

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M 12-169

DIST. 4 REGION _____

W.P. No. 197-77-03

CONT. No. 84-78

W. O. No. _____

STR. SITE No. 10-82-325

HWY. No. 403/407

LOCATION Ramp E-S Underpass (Structure #4)
403 E-407 S Ramp over 403 & 407

No. of PAGES - _____



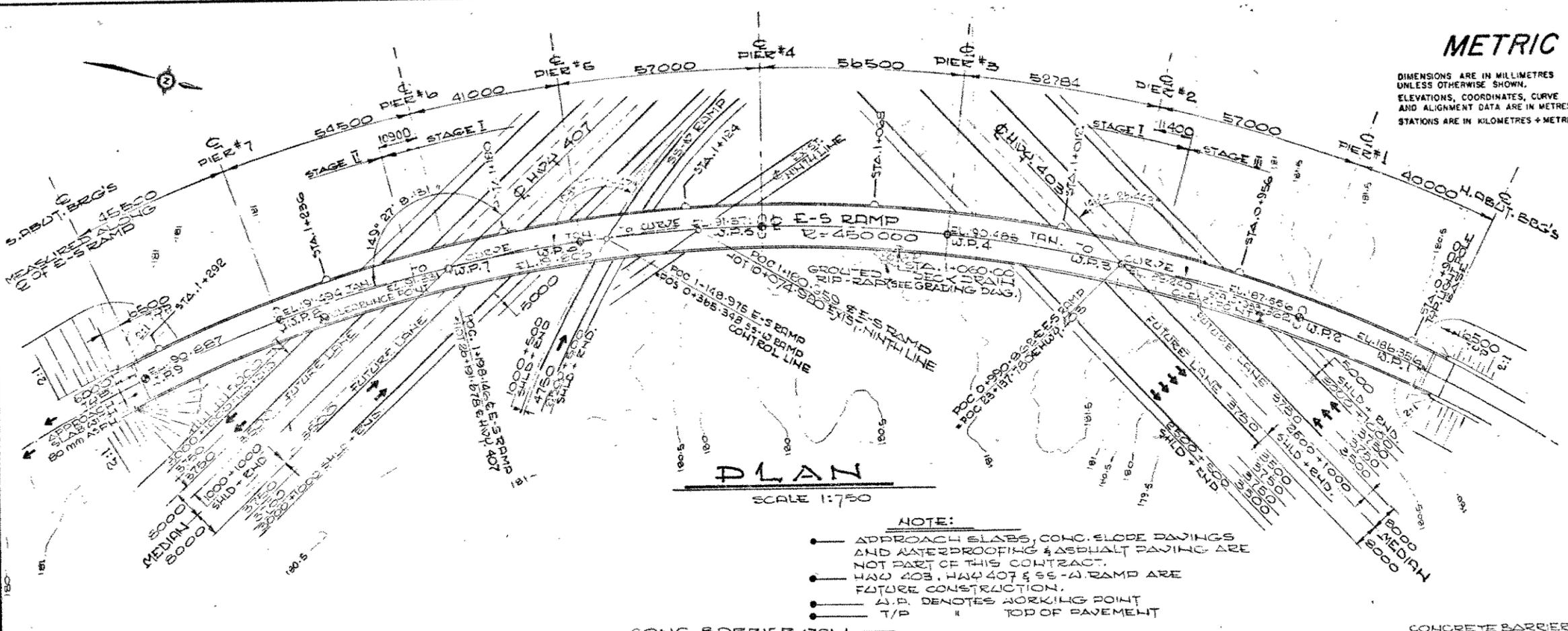
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

G.I.-30 SEPT. 1976

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

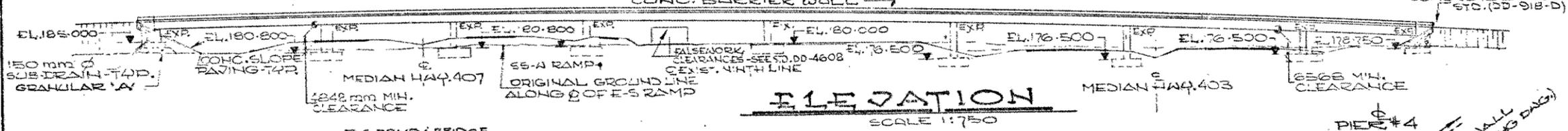


PLAN
SCALE 1:750

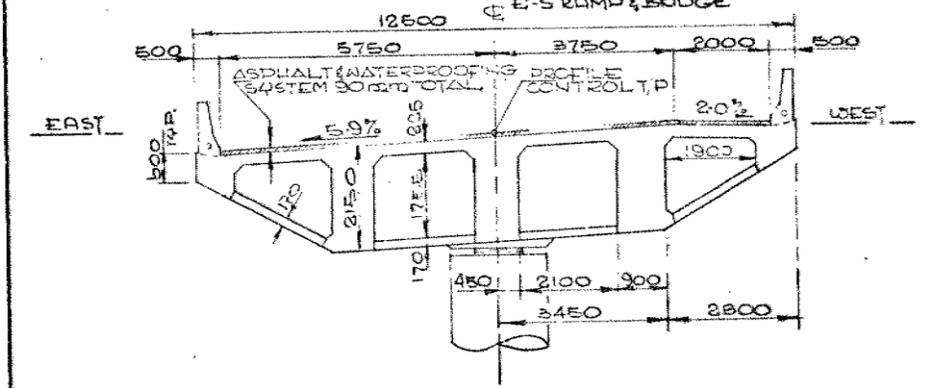
- NOTE:**
- APPROACH SLABS, CONC. SLOPE PAVING AND WATERPROOFING & ASPHALT PAVING ARE NOT PART OF THIS CONTRACT.
 - H/W 403, H/W 407 & SS-A RAMP ARE FUTURE CONSTRUCTION.
 - A.P. DENOTES WORKING POINT
 - T/P " TOP OF PAVEMENT

- GENERAL NOTES**
- CLASS OF CONCRETE**
- DECK & PIER COLUMNS — 35 MPa
 - BARRIER WALLS, ABUTMENTS & WINGWALLS — 30 MPa
 - REMAINDER — 20 MPa
- CLEAR COVER TO REINF. STEEL**
- | | |
|---------------------|------------|
| ROOTINGS | 40 ± 25 mm |
| TOP SLAB - TOP | 70 ± 20 mm |
| TOP SLAB - BOTT. | 40 ± 10 mm |
| BOTTOM SLAB - TOP | 40 ± 10 mm |
| BOTTOM SLAB - BOTT. | 40 ± 10 mm |
| ABUTMENT SIDES | 40 ± 10 mm |
- REINFORCING STEEL**
- REINFORCING STEEL SHALL BE GRADE 40C
 - REINFORCING BARS WITH DESIGNATION 'C' AT END OF BAR MARKS SHALL BE EPOXY COATED BARS.

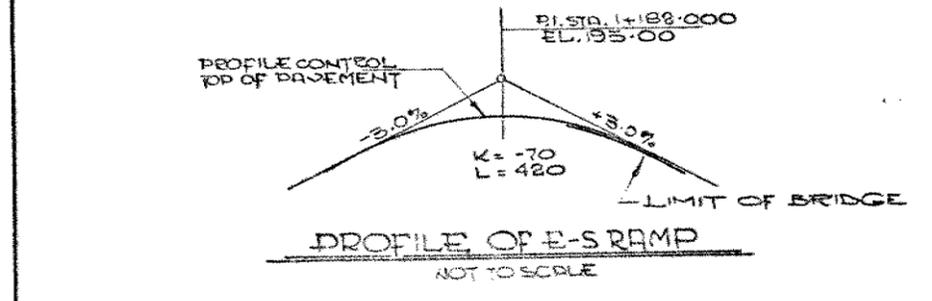
- CONSTRUCTION NOTES**
- THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 3 mm
 - THE SUPERSTRUCTURE SHALL BE BUILT IN THREE CONSTRUCTION STAGES AS SHOWN.



ELEVATION
SCALE 1:750

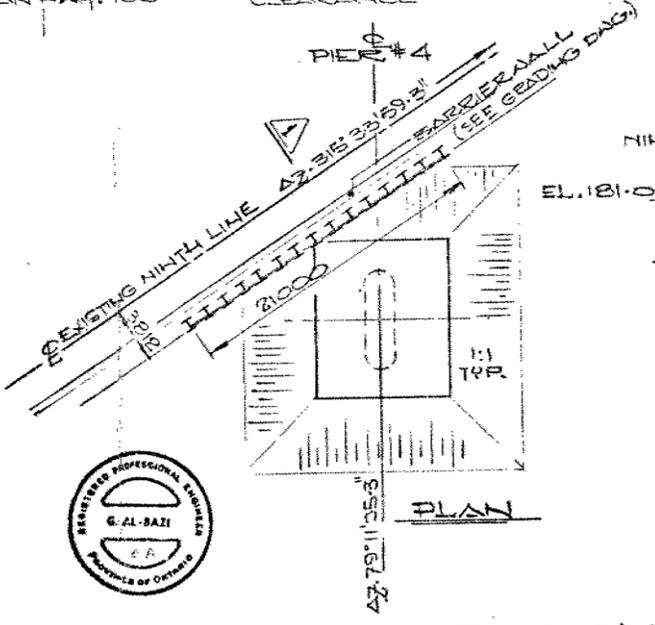


TYPICAL DECK SECTION
SCALE 1:75



PROFILE OF E-S RAMP
NOT TO SCALE

- LIST OF DRAWINGS**
- GENERAL ARRANGEMENT
 - BORING LOCATIONS & SOIL STRATA
 - LOCATION OF WORKING POINTS
 - ABUTMENT FOOTINGS
 - PIER FOOTINGS
 - NORTH ABUTMENT
 - SOUTH ABUTMENT
 - PIER DETAILS
 - BEARINGS
 - DECK DETAILS I
 - " II
 - TRANSVERSE TENDONS
 - LONGITUDINAL CABLE DETAILS I
 - " II
 - DECK REINFORCING DETAILS I
 - " II
 - " III
 - EXPANSION JOINTS
 - BARRIER WALL
 - 6000 mm APPROACH SLABS
 - DETAILS OF CONC. SLOPE PAVING
 - AS CONSTRUCTED ELEV. & DIM.
 - BRIDGE DATA & SITE NUMBER DATA
 - STANDARD DETAILS
 - QUANTITIES (BQD)



TEMPORARY ROAD PROTECTION
NOT TO SCALE

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

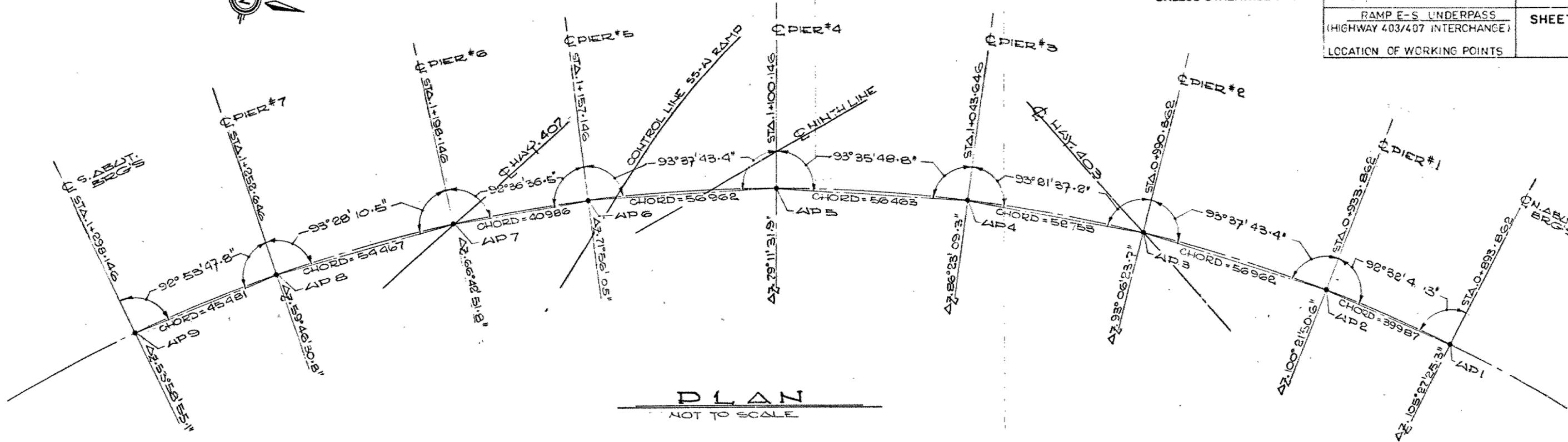
CONT No
WP No 197-77-03

RAMP E-S UNDERPASS
(HIGHWAY 403/407 INTERCHANGE)

LOCATION OF WORKING POINTS



SHEET



PLAN

NOT TO SCALE

PROVINCIAL CO-ORDINATES OF WORKING POINTS

AP9		AP8		AP7		AP6		AP5		AP4		AP3		AP2		AP1	
N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E
4820516.970	286735.275	4820555.061	286710.422	4820603.697	286685.902	4820642.042	286671.431	4820697.206	286657.230	4820753.222	286650.142	4820805.072	286649.939	4820862.544	286656.190	4820901.520	286665.524



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN		CHECK	LOADING
DRAWING		CHECK	SITE No

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84 - 78



Ministry of
Transportation and
Communications

INDEX

<u>PAGE NO.</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations and Symbols
3 - 42	Foundation Investigation Reports For Ramp E-S Underpass Hwy. #403 & #407 Interchange W.P. 197-77-03; Site 10-82-325 Ramp W-S Underpass At Ninth Line Hwy. #403 & #407 Interchange W.P. 197-77-04; Site 10-82-328 Ninth Line Underpass Hwy. #403 & #407 Interchange W.P. 197-77-05; Site 10-82-327 Ramp SS-W Ramp, Hwy. #407 Underpass Hwy. #403 & #407 Interchange W.P. 197-77-17; Site 10-82-326

NOTE: For purposes of the contract these reports supercede all other Foundation Investigation Reports prepared by or for the Ministry in connection with the above mentioned projects.

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.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT
FOR
Ramp E-S Underpass
(Hwy. #403 & 407 Interchange)
W.P. 197-77-03; Site 10-82-325
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 81 12 23 - 82 01 05, 82 10 28 - 82 11 01 and 82 11 22. The fieldwork consisted of seven sampled boreholes and seven dynamic cone penetration tests adjacent to each borings. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped either with 83 mm (I.D.) hollow stem or solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Milton, town of Oakville and the city of Mississauga. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. In some of the borings, a silty clay stratum was encountered over the bedrock. The boundaries of the different strata, together with

the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2 of the contract drawings. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness varies from 7.0 m to 10.5 m. In B.H. 's #14 & 15 this zone was not fully penetrated. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. There are random localized zones where the matrix is only slightly cohesive. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 21 to over 100 blows per 30 cm. In the vicinity of Boreholes #14 & 15 the extreme upper portion (1.0 - 1.5 m) of the material is in a soft to very soft condition due to the stagnant surface water.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	6-16
Liquid Limit (%)	12-29
Plastic Limit (%)	11-18

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard. The very stiff zones are mainly confined to the upper portion of the deposit.

Sandy Silt to Silty Sand, Traces of Gravel & Clay

This stratum was encountered in those borings which were advanced below the above described glacial till. The thickness varied from 5.1 m to 14.4 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with traces of gravel and clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being very dense. The natural moisture content ranges from 9 to 14%. The results of the grain-size analyses performed on selected samples are plotted in an envelope form on Figure #2 of the Appendix.

Silty Clay, Some Sand

An approximate 4.7 to 6.0 m thick silty clay, some (trace) of sand zone was found to underlie the silty sand to sandy silt stratum in B.H.'s #4 and #5.

This deposit has a hard consistency. The natural moisture content is in the order of 15%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand and/or below the silty clay deposits in Boreholes #1, 4, 5 and 102. The shale is badly weathered. No core samples were obtained.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #1 El. 179.9
B.H. #2 El. 180.5
B.H. #3 El. 180.0

No groundwater level measurements were carried out in B.H.'s #5 and #102.

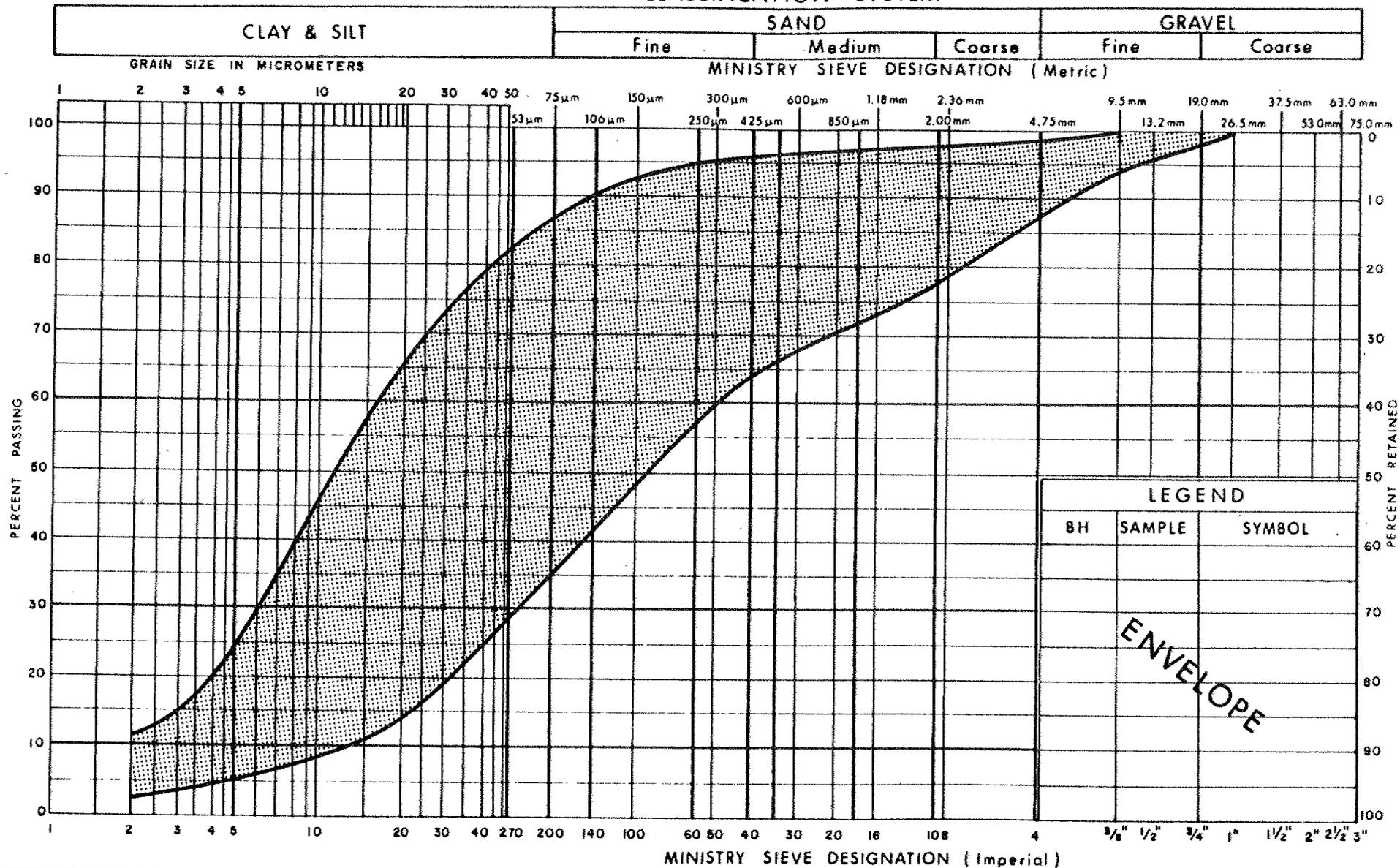


P. Payer
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby
K. G. Selby, P. Eng.
Chief Foundations Engineer(West)

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND

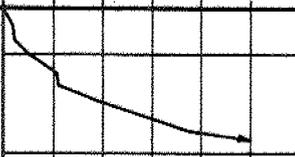
BH	SAMPLE	SYMBOL

ENVELOPE

RECORD OF BOREHOLE No 1

METRIC ¹⁰

W P 197-77-03 LOCATION Co-ords. N 4 820 898.5; E 286 663.8 ORIGINATED BY JR
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
 DATUM Geodetic DATE 82 10 28 CHECKED BY GP

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	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
											○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
											WATER CONTENT (%)					
											10	20	30			
180.9	Ground Level															
0.0	Heterogeneous Mixture of Silty Clay	1	SS	27		180										
	Sand & Gravel	2	SS	33		178										
	V. Stiff to Hard Glacial Till	3	SS	35												
		4	SS	21												
		5	SS	39		176										
		6	SS	69		174										
173.9	7.0 Compact	7	SS	19		172									8 40 42 10	
	Silty Sand to Sandy Silt	8	SS	75/15	cm	170										
	Trace of Gravel & Clay	9	SS	90/8	cm	168										
	Very Dense	10	SS	90/8	cm	166									10 37 51 2	
		11	SS	70/8	cm	164										
		12	SS	64/23	cm	162										
162.5	18.4 Reddish Brown Weathered Shale					162									15 39 34 12	
161.0	19.9 End of Borehole	13	SS	100/5	cm											

+3, x5: Numbers refer to
Sensitivity

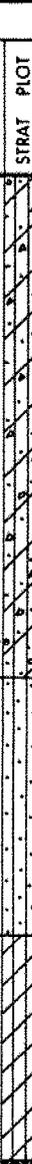
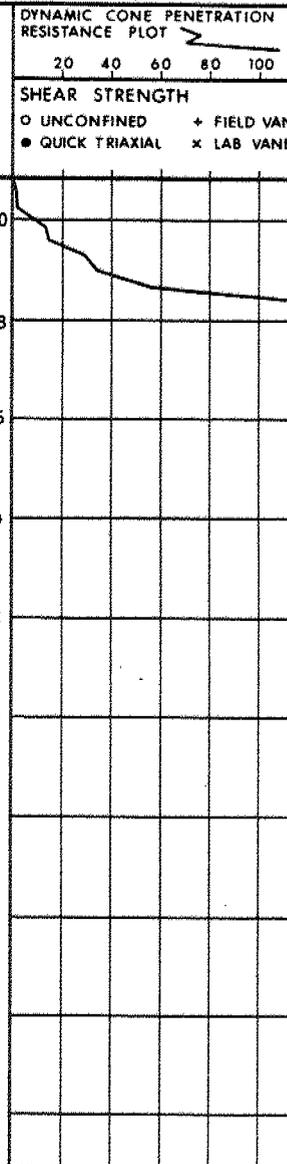
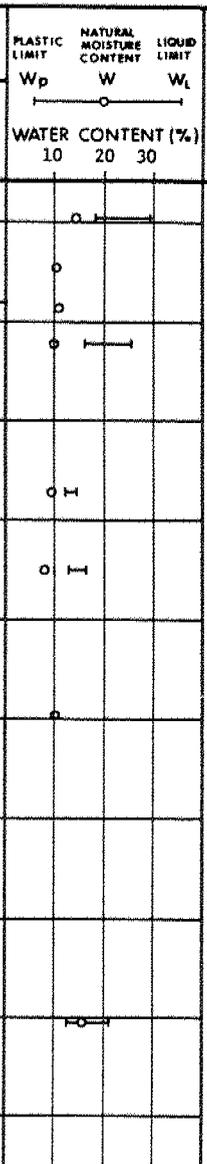
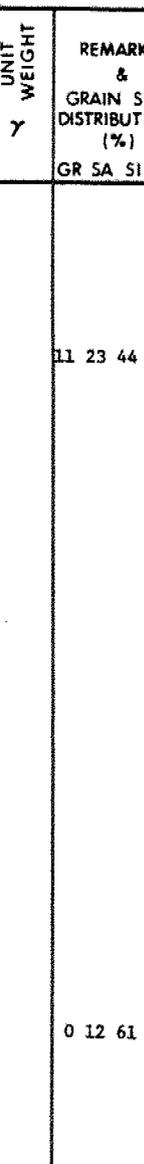
20
15 \div 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC ¹²

W P 197-77-03 LOCATION Co-ords. N 4 820 604.7; E 286 684.4 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 10 29 and 82 11 01 CHECKED BY EP

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									
180.8	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay		1	SS	30						11 23 44 22		
	Sand & Gravel		2	SS	42								
	Hard		3	SS	61								
	Glacial Till		4	SS	92								
			5	SS	40/8	176							
			6	SS	43	174							
			7	SS	60/15	172							
			8	SS	30/8	170							
170.7			9	SS	30/8	170							
10.1	Silty Sand to Sandy Silt		10	SS	90/3	166							
	Traces of Gravel & Clay												
	V. Dense												
165.6													
15.2	Silty Clay	11	SS	30/8	164								
	Some Sand												
	Hard												
160.9		12	SS	60/8	162								
19.9	End of Borehole												
	Reddish Brown Weathered Shale												

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC ¹³

W P 197-77-03 LOCATION Co-ords. N 4 820 516.5; E 286 734.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
 DATUM Geodetic DATE 82 11 01 and 02 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 (%)		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40						60	80
180.5	Ground Level														
0.0	Heterogeneous Mixture of Silty Clay	1	SS	35		180									
	Sand & Gravel	2	SS	76		178									
	Hard	3	SS	65		176									6 25 43 26
	Glacial Till	4	SS	38		174									
		5	SS	42		172									
		6	SS	66/23 cm		170									
		7	SS	101		168									
170.0	Silty Sand to Sandy Silt	8	SS	86/23 cm		166									8 44 43 55
	Traces of Gravel & Clay	9	SS	80/15 cm		164									
	V. Dense	10	SS	70/15 cm		162									4 52 39 5
163.6	Silty Clay	11	SS	65/15 cm		160									
	Traces of Sand	12	SS	100/15 cm		158									0 9 64 27
157.6	Hard														
22.9	Reddish Brown Weathered Shale														
156.1	End of Borehole														
24.4	Note: No Groundwater Level Measurements Were Carried Out.														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 14

METRIC 14

W P 197-77-03 LOCATION Co-ords. N 4 820 467.5; E 286 767.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 11 22 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40					
179.8	Ground Level													
0.0	V. Soft to Soft		1	SS	47									
			2	SS	13									
	Heterogeneous Mixture of Silty Clay		3	SS	38									
			4	SS	84									
	Sand & Gravel		5	SS	91									
	Stiff to Hard		6	SS	60									
174.8			7	SS	59									
5.0	End of Borehole													
	Surface Water Level 15 cm above Ground Level (82 11 22)													

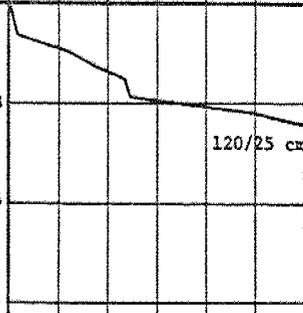
+3, x5: Numbers refer to Sensitivity
 20
 15 5 (%) STRAIN AT FAILURE
 10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15

METRIC ¹⁵

W P 197-77-03 LOCATION Co-ords. N 4 820 415.0; E 286 838.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 11 22 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40					
180.0	Ground Level												
0.0	<u>Soft</u> Heterogeneous Mixture of Silty Clay Sand & Gravel Hard Glacial Till	1	SS	37	28 cm	178						120/25 cm	
		2	SS	98									
		3	SS	89									
		4	SS	71									
		5	SS	34									
		6	SS	40									
173.4	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 102

METRIC 16

W P 197-77-03 LOCATION Co-ords N 4 820 741.1; E 286 632.4 ORIGINATED BY DBC
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (H.S.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 81 12 23 - 82 01 05 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40					
181.0	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay Sand & Gravel V. Stiff to Hard Glacial Till	1	SS	22								16 23 43 18	
		2	SS	29									3 31 42 24
		3	SS	27									
		4	SS	72									
		5	SS	38									
		6	SS	33									
		7	SS	39									26 23 32 20
		8	SS	111									6 31 55 8
		9	SS	83									15 34 38 13
		10	SS	110/18	cm								10 30 45 15
172.5	8.5 Sandy Silt to Silty Sand Traces of Gravel & Clay Occ. Silty Clay Layers V. Dense	11	SS	125/23	cm								
		12	SS	186/15	cm								6 24 61 9
		13	SS	100/10	cm								
		14	SS	115/13	cm								11 43 40 6
		15	SS	49									
		16	SS	100/10	cm								4 38 48 10
		17	SS	100/15	cm								
		18	SS	67/15	cm								1 12 82 5
160.3	20.7 159.5	19	SS	100/15	cm								0 26 57 17
21.5		End of Borehole											
	Note: No Groundwater Level Measurements Were Carried Out.												

+3, x5: Numbers refer to
Sensitivity

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

FOUNDATION INVESTIGATION REPORT

For

Ramp W-S Underpass At Ninth Line
(Hwy. #403 & #407 Interchange)
W.P. 197-77-04; Site: 10-82-328
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigation carried out at the aforementioned site on 82 11 09. The fieldwork consisted of two sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped with solid stem augers.

SITE DESCRIPTION

The site is located west of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Oakville. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONSGeneral

The subsoil at this location was found to consist of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2 of the contract drawings. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness is about 14.6 m. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 24 to over 100 blows per 30 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	7-14
Liquid Limit (%)	18-27
Plastic Limit (%)	11-17

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in each boring below the above described glacial till. The thickness was found to be 6.8 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with some gravel and trace of clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being very dense. The natural moisture content ranges from 12 to 13%. The results of the grain-size analyses performed on four samples are as follows: Gravel: 2-16%, Sand: 18-44%, Silt: 39-67% and Clay: 5-10%.

Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at approximate El. 159+. The shale is badly weathered. No core samples were obtained.

GROUNDWATER CONDITIONS

The groundwater levels were observed to be at ground surface during the field investigation.

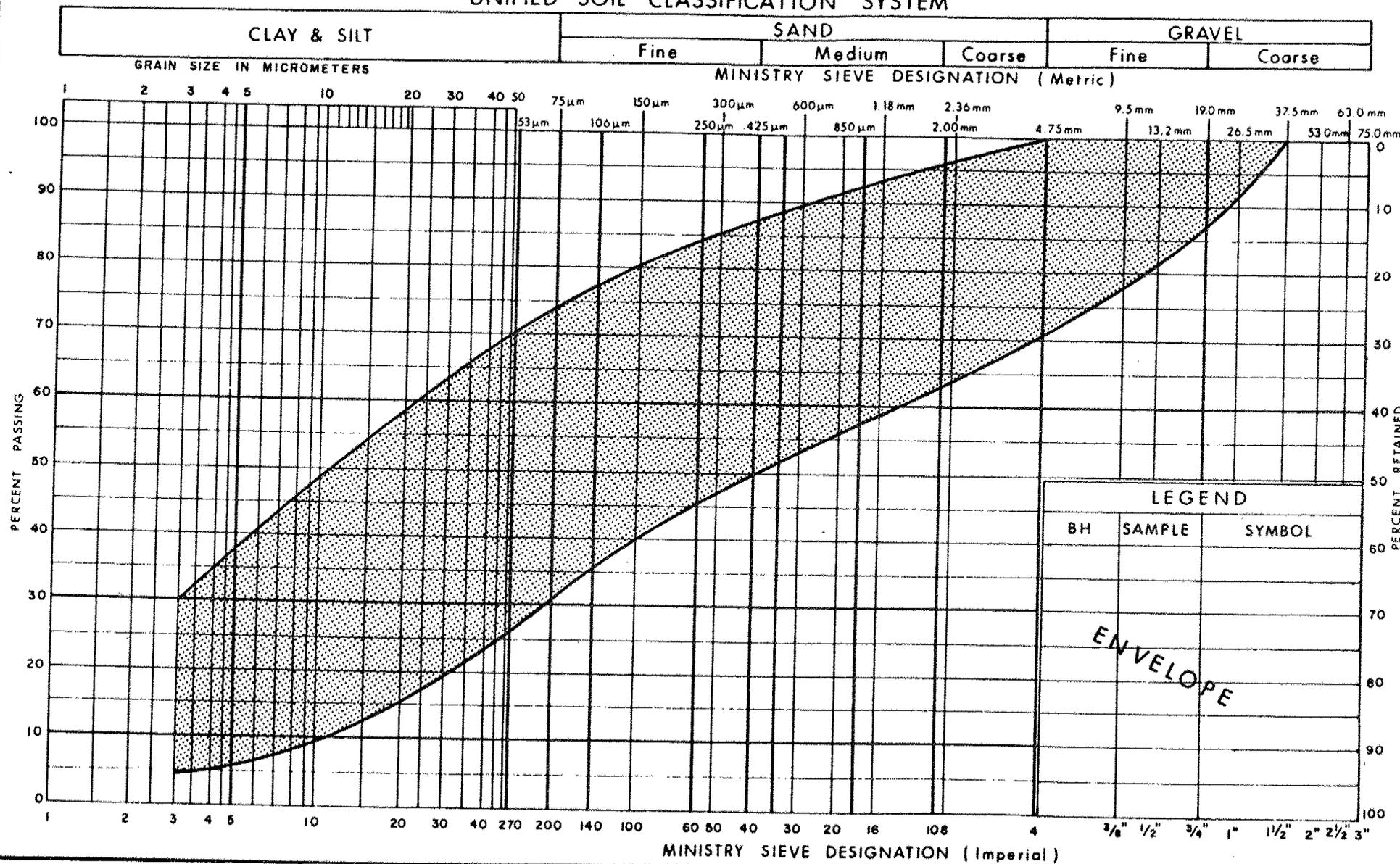


P. Payer
P. Payer, P. Eng.
Foundations Engineer

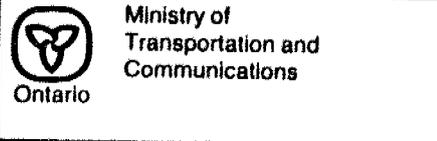
K. G. Selby
K. G. Selby, P. Eng.
Chief Foundations Engineer (West)

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
ENVELOPE		



GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILTY CLAY, SAND
& GRAVEL (Glacial Till)

FIG No 1
 W P 197-77-04

RECORD OF BOREHOLE No 12

METRIC 22

W P 197-77-04 LOCATION Co-ords. 4 820 405.0 N; 286 539.0 E ORIGINATED BY JB
 DIST 4 HWY 403/407 BOREHOLE TYPE Cont'. Flight Auger (S.A.) & Cone Test COMPILED BY JB
 DATUM Geodetic DATE 82 11 09 CHECKED BY *[Signature]*

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								
180.3	Ground Surface											
0.0	E.L. 179.5 STSF		1	SS	25							4 22 53 21
			2	SS	24							
			3	SS	45							
			4	SS	91							
			5	SS	91							
	Heterogeneous Mixture of Silty Clay (CL) Sand & Gravel V. Stiff to Hard Glacial Till		6	SS	106							
			7	SS	79							7 29 46 18
			8	SS	60/	15 cm						15 30 40 15
			9	SS	80/	15 cm						
165.7												
14.6			10	SS	112							4 38 53 5
	Sandy Silt to Silty Sand, Some Gravel Trace of Clay V. Dense		11	SS	83/	15 cm						10 18 67 5
158.9			12	SS	80/	10 cm						
21.4	End of Borehole											
	Weathered Red Shale											

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 13

METRIC 23

W P 197-77-04 LOCATION Co-ords. 4 820 420.6 N; 286 606.8 E ORIGINATED BY JH
 DIST 4 HWY 403/407 BOREHOLE TYPE Cont', Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 82 11 09 CHECKED BY So

SOIL PROFILE		SAMPLES			GROUND WATER LEVEL & 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
180.0	Ground Surface													
0.0	Heterogeneous Mixture of Silty Clay (CL) Sand & Gravel Hard Glacial Till		1	SS	40									
				2	SS	52								
				3	SS	67								
				4	SS	42								
				5	SS	49								0 27 49 24
				6	SS	110								
				7	SS	100/	7.5 cm							
				8	SS	100/	12.5 cm							5 26 54 15
				9	SS	68/	15 cm							
				10	SS	70/	15 cm							29 38 29 5
				11	SS	100/	12.5 cm							16 29 43 12
165.5				12	SS	80/	7.5 cm							2 44 47 7
14.6		Sandy Silt to Silty Sand, Some Gravel Trace of Clay V. Dense		13	SS	100/	7.5 cm							16 35 39 10
158.7				14	SS	100/	5 cm							
21.4	End of Borehole													
	Weathered Red Shale													

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

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
For
Ninth Line Underpass
(Hwy. #403 & 407 Interchange)
W.P. 197-77-05; Site 10-82-327
District 4, Hamilton

INTRODUCTION

This report contains the result of the foundation investigation carried out at the aforementioned site on 82 11 08 and 82 02 16. The fieldwork consisted of two sampled boreholes and one dynamic cone penetration tests adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Milton and town of Oakville. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consists of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2 of the contract drawings. A description of the different strata encountered is given below.

Heterogenous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness varies from 13.7 m to 14.5 m. The material in the deposit was found to consist of a heterogenous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 18 to over 100 blows per 30 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	7-14
Liquid Limit (%)	20-27
Plastic Limit (%)	12-17

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard.

Sandy Silt to Silty Sand, Traces of Gravel & Clay

This stratum was encountered in each boring below the above described glacial till. The thickness varied from 5.3 m to 6.1 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with traces of gravel and clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values to range from 13 to over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being compact to very dense. The natural moisture content ranges from 12 to 13%. The results of the grain-size analyses performed on two samples are as follows: Gravel: 3-13%, Sand: 41-48%, Silt: 34-48%, and Clay: 5-8%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits, at El. 162.9 and at El. 162.4. The shale is badly weathered. No core samples were obtained.

Groundwater Conditions

The groundwater levels were observed to be at ground surface during the field investigation.



P. Payer
P. Payer, P. Eng.
Foundations Engineer

K.G. Selby
K.G. Selby, P. Eng.
Chief Foundations Engineer (West)

A P P E N D I X

RECORD OF BOREHOLE No 10

METRIC 29

W P 197-77-05 LOCATION Co-ords. N 4 820 518.2; E 286 466.6 ORIGINATED BY JB
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone COMPILED BY JB
 DATUM Geodetic DATE 82 11 08 CHECKED BY JB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									'N' VALUES
182.2	Ground Surface												
0.0	Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till) Very Stiff to Hard		1	SS	40							8 22 51 19	
			2	SS	78								6 31 44 19
			3	SS	45								7 31 42 20
			4	SS	18								3 31 45 21
			5	SS	42								6 38 43 13
			6	SS	41								
			7	SS	33								
			8	SS	23								
			9	SS	67	23 cm							
			10	SS	60	5 cm							
			11	SS	68								
			12	SS	90	25 cm							6 31 45 18
168.5													
13.7	Sandy Silt to Silty Sand, Traces of Gravel & Clay Compact to Very Dense		13	SS	13								
			14	SS	60	8 cm							3 41 48 8
162.4													
19.8	Weathered Red Shale		15	SS	110	5 cm							
			16	SS	100	10 cm							
157.7													
24.5	End of Borehole												

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11

METRIC 30

W P 197-77-05 LOCATION Co-ords. N 4 820 560.3; E 286 415.4 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone COMPILED BY JH
 DATUM Geodetic DATE 82 11 08 CHECKED BY *JS*

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
182.7	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till) Very Stiff to Hard		1	SS	37												
			2	SS	88												
			3	SS	79												
			4	SS	47												
			5	SS	29												
			6	SS	24								5	29	47	19	
			7	SS	28												
			8	SS	28									3	28	48	21
			9	SS	40	23 cm								5	25	46	24
			10	SS	60	10 cm								9	39	43	9
			11	SS	50	8 cm											
168.2			12	SS	70	15 cm								18	26	39	17
14.5	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Very Dense		13	SS	60												
			14	SS	30	3 cm								13	48	34	5
162.9																	
19.8	Weathered Red Shale																
161.3			15	SS	100	8 cm											
21.4	End of Borehole																

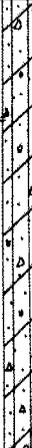
+3, x⁵: Numbers refer to
Sensitivity

20
15 ◊ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 12

METRIC 31

W P 197-77-05 LOCATION Co-ords. N 4 820 539.2; E 286 441.2 ORIGINATED BY SO
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
 DATUM Geodetic DATE 83 02 16 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		NUMBER	TYPE	'N' VALUES			20	40	60	80					
ELEV DEPTH	DESCRIPTION	STRAT PLOT					SHEAR STRENGTH				WATER CONTENT (%)				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
182.1	Ground Level														
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel (glacial till) Very Stiff to Hard		1	SS	55		182								
			2	SS	68		180								
			3	SS	98										
			4	SS	106										
			5	SS	93										
			6	SS	74										
			7	SS	77										
			8	SS	44										
			9	SS	32										
			10	SS	46										
			11	SS	81										
172.9	End of Borehole		12	SS	120	10 cm									

OFFICE REPORT ON SOIL EXPLORATION

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

FOUNDATION INVESTIGATION REPORT
For
Hwy. 407 Underpass (SS-W Ramp)
Hwy. 403/407 Interchange
W.P. 197-77-17; Site 10-82-326
District #4 Hamilton

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 82 11 02 - 82 11 08 and on 83 02 16. The fieldwork consisted of four sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, approximately 1.0 km north of Burnhamthorpe Rd. in the towns of Milton and Oakville. The surrounding terrain is relatively flat. Physiographically, the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by a sandy silt to silty sand deposit, followed by shale bedrock. In one of the borings a silty clay stratum was encountered within the sandy silt to silty sand deposit. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2 of the Contract Drawings. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below the ground surface, a till-like zone was encountered at every boring location. The thickness varies from 6 m to 11 m. This material is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 16 to over 95 blows per 30 cm. In all four boreholes the material has a very stiff to hard consistency.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>	<u>Avg.</u>
Natural Moisture Content (%)	8.0 - 12.5	10.5
Liquid Limit (%)	18.5 - 23.0	21.7
Plastic Limit (%)	13.0 - 16.0	14.3

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in all four borings below the above described glacial till. The thickness varies from 9 m to 13 m. The material in the deposit consists mainly of sands and silts with traces of clay and varying amounts of gravel. A layer of silty clay was found within the deposit at the location of B.H. #7.

Standard Penetration Tests, carried out within the deposit, gave 'N' values from 27 to over 120 blows per 30 cm. These values indicate that the deposit is in a dense to very dense condition. The natural moisture content ranges from 7.5% to 10%. The results of the grain-size analyses performed on selected samples are plotted in envelope form on Figure #2 of the Appendix.

Silty Clay, With Sand, Trace of Gravel

A layer of silty clay approximately 7 m thick was found within the silty sand to sandy silt layer at B.H. #7.

The deposit has a hard consistency, as indicated by 'N' values of 60 blows per 15 cm. The natural moisture content is in the order of 9%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at all four boreholes. The shale is badly weathered and was penetrated by approximately 3m, using augers.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #	6	7	9
El.	181.6	180.9	180.1



P. Payer
 P. Payer, P. Eng.
 Foundations Engineer

K. G. Selby
 K. G. Selby, P. Eng.
 Chief Foundations Engineer (West)

A P P E N D I X

RECORD OF BOREHOLE No 6

METRIC 38

W P 197-77-17 LOCATION Co-ords. N 4 820 651.8; E 286 577.9 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodatic DATE 1982 11 02 and 03 CHECKED BY JH

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						WATER CONTENT (%)
181.6	Ground Level												GR SA SI CL	
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	22								8 23 49 20	
			2	SS	42									
			3	SS	67									
			4	SS	86									
175.3	Sandy Silt to Silty Sand Trace Clay Very Dense with Gravel Trace Gravel		5	SS	75	23 cm							13 23 44 20	
6.3			6	SS	82									10 40 43 7
			7	SS	40	8 cm								
			8	SS	78									
			9	SS	72	15 cm								
			10	SS	100	8 cm								
161.8	Weathered Red Shale												7 43 44 6	
19.8														
158.7	End of Borehole													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC 39

W P 197-77-17 LOCATION Co-ords. N 4 820 695.2; E 286 518.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 1982 11 05 and 08 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	NUMBER	TYPE	'N' VALUES			20	40						60	80
180.9	Ground Level														
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard	1	SS	19		180							6 25 50 19		
		2	SS	35											10 26 48 16
		3	SS	51											5 26 44 25
		4	SS	43											9 25 42 24
		5	SS	20											
		6	SS	16											
175.0		7	SS	24											
5.9	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Dense to Very Dense	8	SS	27											
		9	SS	43											
		10	SS	62											
		11	SS	60/	15 cm										
170.6	Silty Clay with Sand Trace Gravel Hard	12	SS	60/	15 cm										
10.3		13	SS	80/	10 cm										
167.2	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense	14	SS	60/	15 cm										
13.7		15	SS	60/	8 cm										
161.4		16	SS	80/	8 cm										
159.5	Weathered Red Shale														
21.4	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

+³, x³: Numbers refer to Sensitivity 20
 15 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 8

METRIC 40

W P 197-77-17 LOCATION Co-ords. N 4 820 692.5; E 286 607.3 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 1982 11 03 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE 'N' VALUES								
180.6	Ground Level											
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS 23		180						
			2	SS 36		178						3 27 50 20
			3	SS 66		176						
			4	SS 64		174						8 25 44 23
173.4			5	SS 42		172						
7.2	Sandy Silt to Silty Sand, Some Gravel Trace Clay Very Dense		6	SS 70		170						
			7	SS 94		172					2 74 20 4	
			8	SS 60/ 8 cm		170						18 48 28 5
			9	SS 70/ 15 cm		168						
			10	SS 90/ 10 cm		166						12 46 37 5
			11	SS 100/ 15 cm		162						
160.8	19.8	Weathered Red Shale				160						
159.2			12	SS 100/ 8 cm								10 15 52 23
21.4	End of Borehole											
<p>Note: No Groundwater Level Measurements Were Carried Out.</p>												

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC 41

W P 197-77-17 LOCATION Co-ords. N 4 820 735.6; E 286 548.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 1982 11 04 and 05 CHECKED BY [Signature]

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	NUMBER	TYPE	'N' VALUES									
180.1	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard	1	SS	26		180							
		2	SS	70		178							5 27 46 22
		3	SS	36		176							8 30 43 19
		4	SS	41		174							17 22 45 16
		5	SS	46		172							
		6	SS	97		170							17 26 43 14
169.1													
11.0	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense	7	SS	60/	15 cm	168							3 27 64 6
		8	SS	71/	15 cm	166							10 48 37 5
		9	SS	62/	15 cm	162							
160.3													
19.8	Weathered Red Shale					160							
158.7		10	SS	60/	3 cm								
21.4	End of Borehole												

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10

METRIC 42

W P 197-77-17 LOCATION Co-ords. N 4 820 692 E 286 564 ORIGINATED BY SO
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
 DATUM Geodetic DATE 83 02 16 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60						80	100
180.8	Ground Level																
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel (glacial till) Very Stiff to Hard		1	SS	31												
			2	SS	36												
			3	SS	56												
			4	SS	94												
			5	SS	64												
			6	SS	54												
			7	SS	62												
			8	SS	120/		25 cm										
			9	SS	130/		25 cm										
			10	SS	63												
172.8	End of Borehole																
8.0																	

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

OFFICE REPORT UN SOIL EXPLORATION



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 197-77-03

DIST 4

HWY 403 & 407

STR SITE 10-82-325

E-S Ramp Underpass Hwy. #403 & 407 Interchange
Complex

CONT. 84-78

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FOUNDATION INVESTIGATION REPORT

For

E-S Ramp Underpass
Hwy. #403 & 407 Interchange Complex
W.P. 197-77-03; Site 10-82-325
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 81 12 23 - 82 01 05, 82 10 28 - 82 11 01 and 82 11 22. The fieldwork consisted of seven sampled boreholes and seven dynamic cone penetration tests adjacent to each borings. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped either with 83 mm (I.D.) hollow stem or solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. In the town of Milton, town of Oakville and the city of Mississauga. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. In some of the borings, a silty clay stratum was encountered over the bedrock. The boundaries of the different strata, together with

the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977703-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness varies from 7.0 m to 10.5 m. In B.H.'s #14 & 15 this zone was not fully penetrated. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. There are random localized zones where the matrix is only slightly cohesive. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 21 to over 100 blows per 30 cm.

In the vicinity of Boreholes #14 & 15 the extreme upper portion (1.0 - 1.5 m) of the material is in a soft to very soft condition due to the stagnant surface water.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	6-16
Liquid Limit (%)	12-29
Plastic Limit (%)	11-18

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard. The very stiff zones are mainly confined to the upper portion of the deposit.

Sandy Silt to Silty Sand, Traces of Gravel & Clay

This stratum was encountered in those borings which were advanced below the above described glacial till. The thickness varied from 5.1 m to 14.4 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with traces of gravel and clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being very dense. The natural moisture content ranges from 9 to 14%. The results of the grain-size analyses performed on selected samples are plotted in an envelope form on Figure #2 of the Appendix.

Silty Clay, Some Sand

An approximate 4.7 to 6.0 m thick silty clay, some (trace) of sand zone was found to underlie the silty sand to sandy silt stratum in B.H.'s #4 and #5.

This deposit has a hard consistency. The natural moisture content is in the order of 15%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand and/or below the silty clay deposits in Boreholes #1, 4, 5 and 102. The shale is badly weathered. No core samples were obtained.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #1	El. 179.9
B.H. #2	El. 180.5
B.H. #4	El. 180.0

No groundwater level measurements were carried out in B.H.'s #5 and #102.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct two new highways (Hwy. #403 and Hwy. #407) in the vicinity of the existing Ninth Line, about 1.0 km north of Burnhamthorpe Rd. An interchange complex, consisting of several structures will be required to allow traffic transfer from one multi-lane highway to the other. One of these structures, designated as E-S Ramp, is the subject of this report.

This E-S Ramp structure will be built on a horizontal curve, having a radius of 450 m. A total of nine footings will be required. The following span lengths (beginning at the south abutment) are proposed at the time of this report preparation: 44.5 m - 55.5 m - 41.0 m - 55.5 m - 55.5 m - 55.5 m - 53.0 m - 42.5 m. The chainage of the south abutment bearings is at Sta. 1 + 298.142. In this report the piers are numbered from 1 to 7, progressing from the south abutment to the north. The height of the approach embankments are as follows:

South Approach: 10 m

North Approach: 6 m

The vertical clearance is 4.65 m at the crossing of Hwy. #407 N.B.L. and E-S Ramp underpass structure.

STRUCTURE FOUNDATIONS

The following foundation alternatives are recommended:

1) Spread Footings Within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below the following elevations:

<u>Footing Location</u>	<u>Recommended Footing Level (At or Below)</u>
South Abutment	E1. 178.8
Pier #1 7	E1. 178.8 ✓ (178.5)
#2 6	E1. 178.8
#3 5	E1. 178.8
#4 4	E1. 178.2 (179.0)
#5 3	E1. 178.2 ✓ (175.5)
#6 2	E1. 178.2 ✓ (173.5)
#7 1	E1. 177.6 ✓ (175.0)
North Abutment	E1. 177.6

It should be noted, however, that 1.4 m of earth cover should be provided, to the underside of the footings, for frost protection purposes. For footings founded at or below the above quoted elevations, an allowable bearing value of up to 385 kPa can be used in design.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. = 580 kPa
Bearing Capacity at S.L.S. Type II = 385 kPa

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill a non-yielding foundation condition should be assumed, in which case a value of $K_0=0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (approx. 25 mm) in magnitude.

No dewatering problems are anticipated due to the relatively impervious nature of the subsoil.

2) Spread Footings on Compacted Granular Fill

As an alternative, the abutments may be supported on spread footings placed on well compacted, suitable granular material within the approach fills. A safe design load of 355 kPa may be assumed. A detailed construction scheme is outlined on Fig. 3 of the Appendix. In computing the shearing resistance between the base of the footing and the compacted Granular 'A' core, the coefficient of friction may be taken as 0.55. For purposes of the O.H.B.D.C. the following design values are recommended:

Bearing Capacity at S.L.S. Type II = 335 kPa

Factored Bearing Capacity at U.L.S. = 500 kPa

*Increase to 900 kPa
12/28
84-01-04*

3) Perched Abutments on Short Piles

As a second alternative, the abutments may be constructed within the approach fills and supported on short piles driven through the fill some ~~3~~ m into the original subsoil. In the case of steel 'H' piles (310 HP 110 or 310 HP 79) design loads up to 890 kN may be assumed.

10m

The piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11. For the purpose of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. = 1160 kN
Capacity at S.L.S. Type II = 890 kN

The pile caps should have a minimum of 1.4 m earth cover for frost protection requirements.

APPROACH EMBANKMENTS

Fills up to 10 m will be required at this location adjacent to the proposed structure. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles may have to be driven, and it is recommended that this portion of the fill contain no larger grain sizes than 75 mm. It is estimated that the total settlement caused by the embankment loading will be in the order of 50 mm.

In the vicinity of Borehole No. 14 (Sta. 1 + 360+) a very soft, about 1.5 m thick surficial material was encountered. It is recommended that this very soft zone of the glacial till be removed to its full vertical and horizontal extent within the construction area. The exact dimensions (vertical & horizontal) of the soft material at this location and at other locations along the proposed embankment will be determined by the Regional Geotechnical Section.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. D. Collom, Construction Technician (1981) and Mr. J. Hayward, Student Field Technician (1982). The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. P. Payer, and reviewed by Mr. K.G. Selby.

P. Payer
P. Payer, P. Eng.
Foundations Engineer



K.G. Selby
K.G. Selby, P. Eng.
Senior Foundations Engineer

A P P E N D I X

RECORD OF BOREHOLE No 1

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 898.5; E 286 663.8 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
 DATUM Geodetic DATE 82 10 28 CHECKED BY GP

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
180.9	Ground Level													
0-0	Heterogeneous Mixture of Silty Clay Sand & Gravel V. Stiff to Hard Glacial Till		1	SS	27									
			2	SS	33									
			3	SS	35									
			4	SS	21									
			5	SS	39									
			6	SS	69									
173.9	7.0	Compact Silty Sand to Sandy Silt Trace of Gravel & Clay Very Dense	7	SS	19								8 40 42 10	
	8		SS	75/	15 cm									
	9		SS	90/	8 cm									
	10		SS	90/	8 cm									
	11		SS	70/	8 cm									
	12		SS	64/	23 cm									
162.5	18.4		13	SS	100/	5 cm							10 37 51 2	
161.0	161.0		14	SS	100/	5 cm							15 39 34 12	
19.9	End of Borehole													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 805.5; E 286 649.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 10 29 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH					
181.3	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay (CL)												
	Sand & Gravel		1	SS	38/23	cm							
	Hard		2	SS	76/23	cm							
	Glacial Till		3	SS	32								7 28 50 15
			4	SS	60/15	cm							10 35 44 11
			5	SS	60/15	cm							13 32 40 15
			6	SS	60/15	cm							
174.3													
7.0	Sandy Silt to Silty Sand		7	SS	60/15	cm							
	Some Gravel		8	SS	80/8	cm							13 49 32 7
	Traces of Clay		9	SS	75/8	cm							
			10	SS	75/8	cm							10 43 38 9
	Very Dense		11	SS	90/8	cm							
			12	SS	60/10	cm							1 22 75 2
			13	SS	80/10	cm							
159.9													
21.4	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 4

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 604.7; E 286 684.4 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PF
 DATUM Geodetic DATE 82 10 29 and 82 11 01 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	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
180.8	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay	1	SS	30		180							
	Sand & Gravel	2	SS	42									
	Hard	3	SS	61									
	Glacial Till	4	SS	92									
		5	SS	40	8 cm	176							
		6	SS	43		174							
		7	SS	60	15 cm	172							
		8	SS	30	8 cm	170							
170.7													
10.1	Silty Sand to Sandy Silt	9	SS	30	8 cm	170							
	Traces of Gravel & Clay												
	V. Dense												
		10	SS	90	3 cm	166							
165.6													
15.2	Silty Clay												
	Some Sand												
	Hard	11	SS	30	8 cm	164							
						162							
160.9		12	SS	60	8 cm	160							
19.9	End of Borehole												
	Reddish Brown Weathered Shale												

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 5

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 516.5; E 286 734.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
 DATUM Geodetic DATE 82 11 01 and 02 CHECKED BY GP

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	NUMBER	TYPE	'N' VALUES			20	40					
180.5	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay	1	SS	35		180							
		2	SS	76		178							
	Sand & Gravel	3	SS	65		176							
	Hard	4	SS	38		174							6 25 43 26
	Glacial Till	5	SS	42		172							
		6	SS	66/23	cm	170							
		7	SS	101		168							
170.0						166							
10.5	Silty Sand to Sandy Silt	8	SS	86/23	cm	164							
	Traces of Gravel & Clay	9	SS	80/15	cm	162							
	V. Dense	10	SS	70/15	cm	160							
						158							
163.6						156							
16.9	Silty Clay	11	SS	65/15	cm	154							
	Traces of Sand					152							
	Hard	12	SS	100/15	cm	150							
						148							0 9 64 27
157.6						146							
22.9	Reddish Brown Weathered Shale					144							
156.1						142							
24.4	End of Borehole					140							
	Note: No Groundwater Level Measurements Were Carried Out.												

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 14

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 467.5; E 286 767.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 11 22 CHECKED BY [Signature]

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
179.8	Ground Level		1	SS	4/45									
0.0	V. Soft to Soft		2	SS	13									
	Heterogeneous Mixture of Silty Clay		3	SS	38									
	Sand & Gravel		4	SS	84									
	Stiff to Hard		5	SS	91									
174.8	End of Borehole		6	SS	60									
	Surface Water Level 15 cm above Ground Level (82 11 22)		7	SS	59									

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 15

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 415.0; E 286 838.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 11 22 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	NUMBER	TYPE	N' VALUES			20	40						60
180.0	Ground Level													
0.0	Soft													
	Heterogeneous Mixture of Silty Clay	1	SS	37	28 cm									
	Sand & Gravel	2	SS	98										
	Hard	3	SS	89										
	Glacial Till	4	SS	71										
		5	SS	34										
173.4		6	SS	40										
6.6	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 102

METRIC

W P 197-77-03 LOCATION Co-ords N 4 820 741.1; E 286 632.4 ORIGINATED BY DBC
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (H.S.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 81 12 23 - 82 01 05 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40					
181.0	Ground Level												
0.0	Heterogeneous Mixture of Silty Clay	1	SS	22									16 23 43 18
	Sand & Gravel	2	SS	29									3 31 42 24
	V. Stiff to Hard	3	SS	27									
	Glacial Till	4	SS	72									
		5	SS	38									
		6	SS	33									
		7	SS	39									26 23 32 20
		8	SS	111									6 31 55 8
		9	SS	83									15 34 38 13
		10	SS	110	18 cm								10 30 45 15
172.5													
8.5	Sandy Silt to Silty Sand	11	SS	125	23 cm								
	Traces of Gravel & Clay	12	SS	186	15 cm								6 24 61 9
	Occ. Silty Clay Layers	13	SS	100	10 cm								
	V. Dense	14	SS	115	13 cm								11 43 40 6
		15	SS	49									
		16	SS	100	10 cm								4 38 48 10
		17	SS	100	15 cm								
		18	SS	67	15 cm								1 12 82 5
160.3													
20.7	Reddish Brown Weathered Shale	19	SS	100	15 cm								0 26 57 17
159.5													
21.5	End of Borehole												
	Note: No Groundwater Level Measurements Were Carried Out.												

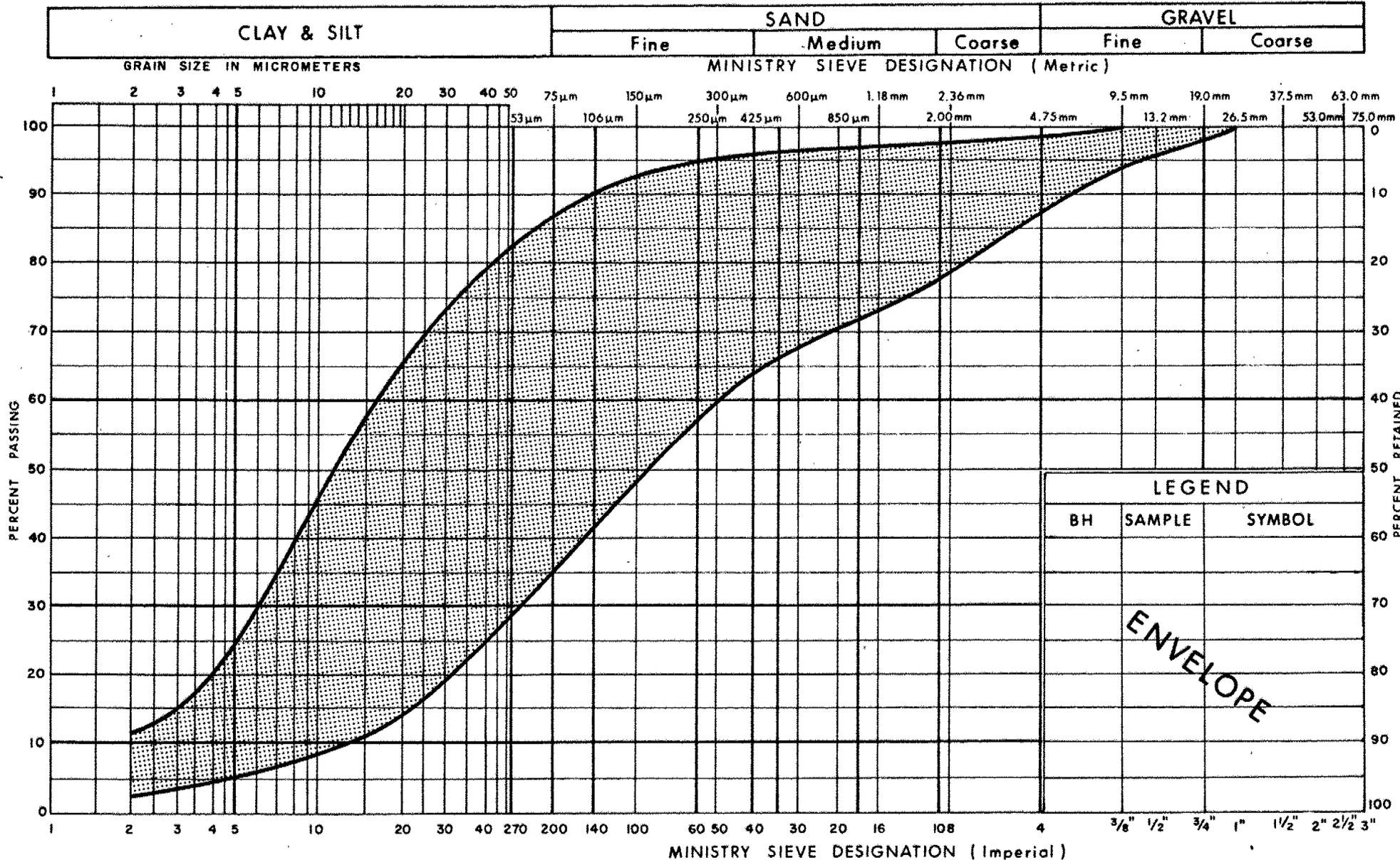
OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (% STRAIN AT FAILURE)

UNIFIED SOIL CLASSIFICATION SYSTEM



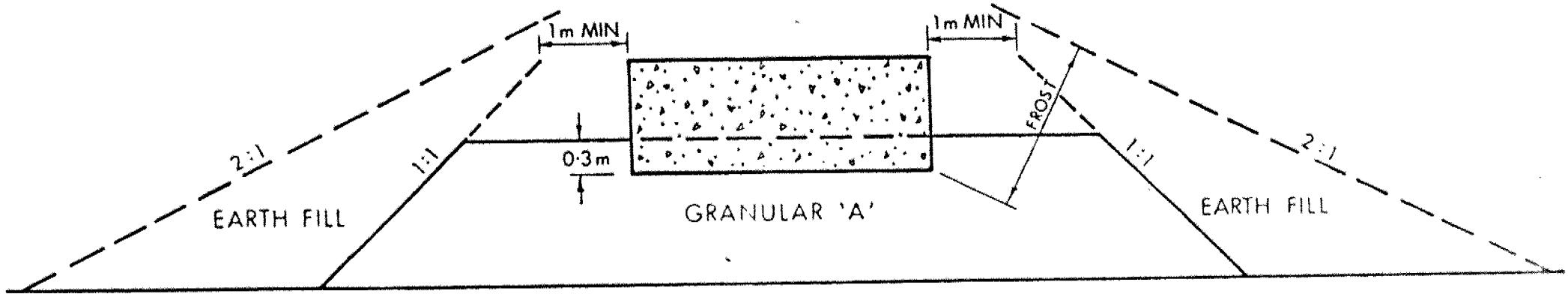
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT
TRACES OF GRAVEL & CLAY

FIG No 2

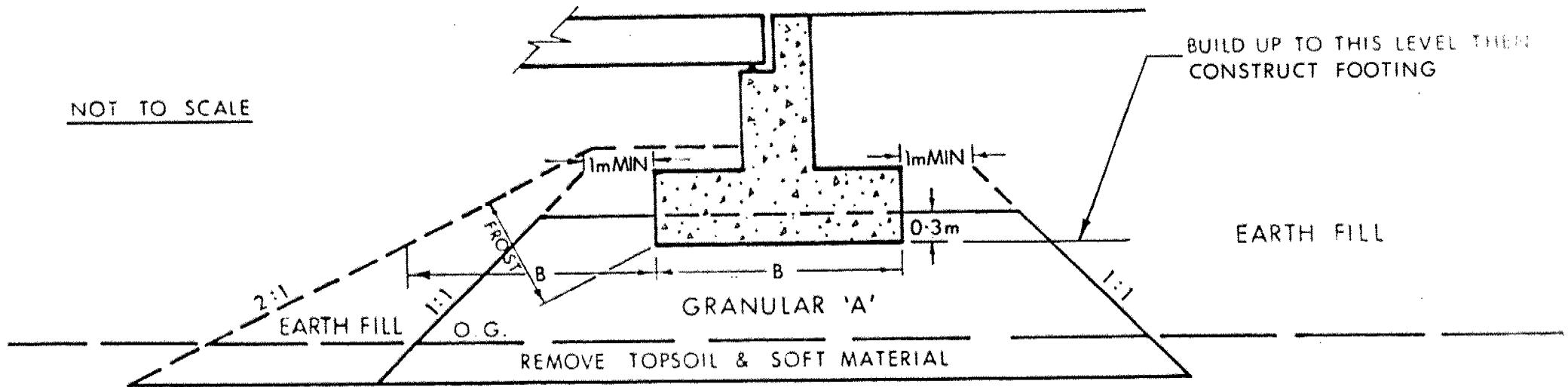
WP 197-77-03

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION

NOT TO SCALE



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

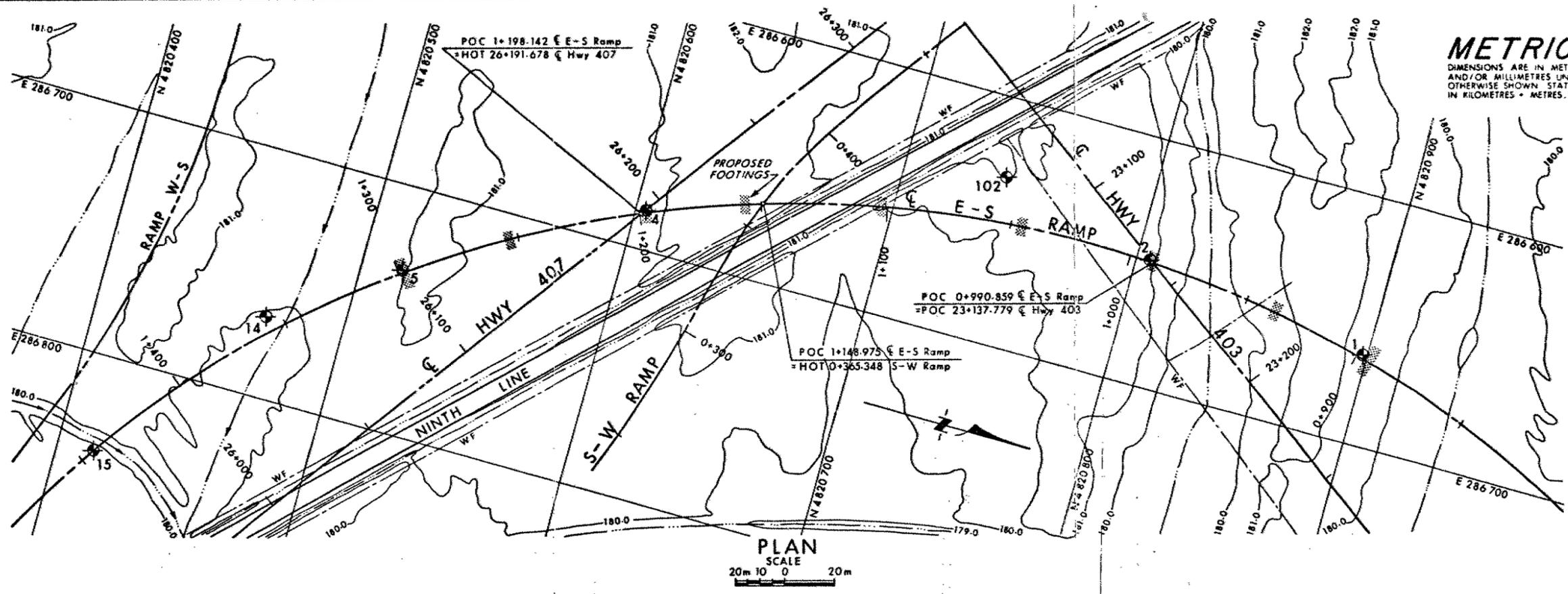
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
C_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w - w_p}$	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						



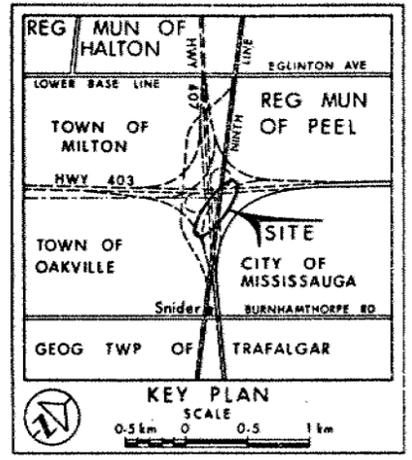
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 197-77-03

E-S RAMP UNDERPASS
(HWY 403 & 407)

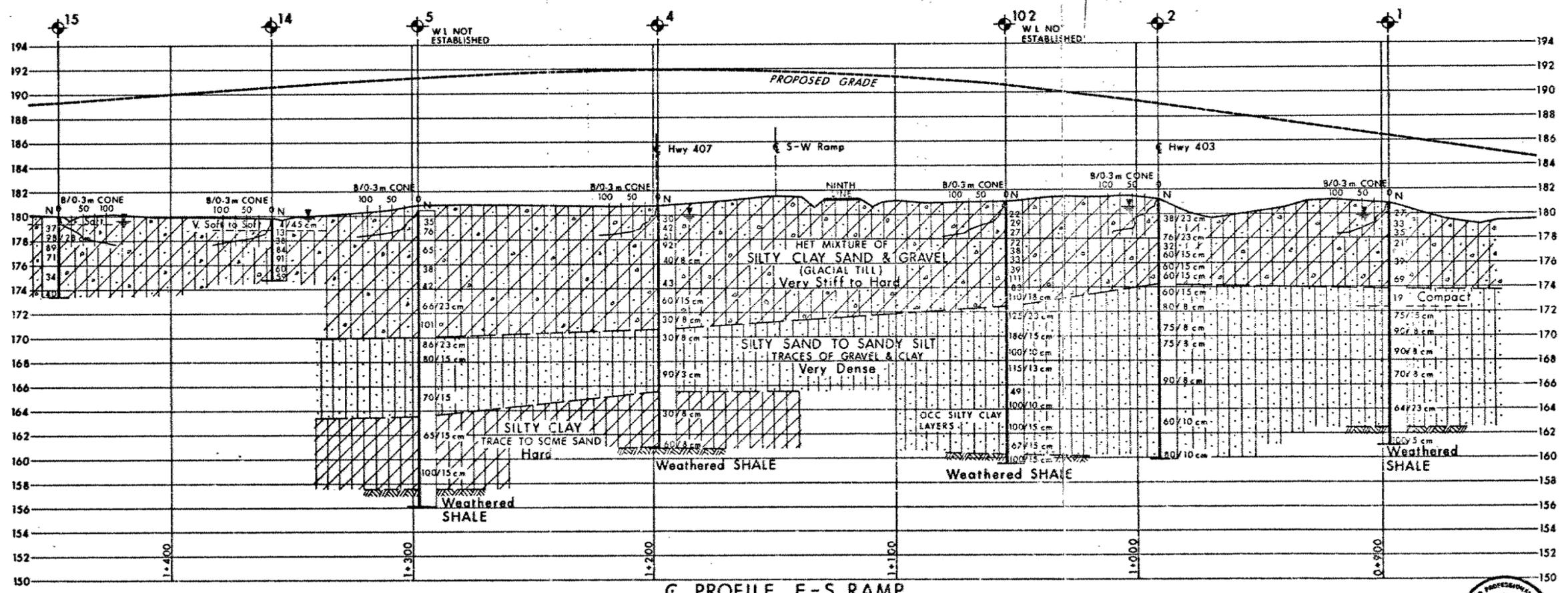
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1982 10 and 1982 11
- W L Not Established in BH 5 & 102



No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	180.9	4 820 898.5	286 663.8
2	181.3	4 820 805.5	286 649.5
4	180.8	4 820 604.7	286 684.4
5	180.5	4 820 516.5	286 734.0
14	179.8	4 820 467.5	286 767.0
15	180.0	4 820 415.0	286 838.5
102	181.0	4 820 741.1	286 632.4

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

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

E-S RAMP PROFILE

SCALE
HOR 20m 10 0 20m
VERT 4m 2 0 4m



REV	DATE	BY	DESCRIPTION

Geocres No 30M12-169

HWY No 403	DIST A
SUBM'D BY CHECKED	DATE 1982 11 30
DRAWN BY CHECKED	SITE 10-A2-325
	DWG 197703-A

memorandum



To: Mr. K. Selby,
Senior Foundation Engineer,
Pavement and Foundation
Design Section,
Central Building, Downsview.

Date: 1983-01-27

Central Region

RE: Foundation Investigation and Design Reports,
Highway 403/407 Interchange Structures,
W.P. 197-77-02, -03, -04 and -05,
District 4, Hamilton

The above four (4) Foundation Investigation Reports, and your memorandum dated 83-01-25, indicate that 1.4 metres of earth cover is required for frost protection purposes. Our practice, however, is to allow for 1.2 metres depth only for the structures located in District 4, Hamilton.

Would you please, therefore, advise us whether the excessive depth for the frost protection to the footings of the structures is necessary.

HKJ:rb

A handwritten signature in cursive script that reads "H. Jagasia".

H.K. Jagasia,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. K.G. Bassi
N. Sen
C.P. Korzeniowski
(McCormick, Rankin & Assoc.)

EARTH COVER: 1.2m. O.K.
APPROVED BY K.G. SELBY
83-01-26

