co-ords. N 5 021 707.4; E 358 688.5				ORIGINATED BY HS							
DIST 9 HWY 416			BOREHOLE TYPE Hollow Stem Auger				COMPILED BY IR							
DATUM Geodetic			DATE 84 05 15				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER 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	IN' VALUES			20 40 60 80 100	15 30 45 60 75					
74.8	Ground Surface													
0.0	Silty Clay some sand		1	SS	4		74						3.7	2 22 52 24
	trace organics													
	Firm		2	SS	2	45 cm	73							
72.8	Heterogeneous Mixture													
2.0	Silty Clay with Sand		3	SS	39									25 32 32 11
72.2	some gravel Hard													
2.0	Refusal to Auger Probable Bedrock End of Borehole													
	* Note: O.M. indicates percentage of organic matter by weight.													

FORMER

RECORD OF BOREHOLE No 8-7

METRIC

W P 127-87-01 LOCATION Co-ords: N 5 021 672.0; E 358 682.0 ORIGINATED BY AL
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BW Casing, BXL Rock Core & Cone Test COMPILED BY TS
DATUM Geodetic DATE 89 08 02 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			SHEAR STRENGTH kPa						
77.0	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30			kN/m ³	GR SA SI CL
0.0	Silty Clay to Clayey Silt Some Sand		1	SS	11		76						17.2	2 36 38 24
	Occ. Sand Seams Grey Very Stiff		2	TW	PH		75							
75.0			3	SS	28		74					17 40 33 10		
2.0	Het. Mixture of Silt, Sand & Gravel (Glacial Till) Compact to Dense		4	SS	41		73							
			5	SS	*		72							
73.0	Bedrock		6	BXL RC	REC 100%									RQD = 96%
71.5	Sound, Unweathered													
5.5	End of Borehole													
	*Sampler Bouncing													

OFFICE REPORT ON SOIL EXPLORATION

FORMER			RECORD OF BOREHOLE No 89-8				METRIC		
W P 127-87-01		LOCATION Co-ords: N 5 021 786.5; E 358 628.0		ORIGINATED BY TK					
DIST 9 HWY 416		BOREHOLE TYPE H.S. Auger, Bw Casing, BXL Rock Core & Cone Test		COMPILED BY JW					
DATUM Geodetic		DATE 89 04 06		CHECKED BY TCK					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT Wp NATURAL MOISTURE CONTENT W LIQUID LIMIT Wl WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER						
76.8 0.0	Ground Surface								
	Brown Grey		1	SS	6				0 15 46 39
	Silty Clay to Clayey Silt Some Sand Very Soft to Firm		2	SS	0			W = 53.5 %	0 6 55 39
			3	SS	0				1 24 38 37
71.2 5.6	Het. Mixture of Silt, Sand and Gravel (Glacial Till) Compact		4	SS	18				17 32 41 10
69.9 6.9	Sandstone Bedrock Sound		5	BXL RC	100% Rec				RQD = 100%
68.9 7.9	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION



W.P. 127-87-00

METRIC

OFFICE REPORT ON SOIL EXPLORATION

[illegible]

+3, x5: Numbers refer to Sensitivity

FORMER

RECORD OF BOREHOLE No 10-4

METRIC

W P 127-87-03 LOCATION Co-ords: N 5 021 882.6: E 358 595.0 ORIGINATED BY TS
DIST 9 HWY 416 BOREHOLE TYPE H S Auger, BW Casing, BXL Rock Core & Cone Test COMPILED BY TS
DATUM Geodetic DATE 89 08 01 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 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 kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
72.9	Ground Surface												
72.6	Topsoil												
0.3	Silty Clay to Clayey Silt Some Sand, Occ. Sand Seams		1	SS	11		72						
			2	SS	4		71					18.9	0 11 47 42
	Stiff	Brown Grey	3	TW	PH								
69.9							70						
3.0	Het. Mixture of Silt, Sand & Gravel		4	SS	21							21.8	16 39 35 10
69.2	(Glacial Till) Compact												
3.7	Sandstone Bedrock Sound		5	BXL RC	REC 100%		69						RQD = 67%
67.6							68						
5.3	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

FORMER			RECORD OF BOREHOLE No 10-6				METRIC							
W P 127-87-03			LOCATION Co-ords: N 5 021 965.0; E 358 642.0				ORIGINATED BY TS							
DIST 9 HWY 416			BOREHOLE TYPE H S Auger & Cone Test				COMPILED BY TS							
DATUM Geodetic			DATE 89 08 02				CHECKED BY							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100						SHEAR STRENGTH kPa
71.7	Ground Surface													
71.4	Topsoil													
0.3	Het. Mixture of Silt, Sand & Gravel Grey, Compact to V. Dense		1	SS	25									
			2	SS	53									
69.4														
2.3	Refusal to Auger (Probable Bedrock) End of Borehole *Borehole Dry													

OFFICE REPORT ON SOIL EXPLORATION



W.P. 127-87-00

METRIC

DATUM Geodetic DATE 89 08 02-03 CHECKED BY _____

[illegible]

+3, x⁵: Numbers refer to Sensitivity

FORMER			RECORD OF BOREHOLE No 10-7					METRIC					
W P 127-87-03			LOCATION Co-ords: N 5 021 970.0; E 358 525.0					ORIGINATED BY TS					
DIST 9 HWY 416			BOREHOLE TYPE H S Auger & Cone Test					COMPILED BY TS					
DATUM Geodetic			DATE 89 08 03					CHECKED BY					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			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	W _p W W _L	20 40 60			
72.3	Ground Surface												
0.0	Topsoil												
71.8													
0.5	Het. Mixture of Silt, Sand & Gravel (Glacial Till)		1	SS	7							22.2	17 37 36 10
	Grey, Loose to Compact		2	SS	11								
69.1			3	SS	*								
3.2	End of Borehole												
	*Sampler Bouncing (Probable Bedrock)												

OFFICE REPORT ON SOIL EXPLORATION

FORMER		RECORD OF BOREHOLE No 15-5										1 OF 1		METRIC			
W.P. 121-87-05		LOCATION N 5 022 220 E 358 422										ORIGINATED BY TS					
DIST 9 HWY 416		BOREHOLE TYPE Dynamic Cone Penetration Test										COMPILED BY TS					
DATUM Geodetic		DATE 90 12 17										CHECKED BY TS					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT UNIT			UNIT WEIGHT 7 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
70.5 79.3	Ground Surface																
0.2	End of Borehole (Probable Bedrock)																

FORMER		RECORD OF BOREHOLE No 11-5				1 OF 1		METRIC					
W.P. 121-87-03		LOCATION Coords: N 5 022 360.0, E 358 492.0				ORIGINATED BY M.M.							
DIST 9 HWY 416		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY M.M.							
DATUM Geodetic		DATE 90-12-12				CHECKED BY B.I.							
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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					
67.6	Ground Surface						20 40 60 80 100						
0.0	Heterogeneous mixture of Silt, Sand and Gravel occasional Boulders (Glacial Till) Very Loose						UNCONFINED + FIELD VANE QUICK TRIAXIAL * LAB VANE 10 20 30 40 50	WATER CONTENT (%) 10 20 30					
65.6													
2.0	End of Borehole • Probable Bedrock, Auger Refusal								120/	23cm			

FORMER		RECORD OF BOREHOLE No 15-4		1 OF 1		METRIC						
W.P. 121-87-05		LOCATION N 5 022 270 E 358 421		ORIGINATED BY TS								
DIST 9 HWY 416		BOREHOLE TYPE HS Auger, BW Casing, Rock Coring		COMPILED BY TS								
DATUM Geodetic		DATE 90 12 17		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 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					
69.4	Ground Surface											
58.9	Clayey Silt, Brown											
0.5	Bedrock, Dolomitic Sandstone Grey, Medium Strong Unweathered		1	RC	REC 85%							RQD = 71%
67.7												
1.7	End of Borehole											
	• 90 12 17											

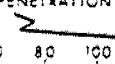


FORMER			RECORD OF BOREHOLE No 15-3				1 OF 1		METRIC								
W.P. 121-87-05			LOCATION N 5 022 305 E 358 406				ORIGINATED BY TS										
DIST 9 HWY 416			BOREHOLE TYPE HS Auger, BW Casing, Rock Coring				COMPILED BY TS										
DATUM Geodetic			DATE 90 12 17				CHECKED BY TS										
SOIL PROFILE			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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
67.9	Ground Surface																
0.5	Bedrock, Dolomitic Sandstone		1	RC	REC 100%												RQD = 38%
66.1	Grey, Medium Strong Unweathered																
1.8	End of Borehole																
	* 90 12 17																
	** Clayey Silt with interbedded sandy silt																

FORMER

RECORD OF BOREHOLE No R6

METRIC

W P 120-87-01 LOCATION Co-ords. N 5 022 302.9; E 358 337.1 ORIGINATED BY JF
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TS
DATUM Geodetic DATE 88 07 27 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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
68.3	Ground Surface													
0.0 68.0	Clayey Silt		1	CS	-	*								
0.3	End of Borehole (Auger Refusal) Probable Bedrock)													
	* Borehole Dry													

FORMER

RECORD OF BOREHOLE No 11-4

1 OF 1

METRIC

W.P. 121-87-03 LOCATION Coords: N 5 022 400.0 E 358 508.0 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
DATUM Geodetic DATE 90-12-12 CHECKED BY B.J.

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 7 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					
67.3	Ground Surface																
0.0	Clayey Silt with interbedded seams of Sandy Silt Soft		1	SS	3		67										
			2	SS	4		66										
65.2																	
2.1	Heterogeneous mixture of Silt, Sand and Gravel occasional Boulders (Glacial Till) Compact		3	SS	17		65										
			4	SS	21		64										1 94 2 3
			5	SS	12												
			6	SS	13		63										
62.2																	
5.1	End of Borehole • Probable Bedrock, Auger Refusal																

FORMER

RECORD OF BOREHOLE No 11-3

1 OF 1

METRIC

W.P. 121-87-03 LOCATION Coords: N 5 022 460.0, E 358 509.0 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Rock core, Wash Boring COMPILED BY M.M.
DATUM Geodetic DATE 90-12-19 CHECKED BY B.L.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT			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	10 20 30 40 50	W _p	W		
68.6	Ground Surface												
0.0	Cloyey Silt with Interbedded seams of Sandy Silt Soft to Stiff		1	SS	5								0 25 49 26
			2	SS	3								
			3	SS	3								
63.7			4	SS	1								
2.9	Brown Grey Heterogeneous mixture of Silt, Sand and Gravel occasional Boulders (Glacial Till) Compact		5	SS	3								
			6	SS	12								
			7	SS	20								0 97 2 1
			8	SS	1								
57.3			9	RC	REC 100%								RQD 91%
9.3	Bedrock Dolomitic Sandstone Medium Strong, Unweathered to Slightly Weathered Quartz Sandstone Medium Strong, Unweathered to Slightly Weathered		10	RC	REC 100%								RQD 100%
54.4													
12.2	End of Borehole												

FORMER			RECORD OF BOREHOLE No 12-5				1 OF 1		METRIC			
W.P. 121-87-04			LOCATION Co-ords N 5 022 406 E 358 416				ORIGINATED BY MM					
DIST 9 HWY 416			BOREHOLE TYPE HS Auger				COMPILED BY TS					
DATUM Geodetic			DATE 90 12 14				CHECKED BY TS					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	W _p		
67.4	Ground Surface											
0.0	Clayey Silt with interbedded seams of Sandy Silt Brown, Firm		1	SS	4	DRY *	67					
65.8			2	SS	100	/15cm	66					
1.8	End of Borehole Auger Refusal(Probable Boulder or Bedrock)											

FORMER		RECORD OF BOREHOLE No 12-4		1 OF 1		METRIC											
W.P. 121-87-04		LOCATION Co-ords N 5 022 445 E 358 415		ORIGINATED BY MM													
DIST 9 HWY 416		BOREHOLE TYPE HS Auger, BW Casing, BXL Rock Coring & Cone Test		COMPILED BY FT													
DATUM Geodetic		DATE 90 12 14		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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES						20	40	60	80	100
66.7	Ground Surface																
0.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Occasional Boulders Brown ----- Grey Very Loose to Compact		1	SS	9												9 45 38 8
			2	SS	18												
			3	SS	1												
			4	SS	1												1 37 48 14
			5	SS	1												
			6	SS	14												3 30 62 5
60.2																	
6.5	Bedrock Dolomitic Sandstone Grey, Medium Strong		7	RC	REC												RQD = 89%
58.7																	
8.0	End of Borehole																
	* 90 12 14																

FORMER

RECORD OF BOREHOLE No R4

METRIC

W P 120-87-01 LOCATION Co-ords. N 5 022 371.4; E 358 265.7 ORIGINATED BY MS
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TS
DATUM Geodetic DATE 88 07 27 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			20	40	60	80	100					
68.5	Ground Surface															
0.0 68.2	Clayey Silt		1	CS	-	*										
0.3	End of Borehole (Auger Refusal) Probable Bedrock															
	* Borehole Dry															

OFFICE REPORT ON SOIL EXPLORATION



W.P. 127-87-00

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to Sensitivity

