DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-172

DIST. 6 REGION

W.P. No. 21-79-02

CONT. No. 84-45

W. O. No.

STR. SITE No. 24-476

HWY. No. 410

LOCATION Orenda Rd. Overpass

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DB-BR 1316 01-06

DIST No 6
CONT No
WP No 21-79-02

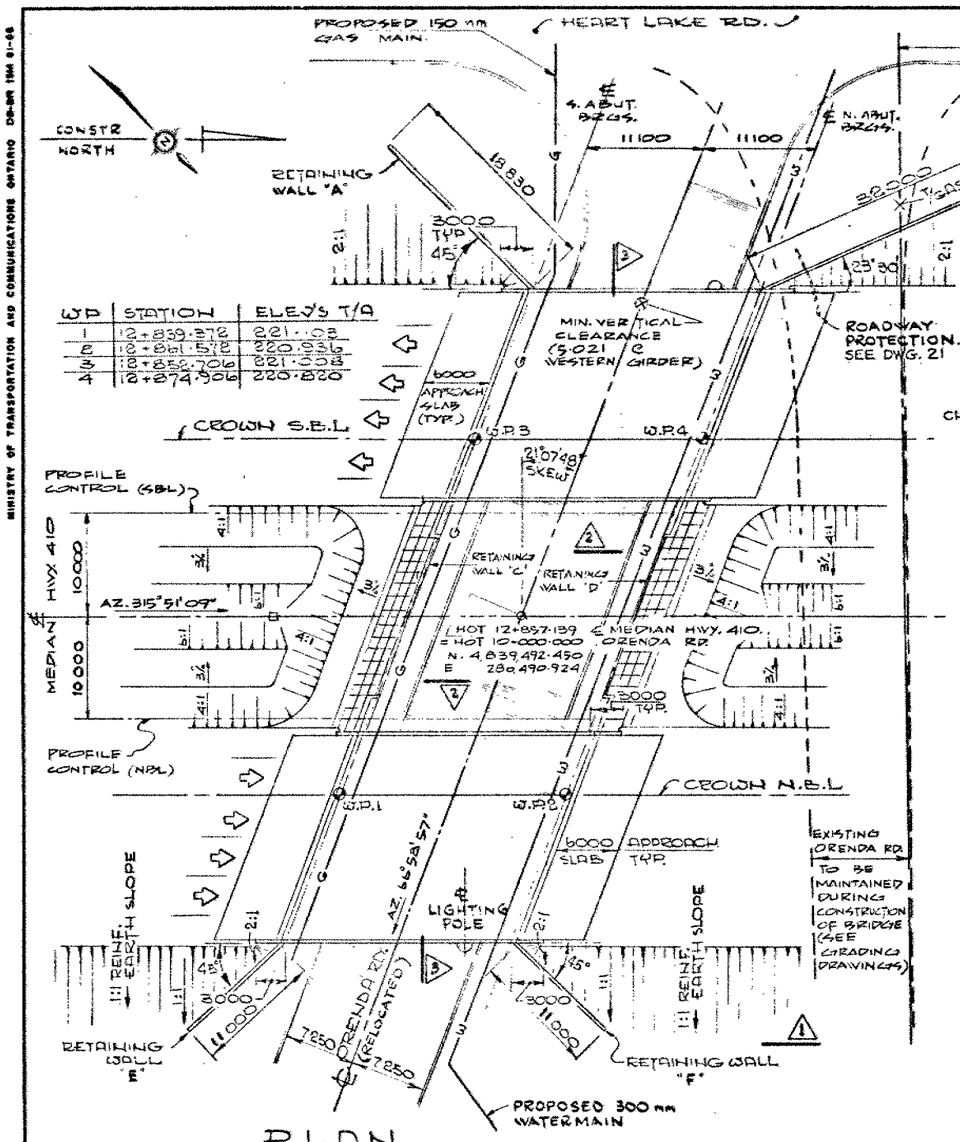
HWY. 410 OVERPASS AT ORENDA RD.

GENERAL ARRANGEMENT

SHEET

METRIC

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

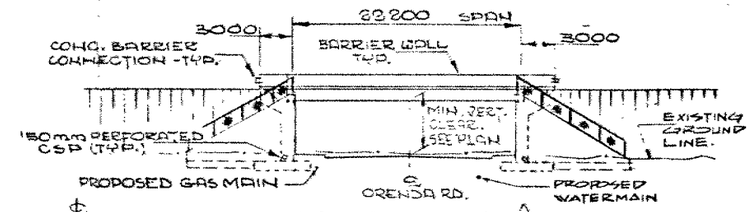


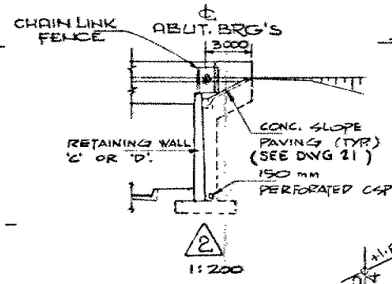
WP	STATION	ELEV'S T/A
1	12+839.378	221.103
2	12+861.578	220.936
3	12+858.706	221.005
4	12+874.906	220.820

PLAN
SCALE 1:300

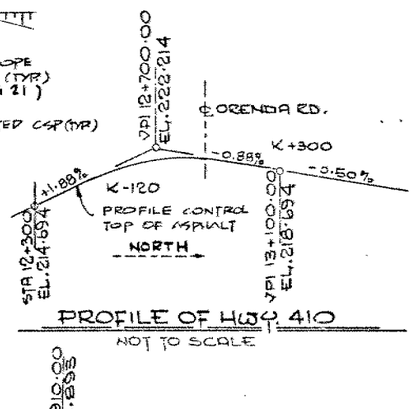
ABANDONED 150 mm GAS MAIN TO BE REMOVED 300 mm ON EACH SIDE OF THE RETAINING WALL FOOTING.

RETAINING WALL "B" TO BE CONSTRUCTED AFTER TRAFFIC DIVERSION. (SEE GRADING DRAWINGS FOR CONSTRUCTION STAGING.)

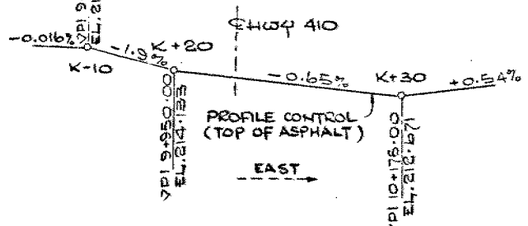




ELEVATION
SCALE 1:300



PROFILE OF HWY 410
NOT TO SCALE



PROFILE OF ORENDA RD.
NOT TO SCALE

GENERAL NOTES

THE APPROACH SLABS (4), ASPHALT AND WATERPROOFING SYSTEMS ARE NOT PART OF THIS CONTRACT.

CLASS OF CONCRETE

ABUTMENTS, WINGWALLS, RET. WALLS DECK, BARRIER WALLS & FOOTINGS	30 MPa
APPROACH SLABS	20 MPa
PRESTRESSED GIRDERS	40 MPa

REINFORCING STEEL

GRADE 400
BAR MARK WITH SUFFIX C DENOTES COATED BAR.

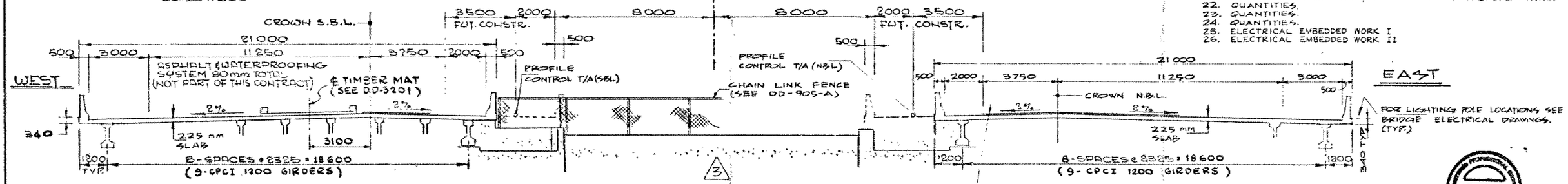
CLEAR COVER TO REINFORCING STEEL	mm
FOOTINGS	100 ± 25
DECK TOP	70 ± 20
DECK BOTTOM	40 ± 10
FRONT FACE OF ABUTMENTS & RETAINING WALLS	80 ± 20
PRESTRESSED GIRDERS	30 ± 5
REMAINDER	70 ± 20

CONSTRUCTION NOTES

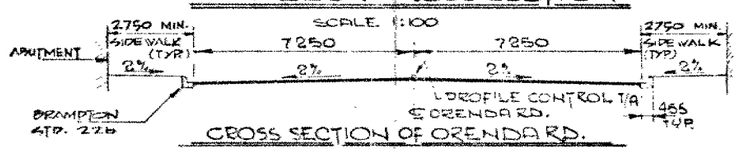
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEV'S WITH A TOLERANCE OF ± 3mm
- SEE DD-3201 FOR MAXIMUM CONSTRUCTION EQUIPMENT LOADING ON S.B.L. STRUCTURE.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT.
2. BOREHOLE LOCATION & SOILS STRATA.
3. FOOTING LAYOUT.
4. ABUTMENT FOOTING REINFORCING.
5. S.E. ABUTMENT I.
6. S.E. ABUTMENT II.
7. S.W. & N.E. ABUTMENTS.
8. N.W. ABUTMENT.
9. RETAINING WALL A.
10. RETAINING WALL B.
11. RETAINING WALLS C & D.
12. RETAINING WALLS E & F.
13. DECK AND SCREED ELEVATIONS.
14. PRESTRESSED GIRDERS & BEARINGS.
15. BARRIER WALL.
16. 6000 mm APPROACH SLABS.
17. EXPANSION JOINT & LIGHTING POLE BASE DETAILS.
18. AS CONSTRUCTED ELEV. & DIM. I.
19. AS CONSTRUCTED ELEV. & DIM. II.
20. BRIDGE DATE & SITE NUMBER DATA.
21. ROADWAY PROTECTION & DETAILS OF CONC. SLOPE PAVING.
22. QUANTITIES.
23. QUANTITIES.
24. QUANTITIES.
25. ELECTRICAL EMBEDDED WORK I
26. ELECTRICAL EMBEDDED WORK II



TYP. DECK CROSS-SECTION
SCALE 1:100



CROSS SECTION OF ORENDA RD.
SCALE 1:100

ASPHALT & WATERPROOFING SYSTEM 80 mm TOTAL (NOT PART OF T/A CONTRACT)

LOADING
- O.H.B.D.C.-A-79 S.B.L. & N.B.L. STRUCTURES.
- DD-3201 (81-08-01 REV. 1), S.B.L. STRUCTURE ONLY

NOTE:
- W.P. DENOTES WORKING POINT.
- T/A DENOTES TOP OF ASPHALT PAVEMENT.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

BM 214.051.
GEODETIC DATUM.
N.W. CORNER OF CONC. SLAB.
15.5 LT. 12 + 934.7.

J.T. BROWN PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN J.B.	CHECK	LOADING	DATE JAN 83
DRAWING	CHECK J.B.	SITE	DWG

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DB-MR 1984 81-88

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
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STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 21-79-02

HWY.410 OVERPASS AT ORENDA RD.

FOOTING LAYOUT

SHEET

N 4839452·264
E 286466·849

AZ. 180° 51' 09"

CONST. NORTH

S. ABUT. ℄ BRGS.

22200

N. ABUT. ℄ BRGS.

N 4839499·191
E 286422·071

AZ. 66° 52' 51"

AZ. 292° 21' 09"

A1 RETAINING WALL 'A' A2 A3

B1 B2 B3 B4 RETAINING WALL 'B'

N. 4839471·092
E. 286467·129

N. 4839457·021
E. 286491·667

21°07'48" SKEW (TYP.)

WP3 WP4 WP1 WP2

CROWN ℄ PAL

℄ HWY. 410

AZ. 315° 51' 09"

S.W. ABUT. ℄ BRGS.

S.E. ABUT. ℄ BRGS.

N. 4839497·879
E 286530·181

N. 4839497.715
E. 286 541·180

N.E. ABUT. ℄ BRGS.

N. 4839524·807
E. 286 514·883

N.W. ABUT. ℄ BRGS.

N. 4839513·868
E. 286514·719

℄ HWY. 410			
POINT	STATION	NORTH	EAST
WP1	12+839·372	4839491·716	286515·676
WP2	12+861·572	4839507·646	286500·214
WP3	12+852·706	4839477·254	286481·634
WP4	12+874·906	4839493·184	286466·172

A 1:50

B 1:50

C 1:50

D 1:50

E 1:50

1 1:50 ABUTMENTS

A3 4 1:50

A2 5 1:50

A1 6 1:50

7 B4 1:50

8 B3 1:50

B2 9 1:50

B1 10 1:50

E2 3 F2 1:50

E1 2 F1 1:50

CONTRACTOR TO REMOVE 4500 mm. OF GAS MAIN & REFILL WITH WELL COMPACTED GRANULAR

FOOTING LAYOUT 1:200

1:200

J.T. BROWN

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN JB | CHECK | LOADING | DATE JAN 83
DRAWING | CHECK JB | SITE | DWG 3

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84-45

Ontario

Ministry of
Transportation and
Communications

INDEX

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1	Index
2	Abbreviations and Symbols
3 - 31	Foundation Investigation Report For: W.P. 21-79-02, Site 24-145-476 Orenda Road Overpass W.P. 21-79-05, Site 24-145-343 Queen Street Underpass

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

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:

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 = $w_L - w_P$	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				k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	e_{max}	1,%	VOID RATIO IN LOOSEST STATE			

FOUNDATION INVESTIGATION REPORT

For

Orenda Road Overpass

W.P. 21-79-02, Site: 24-145-476

Hwy. 410, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation carried out by Morton & Partners Limited at the site mentioned above.

The fieldwork for this investigation was carried out on July 5th and 6th, 1982, and consisted of six boreholes advanced by means of solid stem augers and six dynamic cone penetration tests at the locations shown on Drawing No. 2. The work was carried out using a truck-mounted CME 45 drilling machine.

The elevations of the ground surface at the borehole locations were determined using a benchmark consisting of the northwest corner of a concrete slab, 15.5 m left at chainage 12 + 934.7. The elevation of this benchmark is reported to be at 214.051.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately east of Heart Lake Road and immediately south of Orenda Road. The area is an open and grassed field at the present time and approximately level at about el. 214.

The site is located centrally within the broad, gently southward shelving Peel Clay Plain which was formed by glacial deposition and post-glacial sequential erosion and sedimentation that took place within a large ephemeral garland lake which was dammed up behind (i.e. north of) the remnant of the Wisconsin ice sheet that was left temporarily within the Lake Ontario topographic basin during the ultimate stage of Pleistocene ice retreat. The clay plain tends to be "stepped" into a series of rises from south to north as a result of bedrock influences and by the staged southeastward withdrawal of the ice margin.

Bedrock comprises grey, interbedded thin shales, siltstones, mudstones and limestone of the Meaford-Dundas formation, which are of late Ordovician age. Bedding is essentially flatlying with less than one degree declination (dip) almost due southwest.

SOIL CONDITIONS

The soil conditions at the borehole locations are shown on the Borehole Records and consist essentially of silty clay resting on bedrock as described below.

Topsoil

All boreholes encountered topsoil extending to depths ranging from 50 to 300 mm. In Borehole 8 only, the topsoil was covered with a veneer of sand and gravel fill, about 75 mm in thickness.

Silty Clay (Glacial Till)

The topsoil covers a deposit of silty clay with some sand and widely dispersed fine gravel, extending to bedrock at depths of about 5 to 6 m below ground level.

The colour of the stratum grades from brown to grey-brown with depth and becomes grey, rather abruptly, at about el. 210, i.e. from 3.5 to 4.2 m below the ground surface.

Grain size analyses were carried out on samples from the stratum. The results are shown on the Borehole Records and summarized on the Envelope on Figure 1. In the samples tested, the clay content ranged from 22 to 37% with a median value of 30%.

Atterberg limit tests resulted in liquid limits ranging from 21 to 28 with plasticity indices ranging from 7 to 11, identifying the material as inorganic clay of low plasticity. Moisture content determinations indicated an almost constant moisture content throughout the depth of both the oxidized and non-oxidized parts of the clay stratum, averaging between 12 and 13% and significantly below the plastic limit.

The nature and composition of the material is such that values of shear strength could not conveniently be determined by normal laboratory testing. The insitu strength of the stratum was therefore judged on the basis of 'N' values, visual examination and pocket penetrometer tests.

The standard penetration ('N') values obtained in the upper, brown to grey-brown, part of the deposit (ignoring the surficial ones in each borehole) ranged from 20 to 52 blows per 300 mm with a median value of 34. In the grey part of the deposit, the 'N' values ranged from 17 to 48 with a median value of 31. On the average there is no significant difference in strength between the oxidized (brown) and non-oxidized (grey) parts of the stratum.

On the basis of all the evidence, it is considered that the silty clay stratum is of very stiff to hard consistency with estimated shear strengths of the order of 150 kPa to about el. 212, rapidly increasing to values well in excess of 200 kPa between el. 212 and 210, to decrease to an average value of 150 kPa between el. 210 and the bedrock surface.

Bedrock

Bedrock was encountered at depths ranging from 5 to 6 m below the ground surface, i.e. between el. 208.0 and 208.8 and augered to refusal as deep as el. 204.9.

The bedrock was identified as weathered grey shale with thin limestone bands. It is believed that auger refusal was obtained in more substantial limestone layers.

GROUNDWATER

With the exception of Boreholes 2 and 8, all boreholes were dry during drilling and upon completion. Boreholes 2 and 8 showed evidence of groundwater at a depth just below the bedrock surface and sealed piezometers were installed in these boreholes at depths of about 6 m.

The water levels were measured in the standpipes and in the open cone holes on July 20 (after a prolonged dry spell) and on August 4 (immediately following a night of heavy rain). The results are tabulated below:

WATER LEVEL ELEVATION

	July 20	August 4
Borehole 2	212.8	212.7
Cone 3	211.3	
Cone 4	212.0	212.8
Cone 6	211.9	
Cone 7	212.1	212.8
Borehole 8	212.6	212.9
Cone 9	212.1	212.9
Cone 10	212.1	212.9

On the basis of these observations, it is concluded that the groundwater level was at about el. 212.5 at the time of the investigation.

H. Sturm, P.Eng.
Project Foundation Engineer

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

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,512 N; 286,514 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-05 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × 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
213.52	Ground Level										
0.00	Topsoil 125 mm		1	SS	15	*	213.00		o		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	26				o		4 14 52 30
							212.00				
	Very Stiff to Hard		3	SS	31				o ⊢		2 16 52 30
			4	SS	52		211.00		o		
	Brown and grey-brown becoming grey at elevation 210.1.		5	SS	40		210.00		o		
							209.00				
208.02			6	SS	48				o ⊢		
5.50	Shale Bedrock weathered.						208.00				
			7	SS	100/100mm				o		
206.75			8	SS	100/50mm		207.00		o		
6.77	End of Borehole. Refusal on Auger and Sampler.										

* Groundwater not encountered.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,490 N; 286,548 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-05 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
213.68	Ground Level										
0.00	Topsoil 150 mm		1	SS	6				○		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	25	▼	213.00		○		7 13 43 37
			3	SS	24		212.00		○		3 12 48 37
	Very Stiff to Hard		4	SS	37		211.00		○		
	Brown and grey-brown becoming grey at elevation 210.3.		5	SS	32		210.00		○		
208.48			6	SS	34		209.00		○		
5.20	Shale Bedrock weathered.		7	SS	52		208.00		○		
			8	AS							
206.97			9	SS	100/137mm		207.00		○		
6.71	End of Borehole. Refusal on Auger.										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,485 N; 286,507 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-05 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.11	Ground Level										
0.00	Topsoil		1	SS	5		214.00		o		
0.30	Silty clay, some sand, trace of gravel. (Till)					*					
			2	SS	25		213.00		o		
	Very Stiff to Hard		3	SS	31				o		4 17 47 32
							212.00				
			4	SS	51				o ⊢—⊣		6 17 48 29
	Brown and grey-brown becoming grey at elevation 210.1.						211.00				
			5	SS	36				o		
							210.00				
			6	SS	23				o ⊢—⊣		
208.61			7	AS			209.00				
5.50	Shale Bedrock weathered.										
207.31			8	SS	60/50mm		208.00		o		
6.80	End of Borehole. Refusal on Auger.										

* Groundwater not encountered.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,494 N; 286,471 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-05 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × 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
213.96	Ground Level										
0.00	Gravel fill 75 mm Topsoil 50 mm		1	SS	7				o		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	20	▽	213.00		o		
			3	SS	23		212.00		o		4 19 50 27
	Very Stiff to Hard		4	SS	32				o		
			5	SS	48		211.00		o		
	Brown and grey-brown becoming grey at elevation 209.2						210.00				
			6	SS	28		209.00		o		
208.46											
5.50	Shale Bedrock weathered.		7	SS	50/12mm		208.00				
207.25			8	SS	70/12mm				o		
6.71	End of Borehole. Refusal on Auger and Sampler.										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,445 N; 286,477 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-06 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
214.17	Ground Level										
0.00	Topsoil 50 mm		1	SS	5	✱	214.00		o		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	36		213.00		o		1 20 56 23
			3	SS	38				o		
	Very Stiff to Hard		4	SS	45		212.00		o		9 20 49 22
			5	SS	45		211.00		o		
	Brown and grey-brown becoming grey at elevation 210.0.						210.00				
208.17			6	SS	17		209.00		o		
6.00	Shale Bedrock weathered.		7	SS	90		208.00		o		
			8	SS	100/50mm		207.00		o		
204.87			9	SS	100/50mm		206.00				
9.30	End of Borehole. Refusal on Auger and Sampler.						205.00				

✱ Groundwater not encountered.

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 12

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,499 N; 286,428 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-06 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.04	Ground Level										
0.00	Topsoil 200 mm		1	SS	7	✱	214.00				
	Silty clay, some sand, trace of gravel. (Till)		2	SS	25		213.00				
			3	SS	28		212.00				3 21 48 28
	Very Stiff to Hard		4	SS	42		211.00				
			5	SS	41		210.00				
	Brown to grey-brown becoming grey at elevation 209.8.										
208.84			6	SS	40		209.00				
5.20	Shale Bedrock weathered.		7	SS	100/50mm		208.00				
207.33											
6.71	End of Borehole. Refusal on Auger.										

✱ Groundwater not encountered.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF CONE No 3

METRIC

W P 21-79-02 LOCATION Co-ords 4,839,529 N; 286,510 E ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MS
DATUM Geodetic DATE (Cone 3: 82-07-06) (Cone 4: 82-07-06) (Cone 6: 82-07-06) CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
213.05	Ground Level										
0.00							213.00				
							212.00				
							211.00				
210.00							210.00		122/300 mm		
3.05	End of Dynamic Cone Penetration Test 3										

RECORD OF CONE No 4

Co-ords 4,839,498 N; 286,528E

213.80	Ground Level										
0.00							213.00				
							212.00				
							211.00				
210.60									126/300 mm		
3.20	End of Dynamic Cone Penetration Test 4										

RECORD OF CONE No 6

Co-ords 4,839,502 N; 286,490 E

213.89	Ground Level										
0.00							213.00				
							212.00				
211.00							211.00				
2.89	End of Dynamic Cone Penetration Test 6										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

RECORD OF CONE No 7

METRIC

W P 21-79-02 LOCATION Co-ords 4,839,477 N; 286,487 E ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MS

DATUM Geodetic DATE (Cone 7: 82-06-06) (Cone 9: 82-07-06) (Cone 10: 82-07-06) CHECKED BY AP

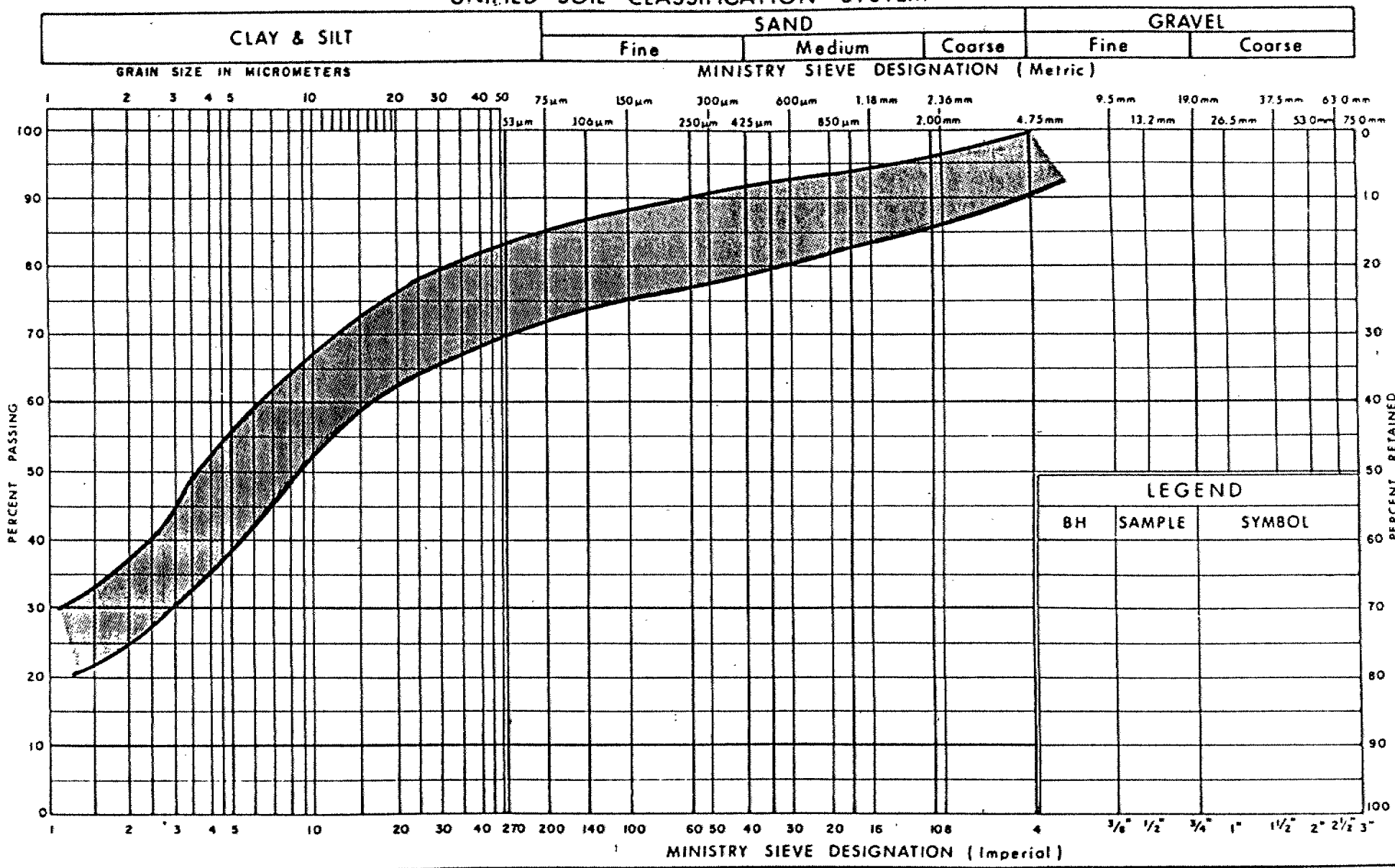
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
214.08	Ground Level										
0.00							214.00				
							213.00				
							212.00				
211.03								189/300 mm			
3.05	End of Dynamic Cone Penetration Test 7										
	RECORD OF CONE No 9 Co-ords 4,839,471 N; 286,465 E										
214.20	Ground Level										
0.00							214.00				
							213.00				
							212.00				
211.15								142/300 mm			
3.05	End of Dynamic Cone Penetration Test 9										
	RECORD OF CONE No 10 Co-ords 4,839,483 N; 286,454 E										
214.16	Ground Level										
0.00							214.00				
							213.00				
							212.00				
211.26								98/150 mm			
2.90	End of Dynamic Cone Penetration Test 10										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
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GRAIN SIZE DISTRIBUTION

ENVELOPE

FIG No 1

WP 21-79-02

FOUNDATION INVESTIGATION REPORT

For

Queen Street (Hwy. 7) Underpass

W.P. 21-79-05 Site: 24-145-343

Hwy. 410, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above mentioned structural site. The fieldwork was carried out between 74 01 29 and 74 02 14 under W.P. 134-73-02.

Six boreholes, four of which accompanied by a dynamic cone penetration test, were put down during the course of the field investigation. The borings and the penetration tests were advanced by means of a continuous flight auger machine adapted for soil sampling purposes for depths ranging from 15.7 to 16.6 m. Bedrock was cored in all boreholes for a maximum depth of 2 m.

Site Description and Geology

The site is located immediately east of the existing intersection of Queen St. (Hwy.7) and Heart Lake Rd., in the City of Brampton, Municipality of Peel.

Land use in the area has recently changed from predominately farming to industrial subdivision development. Topography across the site is generally flat with ground surface sloping gently towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is a ground moraine composed of cohesive glacial till, laid down during the Wisconsinian glacial age. Deposits of silt and sand are often found interbedded within the till.

Subsurface Conditions

Although variable in composition, generally competent subsurface conditions were encountered across the site.

The predominant stratum encountered at the site is a cohesive deposit of stiff to hard silty clay with sand and gravel. At three boring locations this stratum is overlain by fill material of up to 1.5 m thick. The surficial cohesive deposit is followed by a granular deposit ranging from silt to silty sand, which is in turn underlain by a heterogeneous mixture of silty clay, sand and gravel of glacial origin. The overburden is followed by limestone bedrock.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile and three estimated soil stratigraphical sections based on borehole data, are shown on Drawing No. 2.

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

Fill Material

Roadway fill material was encountered at three boring locations (BH's 2, 3 and 4). The fill material was composed of silty clay of low plasiticity with sand and gravel at two boreholes. At BH #3, it is a silty sand with traces of gravel. The thickness of the fill material was found to be 1.5 m at all three boreholes. Standard Penetration Testing carried out within this stratum gave 'N' values ranging from 9 to 18 blows per 0.3 m. Based on these values, it is estimated that the fill material has been moderately compacted.

Silty Clay, with Sand and Gravel

This is the predominant stratum which was encountered immediately below the ground surface or directly under the fill material where it exists. The thickness of this deposit ranges from 2.2 m at BH #3 to 9.8 m a BH #4. Random thin seams of silt and sand are present within this deposit. At BH #4, the upper 2.1 m of this deposit consists of alternate layers of silty sand and silty clay.

Grain-size distribution tests were performed on the samples obtained from the cohesive portion of this deposit. The results are summarized on Fig. #2 in envelope form.

Atterberg Limit tests were carried out on the cohesive portion of the samples obtained. The results, which are plotted on the Record of Borehole Sheets and the Plasticity Chart (Fig.#1), are summarized in tabulated form as below.

			Range
Liquid Limit	(W_L)	%	16-34
Plastic Limit	(W_p)	%	12-20
Natural Moisture Content	(W)	%	8-18

Based on these values, it may be estimated that the cohesive deposit is an inorganic silty clay of low plasticity (CL).

Standard Penetration testing carried out within this deposit gave 'N' values ranging from 14 to in excess of 100 blows per 0.3 m. It is estimated that the consistency of this deposit varies between stiff to hard.

Granular Deposits - Silts and Sands:

Directly underlying the silty clay deposit is a granular deposit, whose composition ranges from silt with some sand to sand with some silt and a trace to some gravel. The thickness of this granular deposit varies between 3.3 m (BH #1) and 8.2 m (BH #2). The results of the grain-size distribution testing carried out on samples recovered from this deposit are presented on Fig.#3. This material is subject to "boiling" if excavations within this deposit are carried out under an unbalanced hydrostatic head. Standard Penetration Testing was carried out within this stratum. This testing gave 'N' values ranging from 37 to in excess of 100 blows per 0.3 m. The relative density of this deposit is therefore estimated to be varying from dense to very dense.

Silty Clay, Sand, and Gravel (Glacial Till)

This deposit of glacial origin was encountered at all boring locations except at BH #2. It is composed of a heterogeneous mixture of silty clay, sand and gravel. Its thickness ranges from 0.9 (BH #3) to 5.9 m (BH #1). Typical grain-size distribution curves are shown on Fig.#4. From a limited number of Atterberg limit tests, it is estimated that the glacial till has a matrix which is an inorganic silty clay of low plasticity (CL). Standard Penetration testing gave 'N' values of in excess of 100 blows per foot. Based on these values, it is estimated that the consistency of the glacial till is hard.

Bedrock

Bedrock was proven at all boring locations by obtaining 1.1 to 2.0 m of BXL size rock core. Rock surface elevations varied from 205.6 to 206.9 corresponding to depths of 14.6 to 13.9 m respectively. Rock is described as a good quality limestone showing signs of minor fracturing.

Groundwater Conditions

Groundwater conditions were observed by recording the water levels in the open boreholes during the course of the field investigation. The observations indicated that the groundwater table within the overburden varied between elevations 220.5 and 218.7 corresponding to levels from 0.5 to 1.5 m below the ground surface at the time of investigation.

H. Sturm, P.Eng.
Project Foundation Engineer

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

APPENDIX

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 1 METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 385.5; E 285 567.7 ORIGINATED BY V.K.

DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.

DATUM Geodetic DATE 74 01 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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	TYPE	'N' VALUES						
221.1	Ground Surface										
0.0	Silty Clay of low plasticity with Sand and Gravel Very Stiff to Hard		1	SS	17		220				22 25 41 12
			2	SS	47	▼					
			3	SS	128			100/28 cm			
			4	SS	146/	28 cm	218				0 31 55 14
	Brown / Grey		5	SS	100/	13 cm					
215.9			6	SS	100/	20 cm	216				
5.2	Grey Silt Some Sand Very Dense										
			7	SS	100/	13 cm					0 23 76 1
212.6							214				
8.5	Grey (Glacial Till) Silty Clay, Sand and Varying amounts of Gravel Hard		8	SS	106						
			9	SS	100/	8 cm	212				
			10	SS	108/	15 cm	210				
			11	SS	100/	5 cm					14 35 41 10
206.6			12	SS	100/	5 cm	208				
14.5	Limestone Bedrock		13	RC BXL	92% REC		206				
204.6											
16.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 2 METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 413.9; E 285 540.3 ORIGINATED BY V.K.

DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.

DATUM Geodetic DATE 74 02 11 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%): PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.4	Ground Level										
0.0	Silty Clay-low plasticity with Sand & Gravel & Trace of Organics (Fill) Stiff		1	SS	14						
219.9							220				
1.5	Brown Silty Clay of low Plasticity with Sand Hard		2	SS	46	▼					19 24 47 10
			3	SS	82			100/25 cm			
			4	SS	105		218				0 38 52 10
			5	SS	150/25 cm						
							216				
			6	SS	128/28 cm						0 28 54 18
215.0											
6.4	Grey Silty Sand with some Gravel Very Dense		7	SS	124		214				
			8	SS	163						0 81 (19)
							212				
			9	SS	125/20 cm						
							210				
			10	SS	191/23 cm						17 59 (24)
206.8											
14.6	Limestone Bedrock Partly Fractured		11	BXL RC	75% REC		208				
			12	BXL RC	76% REC		206				
204.8											
16.6	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 3 METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 411.8 E 285 599.1 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74 02 07 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
220.8	Ground Level										
0.0	Silty Sand with Trace of Gravel						220				
219.3	(Fill) Compact		1	SS	18						
1.5	Silty Clay of Low Plasticity		2	SS	14				○		16 31 38 15
	Some Sand and Gravel		3	SS	44						
217.1	Stiff to Hard Brown		4	SS	93		218		○		0 22 53 25
3.7	Grey		5	SS	57						
	Silty Sand with occasional layers of silt		6	SS	98		216				0 5 95 0
			7	SS	119				○		0 64 (36)
			8	SS	142/28 cm		214				
			9	SS	46		212				
211.0	Very Dense										
9.8	Grey (Glacial Till)		10	SS	100/13 cm				○		
	Silty Clay, Sand varying am'ts of Gravel		11	SS	100/10 cm		210		○		47 36 (17)
206.9	Hard						208				
13.9	Limestone		12	BXL RC	70% REC						
	Bedrock		13	BXL RC	100%		206				
205.1											
15.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 441.0 E 285 570.8 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74-02-13 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
221.0	Ground Level										
0.0	Silty Clay with Seams of Sand and Gravel					▼					
219.5	(Fill) Stiff		1	SS	9		220				
1.5	with alternating layers of Silty Sand		2	SS	43				○		0 57 (43)
			3	SS	77				○——		0 42 45 13
	Brown		4	SS	124		218		○		
	Grey		5	SS	145/23 cm				○—		
	Silty Clay of Low Plasticity with Sand varying am'ts of Gravel		6	SS	88		216				
			7	SS	172/20 cm		214		○—		37 18 29 16
			8	SS	100/15 cm						
	Hard		9	SS	100/15 cm		212		○—		14 30 42 14
209.7											
11.3	Silty Sand, Trace to Some Gravel		10	SS	172/25 cm		210				
	Very Dense		11	SS	100/15 cm		208		○—		0 52 42 6
206.7											
14.3	(Glacial Till) Silty		12	SS	100/10 cm		206		○—		
205.8	Clay, Sand and Gravel Hard		13	BXL RC	70%						
15.2	Limestone Bedrock Partly Fractured		14	BXL RC	80%						
204.2											
16.8	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 447.1; E 285 617.1 ORIGINATED BY V.K.

DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.

DATUM Geodetic DATE 74 01 29 CHECKED BY GP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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	TYPE	'N' VALUES						
220.2	Ground Level										
0.0	Brown Silty Clay of Low Plasticity With Sand and Gravel		1	SS	45	▼	220				
			2	SS	117			100/28 cm			0 41 46 13
			3	SS	100/15 cm		218				
216.4	Hard		4	SS	135/25 cm						0 23 65 12
3.8	Silty Sand With Occ. Layers of Silt		5	SS	118/25 cm		216				3 27 54 16
			6	SS	159/25 cm						
	Dense to Very Dense		7	SS	37		214				0 85 (15)
	Brown		8	SS	113						
	Grey						212				
	Some Gravel		9	SS	166						22 54 (24)
208.3			10	SS	100/15 cm		210				
11.9	Grey (Glacial Till) Silty Clay, Sand, Varying Amt's of Gravel		11	SS	100/8 cm		208				
205.6	Hard						206				
14.6	Limestone Bedrock Partly Fractured		12	BXL RC	67% REC						
203.7			13	BXL RC	67% REC		204				
16.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6 METRIC

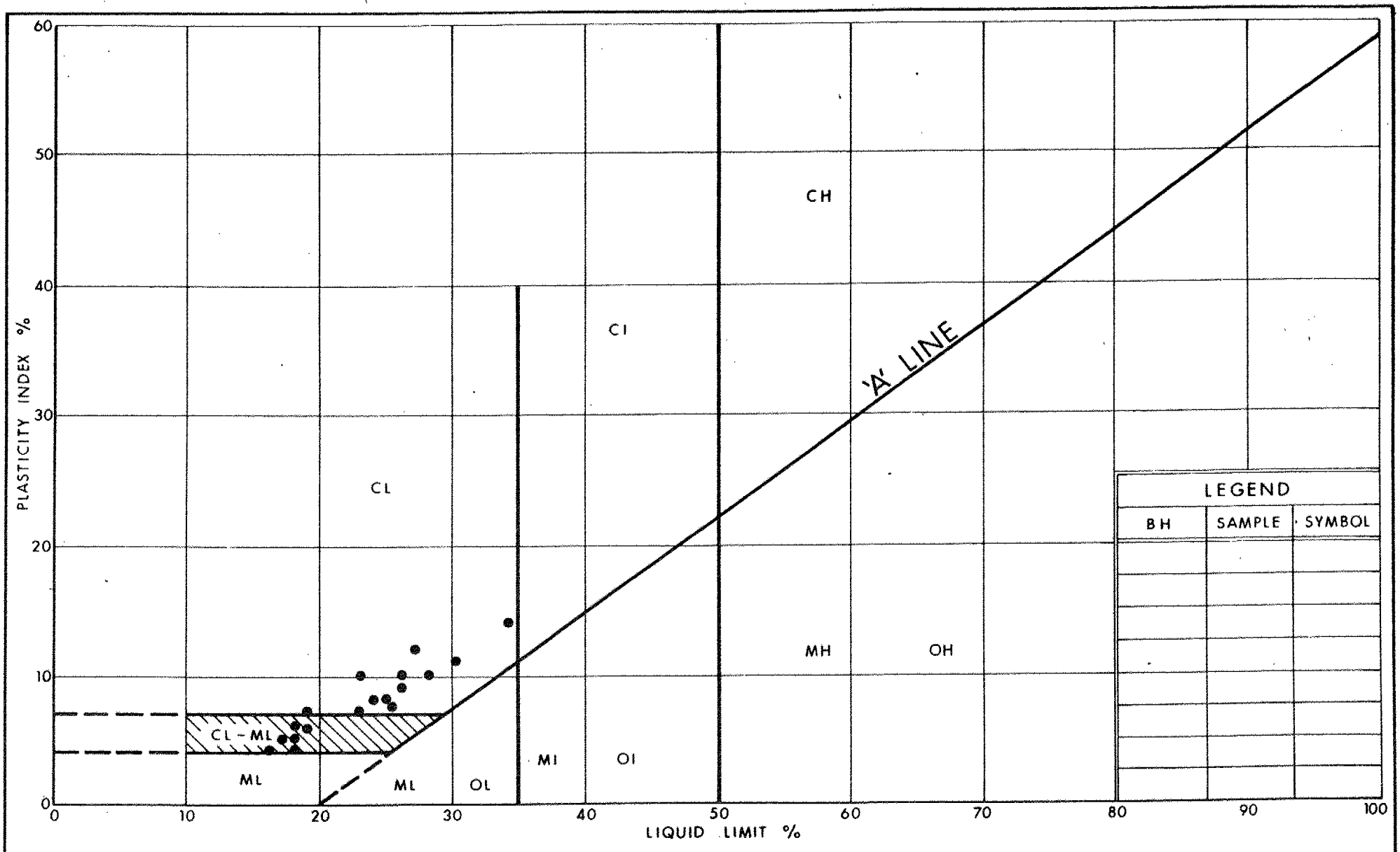
W P 21-79-05 LOCATION Co-ords. N 4 840 472.7 E 285 592.4 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74-02-14 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
220.7	Ground Level										
0.0	Silty Clay of Low Plasticity with varying am'ts of Sand and Gravel		1	SS	47	▼	220	100/25 cm			
			2	SS	47						0 5 85 10
			3	SS	62		218				
	Brown		4	SS	142						20 36 36 8
	Grey		5	SS	190						
							216				
	Hard		6	SS	172						0 16 52 32
214.6											
6.1	Grey						214				
	Silty Sand		7	SS	150						
	Trace of Gravel										
	Very Dense		8	SS	163/25 cm		212				0 75 (25)
			9	SS	173						
							210				
			10	SS	160/23 cm						
207.9											
12.8	Grey (Glacial Till) Silty Clay, Sand and Gravel		11	SS	100/13 cm		208				45 36 (19)
	Hard										
206.1											
14.6	Limestone Bedrock		12	BXL RC	60%		206				
205.0	Partly Fractured										
15.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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Ontario

PLASTICITY CHART

SILTY CLAY, WITH SAND & GRAVEL

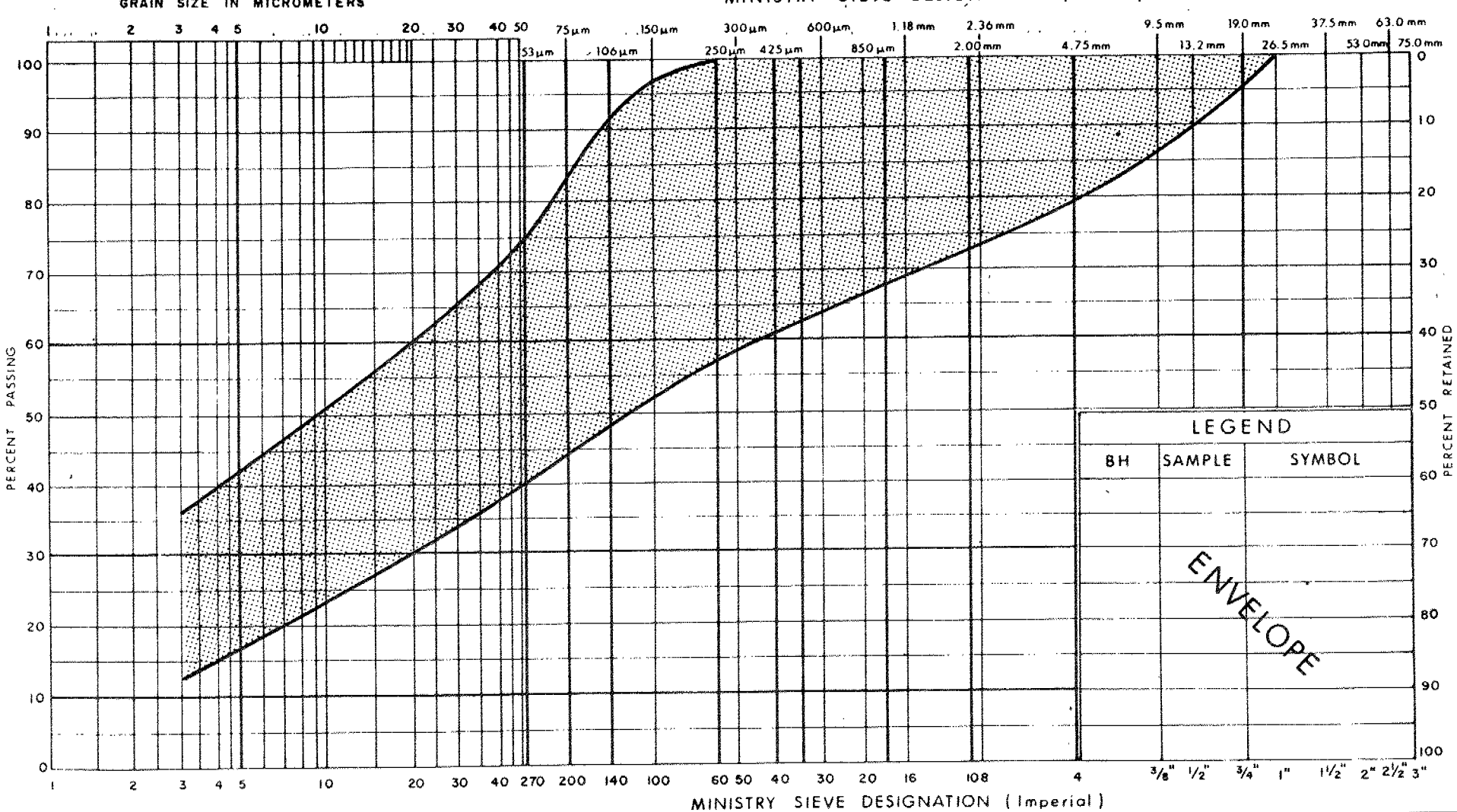
FIG No 1

W P 21-79-05

28

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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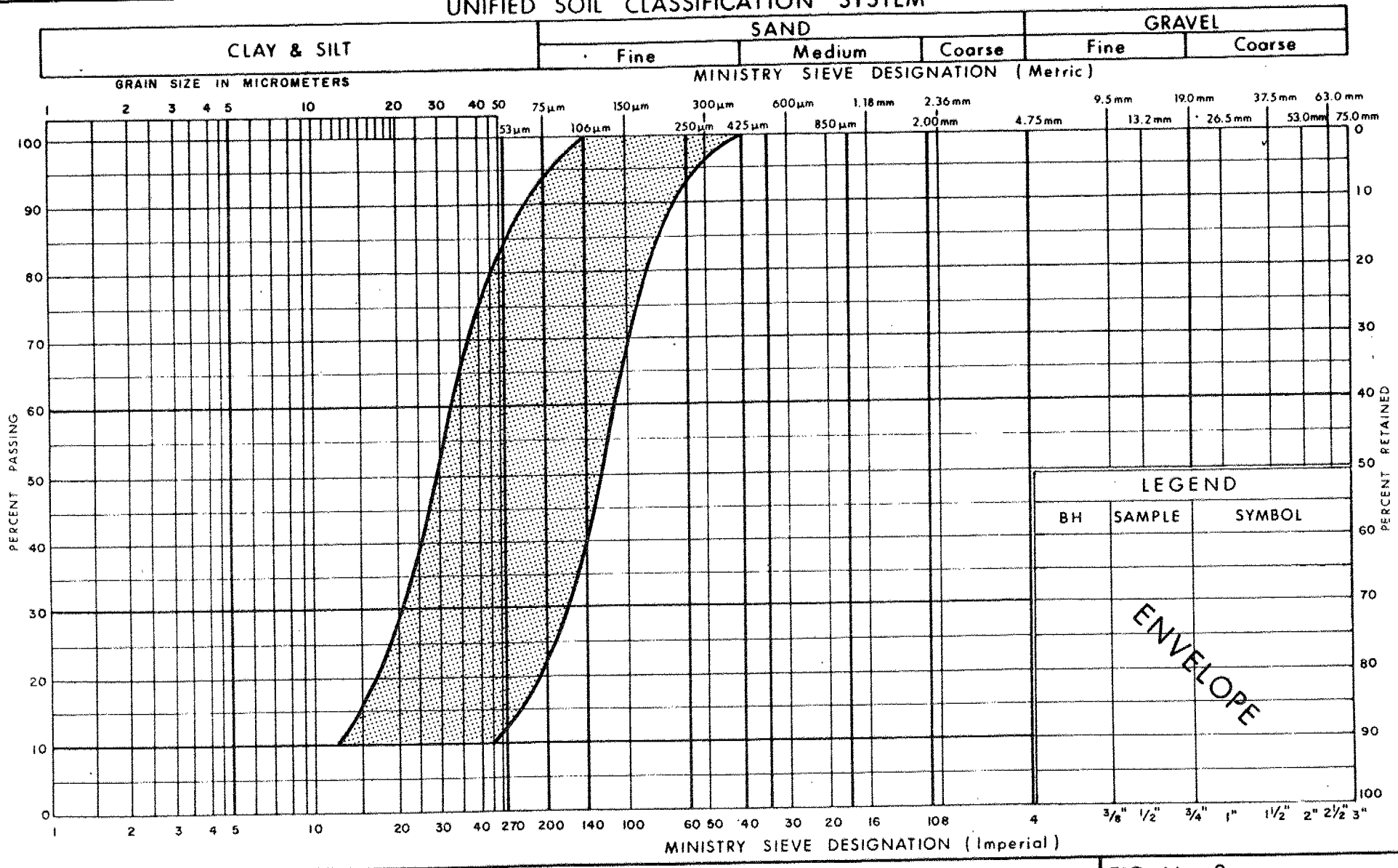
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY (OF LOW PLASTICITY) WITH SAND & GRAVEL

FIG No 2
W P 21-79-05

UNIFIED SOIL CLASSIFICATION SYSTEM



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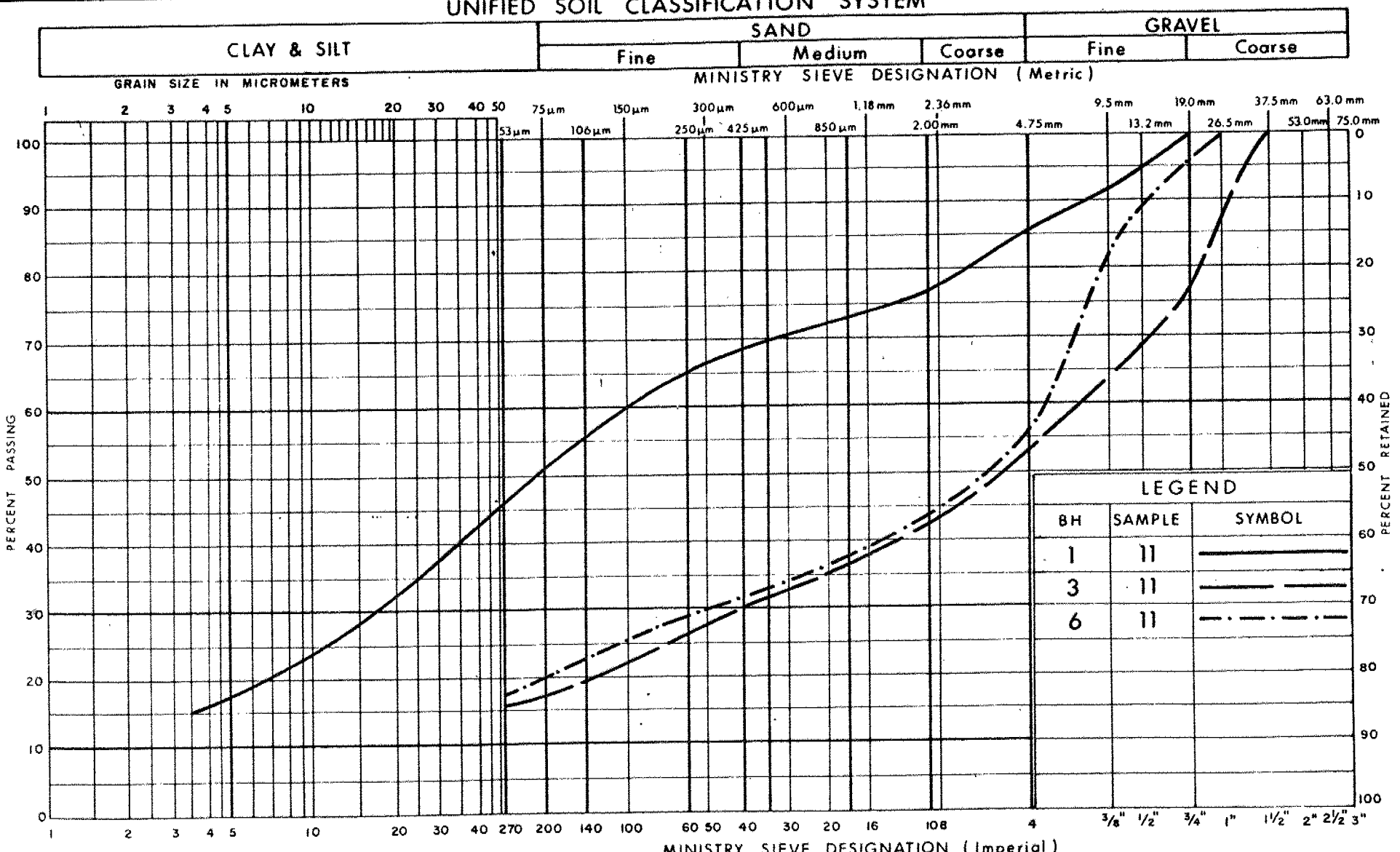
GRAIN SIZE DISTRIBUTION
SILTY SAND

FIG No 3
W P 21-79-05

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

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

FIG No 4
WP 21-79-05

CONT 84-45

memorandum

Ontario

To: Mr. G.C.E. Burkhardt
Head, Structural Planning Section
Central (5000 Yonge St.) Region

Date: 82 08 17

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Orenda Road Overpass
W.P. 21-79-02, Site 24-476
Hwy. 410, District 6, Toronto

Please find attached the complete foundation investigation and design report for the above-mentioned structural site as prepared by Morton & Partners Ltd., consulting geotechnical engineers. We have reviewed this report for technical content/ format and feel that full height abutment footings, founded at or below elevation 212.5, can be designed to the following O.H.B.D.C. parameters:

Factored Capacity at U.L.S.	550 kPa
Capacity at S.L.S. Type II	250 kPa

We trust the above and attached information is sufficient for your design requirements.

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK:syc

cc: R.D. Gunter
F. Norman
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore

R. Fitzgibbon (memo only)
T.J. Kovich (memo only)

Att.

FOUNDATION INVESTIGATION REPORT
ORENDA ROAD OVERPASS
HIGHWAY 410 - BRAMPTON BYPASS

W.P. 21-79-02 SITE 24 - 476

DISTRICT 6 TORONTO

00/82.061 AUGUST, 1982

DISTRIBUTION:

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PREPARED BY:

MORTON & PARTNERS LIMITED
215 CARLINGVIEW DRIVE
REXDALE, ONTARIO M9W 5X8

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	GRAINSIZE DISTRIBUTION CURVES	FIGURE 1
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	CONE RECORDS	
	BOREHOLE LOCATIONS AND SOIL STRATA	SITE PLAN

MORTON & PARTNERS LIMITED
CONSULTING ENGINEERS & ENGINEERING GEOLOGISTS

215 CARLINGVIEW DRIVE,
REXDALE, ONTARIO, CANADA M9W 5X8
TELEPHONE: (416) 675-1440
TELEX: 06-989251

1.0 INTRODUCTION

Morton & Partners Limited have been retained by the Ministry of Transportation and Communications to carry out a foundation investigation for a proposed bridge structure to carry Highway 410 over Orenda Road in the City of Brampton.

2.0 SITE AND GEOLOGY

The site is located immediately east of Heart Lake Road and immediately south of Orenda Road. The area is an open and grassed field at the present time and approximately level at about elevation 214.

The site located centrally within the broad, gently southward shelving Peel Clay Plain which was formed by glacial deposition and post-glacial sequential erosion and sedimentation that took place within a large ephemeral garland lake which was dammed up behind (i.e. north of) the remnant of the Wisconsin ice sheet that was left temporarily within the Lake Ontario topographic basin during the ultimate stage of Pleistocene ice retreat. The clay plain tends to be "stepped" into a series of rises from south to north as a result of bedrock influences and by the staged southeastward withdrawal of the ice margin.

Bedrock comprises grey, interbedded thin shales, siltstones, mudstones and limestones of the Meaford - Dundas formation, which are of late Ordovician age. Bedding is essentially flatlying with less than one degree declination (dip) almost due southwest.

3.0 FIELD WORK

The field work for this investigation was carried out on July 5th and 6th, 1982, and consisted of six boreholes and six dynamic cone penetration tests at the locations shown on the enclosed drawing. The work was carried out using a truck-mounted CME 45 drilling machine.

3.0 FIELD WORK (Continued)

Soil samples were taken using the Standard Penetration Test method and brought to our laboratory for further examination and testing. Samples remaining after testing will normally be stored for a period of three months following the date of this report and then discarded, unless other instructions are received.

The elevations of the ground surface at the borehole locations were determined using a benchmark consisting of the northwest corner of a concrete slab, 15.5 m left at chainage 12 + 934.7. The elevation of this benchmark is reported to be at 214.051.

4.0 SOIL CONDITIONS

The soil conditions at the borehole locations are shown on the Borehole Records and consist essentially of silty clay resting on bedrock as described below.

4.1 Topsoil

All boreholes encountered topsoil extending to depths ranging from 50 to 300 mm. In Borehole 8 only, the topsoil was covered with a veneer of sand and gravel fill, about 75 mm in thickness.

4.2 Silty Clay (Till)

The topsoil covers a deposit of silty clay with some sand and widely dispersed fine gravel, extending to bedrock at depths of about 5 to 6 m below ground level.

The colour of the stratum grades from brown to grey-brown with depth and becomes grey, rather abruptly, at about elevation 210, i.e. from 3.5 to 4.2 m below the ground surface.

4.2 Silty Clay (Till) (Continued)

Grainsize analyses were carried out on samples from the stratum. The results are shown on the Borehole Records and summarized on the Envelope on Figure 1. In the samples tested, the clay content ranged from 22 to 37 per cent with a median value of 30 per cent.

Atterberg limit tests resulted in liquid limits ranging from 21 to 28 with plasticity indices ranging from 7 to 11, identifying the material as inorganic clay of low plasticity. Moisture content determinations indicated an almost constant moisture content throughout the depth of both the oxidized and non-oxidized parts of the clay stratum, averaging between 12 and 13 per cent and significantly below the plastic limit.

The nature and composition of the material is such that values of shear strength could not conveniently be determined by normal laboratory testing. The in-situ strength of the stratum was therefore judged on the basis of "N" values, visual examination and pocket penetrometer tests.

The standard penetration ("N") values obtained in the upper, brown to grey-brown, part of the deposit (ignoring the surficial ones in each borehole) ranged from 20 to 52 blows per 300 mm with a median value of 34. In the grey part of the deposit, the "N" values ranged from 17 to 48 with a median value of 31. On the average there is no significant difference in strength between the oxidized (brown) and non-oxidized (grey) parts of the stratum.

On the basis of all the evidence, it is considered that the silty clay stratum is of very stiff to hard consistency with estimated shear strengths of the order of 150 kPa to about elevation 212, rapidly increasing to values well in excess of 200 kPa between elevations 212 and 210, to decrease to an average value of 150 kPa between elevation 210 and the bedrock surface.

4.3 Bedrock

Bedrock was encountered at depths ranging from 5 to 6 m below the ground surface, i.e. between elevations 208.0 and 208.8 and augered to refusal as deep as elevation 204.9.

4.3 Bedrock (Continued)

The bedrock was identified as weathered grey shale with thin limestone bands. It is believed that auger refusal was obtained in more substantial limestone layers.

5.0 GROUNDWATER

With the exception of Boreholes 2 and 8, all boreholes were dry during drilling and upon completion. Boreholes 2 and 8 showed evidence of groundwater at a depth just below the bedrock surface and sealed piezometers were installed in these boreholes at depths of about 6 m.

The water levels were measured in the standpipes and in the open cone holes on July 20 (after a prolonged dry spell) and on August 4 (immediately following a night of heavy rain). The results are tabulated below:

	WATER LEVEL ELEVATION	
	July 20	August 4
Borehole 2	212.8	212.7
Cone 3	211.3	
Cone 4	212.0	212.8
Cone 6	211.9	
Cone 7	212.1	212.8
Borehole 8	212.6	212.9
Cone 9	212.1	212.9
Cone 10	212.1	212.9

On the basis of these observations, it is concluded that the groundwater level was at about elevation 212.5 at the time of the investigation.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

The proposed overpass will be a twin, single span, bridge structure carrying Highway 410 over Orenda Road. It is understood that the Orenda

6.1 General (Continued)

Road grade elevation will be approximately at present ground level (i.e. at about elevation 214) and that the profile grade of Highway 410, at the crossing, will be at about elevation 221. Consequently, the embankment height at the location of the abutments will be of the order of 7 m.

6.2 Foundations

It is intended that the structure be founded on spread footings. Footing sizes are not known at the present time, but judging from the physical layout, it is assumed that the footing dimensions will be approximately 22 by 3 m. The surficial soil is not or only marginally frost susceptible but it is suggested that the footings be founded below the depth of frost influence. It is, therefore, recommended that the footings be provided with an earth cover of at least 1500 mm. Consequently the footing level will be at or below approximate elevation 212.5.

6.3 Bearing Capacity

It is considered that spread footings are an acceptable foundation solution. The soil at and below the recommended founding elevation (elevation 212.5) consists of very stiff to hard silty clay of low plasticity with a moisture content below the plastic limit. It is deemed to have a shear strength increasing from 150 kPa at the founding elevation to more than 200 kPa at about elevation 210. From there to the bedrock surface at about elevation 208.5, the shear strength is estimated to be of the order of 150 kPa.

The factored bearing capacity at ultimate limit states is expressed as

$$q_f = \gamma D + 5\ c_f\ (1 + 0.2\ \frac{D}{B})\ (1 + 0.2\ \frac{B}{L})$$

6.3 Bearing Capacity (Continued)

where:

γ = unit weight = 22 kN/m^3
D = footing depth = 1.5 m
c_f = factored soil parameter for cohesion = f_c c
f_c = constant = 0.5
c = cohesion = 150 kPa
B = footing width = 3 m
L = footing length = 22 m

Substitution gives q_f = 457 kPa.

The bearing capacity at serviceability limit states is dependent on the anticipated settlement of the clay stratum under actual applied loadings (neglecting transient loads). These loadings are not available at this time. However, it is believed that settlement will be minor, considering the low plasticity of the clay, its low moisture content and its corresponding low void ratio of the order of 0.35. It is further considered that any settlement will be due more to the surcharge of the embankment than to the pressures induced at depth by the abutment footing. If settlement occurs under the embankment surcharge, the seat of such settlement is likely to be in the lower grey part of the clay which is of limited thickness and underlain by essentially unyielding weathered shale.

Consequently, it is believed that the footing design at this site is not governed by settlement considerations. It is further believed that, in any event, the applied bearing pressures, neglecting transient loadings, will be considerably less than the bearing capacity computed for ultimate limit states design.

6.4 Stability

It is assumed that the backfill behind and in front of the abutment wall will be free draining granular material for which the angle of internal friction may be taken as 30 degrees.

6.4 Stability (Continued)

On this basis the earth pressure coefficients for the ultimate limit and serviceability states design may be taken to be equal to:

	ULTIMATE LIMIT STATE	SERVICEABILITY LIMIT STATE
Active State	0.41	0.33
At-Rest State	0.58	0.50
Passive State	2.44	3.00

The resistance to sliding of a horizontal footing on clay may be computed using a cohesion $c_f = 0.65 \times c$ where c may be assumed to be 150 kPa at the recommended footing level.

The recommendations given in the preceeding paragraphs apply to the footings for the abutments for which dimensions have been assumed. The general considerations, however, apply equally to footings for wing walls and retaining walls which may be incorporated.

6.5 Construction

The groundwater level at the time of the investigation appeared to be at elevation ± 212.5, i.e. at or close to the recommended founding elevation. It will therefore probably be necessary to dewater the footing excavation in order to facilitate construction and avoid disturbance of the soil at the founding level. However, as the soil is of relatively low permeability, unusual construction problems are not anticipated.

6.6 Embankments

At the borehole locations, the average topsoil depth was about 125 to 150 mm. This should be stripped prior to placing the embankment fill. The maximum height of fill appears to be of the order of 7 m. The natural soil, below the topsoil is suitable for the support of the embankment with normal side slopes of 1 vertical to 2 horizontal.

7.0 MISCELLANEOUS

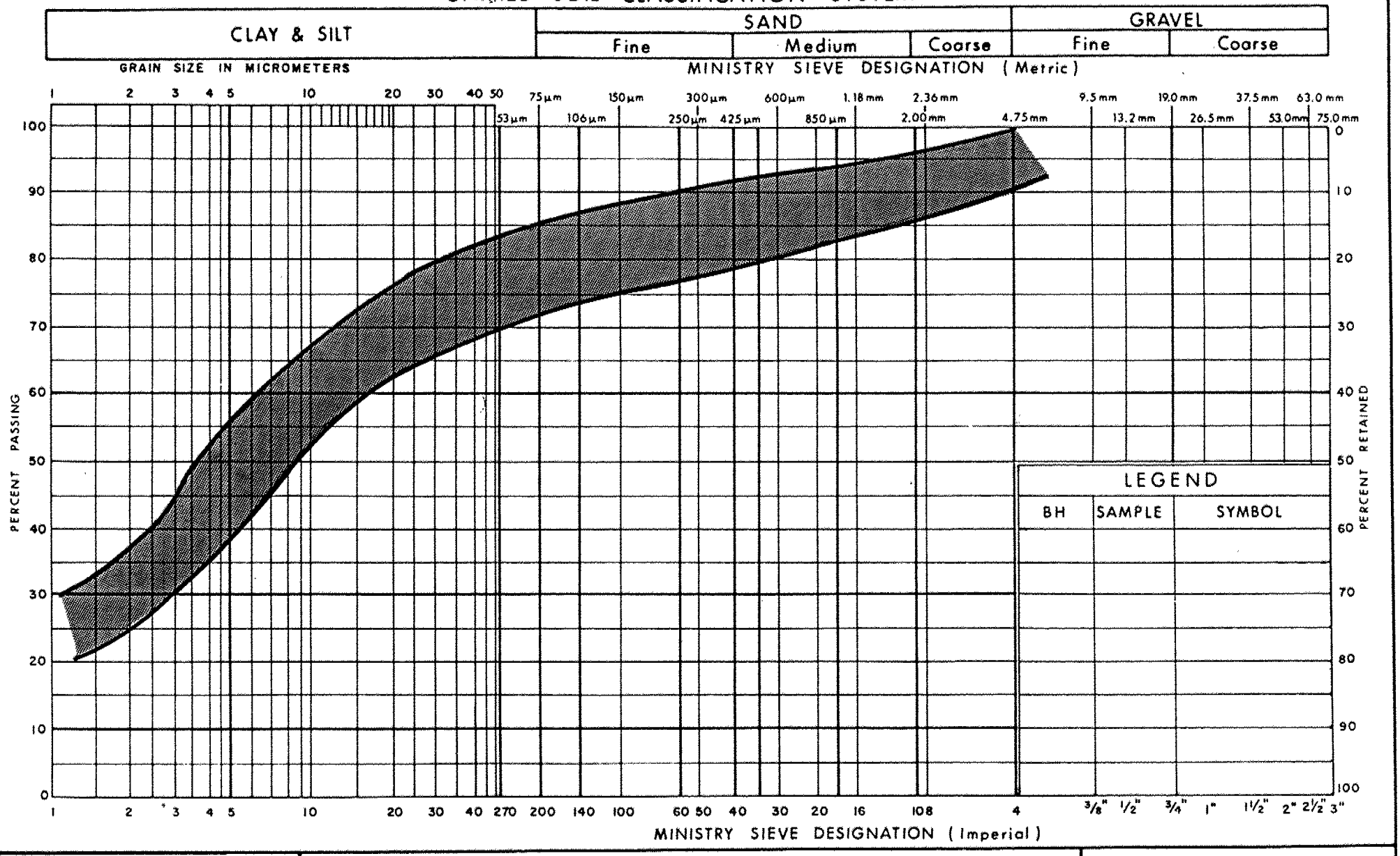
The field work for this investigation was carried out under the supervision of Mr. M. Schiller, using equipment owned and operated by Master Soil Investigations Limited. The report was prepared by Mr. A. Prior, P.Eng.

Respectfully submitted,
MORTON & PARTNERS LIMITED

A. PRIOR, P.Eng.

AP/lh

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

ENVELOPE

FIG No **1**

W P **21-79-02**

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:

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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,512 N; 286,514 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-05 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
215.52	Ground Level										
0.00	Topsoil 125 mm		1	SS	15	*	213.00		○		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	26				○		4 14 52 30
	Very Stiff to Hard		3	SS	31		212.00		○		2 16 52 30
			4	SS	52		211.00		○		
	Brown and grey-brown becoming grey at elevation 210.1.		5	SS	40		210.00		○		
208.02			6	SS	48		209.00		○		
5.50	Shale Bedrock weathered.		7	SS	100/100mm		208.00		○		
206.75			8	SS	100/50mm		207.00		○		
6.77	End of Borehole. Refusal on Auger and Sampler.										

* Groundwater not encountered.

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,490 N; 286,548 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-05 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
213.68	Ground Level										
0.00	Topsoil 150 mm		1	SS	6				o		
	Silty clay, some sand, trace of gravel.						213.00				
	(Till)		2	SS	25	▼			o		7 13 43 37
							212.00				
			3	SS	24				o		5 12 48 37
	Very Stiff to Hard										
			4	SS	37		211.00		o		
	Brown and grey-brown becoming grey at elevation 210.3.		5	SS	32				o		
							210.00				
208.48							209.00				
5.20	Shale Bedrock weathered.		6	SS	34				o		
			7	SS	52				o		
			8	AS			208.00				
			9	SS	100/137mm				o		
206.97							207.00				
6.71	End of Borehole.										
	Refusal on Auger.										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ✧ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,485 N; 286,507 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-05 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
214.11	Ground Level										
0.00	Topsoil						214.00				
0.30	Silty clay, some sand, trace of gravel. (Till)		1	SS	5	*			o		
			2	SS	25		213.00		o		
	Very Stiff to Hard		3	SS	31				o		4 17 47 32
			4	SS	51		212.00		o ⊢		6 17 48 29
	Brown and grey-brown becoming grey at elevation 210.1.		5	SS	36		211.00		o		
			6	SS	23		210.00		o ⊢		
208.61			7	AS			209.00				
5.50	Shale Bedrock weathered.		8	SS	60/50mm		208.00		o		
207.31											
6.80	End of Borehole. Refusal on Auger.										
	* Groundwater not encountered.										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,494 N; 286,471 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-05 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
213.96	Ground Level										
0.00	Gravel fill 75 mm Topsoil 50 mm		1	SS	7				o		
	Silty clay, some sand, trace of gravel.		2	SS	20	▽	213.00		o		
	(Till)		3	SS	23		212.00		o		4 19 50 27
	Very Stiff to Hard		4	SS	32				o ⊢		
			5	SS	48		211.00		o		
	Brown and grey-brown becoming grey at elevation 209.2						210.00				
208.46			6	SS	28		209.00		o ⊢		
5.50	Shale Bedrock weathered.						208.00				
			7	SS	50/13mm						
207.25			8	SS	70/12mm				o		
6.71	End of Borehole. Refusal on Auger and Sampler.										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,445 N; 286,477 E. ORIGINATED BY MS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS
DATUM Geodetic DATE 82-07-06 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
214.17	Ground Level										
0.00	Topsoil 50 mm		1	SS	5	✱	214.00		o		
	Silty clay, some sand, trace of gravel. (Till)		2	SS	36		213.00		o		
			3	SS	38				o		1 20 56 23
	Very Stiff to Hard		4	SS	45		212.00		o		9 20 49 22
			5	SS	45		211.00		o		
	Brown and grey-brown becoming grey at elevation 210.0.						210.00				
			6	SS	17		209.00		o		
208.17											
6.00	Shale Bedrock weathered.		7	SS	90		208.00		o		
			8	SS	100/150mm		207.00		o		
204.87							206.00				
9.30			9	SS	100/150mm		205.00				
	End of Borehole. Refusal on Auger and Sampler.										
	✱ Groundwater not encountered.										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12

METRIC

W P 21-79-02 LOCATION Co-ords. 4,839,499 N; 286,428 E. ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY MS

DATUM Geodetic DATE 82-07-06 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
214.04	Ground Level										GR SA SI CL
0.00	Topsoil 200 mm		1	SS	7	✱	214.00				
	Silty clay, some sand, trace of gravel. (Till)		2	SS	25		213.00				
			3	SS	28		212.00				3 21 48 28
	Very Stiff to Hard		4	SS	42		211.00				
			5	SS	41						
	Brown to grey-brown becoming grey at elevation 209.8.						210.00				
208.84			6	SS	40		209.00				
5.20	Shale Bedrock weathered.										
207.33			7	SS	100/50mm		208.00				
6.71	End of Borehole. Refusal on Auger.										

✱ Groundwater not encountered.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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Ontario

RECORD OF CONE No 3

METRIC

W P 21-79-02 LOCATION Co-ords 4,839,529 N; 286,510 E ORIGINATED BY NS
DIST 6 HWY 410 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MS
DATUM Geodetic DATE (Cone 3: 82-07-06) (Cone 4: 82-07-06) (Cone 6: 82-07-06) CHECKED BY AI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
213.05	Ground Level										
0.00							213.00				
							212.00				
							211.00				
210.00							210.00		122/300 mm		
3.05	End of Dynamic Cone Penetration Test 3										
	RECORD OF CONE No 4 Co-ords 4,839,498 N; 286,528E										
213.80	Ground Level										
0.00							213.00				
							212.00				
							211.00				
210.60									126/300 mm		
3.20	End of Dynamic Cone Penetration Test 4										
	RECORD OF CONE No 6 Co-ords 4,839,502 N; 286,490 E										
213.89	Ground Level										
0.00							213.00				
							212.00				
211.00							211.00				
2.89	End of Dynamic Cone Penetration Test 6										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF CONE No 7

METRIC

W P 21-79-02 LOCATION Co-ords 4,839,477 N; 286,487 E ORIGINATED BY MS

DIST 6 HWY 410 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MS

DATUM Geodetic DATE (Cone 7: 82-06-06) (Cone 9: 82-07-06) (Cone 10: 82-07-06) CHECKED BY AP

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.08	Ground Level									
0.00							214.00			
							213.00			
							212.00	189/300 mm		
211.03										
3.05	End of Dynamic Cone Penetration Test 7									

RECORD OF CONE No 9

Co-ords 4,839,471 N; 286,465 E

214.20	Ground Level									
0.00							214.00			
							213.00			
							212.00	142/300 mm		
211.15										
3.05	End of Dynamic Cone Penetration Test 9									

RECORD OF CONE No 10

Co-ords 4,839,483 N; 286,458 E

214.16	Ground Level									
0.00							214.00			
							213.00			
							212.00	98/150 mm		
211.20										
2.90	End of Dynamic Cone Penetration Test 10									

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

CONT No
WP No 21-79-02

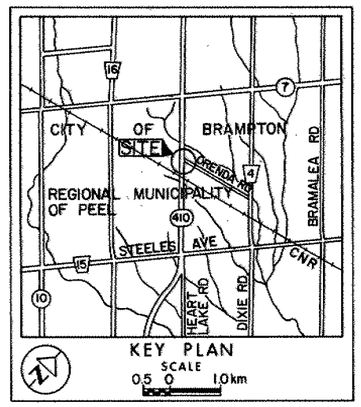
ORENDA ROAD OVERPASS
HIGHWAY 410
BORE HOLE LOCATIONS & SOIL STRATA

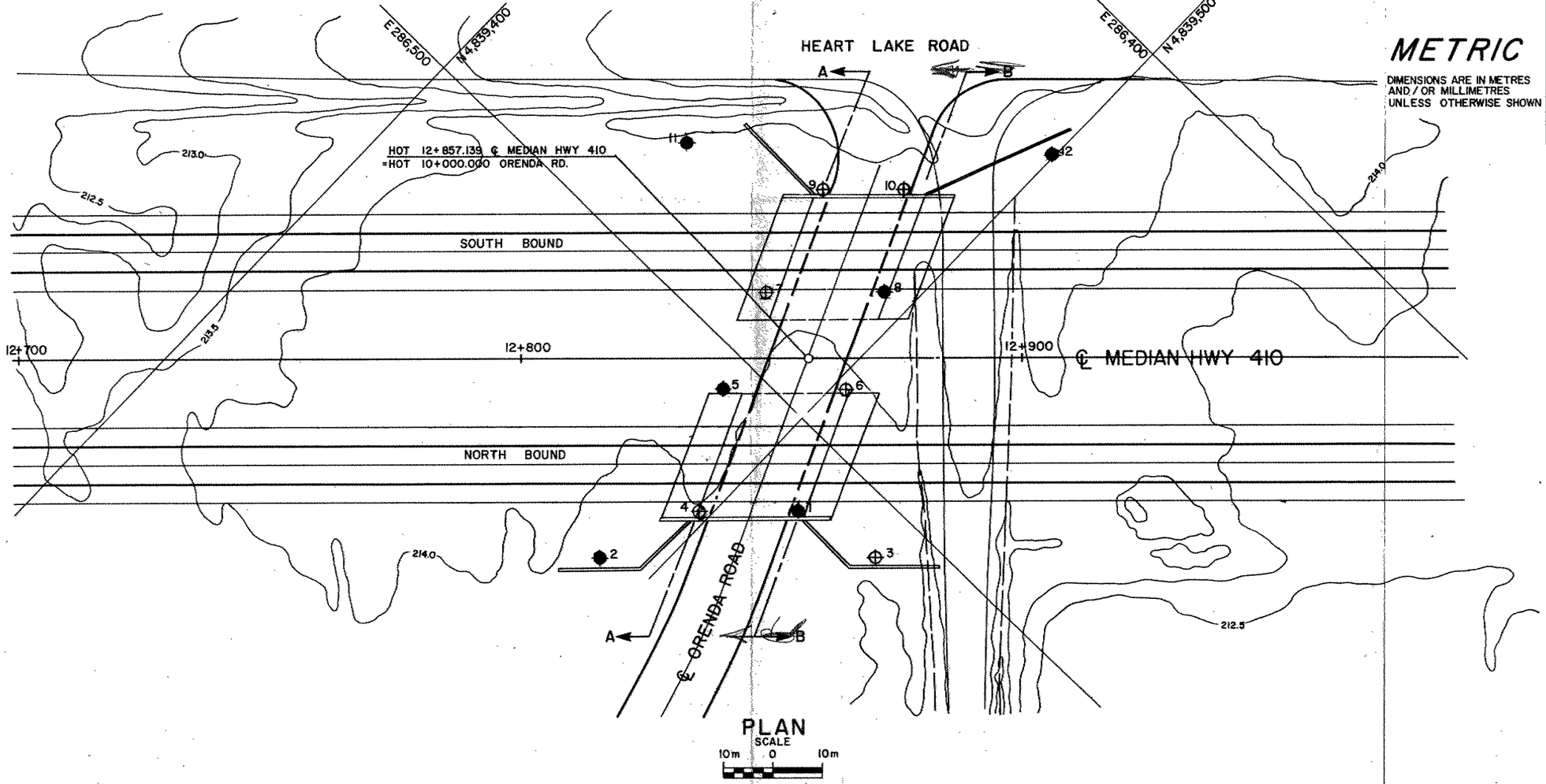
SHEET

METRIC

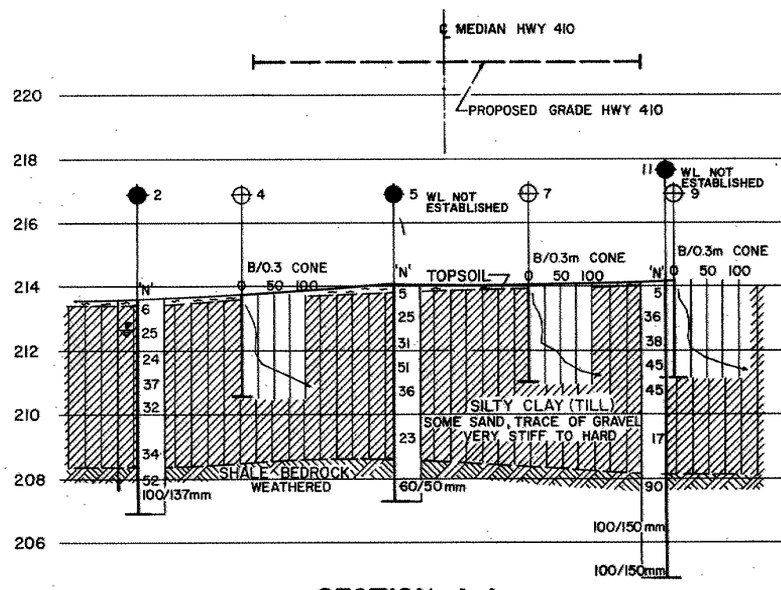
DIMENSIONS ARE IN METRES AND / OR MILLIMETRES UNLESS OTHERWISE SHOWN

MORTON AND PARTNERS LTD

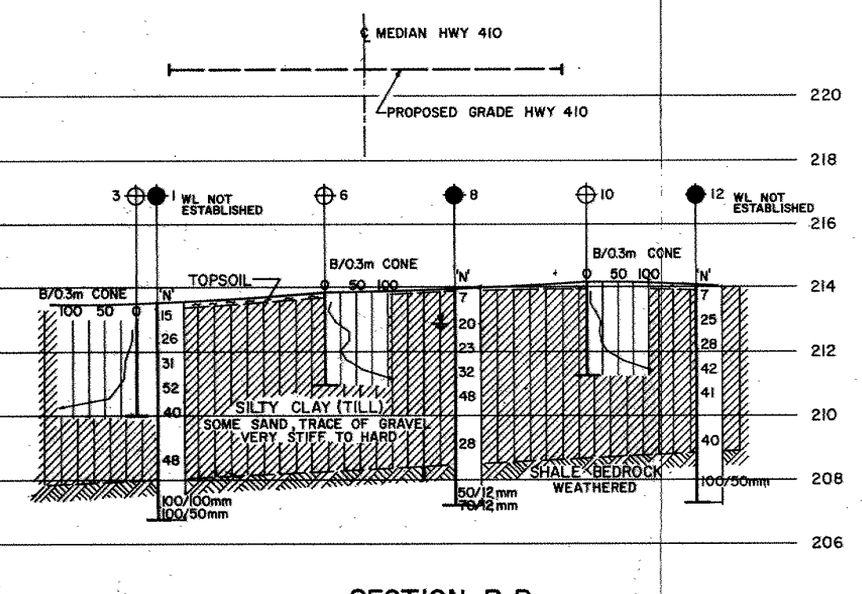




PLAN
SCALE
10m 0 10m



SECTION A-A
SCALE
HOR 10m 0 10m
VERT 2m 0 2m



SECTION B-B
SCALE
HOR 10m 0 10m
VERT 2m 0 2m

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 July 1982

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	213.52	N4,839,512	E286,514
2	213.68	N4,839,490	E286,548
3	213.05	N4,839,529	E286,510
4	213.80	N4,839,498	E286,528
5	214.11	N4,839,485	E286,507
6	213.89	N4,839,502	E286,490
7	214.08	N4,839,477	E286,487
8	213.96	N4,839,494	E286,471
9	214.20	N4,839,471	E286,465
10	214.16	N4,839,483	E286,454
11	214.17	N4,839,445	E286,477
12	214.04	N4,839,499	E286,428

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

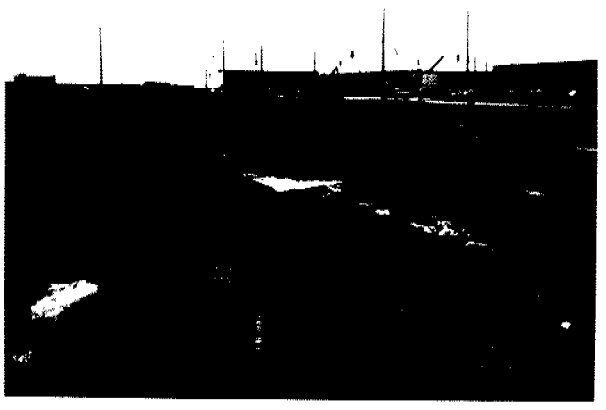
REVISIONS		
DATE	BY	DESCRIPTION

Geocres No

HWY No 410			DIST 6
SUBM'D AP	CHECKED	DATE 82-07-15	SITE 24-476
DRAWN MS	CHECKED	APPROVED	DWG 217902-A

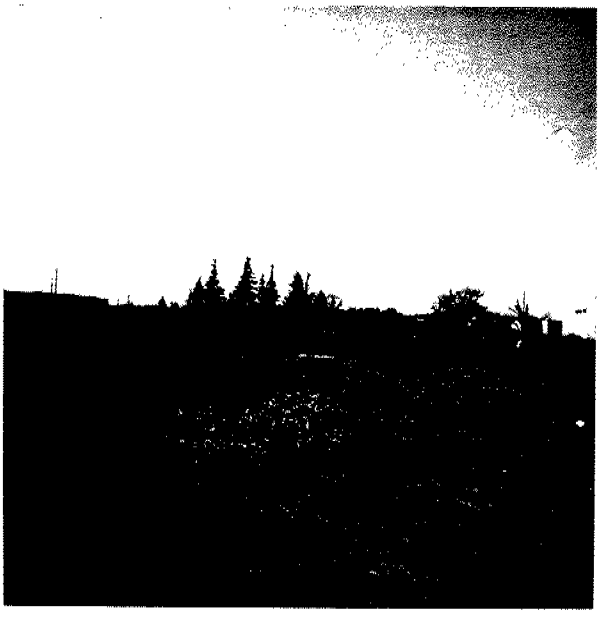
410 - ORENDA RD. O'PASS

SITE 24-476 W.P. 21-79-02

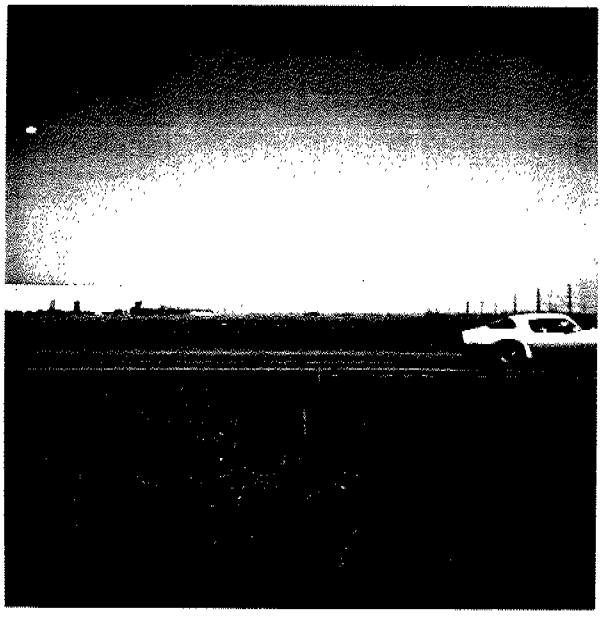


LOOKING WEST ALONG ORENDA RD.
ALIGNMENT TOWARD 410

LOOKING EAST ALONG ORENDA RD.
ALIGNMENT TOWARD 410



LOOKING NORTH ALONG 410 ALIGNMENT
TOWARD ORENDA RD.



LOOKING SOUTH ALONG 410 ALIGNMENT
TOWARD ORENDA RD.