

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-165

DIST. 6 REGION

W.P. No. 127-66-75

CONT. No. 83-68

W. O. No.

STR. SITE No. 24-81-329

HWY. No. 403/401

LOCATION Bridge # 25, Hwy 403 W.B.
Collector over Hwy 401 Core

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

DISTRICT No 6
CONT No
WP No 127-66-75



HWY. 403 W.B. COLLECTOR OVER
HWY. 401 EXPRESS
BRIDGE No. 25
GENERAL ARRANGEMENT

SHEET

McCORMICK RANKIN
CONSULTING ENGINEERS

METRIC

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

GENERAL NOTES

CLASS OF CONCRETE

DECK	35 MPa
PIER COLUMNS	35 MPa
ABUTMENTS, WINGWALLS, RETAINING WALLS & BARRIER WALLS	30 MPa
REMAINDER	20 MPa

REINFORCING STEEL

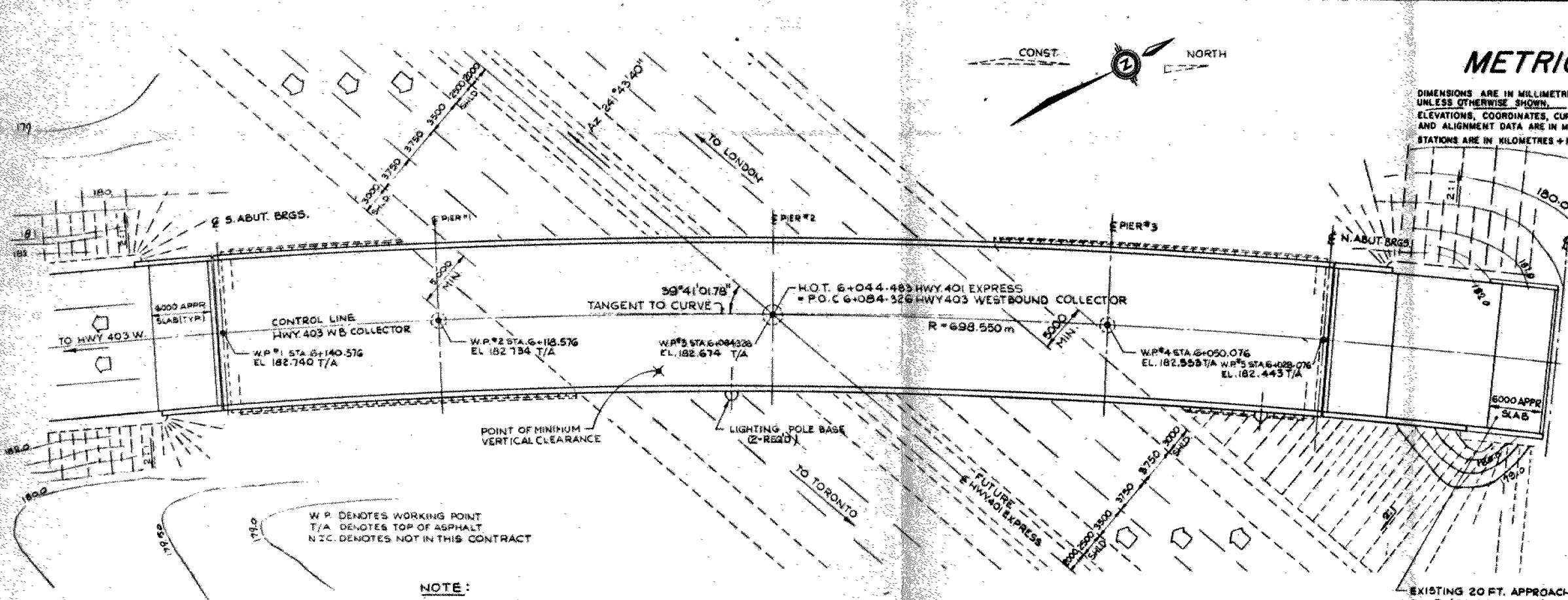
GRADE 400
REINFORCING BAR MARKS WITH SUFFIX 'C'
TO BE COATED BARS

COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25 mm
PIER COLUMNS	80 ± 20 mm
ABUTMENTS, WINGWALLS & RETAINING WALLS	FRONT FACE 80 ± 20 mm BACK FACE 70 ± 20 mm
DECK	70 ± 20 mm TOP 50 ± 10 mm BOT.
REMAINDER	70 ± 20 mm OR AS NOTED ON DWG'S.

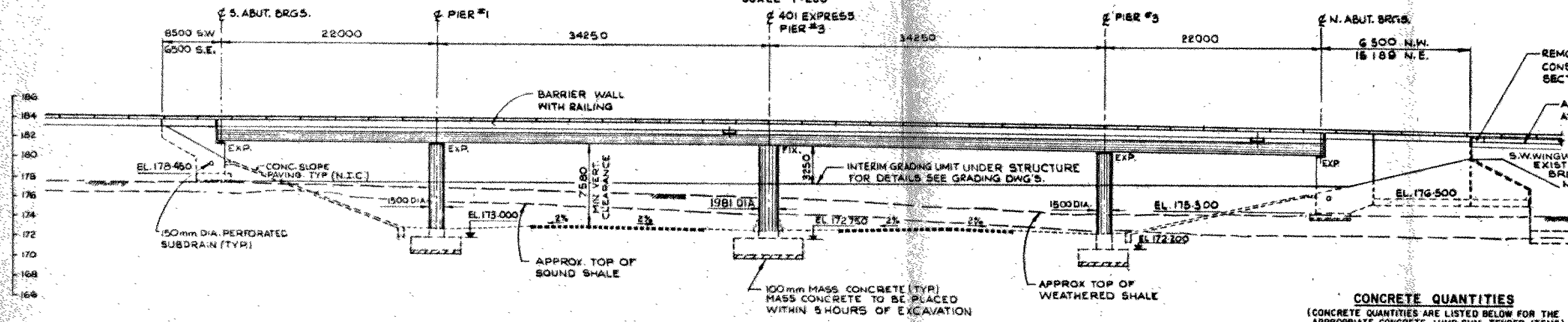
CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING
THE BEARING SEATS DEAD LEVEL TO THE
SPECIFIED ELEVATIONS WITH A TOLERANCE
OF ± 3 mm



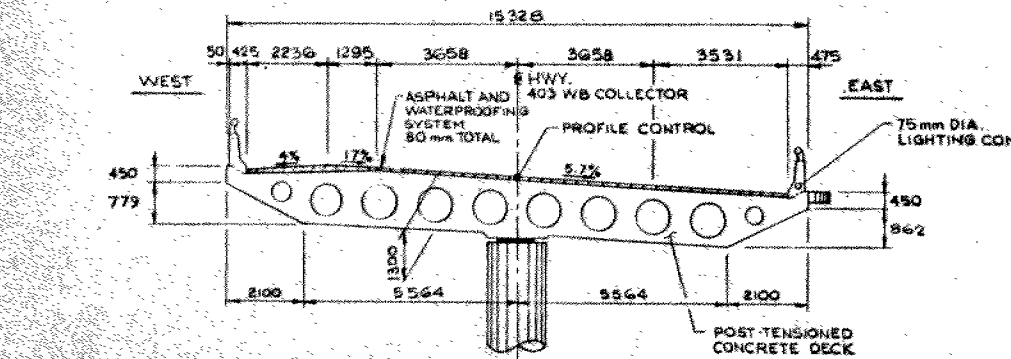
PLAN

SCALE 1:250



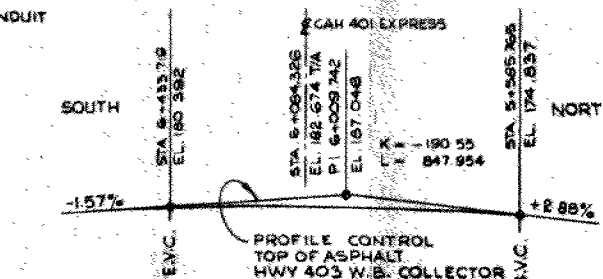
ELEVATION

SCALE 1:250



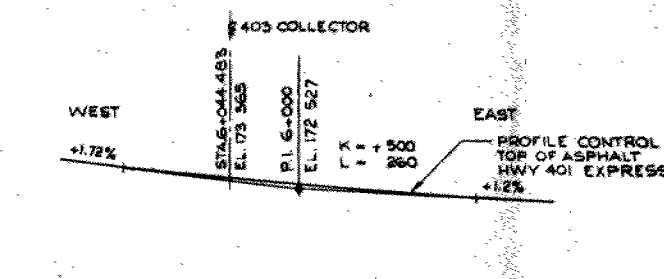
TYP. DECK SECTION

SCALE 1:100



PROFILE OF HWY. 403 W.B. COLLECTOR

N.T.S.



PROFILE OF HWY. 401 EXPRESS

N.T.S.

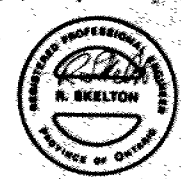
CONCRETE QUANTITIES

(CONCRETE QUANTITIES ARE LISTED BELOW FOR THE
APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS)

• CONCRETE IN PIERS	56 m³
• CONCRETE IN ABUTMENTS, WINGWALLS AND RETAINING WALLS	253 m³
• CONCRETE IN DECK	1670 m³
• CONCRETE IN BARRIER WALLS	63 m³
• CONCRETE IN APPROACH SLABS	65 m³

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION AND SOIL STRATA
3. FOUNDATION LAYOUT
4. FOUNDATION REINFORCING
5. PIER DETAILS
6. SOUTH ABUTMENT
7. NORTH ABUTMENT
8. RETAINING WALL DETAILS
9. DECK LAYOUT
10. LONGITUDINAL CABLE DETAILS
11. TRANSVERSE CABLE DETAILS
12. DECK REINFORCING I
13. DECK REINFORCING II
14. BARRIER WALL WITH RAILING
15. RAILING FOR BARRIER WALL
16. 6000 mm APPROACH SLAB
17. DETAILS OF CONCRETE SLOPE PAVING
18. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
19. BRIDGE DATE AND SITE NUMBER DATA
20. STANDARDS
21. ELECTRICAL EMBEDDED WORK
22. ELECTRICAL STANDARDS



REVISIONS	DATE	BY	DESCRIPTION

DESIGN A.S.W. CHECK T.J.W. LOADING ON BDC-A-79 DATE NOV. 82
DRAWING W.C.D. CHECK A.S.W. SITE 24-61-323 DWG. 1

DISTRICT No 6
CONT No
WP No 127-66-75

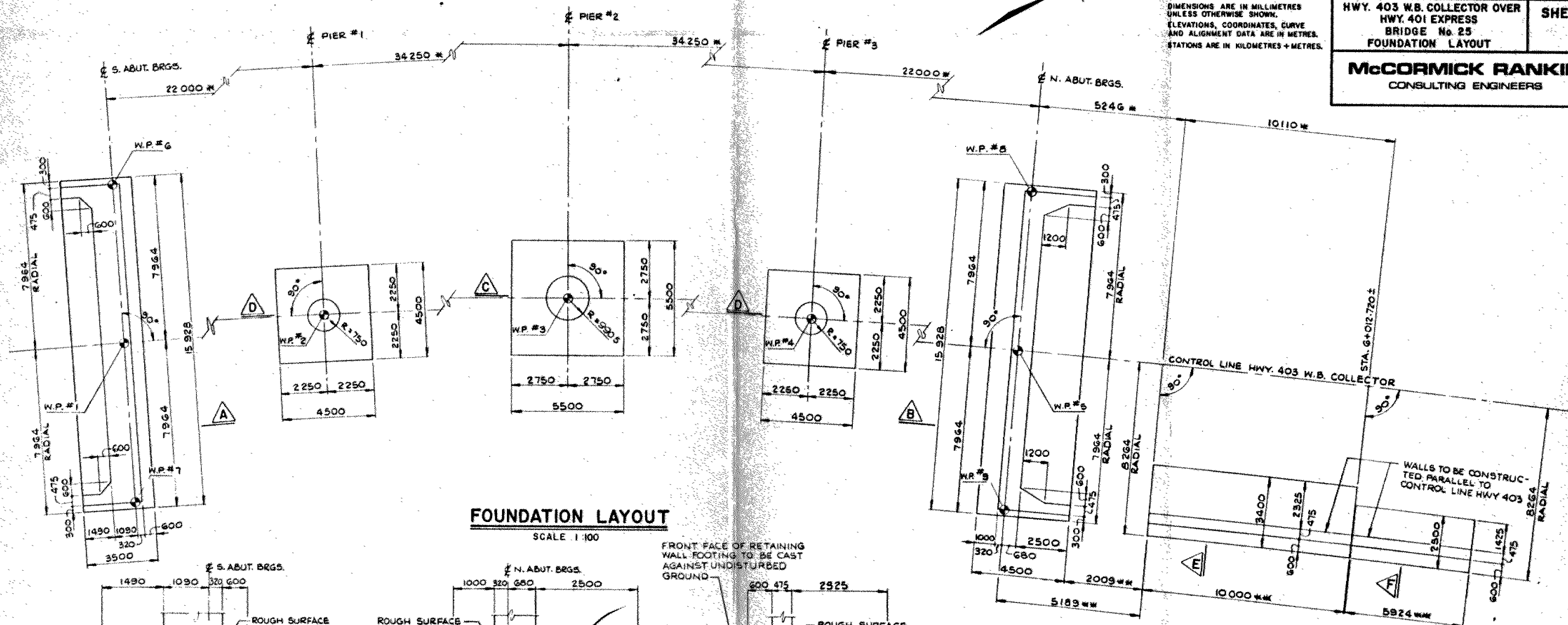
HWY. 403 W.B. COLLECTOR OVER
HWY. 401 EXPRESS
BRIDGE No. 25
FOUNDATION LAYOUT

McCORMICK RANKIN
CONSULTING ENGINEERS

SHEET

METRIC

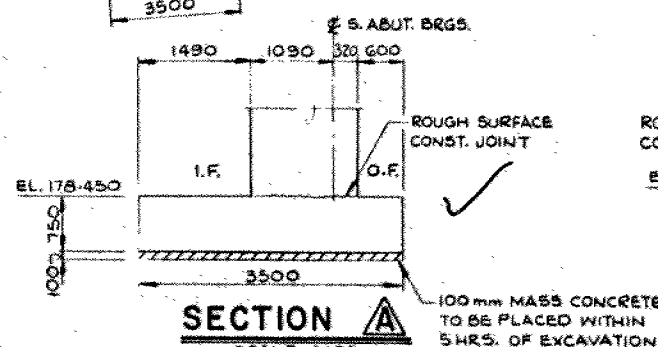
DIMENSIONS ARE IN MILLIMETRES
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AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



FOUNDATION LAYOUT

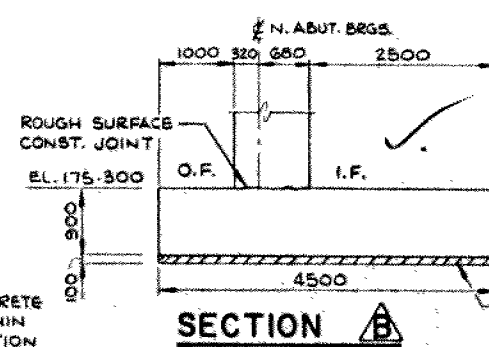
SCALE 1:100

FRONT FACE OF RETAINING
WALL FOOTING TO BE CAST
AGAINST UNDISTURBED
GROUND



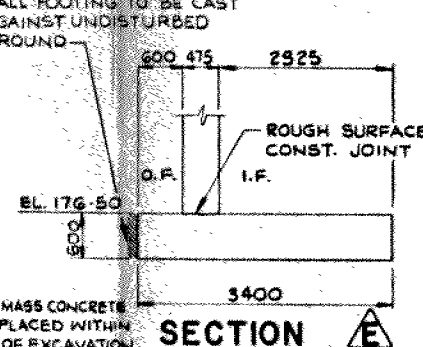
SECTION A

SCALE 1:50



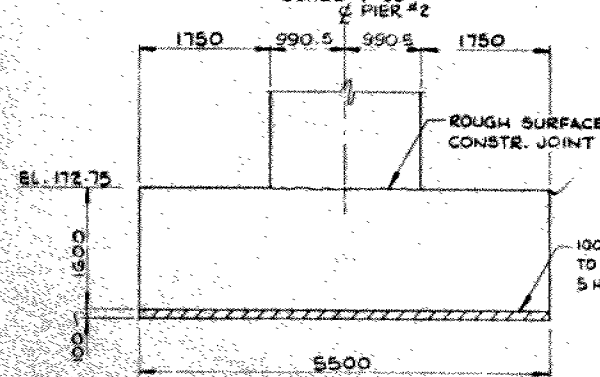
SECTION B

SCALE 1:50



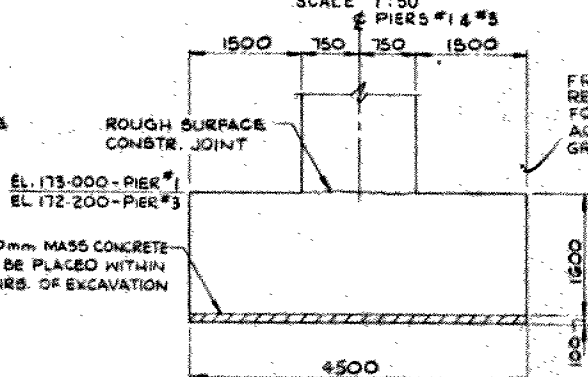
SECTION E

SCALE 1:50



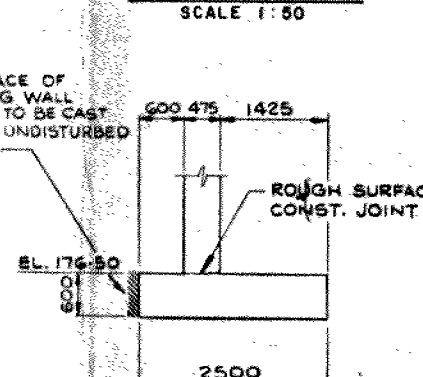
SECTION C

SCALE 1:50



SECTION D

SCALE 1:50



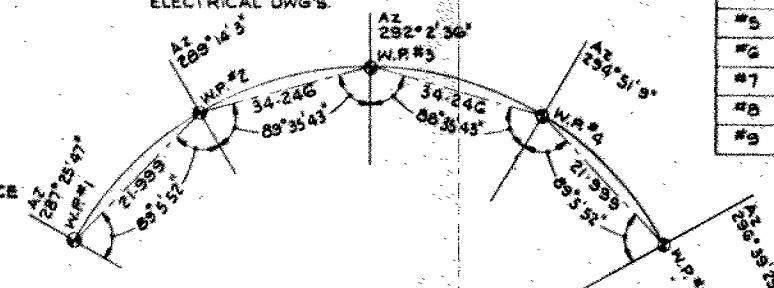
SECTION F

SCALE 1:50

NOTE:

- * DENOTES MEASUREMENT TAKEN ALONG CONTROL LINE HWY. 403 W.B. COLLECTOR
- ** DENOTES MEASUREMENT TAKEN ALONG OUTSIDE FACE OF WALL. TO BE ADJUSTED IN FIELD TO SUIT EXISTING S.W. WALL DIMENSION ON BRIDGE No. 52.
- FOR ELECTRICAL EMBEDDED WORK DETAILS SEE ELECTRICAL DWGS.

W.P.	STATION	CO-ORDINATES	
		NORTH	EAST
#1	G+140.576	833202.213	292212.276
#2	G+118.576	833225.096	292219.198
#3	G+084.326	833255.145	292231.269
#4	G+050.076	833286.563	292244.096
#5	G+028.076	833306.377	292254.455
#6	G+140.576	833204.509	292204.566
#7	G+140.576	833198.918	292219.551
#8	G+028.076	833309.815	292247.605
#9	G+028.076	833302.939	292261.305



LOCATION OF WORKING POINTS

N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REVISIONS	DATE	BY	DESCRIPTION
DESIGN A.S.W.			CHECK T.J.W. LOADING ON BRIDGE A-70 DATE NOV. 82
DRAWING J.W.B.			CHECK R.S. SITE 24-81-329 DWG 5

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 68



Ministry of
Transportation and
Communications



I N D E X

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3-16	Foundation Investigation Report For W.P. 127-66-75, Site 24-81-329 Highway 403 W. B. Collector Over Highway 401 Expressway

NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

3

For

Bridge #25

Highway 403 W.B. Collector

Over Highway 401 Expressway

W.P. 127-66-75, Site 24-81-329

Hwy. 403, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned site.

The fieldwork was carried out between 82 03 15 and 82 03 18 and consisted of advancing 5 sampled boreholes using solid stem continuous flight augers with bedrock being cored in three of the borings. The depth of borings ranged from 12.1 metres to 13.9 metres terminating within the bedrock.

Site Description and Geology

The structure site is located immediately south of the existing Hwy. 403 W.B. Collector structure (Bridge #52) over Hwy. 401 W.B. Collector.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually 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 composed of cohesive glacial till. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

Subsurface Conditions

The extent and composition of the overburden is generally uniform across the site. The existing embankment fill is composed of a mixture of reworked glacial till and fragments of bedrock extending for a maximum height of 6.7 metres. This fill is underlain by a thin deposit of cohesive glacial till overlying shale bedrock. The upper portion of the shale was found to be in a weathered state.

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 showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2 of the contract drawings.

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

Fill Material

The existing Hwy.403 W.B. embankment fill is composed of a mixture of reworked silty clay till and a highly fragmented shale and limestone. This fill is predominately derived from the parent glacial till and bedrock indigenous to the area. Typical grain size distribution curves for the fill are plotted in envelope form on Figure 1. This embankment material was encountered for thickness ranging from 5.0 to 6.7 metres.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	6-14	10
Liquid Limit	(W _L) %	27-37	32
Plastic Limit	(W _p) %	16-19	18
Plasticity Index	(I _p) %	10-18	14

These results indicate the cohesive matrix of the cohesive fill to be an inorganic silty clay of low plasticity (CL).

Based on the interpretation of Standard Penetration Test 'N' values ranging from 10 to in excess of 50 blows per 0.3 m but averaging 20 blows per 0.3 m, it is estimated that the fill material has undergone a moderately high degree of compactive effort.

Silty Clay, Gravel and Sand (Glacial Till)

The natural surficial deposit overlying most of the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with some sand and gravel. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 3.

An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 4) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	9-16	13
Liquid Limit	(W _L) %	36-42	40
Plastic Limit	(W _p) %	17-19	18
Plasticity Index (I _p) %		17-23	21

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 23 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from very stiff to hard.

Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit or fill material across the site. The upper 1.3 to 2.0 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 174.4 to 177.7 corresponding to depths of approximately 7.9 to 5.2 metres below the existing roadway shoulder surface.

Bedrock surface is sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The highly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

Groundwater Conditions

Due to the location of borings in the embankment shoulders, open boreholes could not be maintained to get an accurate stabilized ground water level.

Generally, upon completion of rock coring operations, the induced drill water remained perched within the boreholes, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Heart Lake Road geometry effectively drains the immediate structure location to the respective roadway grades.

M. MacLean

M. MacLean, P. Eng.
Foundation Engineer

M. Devata

M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC 8

W P 127-66-75 LOCATION Co-ords. N 4 833 309.6; E 292 248.4 ORIGINATED BY V.P.
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers, BXL Rock Core COMPILED BY V.P.
DATUM Geodetic DATE 82 03 15 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
182.6	Roadway Shoulder															
0.0	Gray Fill															
	Silty Clay		1	SS	40											34 17 32 17
	some Sand and Gravel		2	SS	42											
	mixed with fragments		3	SS	13											
	of Shale and Limestone		4	SS	17											40 20 26 14
			5	SS	17											
			6	SS	15											
			7	SS	24											
			8	SS	10											
175.9	(Glacial Till)		9	SS	69	28 cm										3 17 40 40
6.7	Silty Clay, some Sand		10	SS	66											16 12 38 34
174.4	& Gravel Hard															
8.2	Gray		11	SS	75	15 cm										
	Weathered		12	SS	75	10 cm										
	Shale Bedrock with		13	BXL	REC											
	thin layers of			RC	95%											
	Limestone		14	BXL	REC											
170.3				RC	100%											
12.3	End of Borehole															
	Refusal to auger at															
	10.3 metres.															
	* Note: Water level															
	not established.															

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



RECORD OF BOREHOLE No 2

METRIC 9

W P 127-66-75 LOCATION Co-ords. N 4 833 285.0; E 292 250.2 ORIGINATED BY V.P.
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 03 15 CHECKED BY *EP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
182.3	Roadway Shoulder													
0.0	Gray Fill					*	182							
	Silty Clay, some Sand and Gravel mixed with fragments of Shale and Limestone		1	SS	43									
			2	SS	33									51 14 27 8
			3	SS	51	25cm	180							
			4	SS	45									
			5	SS	44		178							
177.3	(Glacial Till)		6	SS	15									33 20 31 16
5.0	Silty Clay, some Sand & Gravel		7	SS	23									
	Very Stiff to Hard		8	SS	41		176							2 17 46 35
	Shale and Limestone fragments		9	SS	50	15 cm								
174.4	Grey		10	SS	65	7 cm								9 17 35 39
7.9	Weathered		11	SS	80	13 cm	174							
	Shale Bedrock with thin layers of Limestone		12	SS	50	7 cm	172							
							170							
169.2	End of Borehole													
13.1	Refusal to Auger													
	* Note: Water level not established.													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
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Ontario

RECORD OF BOREHOLE No 3

METRIC 10

W P 127-66-75

LOCATION Co-ords. N 4 833 257.3;

E 292 225.5

ORIGINATED BY V.P.

DIST 6 HWY 403

BOREHOLE TYPE Solid Stem Augers

COMPILED BY V.P.

DATUM Geodetic

DATE 82 03 17

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
183.0	Roadway Shoulder															
0.0	Grey Fill															
	Silty Clay, some Sand and Gravel mixed with fragments of Shale and Limestone		1	SS	50	10 cm	182									
			2	SS	25											
			3	SS	19											
			4	SS	25		180									36 15 34 15
			5	SS	46											
177.8	Gravelly Sand		6	SS	50	12 cm	178									32 48 14 6
5.2	(Glacial Till)		7	SS	73											
	Silty Clay, some Sand and Gravel with Rock frags. Hard		8	SS	50	3 cm	176									10 16 43 31
176.0	Grey		9	SS	50	2 cm										
7.0	Weathered		10	SS	65	10 cm	174									
	Shale Bedrock with thin layers of Limestone		11	SS	65	1 cm	172									
			12	SS	50	1 cm										
							170									
169.1	End of Borehole		13	SS	80	15 cm										
13.9	* Note: Water Level not established.															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



METRIC 11

W P 127-66-75 LOCATION Co-ords, N 4 833 223.0; E 292 225.1 ORIGINATED BY VP
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers, BXL Rock Core COMPILED BY VP
DATUM Geodetic DATE 82 03 18 CHECKED BY VP

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC 12

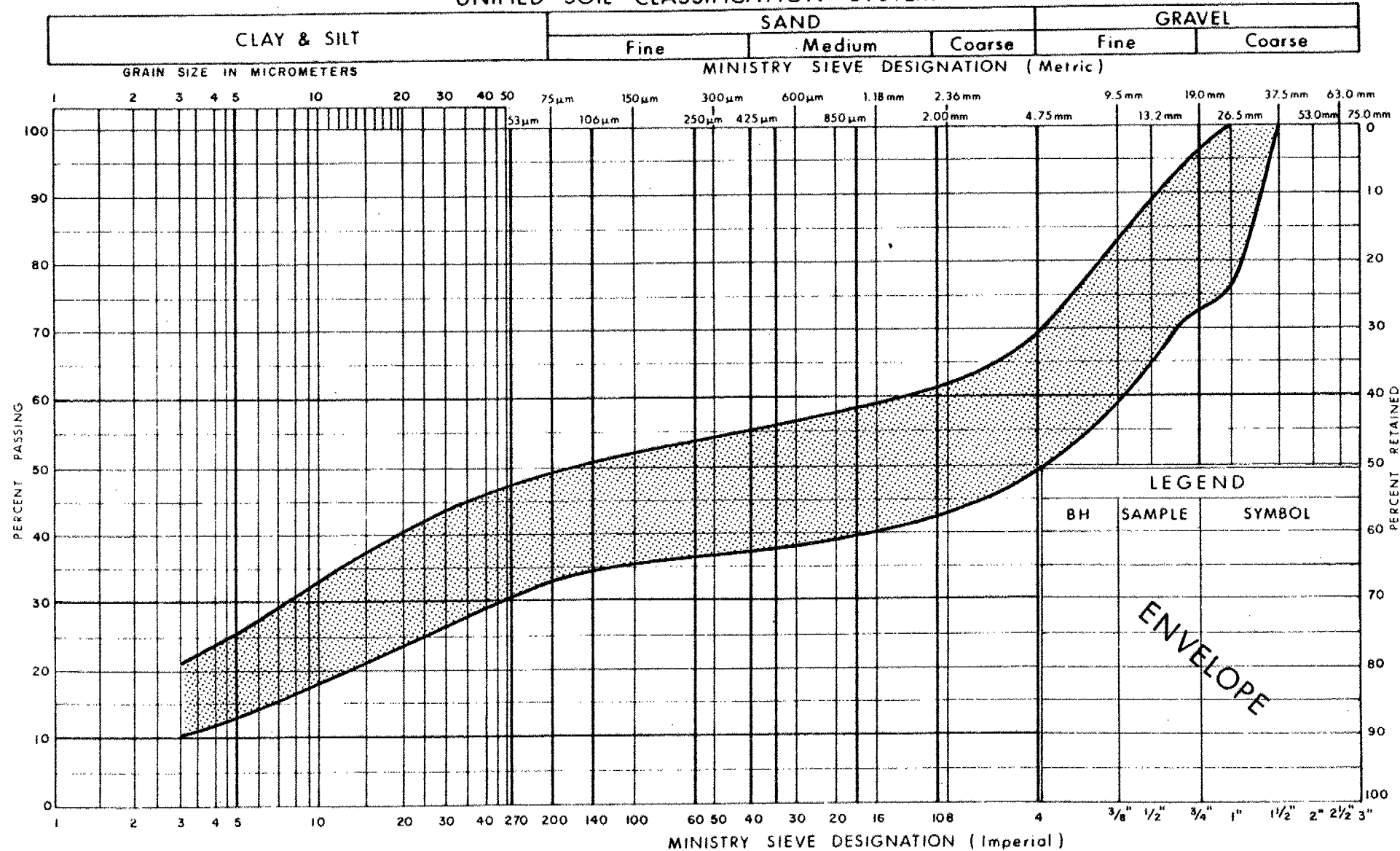
W P 127-66-75 LOCATION Co-ords. N 4 833 205.6; E 292 206.2 ORIGINATED BY VP
 DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers BXL Rock Core COMPILED BY VP
 DATUM Geodetic DATE 82 03 16 CHECKED BY *SP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W _p W W _L	WATER CONTENT (%)			
182.9	Roadway Shoulder												
0.0	Grey <u>Fill</u>		1	SS	109	25 cm	182						
			2	SS	18								
	Silty Clay some Sand and Gravel mixed with fragments of Shale and Limestone		3	SS	50	10 cm	180						
			4	SS	20								
			5	SS	15								
177.7			6	SS	18		178						
5.2	Grey		7	SS	55	8 cm							
	<u>Weathered</u>		8	SS	75	8 cm							
			9	BXL RC	REC 100%		176						
			10	BXL RC	REC 100%		174						
	Shale Bedrock with thin layers of Lime- stone		11	BXL RC	REC 100%								
			12	BXL RC	REC 100%		172						
169.9			13	BXL RC	REC 100%		170						
13.0	End of Borehole												
	* Note: Water Level not Established												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

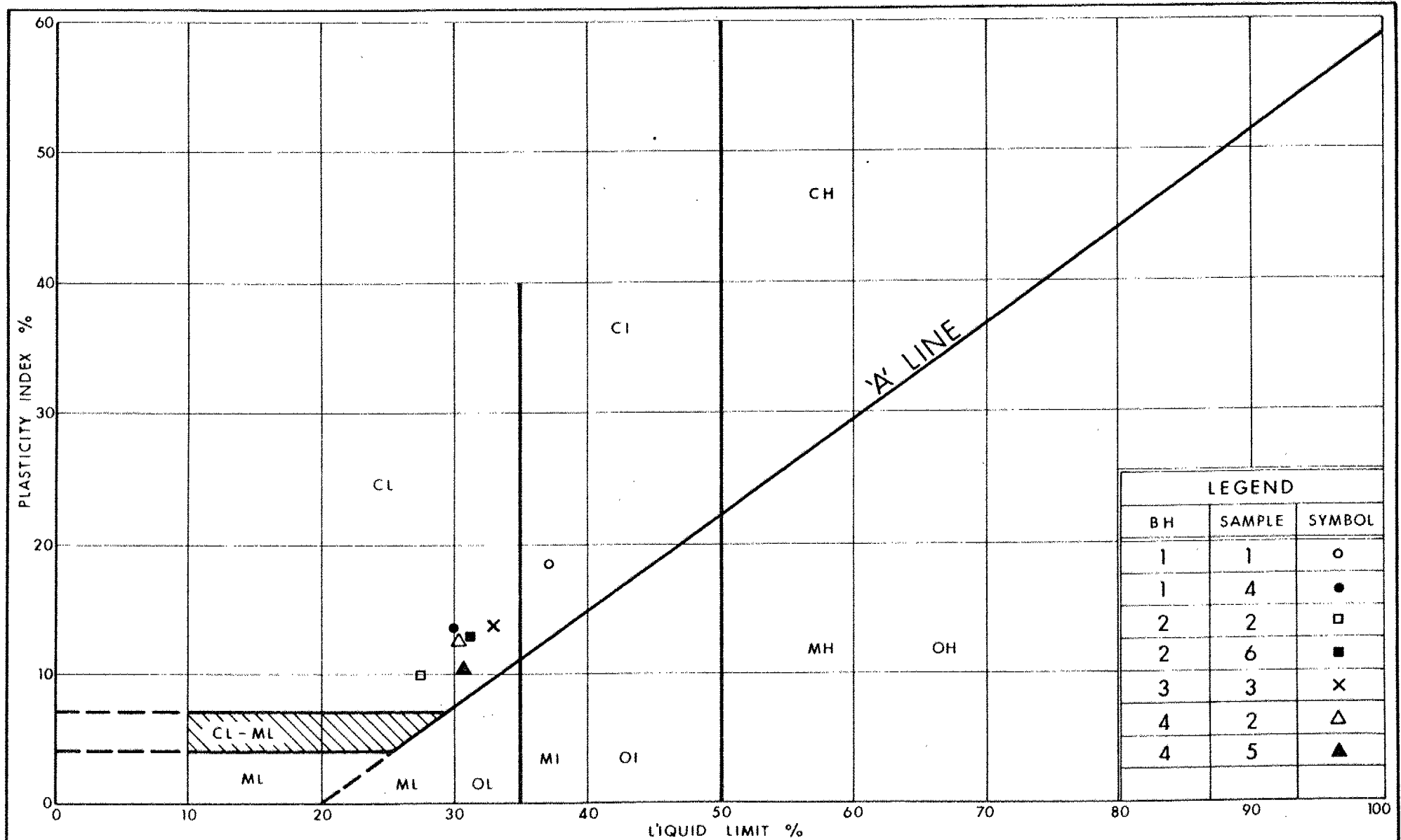


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GRAIN SIZE DISTRIBUTION
SILTY CLAY SOME SAND & GRAVEL (Fill)
 MIXED WITH FRAGMENTS OF SHALE & LIMESTONE

FIG No 1

W P 127-66-75



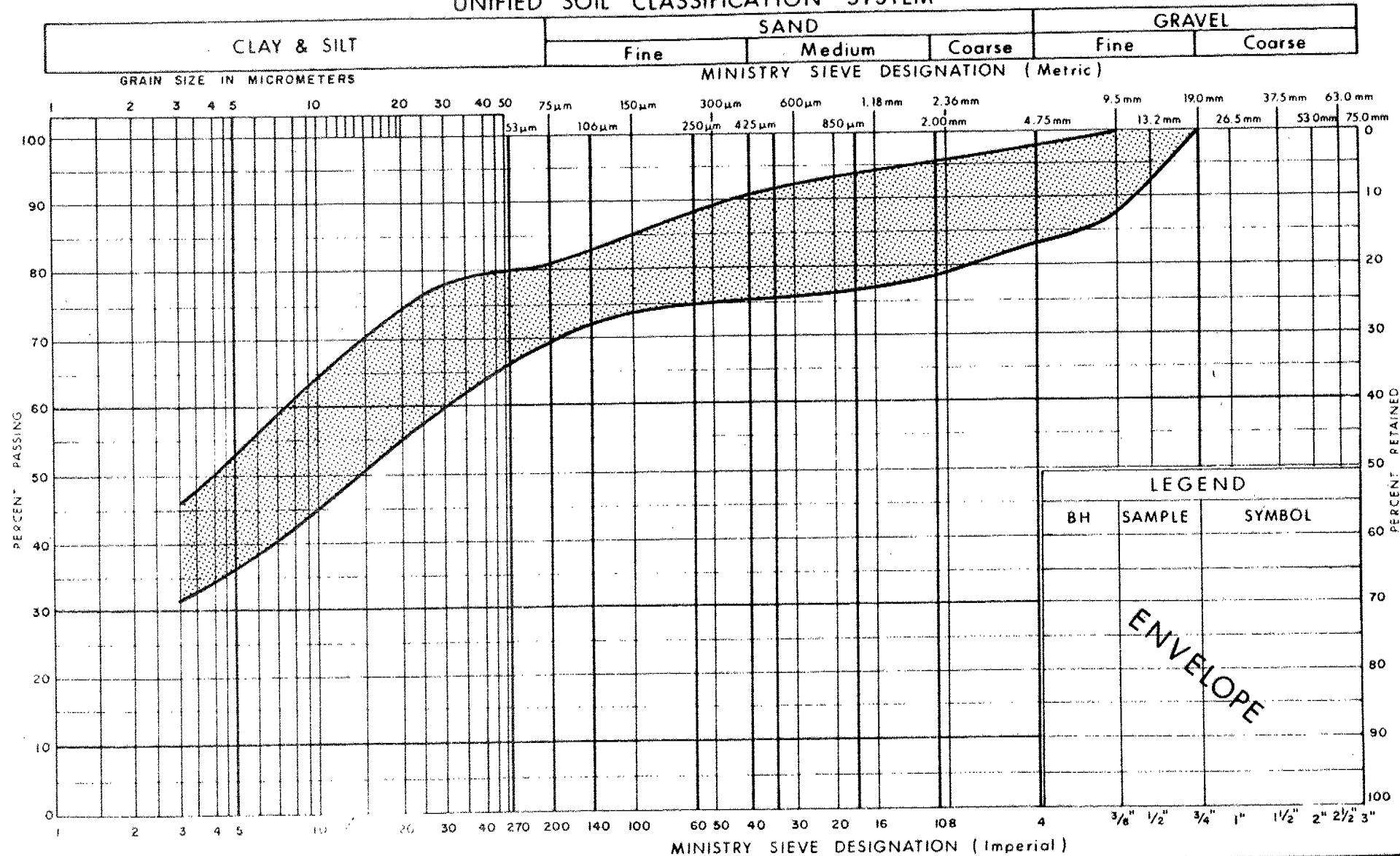
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PLASTICITY CHART
(EMBANKMENT Fill Matrix)
SILTY CLAY (OF LOW PLASTICITY)

FIG No 2

W P 127-66-75

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

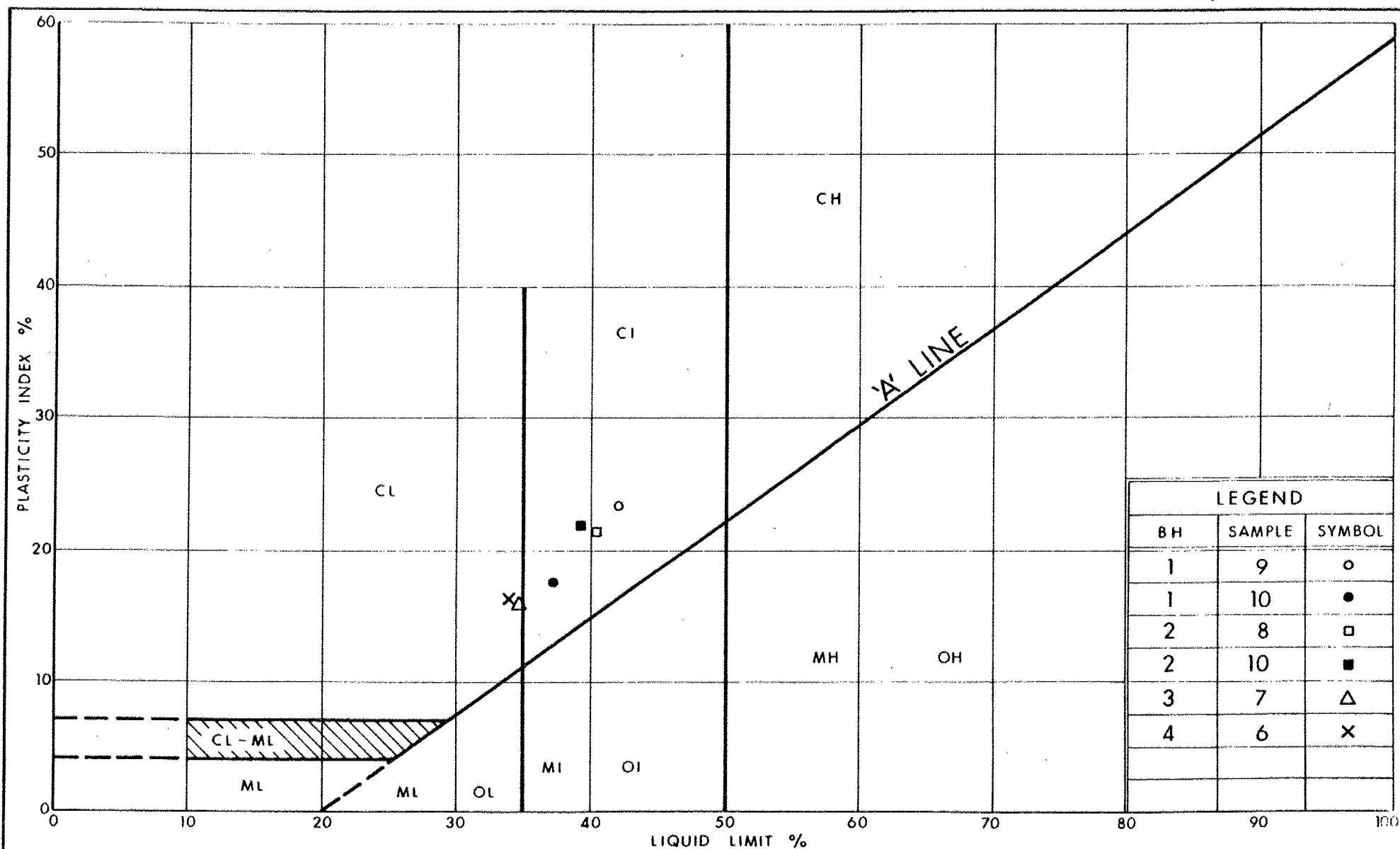
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

SILTY CLAY, SOME SAND & GRAVEL (Glacial Till)

FIG No 3

WP 127-66-75



Ministry of
Transportation and
Communications

PLASTICITY CHART
(Glacial Till Matrix)
SILTY CLAY (OF INTERMEDIATE PLASTICITY)

FIG No 4

W P 127-66-75

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 127-66-75

DIST 6

HWY 403

STR SITE 24-81-329

Bridge #25, Highway 403 W.B. Collector Over
Highway 401 Expressway

DISTRIBUTION

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T.J. Kovich (Cover Only)

~~Files~~

FOUNDATION INVESTIGATION REPORT

For

Bridge #25

Highway 403 W.B. Collector

Over Highway 401 Expressway

W.P. 127-66-75, Site 24-81-329

Hwy. 403, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks.

The fieldwork was carried out between 82 03 15 and 82 03 18 and consisted of advancing 5 sampled boreholes using solid stem continuous flight augers with bedrock being cored in three of the borings. The depth of borings ranged from 12.1 metres to 13.9 metres terminating within the shale bedrock.

Site Description and Geology

The structure site is located immediately south of the existing Hwy. 403 W.B. Collector structure (Bridge #52) over Hwy.401 W.B. Collector which was constructed under Contract 76-120 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually 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 composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

Subsurface Conditions

The extent and composition of the overburden is generally uniform across the site. The existing embankment fill is composed of a mixture of reworked glacial till and fragments of bedrock extending for a maximum height of 6.7 metres. This fill is underlain by a thin deposit of cohesive glacial till overlying shale bedrock. The upper portion of the shale was found to be in a weathered state.

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 showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 1276675-A.

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

Fill Material

The existing Hwy.403 W.B. embankment fill is composed of a mixture of reworked silty clay till and a highly fragmented shale and limestone. This fill is predominately derived from the parent glacial till and bedrock indeginous to the area. Typical grain size distribution curves for the fill are plotted in envelope form on Figure 1. This embankment material was encountered for thickness ranging from 5.0 to 6.7 metres.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		Range	Average
Water Content	(w) %	6-14	10
Liquid Limit	(W _L) %	27-37	32
Plastic Limit	(W _p) %	16-19	18
Plasticity Index	(I _p) %	10-18	14

These results indicate the cohesive matrix of the cohesive fill to be an inorganic silty clay of low plasticity (CL).

Based on the interpretation of Standard Penetration Test 'N' values ranging from 10 to in excess of 50 blows per 0.3 m but averaging 20 blows per 0.3 m, it is estimated that the fill material has undergone a moderately high degree of compactive effort.

Silty Clay, Gravel and Sand (Glacial Till)

The natural surficial deposit overlying most of the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with some sand and gravel. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 3. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 4) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	9-16	13
Liquid Limit	(W _L) %	36-42	40
Plastic Limit	(W _p) %	17-19	18
Plasticity Index (I _p) %		17-23	21

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 23 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from very stiff to hard.

Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit or fill material across the site. The upper 1.3 to 2.0 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 174.4 to 177.7 corresponding to depths of approximately 7.9 to 5.2 metres below existing roadway shoulder surface.

Bedrock surface ~~are~~ sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The highly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

Groundwater Conditions

Due to the location of borings in the embankment shoulders, open boreholes could not be maintained to get an accurate stabilized ground water level.

Generally, upon completion of rock coring operations, the induced drill water remained perched within the boreholes, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Heart Lake Road geometry effectively drains the immediate structure location to the respective roadway grades.

DISCUSSION AND RECOMMENDATION

As part of the upgrading of Highways 401 and 403 to a collector/core network, a Hwy.403 West Bound Collector Overpass structure is required at the crossing of Hwy. 401 Expressway. The proposed W.B. structure (Bridge #25) will consist of a 4 span (22 - 34 - 34 - 22 metres) continuous concrete voided structure some 15 metres wide. A proposed Hwy. 403 profile grade of 183.0, proposed Hwy. 401 Core profile grade of 173.0, and average natural ground surface elevation ranging from 176 to 178 will necessitate maximum cuts in the order of 4.0 metres through the parent material of the area.

In consideration of the proximity of competent shale bedrock to ground surface across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as follows:

Perched abutments can be founded on spread footings located above the natural ground surface on a core of well compacted Granular 'A' constructed to current M.T.C. specifications. Footings so founded can be designed for a factored capacity at the U.L.S. of 800 kPa and a capacity at the S.L.S. Type II of 350 kPa. All existing embankment fill and organic/softened material must be excavated within the full limits of the granular core prior to placement of any Granular 'A'.

Alternatively, perched abutments can be supported on shallow spread footings located within the weathered shale for a factored bearing capacity at the U.L.S. of 1,000 kPa or within the intact shale for a factored capacity (U.L.S.) of 1,500 kPa.

The design of shallow foundations founded on an unyielding medium such as shale bedrock will not be governed by settlement since the bearing capacity at the S.L.S. Type II is much larger than the factored capacity at U.L.S.

Pier footings can be supported on shallow spread footings located and designed within the intact shale at or below elevation 172.5 for a factored capacity at the U.L.S. of 1500 kPa.

A minimum earth cover of 1.25 metres should be provided to the underside of the footings, since the shale is considered susceptible to frost action.

The base of all footing excavations within bedrock should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed shale from weathering and softening.

Earth pressures against the abutment walls should be computed as per Subsection 6.6.1.2.2 of the O. H. B. D. C. Manual with provisions made from adequate drainage behind the abutment.

Provided backfill to the abutments consists of free draining granular material and adequate provisions are made for an appropriate drainage scheme, the following equivalent fluid pressures may be assumed for computation of earth pressures.

- a) At ultimate limit state
 - active condition 8.0 kPa/m
 - at rest condition 10.0 kPa/m
- b) At serviceability limit state
 - active condition 6.5 kPa/m
 - at rest condition 8.5 kPa/m

In addition, any new fill material should be properly benched in the existing slopes as per current MTC standards.

A constraint on the use of heavy vibratory equipment within a restricted distance to the back of abutment wall should be included as per current MTC directives.

Resistance to sliding of the abutment footings can be calculated assuming a coefficient of friction of 0.8 between the underside of the concrete footing and the rough shale surface.

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till and shale bedrock. Localized seepage into excavations can be controlled by perimeter ditches and pumping from corner sumps.

Provided the bridge is constructed prior to the roadway excavations for Hwy. 401 Core and an interim ground line is specified, the site should be properly graded and ditched to allow for free drainage in order to prevent ponding of water around the structure and possible softening of the founding shale.

No stability problems are anticipated for permanent embankment and cut slopes constructed to a 2:1 geometry. Exposed shale in cut slopes should be protected with adequate earth/topsoil cover and sodded.

Temporary cut slopes will stand at a 1:1 geometry or steeper, however, these slopes will weather rapidly and show signs of surficial distress if not protected in a reasonable length of time.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. V. Parker, Field Technician, utilizing equipment owned and operated by Atcost Drilling Co., Toronto. This report was written by Mr. T. J. Kazmierowski, Foundations Engineer and reviewed by Mr. M. Devata, Senior Foundations Engineer.



A handwritten signature in black ink, appearing to read 'T. J. Kazmierowski'.

T. J. Kazmierowski, P. Eng.
Foundation Engineer

A handwritten signature in black ink, appearing to read 'M. Devata'.

M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X



Ministry of
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Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 127-66-75 LOCATION Co-ords. N 4 833 309.6; E 292 248.4 ORIGINATED BY V.P.
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers, BXL Rock Core COMPILED BY V.P.
DATUM Geodetic DATE 82 03 15 CHECKED BY *EP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
182.6	Roadway Shoulder																
0.0	Grey Fill					*	182										34 17 32 17
	Silty Clay		1	SS	40												
	some Sand and Gravel		2	SS	42												
	mixed with fragments		3	SS	13		180										
	of Shale and Limestone		4	SS	17												40 20 26 14
			5	SS	17												
			6	SS	15		178										
			7	SS	24												
			8	SS	10												
175.9	(Glacial Till)		9	SS	69/28 cm		176										3 17 40 40
6.7	Silty Clay, some Sand		10	SS	66												16 12 38 34
174.4	& Gravel Hard																
8.2	Grey		11	SS	75/15 cm		174										
	Weathered		12	SS	75/10 cm												
	Shale Bedrock with		13	BXL	REC		172										
	thin layers of			RC	95%												
	Limestone		14	BXL	REC												
170.3				RC	100%												
12.3	End of Borehole																
	Refusal to auger at																
	10.3 metres.																
	* Note: Water level																
	not established.																

+³, x⁵: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 2

METRIC

W P 127-66-75 LOCATION Co-ords. N 4 833 285.0; E 292 250.2 ORIGINATED BY V.P.
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 03 15 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	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
182.3	Roadway Shoulder															
0.0	Grey Fill															
	Silty Clay, some Sand and Gravel mixed with fragments of Shale and Limestone		1	SS	43											
			2	SS	33											
			3	SS	51	25cm										
			4	SS	45											
			5	SS	44											
177.3			6	SS	15											
5.0	(Glacial Till)		7	SS	23											
	Silty Clay, some Sand & Gravel		8	SS	41											
	Very Stiff to Hard		9	SS	50	15 cm										
	Shale and Limestone fragments		10	SS	65	7 cm										
174.4																
7.9	Grey															
	Weathered		11	SS	80	13 cm										
	Shale Bedrock with thin layers of Limestone		12	SS	50	7 cm										
169.2																
13.1	End of Borehole															
	Refusal to Auger															
	* Note: Water level not established.															

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 127-66-75 LOCATION Co-ords. N 4 833 257.3; E 292 225.5 ORIGINATED BY V.P.
 DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
 DATUM Geodetic DATE 82 03 17 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			20	40					
183.0	Roadway Shoulder													
0.0	Grey Fill					*								
	Silty Clay, some Sand and Gravel mixed with fragments of Shale and Limestone		1	SS	50	10 cm	182							
			2	SS	25									
			3	SS	19		180							36 15 34 15
			4	SS	25									
			5	SS	46									
177.8	Gravelly Sand		6	SS	50	12 cm	178							32 48 14 6
5.2	(Glacial Till)		7	SS	73									
	Silty Clay, some Sand and Gravel with Rock frags. Hard		8	SS	50	3 cm								10 16 43 31
176.0	Gray		9	SS	50	2 cm	176							
7.0	Weathered		10	SS	65	10 cm								
	Shale Bedrock with thin layers of Limestone		11	SS	65	1 cm	174							
			12	SS	50	1 cm	172							
							170							
169.1			13	SS	80	15 cm								
13.9	End of Borehole													
	* Note: Water level not established.													

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

W P 127-66-75 LOCATION Co-ords. N 4 833 223.0; E 292 225.1 ORIGINATED BY VP
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers, BXL Rock Core COMPILED BY VP
DATUM Geodetic DATE 82 03 18 CHECKED BY *EP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L	
182.5	Roadway Shoulder														
0.0	Grey <u>Fill</u>														
			1	SS	60	*									
			2	SS	18										34 17 34 15
	Silty Clay some Sand and Gravel mixed with fragments of Shale and Limestone		3	SS	16										
			4	SS	20										
			5	SS	14										
177.6			6	SS	11										51 15 26 8
177.3	Glacial Till		7	SS	55	7 m									6 24 43 27
5.2	Grey		8	SS	60	10 cm									
	<u>Weathered</u>		9	SS	50	7 m									
			10	BXL RC	REC 100%										
	Shale Bedrock with thin layers of Limestone		11	BXL RC	REC 100%										
			12	BXL RC	REC 100%										
170.4															
12.1	End of Borehole														
	Refusal to Auger at 8.1 metres														
	* Note: Water Level not Established														

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 5

METRIC

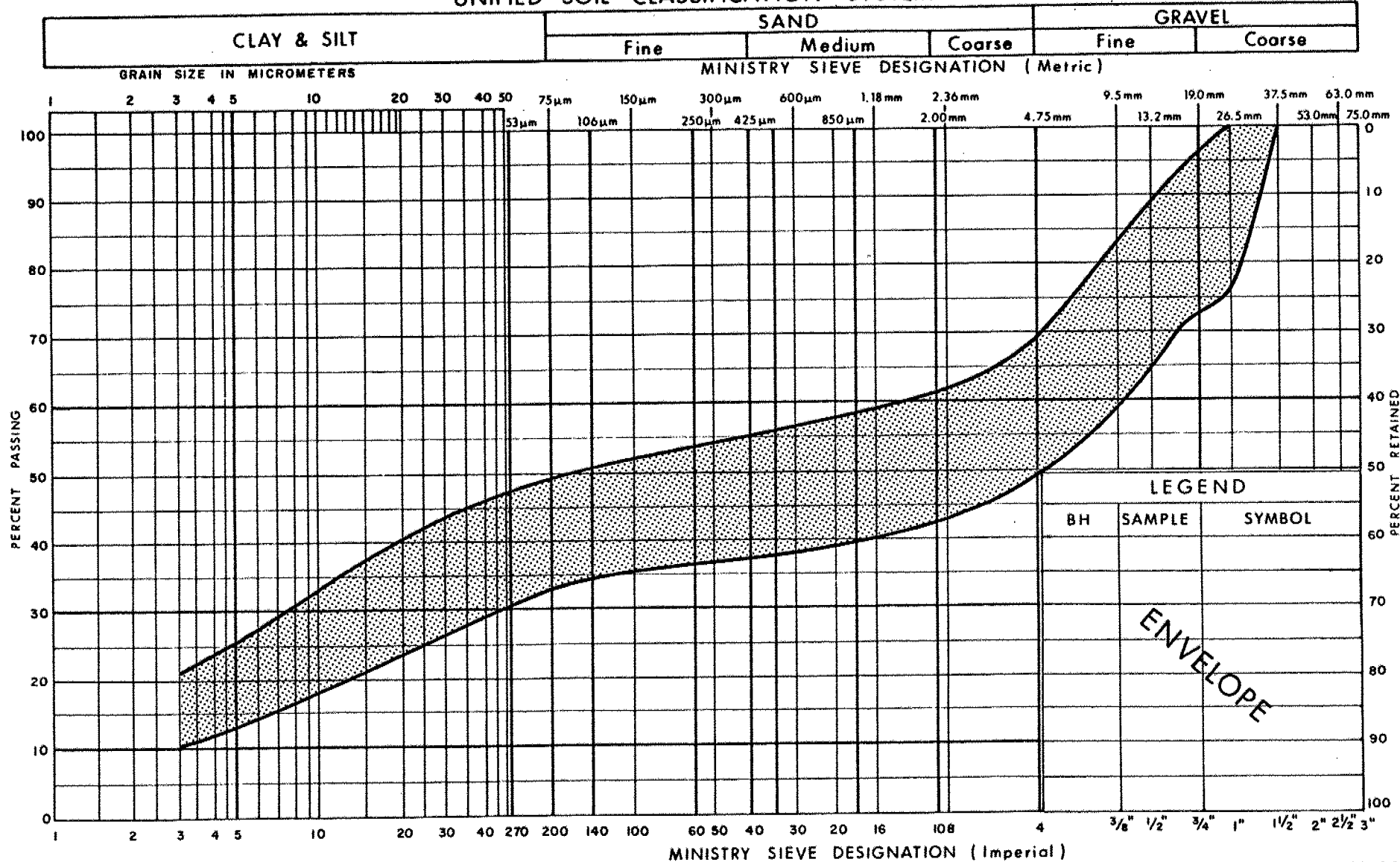
W P 127-66-75 LOCATION Co-ords. N 4 833 205.6; E 292 206.2 ORIGINATED BY VP
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers BXL Rock Core COMPILED BY VP
DATUM Geodetic DATE 82 03 16 CHECKED BY SP

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 ^o VALUES		20	40	60	80	100					
182.9	Roadway Shoulder															
0.0	Grey Fill		1	SS	109	25 cm										
			2	SS	18											
	Silty Clay some Sand and Gravel mixed with fragments of Shale and Limestone		3	SS	50	10 cm										
			4	SS	20											
			5	SS	15											
177.7			6	SS	18											
5.2	Grey		7	SS	55	8 cm										
	Weathered		8	SS	75	8 cm										
			9	BXL RC	REC 100%											
			10	BXL RC	REC 100%											
	Shale Bedrock with thin layers of Lime- stone		11	BXL RC	REC 100%											
			12	BXL RC	REC 100%											
169.9			13	BXL RC	REC 100%											
13.0	End of Borehole															
	* Note: Water Level not Established															

+3, x5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



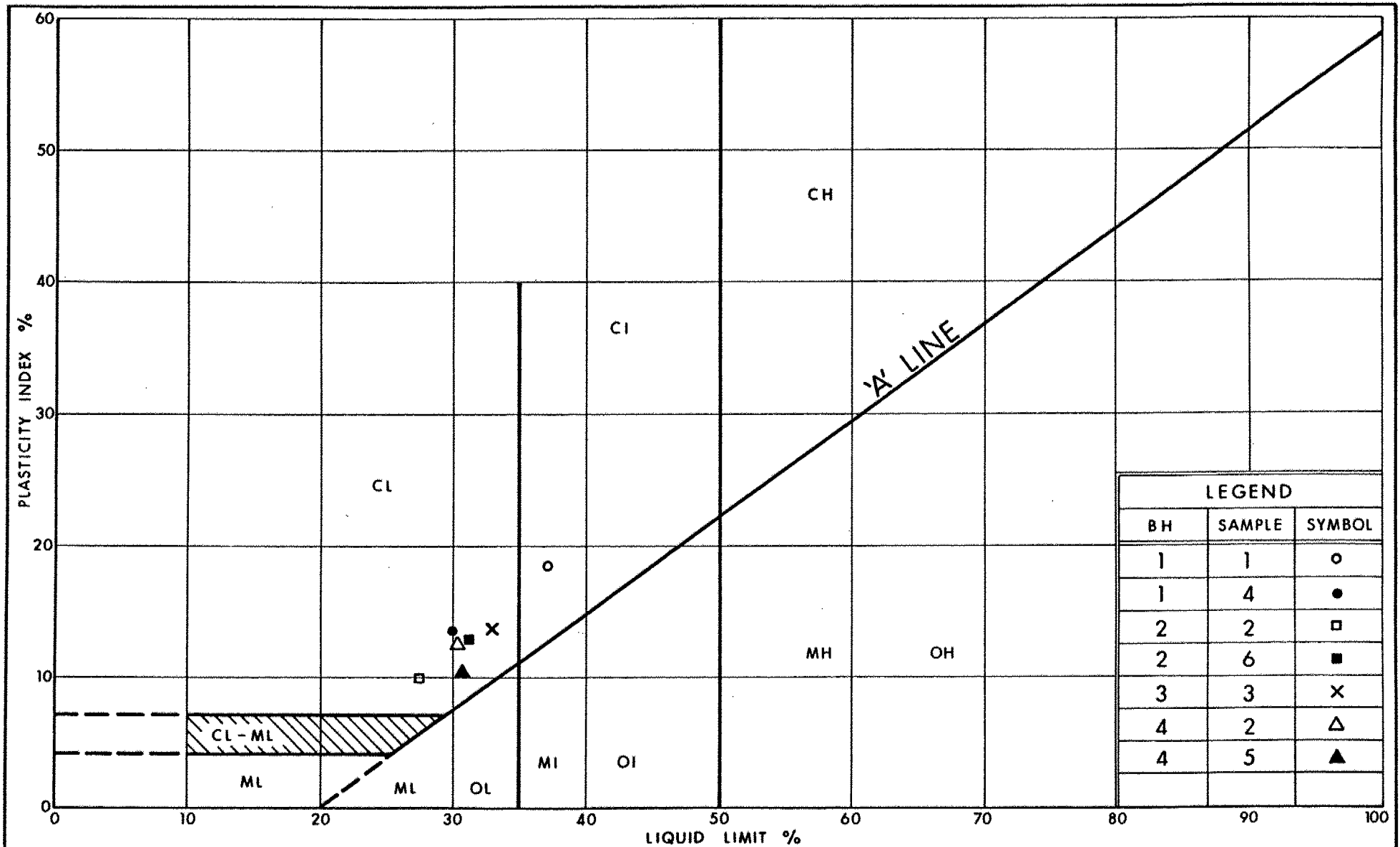
Ontario

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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY SOME SAND & GRAVEL (Fill)
 MIXED WITH FRAGMENTS OF SHALE & LIMESTONE

FIG No 1

W P 127-66-75



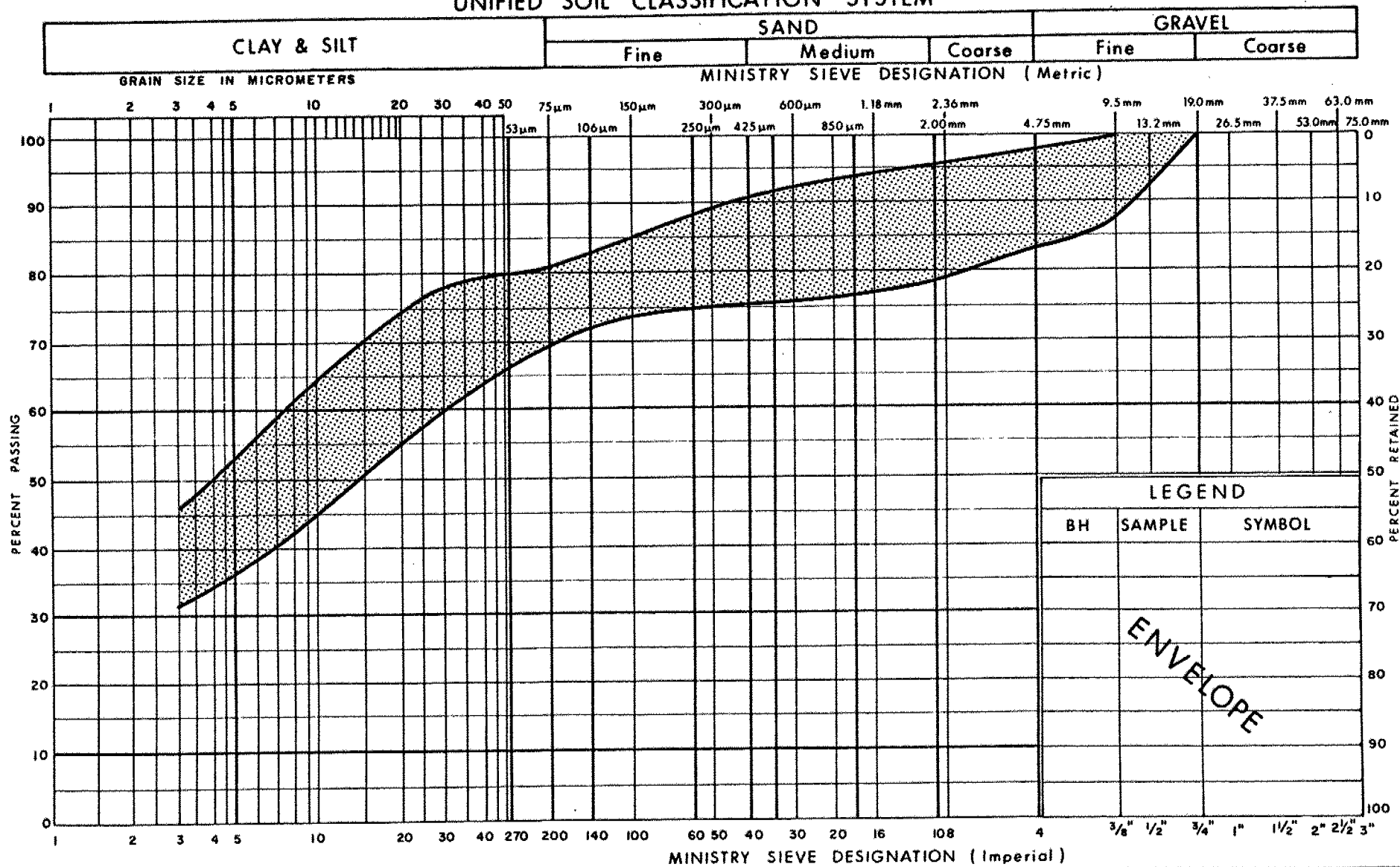
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PLASTICITY CHART
(EMBANKMENT Fill Matrix)
SILTY CLAY (OF LOW PLASTICITY)

FIG No 2

W P 127-66-75

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

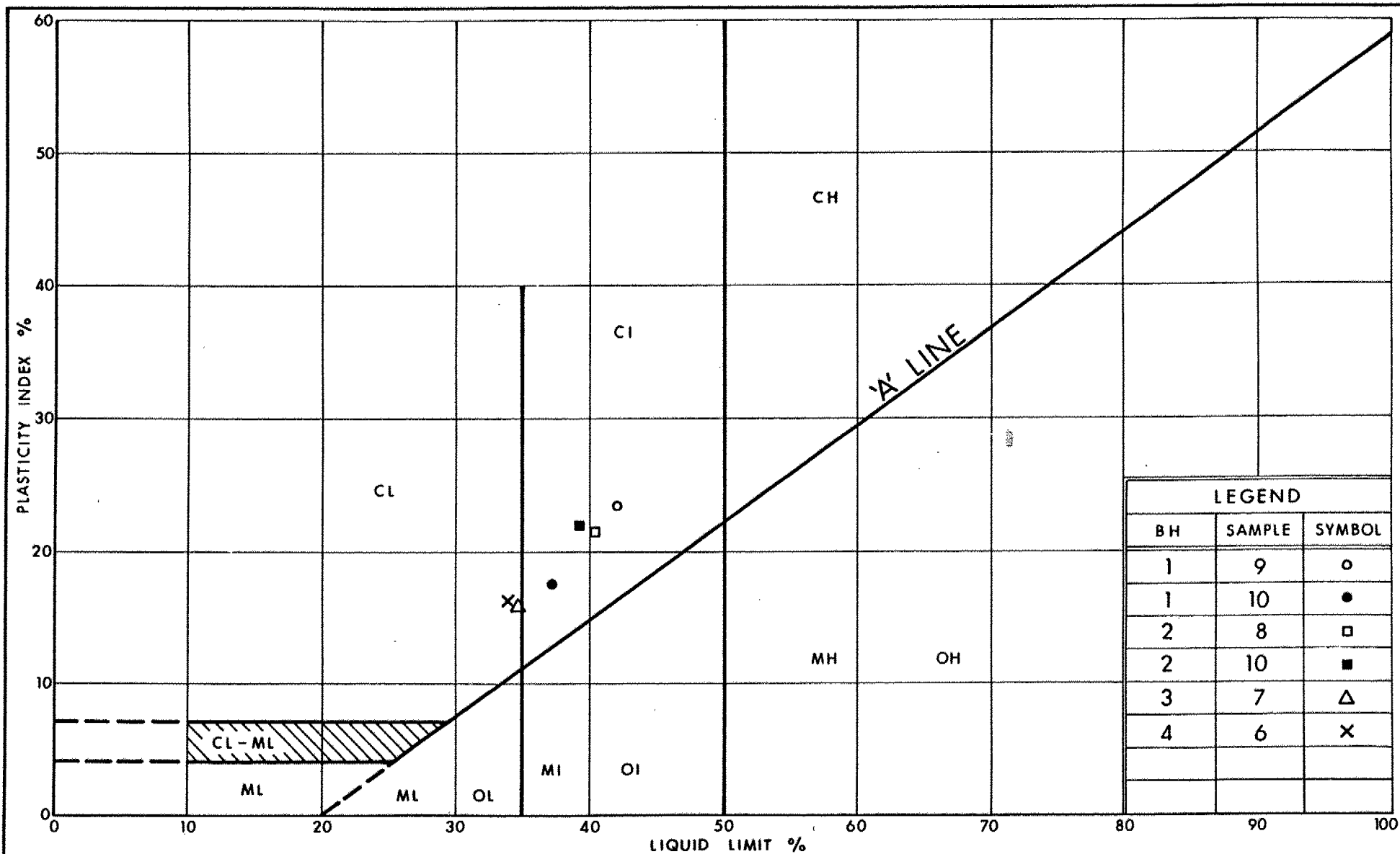
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GRAIN SIZE DISTRIBUTION

SILTY CLAY, SOME SAND & GRAVEL (Glacial Till)

FIG No 3

W P 127-66-75



Ministry of
Transportation and
Communications

PLASTICITY CHART
(Glacial Till Matrix)
SILTY CLAY (OF INTERMEDIATE PLASTICITY)

FIG No 4

W P 127-66-75

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 = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kn/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m^3	SEEPAGE FORCE
γ'	kn/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC

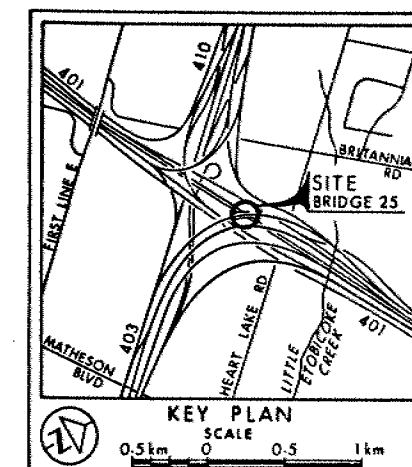
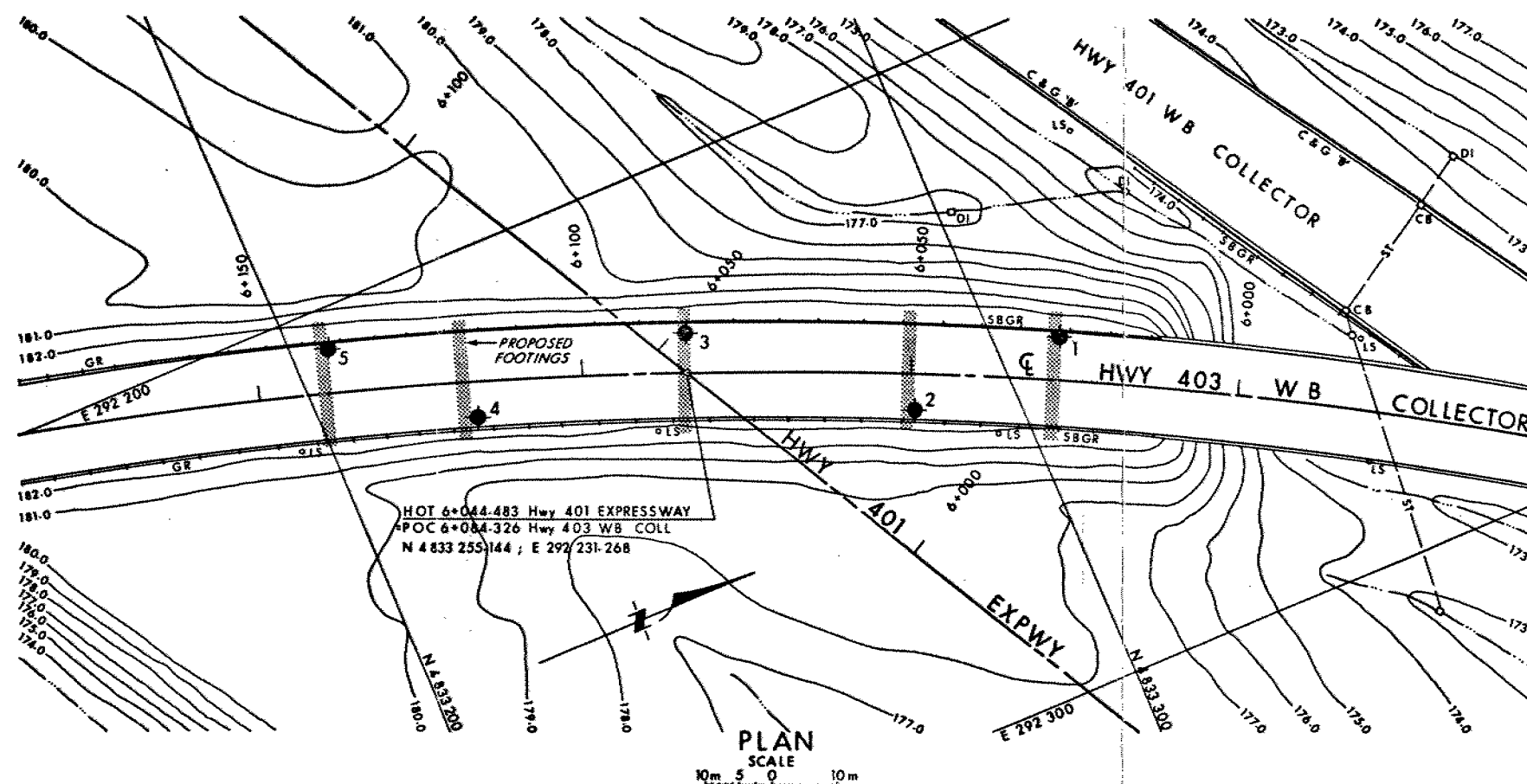
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN.
STATIONS ARE IN
KILOMETRES + METRES.

CONT No
WP No 127-66-75

HWY 403 WB COLL OVER
HWY 401 EXPWY (BRIDGE 25)
BORE HOLE LOCATIONS & SOIL STRATA

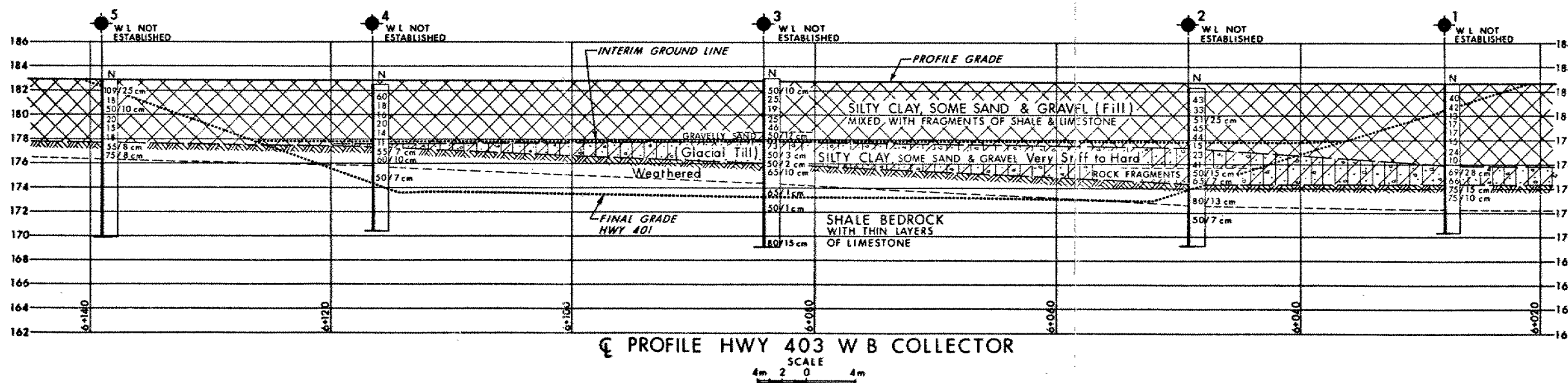


SHEET



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)
- ⬇ WL at time of investigation
- ⬇ WL Not Established



No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	182.6	4 833 309.6	292 248.4
2	182.3	4 833 285.0	292 250.2
3	183.0	4 833 257.3	292 225.5
4	182.5	4 833 223.0	292 225.1
5	182.9	4 833 205.6	292 206.2

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 30M12-165

HWY No 403
SUBMITTAL CHECKED DATE 1982 05 12 SITE 24-81-329
DRAWN BY CHECKED APPROVED DWG 1276675-A

memorandum



To: Mr. W.L. Lin
Design Engineer (Central)
Structural Office
3501 Dufferin St., 4th Floor

Date: 83 02 23

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

Re: Hwy. 403 W.B. Collector over Hwy. 401 Express
Bridge #25
W.P. 127-66-75, Site 24-329
District 6, Toronto

We have reviewed the comments by McCormick Rankin in the memo dated 83 01 20 and are satisfied with their response to our queries. As per your accompanying request for confirmation of the bearing capacity of the soil at the two northeast retaining wall panels, we provide the following comments:

- 1) In view of the uncertainty regarding the condition and location of the parent glacial till and backfill material in the area of the existing west abutment (Bridge #52) due to construction activity and weathering processes; and to minimize poor footing performance as a result of differential settlement caused by variable bearing conditions, the following treatments are suggested:
 - a) if the glacial till is disturbed and/or softened at the bearing elevation within the planned limits of the footing, then the retaining wall should be founded on a minimum 1 metre thick compacted Granular 'A' core.
 - b) if the glacial till is competent and undisturbed, however fill material has been placed in the area of the proposed footing, the old fill should be subexcavated and replaced with mass concrete to the required bearing elevation.
 - c) provided the hard glacial till is undisturbed and continuous within the footing limits, then footings can be founded on the parent till at the specified elevations.
- 2) In order to ascertain the condition of the bearing stratum, a qualified engineer should inspect the base of the excavation during construction. The construction personnel should be so advised.

.../2

- 3) Provided these recommendations are followed, no problems are anticipated for footings constructed according to the stated bearing pressures.

We trust this information is sufficient for your design requirements. If further discussion is warranted, feel free to contact this Section.

A handwritten signature in dark ink, appearing to read 'Tom Kazmierowski', is written over a faint, larger signature that appears to be 'Tom Kazmierowski'.

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK:syc

cc: G.C.E. Burkhardt

**McCORMICK, RANKIN & ASSOCIATES
LIMITED**

consulting engineers

January 20, 1983

Mr. K. G. Bassi, P. Eng.
Head, Operating Section
Structural Office
3501 Dufferin Street
4th Floor
DOWNSVIEW, Ontario
M3K 1N6

Attention: Mr. W. Lin, P. Eng.

RE: Highway 403 W.B. Collector over Highway 401 Express
Bridge No. 25
W.P. 127-66-75, Site 24-329
District 6, (Toronto)
Our File: W.O. 1272-200

Dear Sir:

We are in receipt of a copy of a memorandum dated December 22, 1982 from the Pavement and Foundation Design Section raising a number of questions regarding the foundation design for the above-noted structure.

Our comments on the points raised are as follows:

- 1.) The elevations of the underside of the pier footings are controlled by the depths of the footings (1.6 m) and the need to provide sufficient cover to the tops of the footings. At Piers 1 and 4 the cover is controlled by the toe-walls at the bottom of the slope paving and the tops of these footings are set approximately 600 mm below the future finished grades at these locations. Similarly, at Pier 2 the top of footing is located approximately at the underside of the granular base course which extends under the concrete median barrier system at the pier (Ref. St'd. DD-918-C).

Since the footings are 1.60 m deep the frost cover requirement of 1.25 m does not control the pier footing elevations.

2. The elevation of the underside of the north abutment footing is controlled by the frost cover requirement of 1.25 m at the northeast corner of the footing. Due to the skew arrangement of the bridge and the slope development of the north abutment the finished grade at the northwest corner of the abutment is approximately 3 m higher than that at the northeast corner.

.....

Mr. W. Lin, P. Eng.
January 21, 1983

Page 2.

The Pavement and Foundation Section have suggested that consideration be given to stepping the abutment footing and founding the higher section on a compacted granular 'A' core.

In our opinion this proposal is undesirable for the following reasons:

- o Potential differential foundation performance for adjacent sections of the north abutment with the east half founded within the shale/glacial till and the west half on a compacted granular 'A' core.
- o Structural difficulties associated with differential behaviour and displacement of adjacent sections of cantilevered abutment walls, which are of different heights but which are structurally connected.

In addition, it is our experience that the cost benefits associated with stepping foundations are usually not significant unless the abutment is very long in which case several smaller steps can be introduced.

3. The northeast retaining wall consists of two panels. One full-height panel adjacent to the north abutment together with a small panel extending under the wingwall of the adjacent existing bridge. The founding elevation for the full height panel is controlled by the 1.25 m frost cover requirement adjacent to the new bridge abutment. This results in an elevation for the underside of the footing at El. 175.90. This is at or very close to the hard glacial till overlaying the shale bedrock (Ref. Borehole No. 1 Record).

Similarly, the elevation for the underside of the foundation for the small retaining wall extending under the existing bridge wingwall is controlled by the 1.25 m frost cover requirement at the north end of this panel. This also results in an elevation for the underside of the foundation at El. 175.90. It is acknowledged that the northern limit of this small retaining wall panel is founded on compacted backfill to the existing bridge abutment.

As requested, we are pleased to confirm the following bearing pressures for these retaining wall panels.

	Bearing Pressure	
	<u>S.L.S.</u>	<u>U.L.S.</u>
Full Height Panel	235 KPa (2.2 ton/ft ²)	269 KPa (2.5 ton/ft ²)
Panel Extending under existing Bridge Wingwall	157 KPa (1.5 ton/ft ²) for max wall height	182 KPa (1.7 ton/ft ²) for max. wall height

Mr. W. Lin, P. Eng.
January 20, 1983

Page 3.

On the basis of the above-noted bearing pressures we would appreciate confirmation of the Pavement & Foundation Section's recommendation that 1 metre± of hard glacial till be excavated over the lengths of these walls and replaced with a compacted granular 'A' core. A recommendation regarding the foundation treatment at the north limit of the small retaining wall adjacent to the existing bridge is also requested.

4. We concur with the comment regarding the need for proper grading and drainage of the site to prevent ponding water around the structure. This drainage scheme should be properly indicated on the appropriate grading drawings.

We trust that the above-noted comments will be of assistance during further reviews of this project. If you have any questions or require further information this submission please do not hesitate to call. In the meantime, we will await your direction before proceeding with any revisions to the bridge drawings.

Yours very truly,

McCORMICK RANKIN



R. Skelton, P. Eng.

RS:mj

memorandum



To: Mr. W.L. Lin
Design Engineer (Central)
Structural Office
3501 Dufferin St., 4th Floor

Date: 82 12 22

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

Re: Hwy. 403 W.B. Collector over Hwy. 401 Express.
Bridge #25
W.P. 127-66-75, Site 24-329
District 6 (Toronto)

Upon review of the final bridge design drawings and documentation for the above-mentioned structure site, the following questions arise:

- 1) Why have the pier footings been located to such a depth within the intact shale bedrock?
Pier footings can be founded to a minimum elevation of 172.5 within intact shale with allowances made for 1.25 metres of frost cover below profile grade.
- 2) Why has the North Abutment been taken down to weathered shale when the overall abutment height can be shortened by founding the footing on a well compacted Granular 'A' core?
Due to the skew arrangement, if the footing infringes on the slope face, consideration should be given to stepping the abutment footing while still founding the footing on a compacted Granular 'A' core.
- 3) How is the N.E. retaining wall being founded and what bearing pressures are being considered?
Due to previous construction activity in this area and the variable sloping nature of the glacial till surface, the retaining wall should be founded on a minimum 1 metre thick compacted Granular 'A' core as per design recommendations within the Foundation Report.
- 4) The site must be properly graded and drained to prevent ponding of water around the structure and possible softening of the bearing stratum. This drainage scheme should be properly indicated on the appropriate grading drawings.

A handwritten signature in dark ink, appearing to read "Tom Kazmierowski".

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK:syc

cc: G.C.E. Burkhardt
F. Norman

memorandum



To: Mr. W.L. Lin
Design Engineer (Central)
Operating Section

Date: 82 08 25

From: Pavement and Foundation Design
Room 315, Central Building
Downsview, Ontario

Re: Hwy. 403 W.B. Collector over
Hwy. 401 Express (Bridge #25)
W.P. 127-66-75, Site 24-329
District 6, Toronto

We have reviewed the preliminary drawing P1 for the above-mentioned structure and provide the following comments:

1. Excavations for the compacted granular "A" core supporting the north-east retaining wall need only be carried down to the hard glacial till stratum i.e. elevation 176 ±
2. The site must be properly graded and drained to prevent ponding of water around the structure provided an interim grade line is incorporated.

A handwritten signature in black ink, appearing to read "T. Kazmierowski".

T. Kazmierowski, P. Eng.
Foundations Engineer

TK/jb