

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30 M12-153

DIST. 6 REGION

W.P. No. 127-66-26

CONT. No. 82-106

W. O. No.

STR. SITE No. 24-81-184C

HWY. No. 401

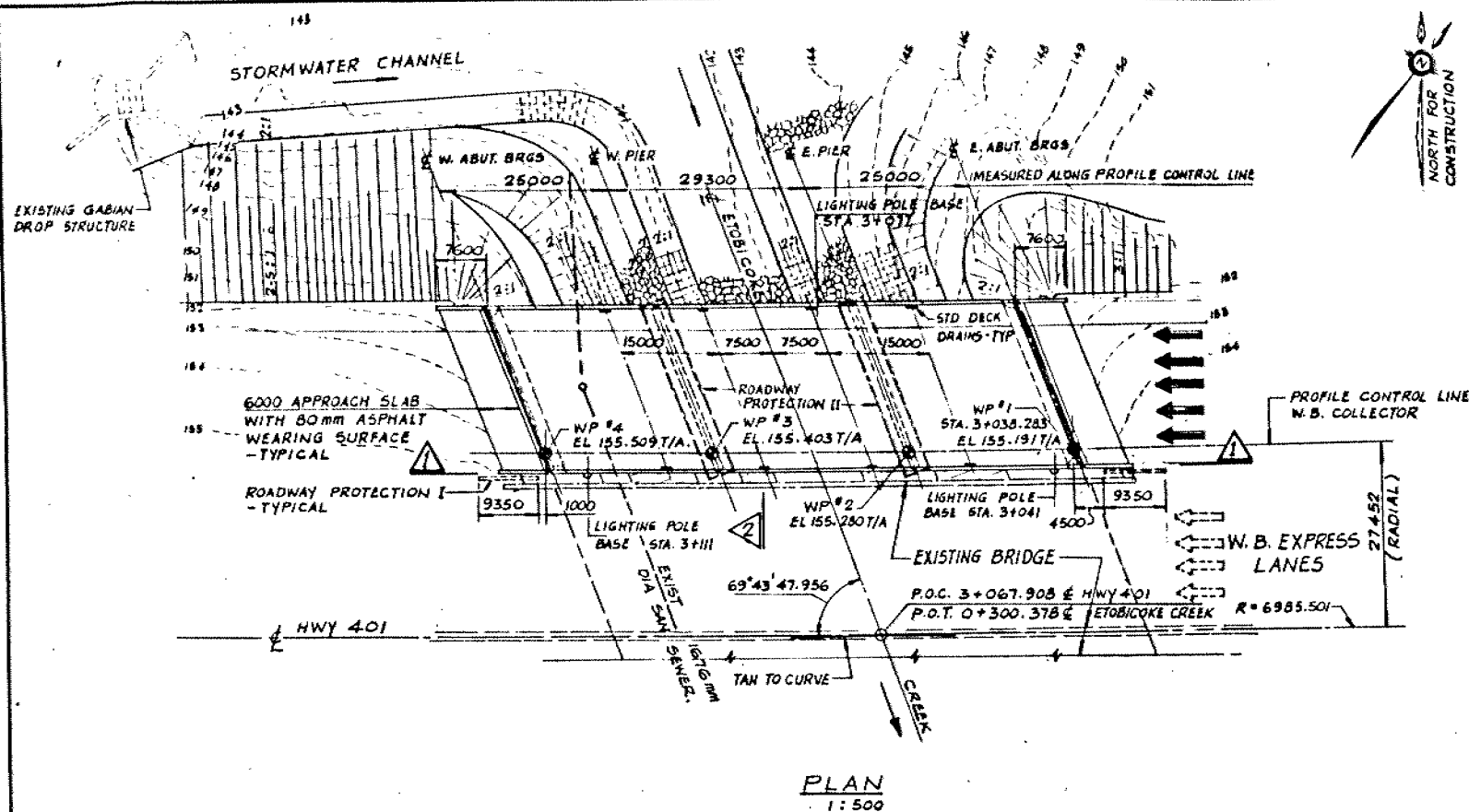
LOCATION Bridge #10, Hwy 401 ^{WB Collector over}
Etobicoke Creek

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

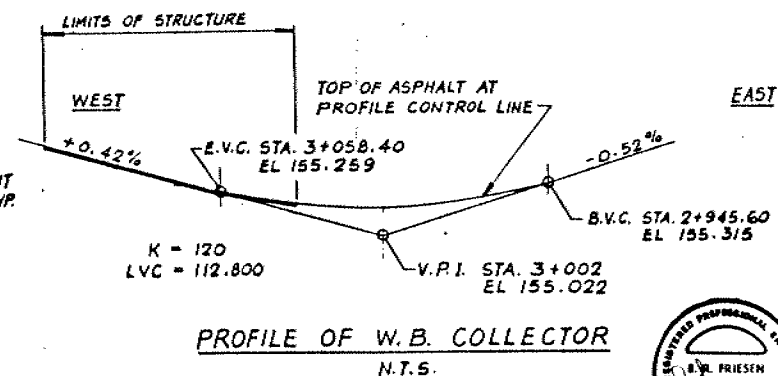
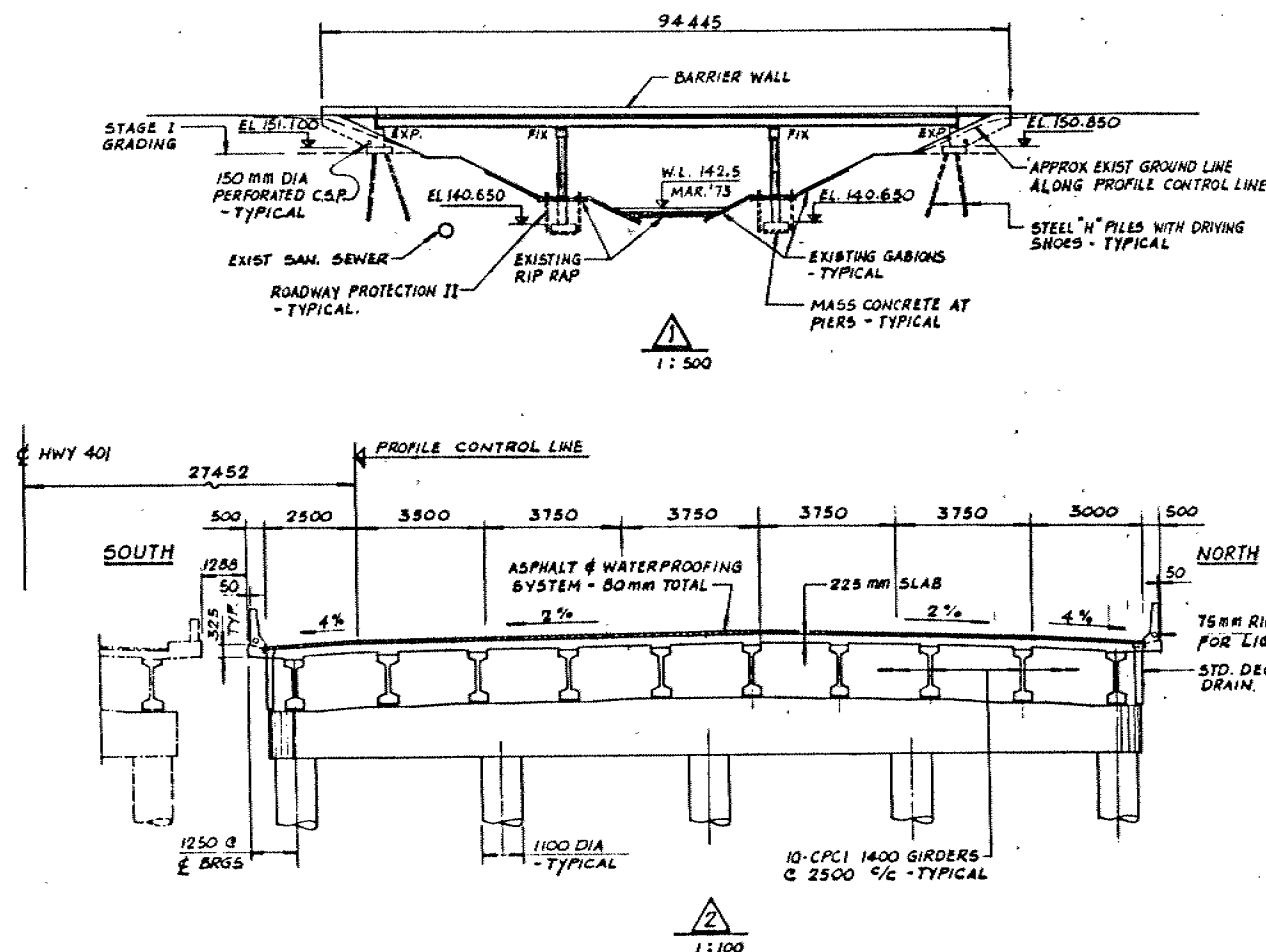
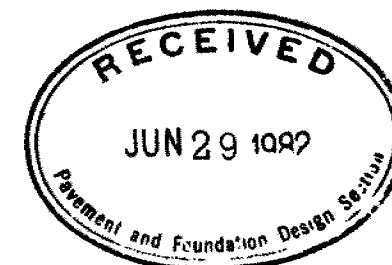
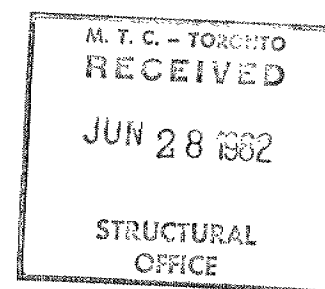
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS DETAIL DRAWING 104-B-1-145



METRIC

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

- NOTE
1. WIP DENOTES WORKING POINT
 2. T/A DENOTES TOP OF ASPHALT PAVEMENT
 3. SEE GRADING DNGS FOR LIMIT OF EXISTING AND PROPOSED CHANNEL PROTECTION.
 4. SEE GRADING DNGS FOR RESTORATION OF EXISTING RIP RAP AND CHANNEL PROTECTION.



DISTR. 6
CONT No
WP No 127-66-26



BRIDGE NO. 10 - HWY 401 W B
COLLECTOR OVER ETOBICOKE CREEK

SHEET

GENERAL ARRANGEMENT

DelCan
DE LEUWEATHER CANADA LTD
CONSULTING ENGINEERS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE
PRESTRESSED CONCRETE GIRDERS — 40 MPa
FOOTINGS & APPROACH SLABS — 20 MPa
REMAINDER — 30 MPa

REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLEAR COVER TO REINFORCING STEEL
FOOTINGS — 100 ± 25 mm
PIERS AND FRONT FACE OF ABUTMENTS — 80 ± 20 mm
AND WINGWALLS.
BOTTOM OF DECK — 40 ± 10 mm
REMAINDER — 70 ± 20 mm
UNLESS OTHERWISE NOTED

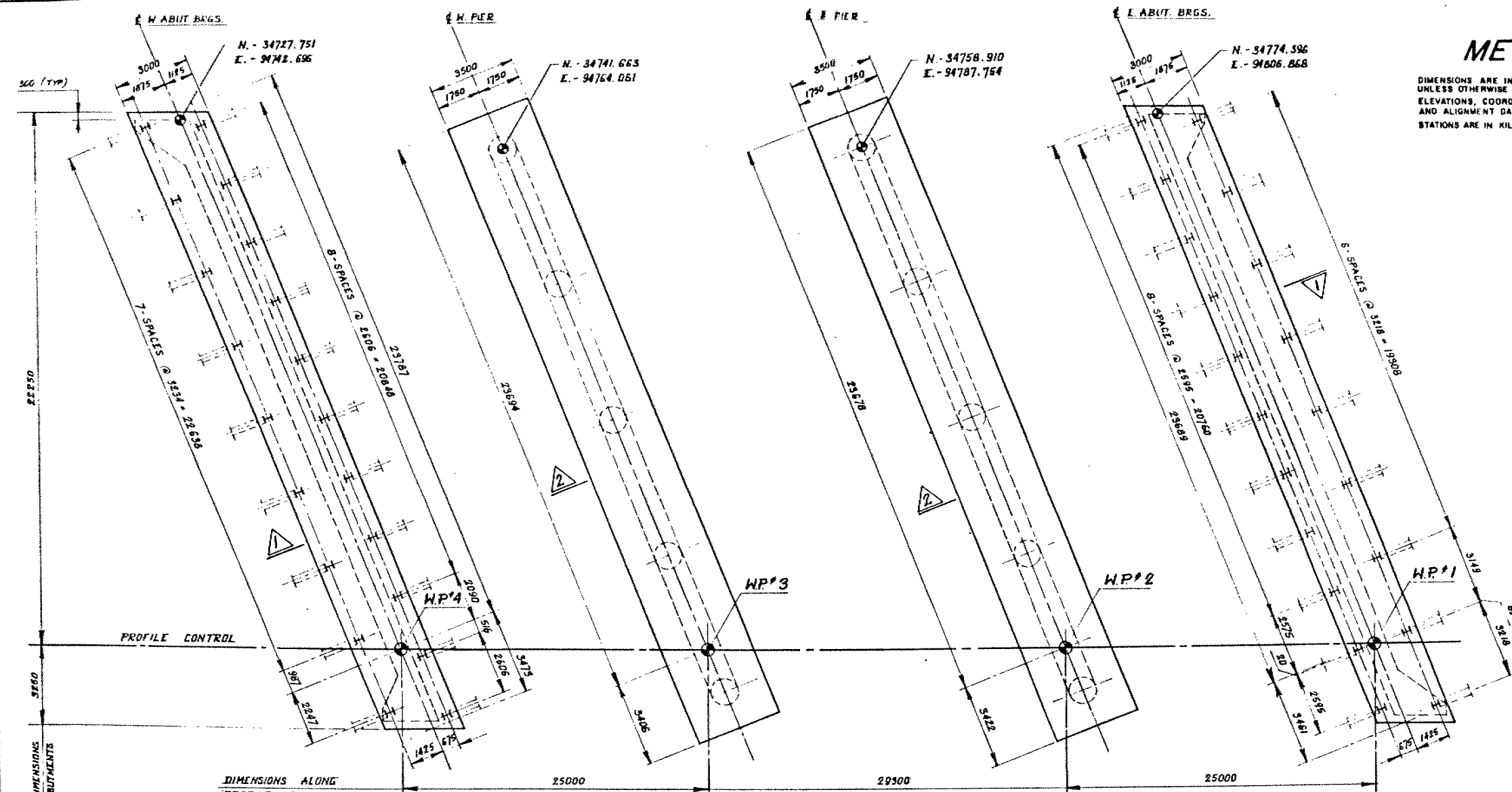
CONSTRUCTION NOTES
COMPACTED FILL, MAX GRAIN SIZE 75mm SHALL BE PLACED UP TO THE BOTTOM OF FOOTING ELEVATION PRIOR TO DRIVING PILES.
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3 mm.

LIST OF DRAWINGS

- 1 GENERAL ARRANGEMENT
- 2 BOREHOLE LOCATIONS & SOIL STRATA
- 3 FOUNDATION LAYOUT
- 4 FOOTING REINFORCEMENT
- 5 EAST ABUTMENT I
- 6 EAST ABUTMENT II
- 7 WEST ABUTMENT I
- 8 WEST ABUTMENT II
- 9 PIERS
- 10 PRESTRESSED GIRDERS & BEARINGS
- 11 DECK
- 12 BARRIER WALLS
- 13 6000 mm APPROACH SLAB
- 14 STANDARD DETAILS
- 15 BRIDGE DATE & SITE NUMBER DATA
- 16 AS CONSTRUCTED ELEVATIONS & DIMENSIONS
- 17 ROADWAY PROTECTION I
- 18 ROADWAY PROTECTION II
- 19 PILE DRIVING - DROP HAMMERS
- 20 PILE DRIVING - STEAM & DIESEL HAMMERS
- 21 ELECTRICAL EMBEDDED WORK
- 22 QUANTITIES - STRUCTURE
- 23 QUANTITIES - STRUCTURE

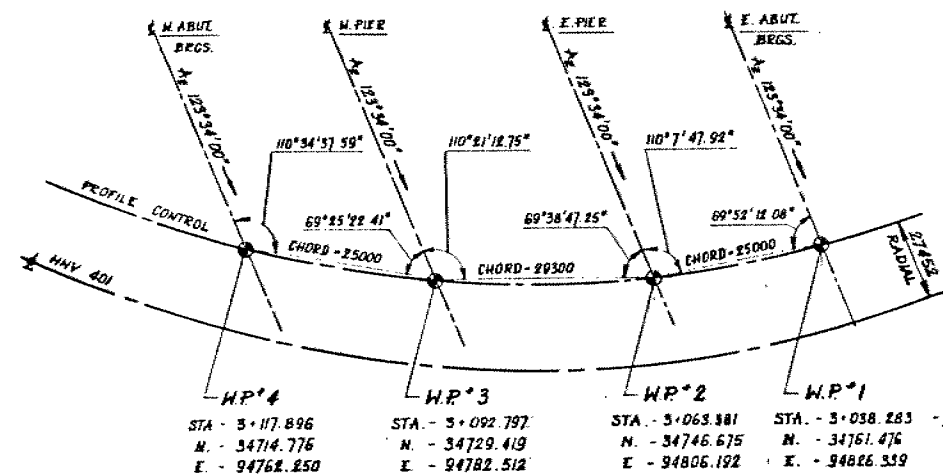
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN BRF	CHECK 666	LOADING ON BDC-A-79	DATE MAY 82
DRAWING DNG	CHECK 655	SITE 24-B-184C	DWG 1



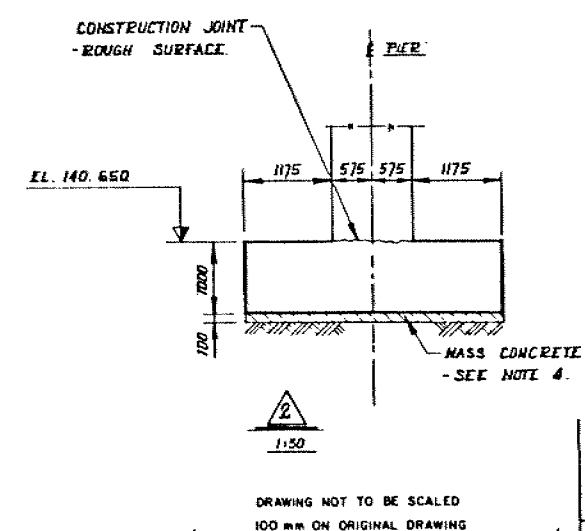
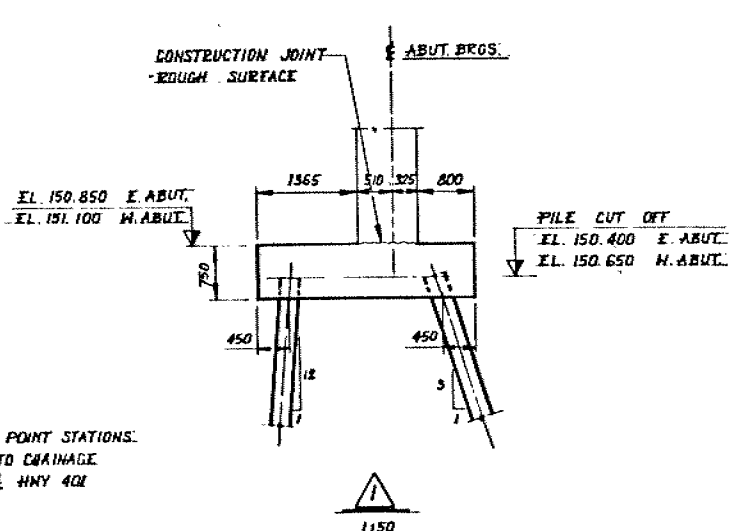
FOUNDATION PLAN

N.T.S.



LOCATION OF WORKING POINTS

N.T.S.



METRIC

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

CONT No
WP No 127-66-26

BRIDGE NO. 10 - HWY 401 W B
COLLECTOR OVER ETOBICOKE CREEK
FOUNDATION LAYOUT

DelCan DE LEUW LATHER CANADA LTD
CONSULTING ENGINEERS AND PLANNERS



SHEET

NOTES

1. PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 103-10 OR SS 103-11.
2. PILE DRIVING ENERGY SHALL DELIVER NOT LESS THAN 48 000 JOULES PER BLOW.
3. PILE SPACING TO BE MEASURED AT THE UNDERSIDE OF FOOTINGS.
4. MASS CONCRETE TO BE PLACED WITHIN 3 HOURS OF EXCAVATION FOR PIER FOUNDATIONS.

STEEL PILE DATA

LOCATION	N° REQD.	LGTH. mm	TYPE
EAST ABUTMENT	20	11000	HP 310 x 110 WITH DRIVING SHOES
WEST ABUTMENT	20	10700	

- PILE LENGTHS SHOWN ARE THEORETICAL LENGTH BELOW CUT OFF
- FOR DETAILS OF DRIVING SHOES SEE STANDARD DD 330L
- PILE DESIGN DATA
CAPACITY AT S.L.S. TYPE II - 1000 KN
FACTORED CAPACITY AT U.L.S. - 1650 KN
ULTIMATE CAPACITY - 3000 KN



REVISIONS	DATE	BY	DESCRIPTION
DESIGN R.D.P.	CHECK B.R.F.	LOADING CHWDC-A-75	DATE MAY 88
DRAWING M.K.	CHECK B.R.F.	SITE 24-81-1842	DWG 3

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

CONT No
WP No 127-66-26

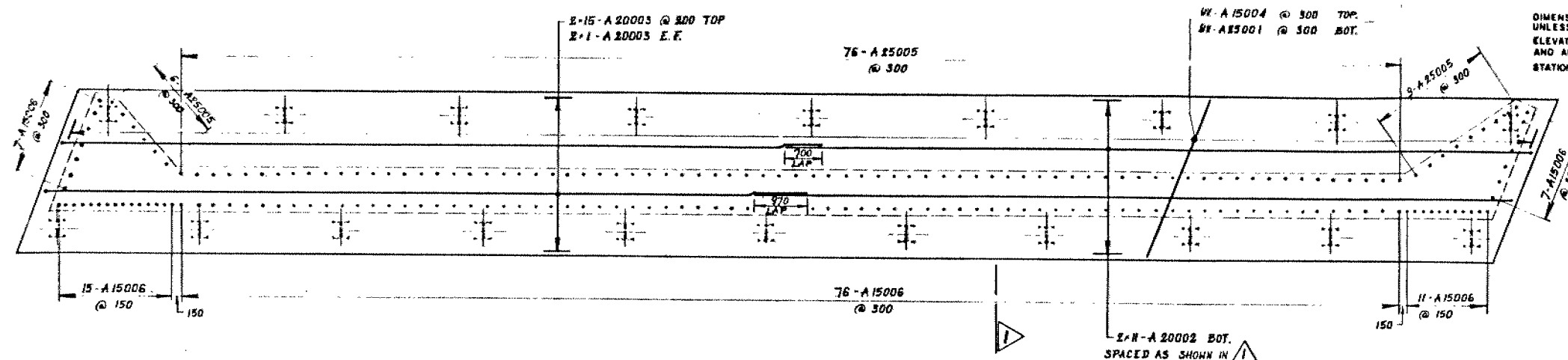
BRIDGE NO. 10-HWY 401 W B
COLLECTOR OVER ETOBICOKE CREEK
FOOTING REINFORCEMENT

DelCan
DE LEON CATHEN CANADA LTD
CONSULTING ENGINEERS AND PLANNERS

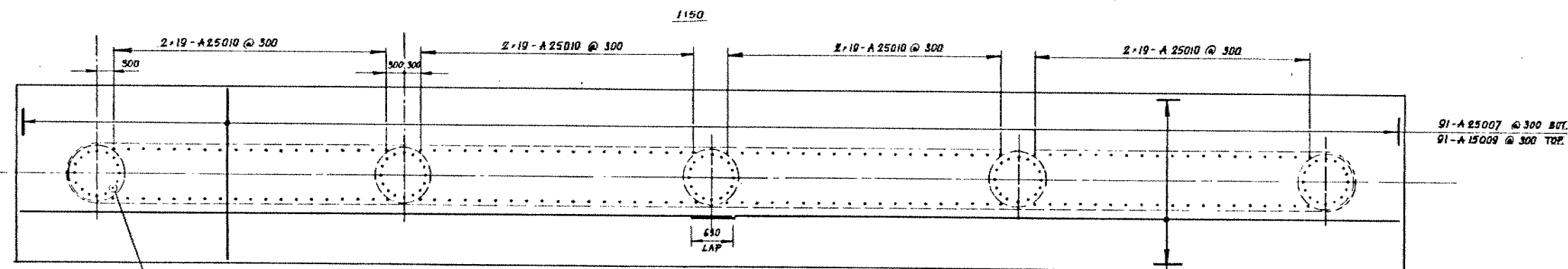
SHEET

NOTE

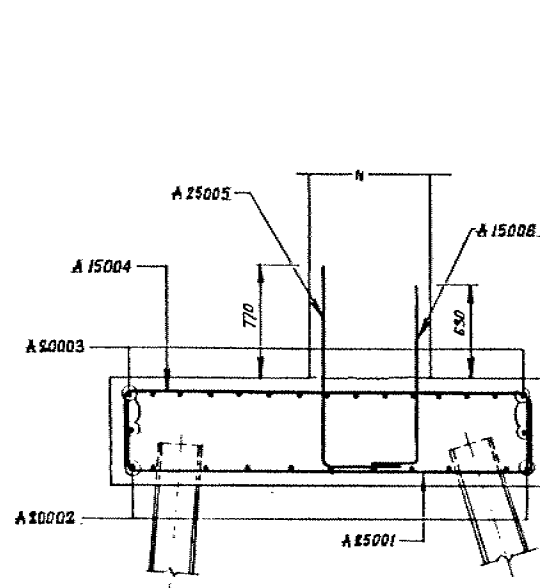
E.F. DENOTES EACH FACE.



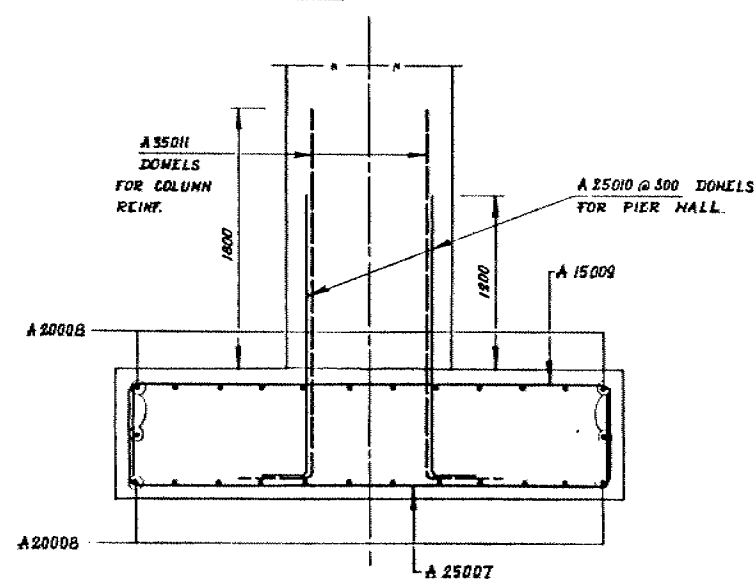
PLAN OF E. & W. ABUT. FTGS.



PLAN OF E. & W. PIER FTGS.



1:25



1:25

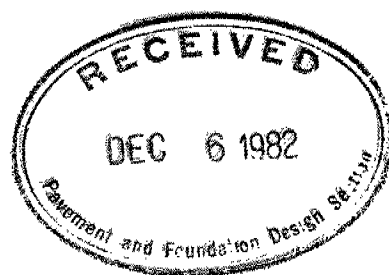
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REVISIONS	DATE	BY	DESCRIPTION
DESIGN R.D.P.	CHECK B.R.F.	LOADING CHBDC-A-79	DATE MAY 88
DRAWING M.E.	CHECK B.R.F.	SITE 24-81-184 C	DWG 4

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82 - 106



Ministry of
Transportation and
Communications

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<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3- 56	Foundation Investigation Reports For Highway 401 W.B. Collector Over Etobicoke Creek W.P. 127-66-26; Site 24-81-184C Highway 401 E.B. Collector Over Etobicoke Creek W.P. 127-66-27; Site 24-81-184D Highway 401 E.B. Core Over Etobicoke Creek W.P. 127-66-80; Site 24-81-184

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

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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

3

For

Bridge #10

Highway 401 W.B. Collector

Over Etobicoke Creek

W.P. 127-66-26, Site 24-81-184C

Hwy. 401, 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 in two stages:

- i) a total of 4 sampled borings (BH#13 to #16), all accompanied by dynamic cone penetration tests, were originally advanced between 73-03-06 and 73-03-21 as part of the field investigation for the existing Bridge #9, Hwy. 401 Core over Etobicoke Creek. Subsequently a Foundation Report was issued under W.P. 127-66-28 dated 73-05-29 and the bridge constructed under Contract 74-109. These borings ranged in depth from 6.1 to 9.5 metres, with bedrock being cored in all borings for a maximum depth 4.8 metres.
- ii) The second stage of the field investigation consisted of 4 sampled borings advanced between 82-01-15 and 82-01-21 for depths ranging from 5.5 to 14.1 metres. Bedrock was augered in all boreholes and cored in one for 1.2 metres.

SITE DESCRIPTION AND GEOLOGY

The area under investigation is located at the crossing of Hwy. 401 and Etobicoke Creek in the City of Mississauga, Regional Municipality of Peel. Topographically, the area can best be described as a broad plain with the Etobicoke Creek cutting deep into the overburden. The resulting valley is approximately 125 metres wide with a depth of 12.5 metres. The land is primarily used for farming purposes, with Toronto International Airport located immediately north of the site.

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 a cohesive glacial till whose thickness is quite variable. In the region, the Credit River, Oakville and Etobicoke Creeks have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

Subsurface Conditions

In general, the extent and composition of the overburden is uniform across the site. The predominate surficial deposit is a cohesive glacial till consisting of silty clay with sand and varying amounts of gravel extending for a maximum depth of 3.8 metres. Borings in the vicinity of the creek channel encountered a deposit ranging from a gravel to gravelly sand with fines for a maximum thickness of 2.9 metres. In boreholes put down through the approach embankments of the existing Etobicoke Creek Bridge, fill material up to 8.3 metres thick, composed of the parent glacial till material of the area was found to overly the till and/or shale bedrock. Weathered shale bedrock was encountered in all borings at elevations ranging from 140.1 to 141.9.

The boundaries between the various soil types as encountered at the time of investigation, 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 four estimated stratigraphical sections based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

It should be noted that boreholes 13 to 16 were completed prior to the construction of the existing Bridge #9 and hence do not necessarily represent the existing overburden conditions and bedrock surface after construction activities.

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

Embankment Fill Material

Borings advanced through the existing approach embankments indicate the fill material to be predominately derived from the parent glacial till of the area, consisting of a silty clay of low plasticity with sand and varying amounts of gravel. This fill was encountered for thickness ranging from 7.3 to 8.3 metres at the abutment locations, and some 2 metres at the pier locations during the recent field investigation. At one pier boring location the fill was found to consist of a compact to dense gravelly sand some silt and a trace of clay-sized particles, possibly originating from the creek alluvium which was identified in the early investigation in BH14 as a compact to very dense gravel with sand and some silty clay.

Typical grainsize distribution curves for the cohesive fill material are plotted in envelope form on Figure 1. Results of water content and Atterberg Limit testing on recent samples are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	13-19	16
Liquid Content	(W _L) %	26-31	28
Plastic Limit	(W _p) %	13-17	16
Plasticity Index (I _p) %		9-15	12

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

Based on Standard Penetration Test 'N' values generally averaging 8 to 10 blows/0.3 metre, it is estimated that the fill material has undergone a relatively moderate degree of compaction.

Silty Clay, Sand, and Gravel (Glacial Till)

The natural surficial deposit across the site is a glacial till composed of silty clay of low plasticity with sand and varying amounts of

gravel. As a result of previous construction activity, this till is often reworked and difficult to distinguish from the derived embankment fill material. Where identified, it ranges from 1.7 to 3.8 metres in thickness, and contains an increasing frequency of fragments and detached slabs of shale in it's lower portion.

Results of identity testing indicate the cohesive matrix of the till material to consist of a inorganic silty clay of low plasticity. Typical grain size distribution curves are shown on Figure 3.

Based on interpretation of 'N' values ranging 5 to 78 blows per 0.3 metres and augering operation, the consistency of this deposit ranges from firm to hard.

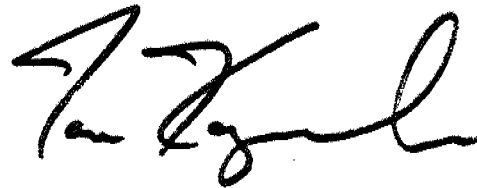
Bedrock

Bedrock surface was encountered immediately below the glacial till and embankment fill material at depths corresponding to elevations ranging from 140 to 141.4 during the recent investigation. These elevations closely relate to elevations of 140.1 to 141.9 encountered during the earlier investigation. The surface of bedrock appears to be relatively flat across the site and can be expected to exhibit minor undulations across the footing locations.

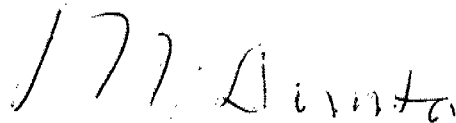
Based on visual examination of BXL rock cores, bedrock is described as a thin to medium bedded dark grey shale with occasional thin layers of limestone and silty limestone of the Dundas Formation. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock. The depth of weathering varied from 0.7 metres to in excess of 3 metres across the site.

Groundwater Conditions

Readings of stabilized water levels taken in open boreholes, indicate a water table ranging between elevations 141.6 and 142.6, but averaging an approx. elevation of 142.5 across the site during the recent investigation. This elevation roughly corresponds with the creek water level, and can be expected to fluctuate accordingly.



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



M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X



RECORD OF BOREHOLE No 1

METRIC 9

W P 127-66-26 LOCATION Co-ords. N 4 834 775.4; E 294 804.5 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 15 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
148.7	Ground Surface																
0.0	Fill		1	SS	20		148										
			2	SS	8												4-24-51-21
	Brown Grey		3	SS	10		146										
	Silty Clay With Sand Some Gravel Stiff to Very Stiff		4	SS	8												16-30-39-15
			5	SS	10		144										
			6	SS	11												
	Fragments and Detached Slabs of Shale		7	SS	16		142										30-28-30-12
141.4	Weathered		8	SS	110												
7.3	Shale Bedrock		9	SS	102	16 cm	140										
138.4	End of Borehole																
10.3																	

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC ¹⁰

W P 127-66-26 LOCATION Co-ords. N 4 834 754.5; E 294 791.3 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 18 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH				WATER CONTENT (%)				
143.7	Ground Surface							20	40	60	80	100				
0.0	(Fill)															
	Gravelly Sand		1	SS	38											31-40-22-7
	Some Silt															
	Trace of Clay															
141.7	Compact to Dense		2	SS	23		142									25-48-19-8
2.0	(Glacial Till) Brown		3	SS	11											24-35-28-13
	Silty Clay Grey															
	With Sand and		4	SS	8		140									
140.0	Gravel Stiff															
3.7	Grey		5	SS	57											
			6	SS	65	15 cm										
	weathered						138									
			7	SS	65	5 cm										
	Shale						136									
	Bedrock															
			BXL	REC												
133.6			8	RC	100%		134									
10.1	End of Borehole															

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



RECORD OF BOREHOLE No 3

METRIC ¹¹

W P 127-66-26 LOCATION Co-ords. N 4 834 733.2; E 294 776.6 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 21 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
143.8	Ground Surface												
0.0	Grey (Glacial Till) Silty Clay with Sand Varying amounts of Gravel												
	Hard		1	SS	46		142						47-27-20-6
	Fragments and detached Slabs of Shale		2	SS	43								
140.0			3	SS	68								14-22-50-14
3.8	Weathered Shale		4	SS	115		140						
	Bedrock		5	SS	46								
138.3													
5.5	End of Borehole												

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 4

METRIC 12

W P 127-66-26 LOCATION Co-ords. N 4 834 736.3; E 294 729.6 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 21 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 60 80 100									
								SHEAR STRENGTH							WATER CONTENT (%)		
149.0	Ground Surface																
0.0			1	SS	6		148										
	Grey		2	SS	28												
	Brown		3	SS	8												
	Fill		4	SS	9		146										
	Silty Clay		5	SS	8												
	with Sand		6	SS	6												
	Varying Amounts		7	SS	8		144										
	of Gravel																
	Firm																
			8	SS	69		142										
140.7	Detached Fragments and																
8.3	Slabs of Shale		9	SS	145		140										
	Grey		10	SS	100/	13 cm	138										
	Weathered		11	SS	100/	8 cm	136										
	Shale		12	SS	100/	5 cm											
	Bedrock																
134.9																	
14.1	End of Borehole																

RECORD OF BOREHOLE No 13

METRIC

13

W P 127-66-26 LOCATION Co-ords, N 4 834 711.4; E 294 765.4 ORIGINATED BY V.K.
 DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & EXL Rock Core COMPILED BY J.B.
 DATUM Geodetic DATE 73 03 06 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
144.5	Ground Surface											
0.0	Fill											
143.0	Silty Clay, Sand & Gravel, trace orgs. Stiff		1	SS	13							
1.5	(Glacial Till)		2	SS	5							
	Silty Clay, Sand and Gravel		3	SS	78							
140.9	Firm to Very Stiff		4	SS	100	13 cm						
3.6	Weathered Shale Bedrock Sound		5	RC EXL	90% REC							
138.4												
6.1	End of Borehole											

2, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14

METRIC ¹⁴

W P 127-66-26 LOCATION Co-ords. N 4 834 729.0; E 294 789.8 ORIGINATED BY V.K.
 DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
 DATUM Geodetic DATE 73 03 13 CHECKED BY JP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
143.0	Ground Surface									
0.0	Gravel With Sand and Some Silty Clay Compact to Very Dense		1	SS	27					
			2	SS	100	13 cm				
140.1			3	SS	100	5 cm				
2.9	Weathered Shale Bedrock Sound		4	AS	-					
			5	RC BXL	100% REC					
136.9										
6.1	End of Borehole									

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



RECORD OF BOREHOLE No 15

METRIC ¹⁵

W P 127-66-26 LOCATION Co-ords. N 4 834 742.2; E 294 811.1 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 73 03 14 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							
145.2	Ground Surface										
0.0	Fill Silty Clay Some Sand & Gravel Firm to Very Stiff	[Pattern]	1	SS	16						
142.8			2	SS	7						
2.4	(Glacial Till) Silty Clay, Sand and Gravel	[Pattern]	3	SS	50						24 19 41 16
140.6	Hard										
4.6	Weathered Shale Bedrock Sound	[Pattern]	4	RC BXL	30% REC						
			5	RC BXL	60% REC						
			6	RC BXL	98% REC						
136.7	End of Borehole										
8.5											



RECORD OF BOREHOLE No 16

METRIC 16

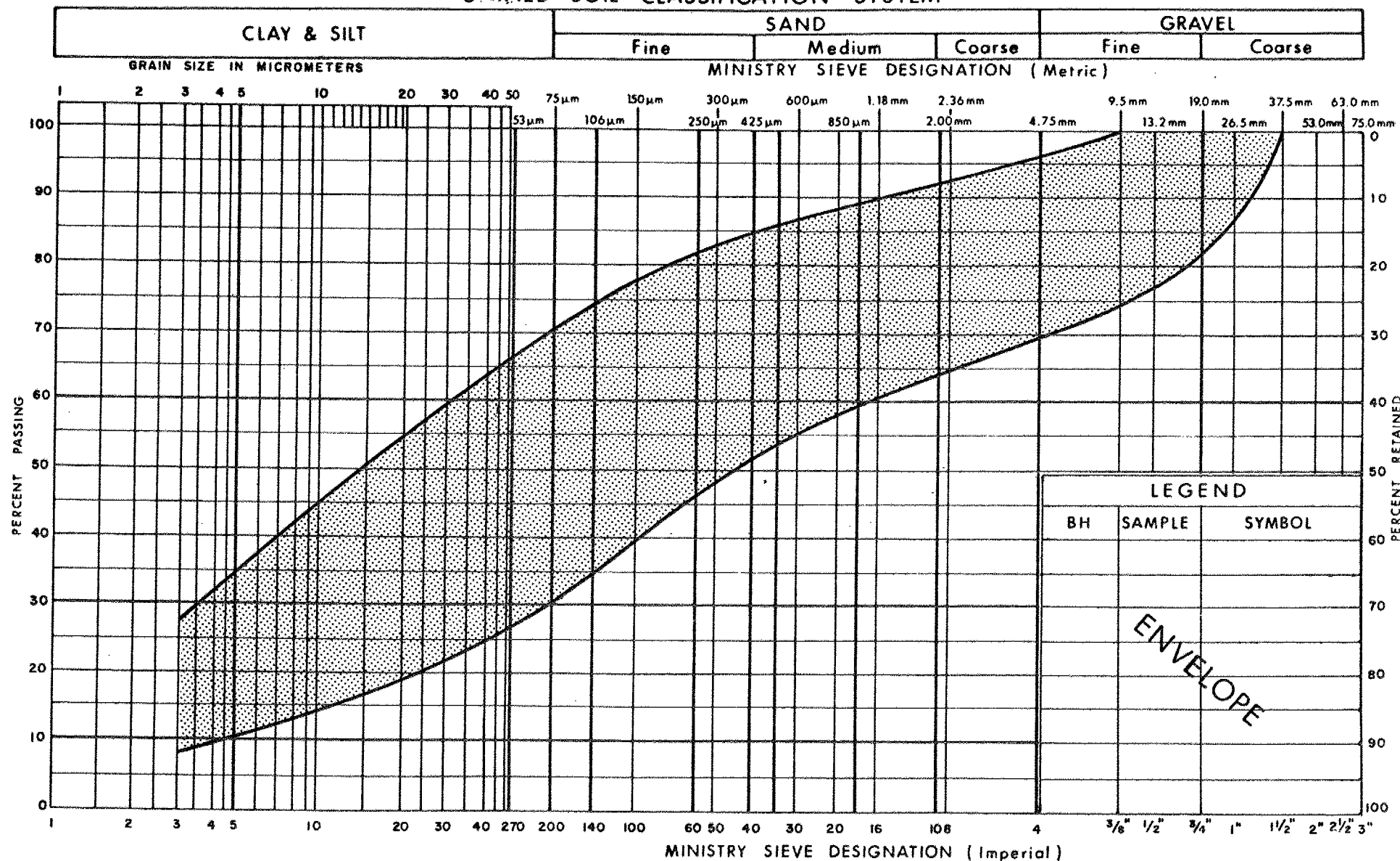
W P 127-66-26 LOCATION Co-ords. N 4 834 754.4; E 294 830.0 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger. Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 73 03 21 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
146.6	Ground Surface											
0.0	Fill Silty Clay with Sand Some Gravel trace of organics Firm to Stiff		1	SS	14	15 cm						17 55 21 7 6 29 46 19
			2	SS	9							
			3	SS	4							
			4	SS	6							
			5	SS	100/							
141.9	Weathered		6	RC BXL	21% REC	142						
4.7			7	RC BXL	45% REC	140						
			8	RC BXL	100% REC	138						
137.1	Shale Bedrock Sound											
9.5	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

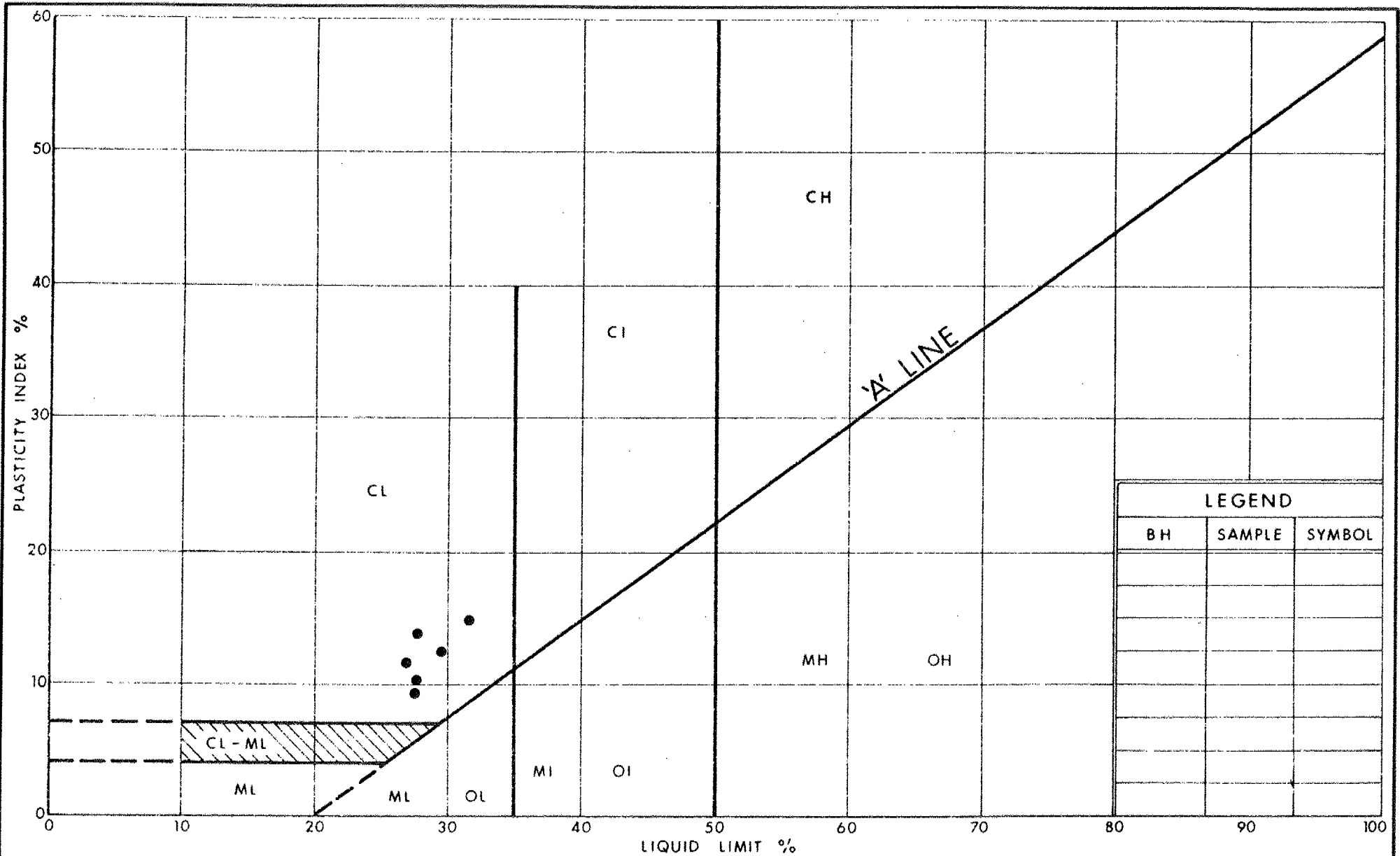
 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
(FILL)

SILTY CLAY WITH SAND & VARYING AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-26



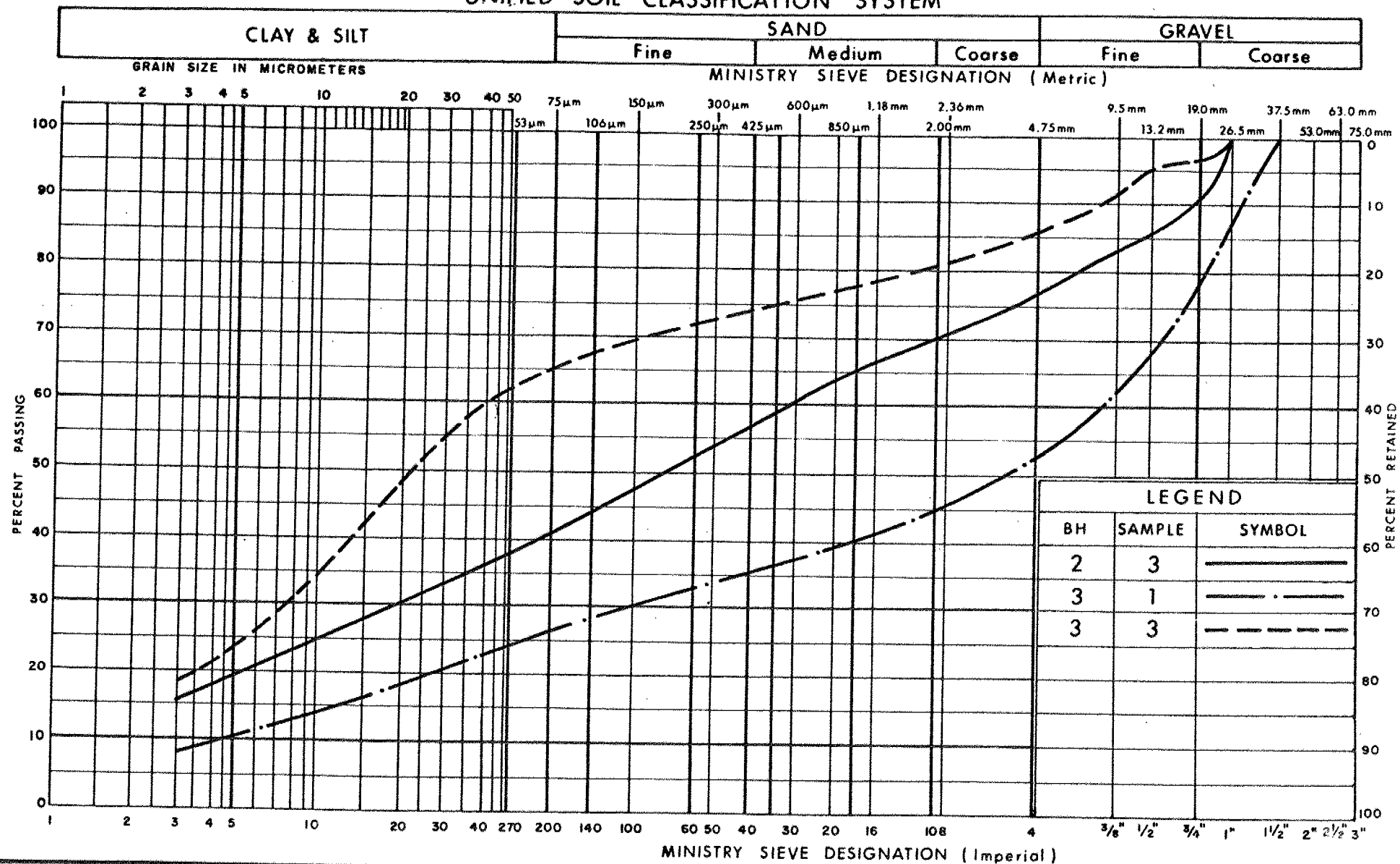
Ministry of
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Communications

PLASTICITY CHART
FILL (Reworked Glacial Till)
SILTY CLAY Matrix

FIG No 2

W P 127-66-26

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications

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

FIG No 3

W P 127-66-26

For
Bridge #8
Highway 401 E.B. Collector
Over Etobicoke Creek
W.P. 127-66-27, Site 24-81-184D
Hwy. 401, 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 in two stages:

- i) a total of 5 sampled borings (BH#1 to #4 and #21), four accompanied by dynamic cone penetration tests, were originally advanced between 73-03-01 and 73-11-14 as part of the field investigation for the existing Bridge #9, Hwy. 401 Core over Etobicoke Creek. Subsequently a Foundation Report was issued under W.P. 127-66-28 dated 73-05-29 and the bridge constructed under Contract 74-109. These borings ranged in depth from 4.6 to 13.1 metres, with bedrock being cored in all borings for a maximum depth 4.9 metres.
- ii) The second stage of the field investigation consisted of 4 sampled borings (BH #101 to #104) advanced between 82-01-13 and 82-01-22 for depths ranging from 5.6 to 19.7 metres. Bedrock was augered in all boreholes and cored in one for 2.3 metres.

SITE DESCRIPTION AND GEOLOGY

The area under investigation is located at the crossing of Hwy. 401 and Etobicoke Creek in the City of Mississauga, Regional Municipality of Peel. Topographically, the area can best be described as a broad plain with the Etobicoke Creek cutting deep into the overburden. The resulting valley is approximately 125 metres wide with a depth of 12.5 metres. The land is primarily used for farming purposes, with Toronto International Airport located immediately north of the site.

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 a cohesive glacial till whose thickness is quite variable. In the region, the Credit River, Oakville and Etobicoke Creeks have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

Subsurface Conditions

In general, the extent and composition of the overburden is uniform across the site. The predominate natural surficial deposit is a cohesive glacial till consisting of silty clay with sand and varying amounts of gravel extending for a maximum thickness of 5.1 metres during the recent investigation. Borings in the vicinity of the creek channel encountered a fluvial deposit composed of sand and gravel with fines for a maximum thickness of 3.1 metres during the initial investigation. In boreholes put down through the approach embankments of the existing Etobicoke Creek Bridge, fill material up to 10.1 metres thick, composed of the parent glacial till material of the area was found to overly the till and/or shale bedrock. Weathered shale bedrock was encountered in all borings at elevations ranging from 139.9 to 141.7.

The boundaries between the various soil types as encountered at the time of investigation, 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 four estimated stratigraphical sections based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

It should be noted that boreholes 1 to 4 and 21 were completed prior to the construction of the existing Bridge #9 and hence do not necessarily represent the existing overburden conditions and bedrock surface after construction activities.

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

Embankment Fill Material

Borings advanced through the existing approach embankments indicate the fill material to be predominately derived from the parent glacial till of the area, consisting of a silty clay of low plasticity with some sand and varying amounts of gravel. This fill was encountered for thicknesses ranging from 3.7 to 10.1 metres at the abutment locations, and some 1.2 metres at the pier locations during the recent field investigation.

Typical grainsize distribution curves for the cohesive fill material are plotted on Figure 1. Results of water content and Atterberg Limit testing on recent samples are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	13-20	15
Liquid Limit	(W _L) %	33-39	37
Plastic Limit	(W _p) %	16-20	18
Plasticity Index	(I _p) %	15-20	19

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

Based on Standard Penetration Test 'N' values generally averaging 10 to 12 blows/0.3 metre, it is estimated that the fill material has undergone a relatively moderate degree of compaction.

Silty Clay, Sand, and Gravel (Glacial Till)

The natural surficial deposit across the site is a glacial till composed of silty clay of low plasticity with sand and varying amounts of gravel. As a result of previous construction activity, this till is often reworked and difficult to distinguish from the overlying derived embankment fill material. Where identified in the recent investigation,

it ranges from 1.7 to 5.1 metres in thickness, and contains an increasing frequency of fragments and detached slabs of weathered shale and limestone in it's lower portion.

Results of identity testing of recent samples (plotted on the Plasticity Chart, Figure 3) indicate the cohesive matrix of the till material to consist of a inorganic silty clay of low plasticity (CL). Typical grain size distribution curves for this deposit are shown on Figure 4.

Based on interpretation of 'N' values ranging 14 to in excess of 100 blows per 0.3 metres and augering operations, the consistency of this deposit ranges from stiff to hard.

Sand and Gravel Alluvium

Three of the borings carried out for the initial investigation identified an alluvial deposit composed of sand and gravel with traces of silt and clay sized particles, ranging in thickness from 2.1 to 3.1 metres. Based on interpretation of 'N' values the denseness of this river deposit ranges from loose to dense. This material was not encountered in the recent investigation.

Bedrock


Bedrock surface was encountered immediately below the glacial till and embankment fill material at depths corresponding to elevations ranging from 140.5 to 140.8 during the recent investigation. These elevations closely relate to elevations of 139.9 to 141.7 encountered during the earlier investigation. The surface of bedrock appears to be relatively flat across the site and can be expected to exhibit minor undulations across the footing locations.

Based on visual examination of BXL rock cores, bedrock is described as a thin to medium bedded dark grey shale with occasional thin layers of limestone and silty limestone of the Dundas Formation. 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 badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock. The depth of weathering varied from 0.7 metres to in excess of 3 metres across the site.

Groundwater Conditions

Readings of stabilized water levels taken in open boreholes, indicate a water table ranging between elevations 140.9 and 142.1. This elevation roughly corresponds with the creek water level, and can be expected to fluctuate accordingly.



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



M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X

RECORD OF BOREHOLE No 1

METRIC ²⁶

W P 127-66-27 LOCATION Co-ords. N 4 834 665.4; E 294 832.4 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test and BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 01 CHECKED BY *JP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
144.0	Ground Surface												
0.0	Sand and Gravel traces of Silty Clay Loose to Compact		1	SS	5								
	Shale —		2	SS	11								
140.9	Shale — Fragments		3	SS	100	15 cm							
3.1	Grey		4	RC BXL	47% REC								
	Weathered		5	RC BXL	99% REC								
	Shale Bedrock		6	RC BXL	100% REC								
137.3													
6.7	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC 27

W P 127-66-27 LOCATION Co-ords. N 4 834 682.1; E 294 853.8 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 02 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
143.4	Ground Surface												
0.0	Sand and Gravel traces of Silt		1	SS	21								
	Compact		2	SS	16								
140.7			3	SS	160	25 cm							
2.7	Weathered		4	AS	-								
	Shale Bedrock Sound		5	RC BXL	100% REC								
			6	RC BXL	100% REC								
135.8													
7.6	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

METRIC 28

W P 127-66-27 LOCATION Co-ords. N 4 834 699.5; E 294 876.6 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 07 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
143.5	Ground Surface												
0.0	(Glacial Till)												
	Silty Clay, with												
	Sand and Gravel												
141.7	Hard		1	SS	34		142						
1.8	Grey Shale		2	BXL	45%								
	Bedrock		3	RC	17%								
			4	BXL	REC		140						
	Weathered		5	RC	36%								
	Intact			BXL	REC								
137.8				RC	94%		138						
				BXL	REC								
5.7	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC 29

W P 127-66-27 LOCATION Co-ords, N 4 834 715.7; E 294 898.6 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
150.3	Ground Surface													GR SA SI CL
0.0	Fill						150							
148.8	Silty Clay, traces of Sand, Gravel & organics Stiff		1	SS	8		148							5 31 53 11
1.5	(Glacial Till) Silty Clay, Sand and Gravel Very Stiff to Hard		2	SS	27									
			3	SS	77									
			4	SS	79									
			5	SS	100	15 cm	146							15 37 43 5
			6	SS	100	13 cm								
	with detached slabs and fragments of weathered Shale and Limestone		7	SS	100	10 cm	144							
			8	SS	100	8 cm								
			9	SS	100	10 cm	142							
139.9							140							
10.4	Grey		10	RC BXL	25% REC									
	Weathered Shale Bedrock		11	RC BXL	77% REC		138							
137.2														
13.1	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 21

METRIC 30

W P 127-66-27 LOCATION Co-ords. N 4 834 692.2; E 294 838.2 ORIGINATED BY J.B.
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger & Rock Core COMPILED BY J.B.
 DATUM Geodetic DATE 1973 11 14 CHECKED BY CP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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		
143.0	Ground Surface																
0.0	Sand and Gravel trace of Silt Compact to Dense		1	SS	26												
140.9			2	SS	38												
2.1	Grey Weathered Shale Bedrock occ. bands of Limestone		3	SS	100	13 cm											
			4	SS	50	5 cm											
138.4			5	RC	70%												
4.6	End of Borehole																



RECORD OF BOREHOLE No 101

METRIC 31

W P 127-66-27 LOCATION Co-ords. N 4 834 697.7; E 294 910.0 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 13 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						x LAB VANE	W _p	W
149.3	Ground Surface							20	40	60	80	100						
0.0	Fill (Reworked Glacial Till) Silty Clay some Sand trace of Gravel stiff to very stiff		1	SS	10		148								7 19 40 34			
			2	SS	11													
			3	SS	10													
145.6			4	SS	17		146											
3.7	Grey (Glacial Till) Silty Clay some Sand trace of Gravel with fragments of Shale and Limestone Hard		5	SS	40													
			6	SS	49													
			7	SS	60		144											
			8	SS	53		142											
140.5			9	SS	100/5 cm		140											
8.8	Grey		10	SS	100/15 cm		138											
	Weathered Shale Bedrock occasional thin layers of Limestone		11	RC EXL	REC 98%													
135.6			12	RC	REC 100%		136											
13.7	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

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



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RECORD OF BOREHOLE No 102

METRIC 32

W P 127-66-27 LOCATION Co-ords. N 4 834 690.0; E 294 888.6 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 20 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
143.6	Ground Surface												
0.0	(Glacial Till) Silty Clay with Sand, trace of Gravel stiff to very stiff		1	SS	15								9 28 39 24
	Brown		2	SS	14								
140.5	Shale fragments		3	SS	24								
3.1	Grey Shale Bedrock		4	SS	48								
			5	SS	41								
			6	SS	63								
	Weathered												
	occ. thin layers of Limestone		7	SS	100/0 cm								
135.7													
7.9	Refusal to augers on intact bedrock. End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 103

METRIC 33

W P 127-66-27 LOCATION Co-ords. N 4 834 688.2; E 294 844.3 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 21 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100				
143.6	Ground Surface														
0.0	Fill														
142.4	Reworked Till and Concrete Slabs														
1.2	(Glacial Till)														
	Silty Clay with Sand and Shale fragments		1	SS	26										
140.7	Very Stiff to Hard		2	SS	127										
2.9	Grey		3	SS	130										
	Weathered Shale Bedrock		4	SS	120	18 cm									
			5	SS	100	9 cm									
138.0															
5.6	Refusal to Augers on intact bedrock. End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 104

METRIC 34

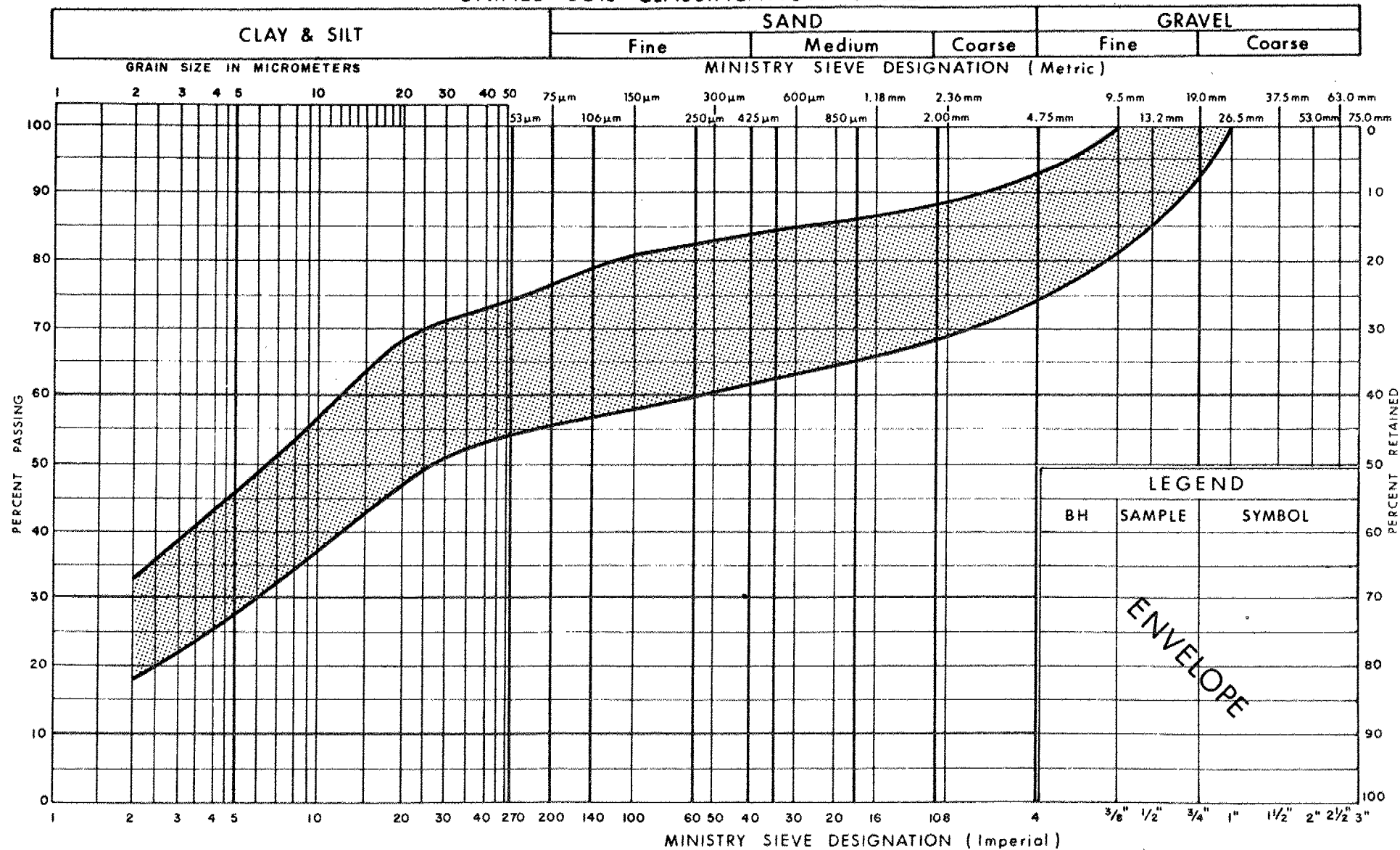
W P 127-66-27 LOCATION Co-ords. N 4 834 668.8; E 294 811.7 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
154.1	Ground Surface																
0.0	Fill (Reworked glacial till) Silty Clay, some Sand varying amounts of Gravel		1	SS	7	*	154										
			2	SS	11		152										26 18 38 18
			3	SS	67												
			4	SS	12												
	Angular Shale and Limestone fragments		5	SS	11		150										24 12 39 25
	Firm to very stiff		6	SS	19												
			7	SS	14		148										11 13 43 33
			8	SS	27		146										
			9	SS	29												19 20 38 23
144.0	(Glacial Till) Silty Clay, some Sand varying amounts of Gravel		10	SS	43		144										
	Very stiff to Hard		11	SS	28		142										
140.8	Grey		12	SS	126/20 cm		140										
13.3	Weathered Shale Bedrock with thin layers of Limestone		13	SS	110/13 cm		138										
			14	SS	100/8 cm		136										
134.4	End of Borehole																
19.7	* Note: W.L. not established																

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

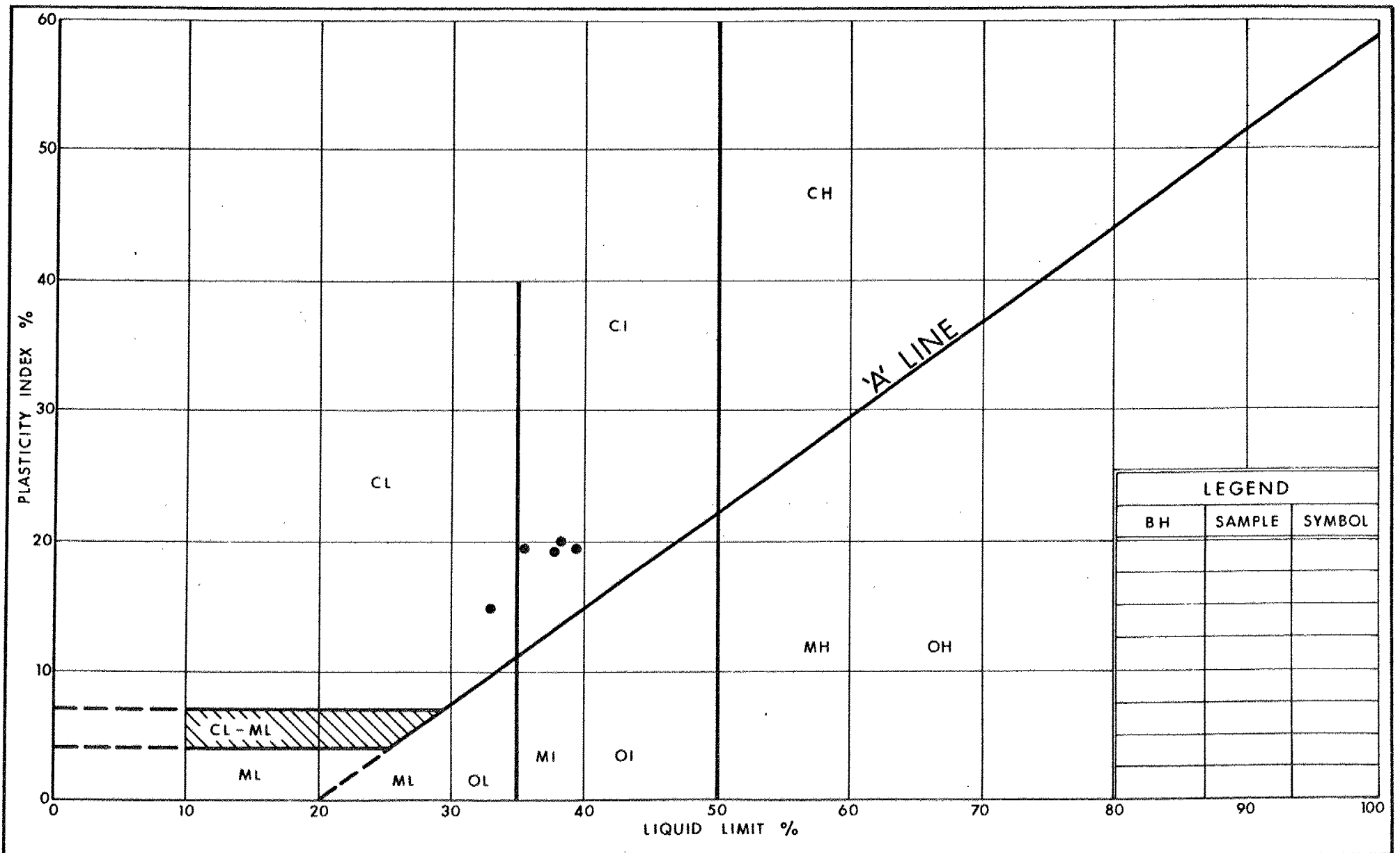


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GRAIN SIZE DISTRIBUTION
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-27

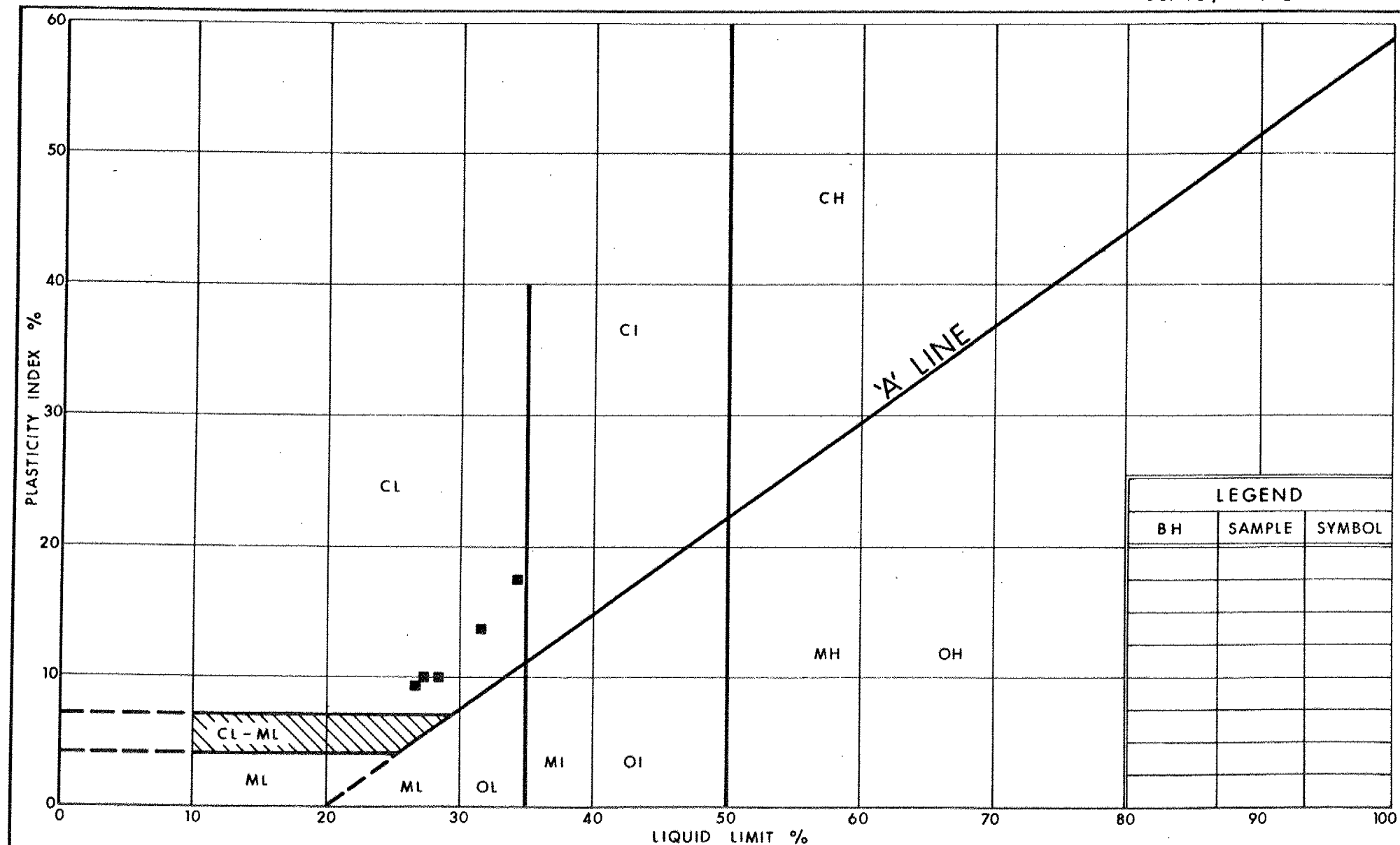


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PLASTICITY CHART
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 2

W P 127-66-27



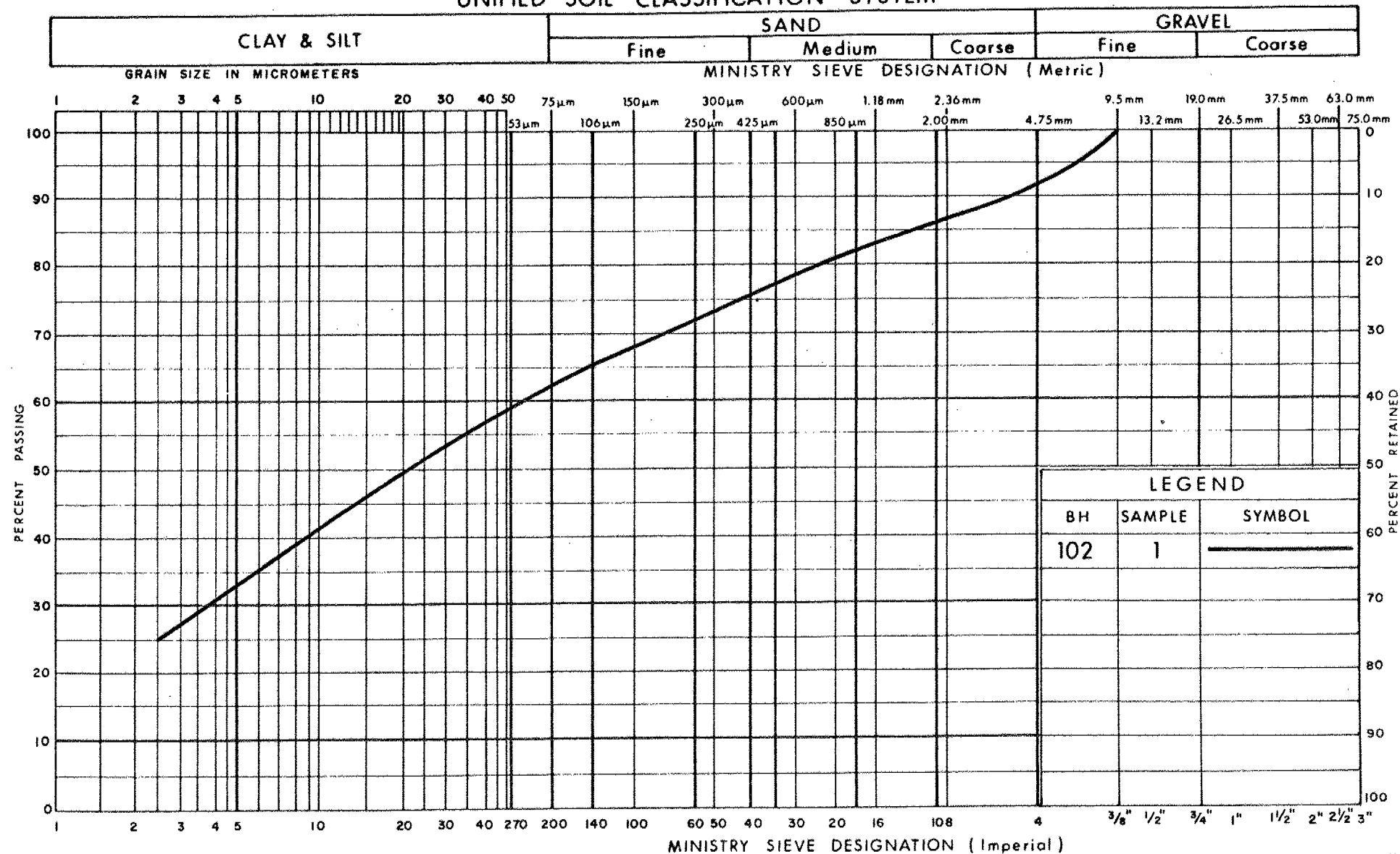
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PLASTICITY CHART Glacial Till - SILTY CLAY Matrix

FIG No 3

WP 127-66-27

UNIFIED SOIL CLASSIFICATION SYSTEM



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

FIG No 4

W P 127-66-27

For
Bridge #9 Widening
Highway 401 E.B. Core
Over Etobicoke Creek
W.P. 127-66-80, Site 24-81-184
Hwy. 401, 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 in two stages:

- i) a total of 5 sampled borings (BH# 5, 7, 8, 21, and 22), three accompanied by dynamic cone penetration tests, were originally advanced between 73-03-02 and 73-11-14 as part of the field investigation for the existing Bridge #9, Hwy. 401 Core over Etobicoke Creek. Subsequently a Foundation Report was issued under W.P. 127-66-28 dated 73-05-29 and the bridge constructed under Contract 74-109. These borings ranged in depth from 4.4 to 13.6 metres, with bedrock being cored in all borings for a maximum depth 4.2 metres.
- ii) The second stage of the field investigation consisted of 3 sampled borings (BH# 104, 201, and 202) advanced between 82-01-15 and 82-01-22 for depths ranging from 10.5 to 19.7 metres. Bedrock was augered in all boreholes and cored in one for 1.5 metres.

SITE DESCRIPTION AND GEOLOGY

The area under investigation is located at the crossing of Hwy. 401 and Etobicoke Creek in the City of Mississauga, Regional Municipality of Peel. Topographically, the area can best be described as a broad plain with the Etobicoke Creek cutting deep into the overburden. The resulting valley is approximately 125 metres wide with a depth of 12.5 metres. The land is primarily used for farming purposes, with Toronto International Airport located immediately north of the site.

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 a cohesive glacial till whose thickness is quite variable. In the region, the Credit River, Oakville and Etobicoke Creeks have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

Subsurface Conditions

In general, the extent and composition of the overburden is uniform across the site. The predominate surficial deposit is a cohesive glacial till consisting of silty clay with sand and varying amounts of gravel extending for a maximum depth of 9.0 metres. Borings for the initial investigation in the vicinity of the creek channel encountered an alluvial deposit ranging from a silty sand to sand and gravel with fines for a maximum thickness of 2.1 metres. In boreholes put down through the approach embankments of the existing Etobicoke Creek Bridge, fill material up to 10.1 metres thick, composed of the parent glacial till material of the area was found to overly the till and/or shale bedrock. Weathered shale bedrock was encountered in all borings at elevations ranging from 140.1 to 141.0.

The boundaries between the various soil types as encountered at the time of investigation, 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 stratigraphical sections based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

It should be noted that boreholes 5, 7, 8, 21, and 22 were completed prior to the construction of the existing Bridge #9 and hence do not necessarily represent the existing overburden conditions and bedrock surface after construction activities.

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

Embankment Fill Material

Borings advanced through the existing approach embankments indicate the fill material to be predominately derived from the parent glacial till of the area, consisting of a silty clay of low to intermediate plasticity with sand and varying amounts of gravel. This fill was encountered for thickness ranging from 2.9 to 10.1 metres at the abutment locations, and some 1.5 to 2.1 metres at the pier locations.

Three pier location borings advanced during the initial investigation identified a surficial alluvium consisting of compact to dense sand and gravel, trace of silt to a loose silty sand some gravel extending for a maximum depth of 2.1 metres. This alluvial deposit was not encountered in any of the recent borings at the site.

Typical grainsize distribution curves for recent representative samples of the cohesive fill material are plotted in envelope form on Figure 1. Results of water content and Atterberg Limit testing on recent samples are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	13-21	16
Liquid Content	(W _L) %	27-41	35
Plastic Limit	(W _p) %	15-19	17
Plasticity Index (I _p) %		11-21	18

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

Based on Standard Penetration Test 'N' values generally averaging 10 to 20 blows/0.3 metre, it is estimated that the fill material has undergone a relatively moderate degree of compaction.

Silty Clay, Sand, and Gravel (Glacial Till)

The natural surficial deposit across the site is a glacial till composed of silty clay of low plasticity with sand and varying amounts of gravel. As a result of previous construction activity, this till is often reworked and difficult to distinguish from the derived embankment fill material. Where identified, it ranges from 0.7 to 1.6 metres thick at the pier locations and 3.1 to 9.0 metres at the abutment locations, and contains an increasing frequency of fragments and detached slabs of shale in its lower portion.

Results of index testing on recent samples (plotted on Fig. 3) indicate the cohesive matrix of the till material to consist of a inorganic silty clay of low plasticity which agrees with the original findings. Typical grain size distribution curves for this deposit are shown on Figure 4.

Based on interpretation of 'N' values ranging from 14 to in excess of 100 blows/0.3 metres and augering operations, the consistency of this deposit ranges from stiff to hard.

Bedrock

Bedrock surface was encountered immediately below the glacial till deposit at depths corresponding to elevations ranging from 140 to 141.0 during the recent investigation. These elevations closely relate to elevations of 140.1 to 141.0 encountered during the earlier investigation. The surface of bedrock appears to be relatively flat across the site and can be expected to exhibit minor undulations across the footing locations.

Based on visual examination of BXL rock cores, bedrock is described as a thin to medium bedded dark grey shale with occasional thin layers of limestone and silty limestone of the Dundas Formation. 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 badly weathered zone of shale near the top

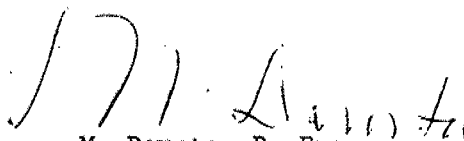
of bedrock grades through a zone of moderate weathering into intact bedrock. The depth of weathering varied from 0.9 metres to 3 metres across the site.

Groundwater Conditions

Readings of stabilized water levels taken in open boreholes, indicate a water table ranging between elevations 141.9 and 149.5 across the site, but averaging an approximate elevation of 142.5 in the vicinity of the creek during the recent investigation. This elevation roughly corresponds with the creek water level, and can be expected to fluctuate accordingly.



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



M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X



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RECORD OF BOREHOLE No 5*

METRIC 45

W P 127-66-80 LOCATION Co-ords. N 4 834 683.3; E 294 805.3 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 02 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
144.1	Ground Surface												
0.0	Topsoil (Glacial Till)												
	Silty Clay, Sand and Gravel		1	SS	21								
	Stiff to Hard		2	SS	14								
			3	SS	56								
140.4	Grey		4	SS	100	15 cm							
3.7	Weathered Shale Bedrock		5	RC BXL	96% REC								
138.1	End of Borehole												
6.0													
	* Note: This borehole completed prior to Bridge #9 construction, and does not neces- sarily represent existing subsurface conditions.												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 7 *

METRIC 46

W P 127-66-80 LOCATION Co-ords. N 4 834 716.9; E 294 851.0 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & EXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 09 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
143.3	Ground Surface												
0.0	Silty Sand some Gravel Loose		1	SS	6		142						
141.8	(Glacial Till)		2	SS	17								
1.5	Silty Clay, Sand and Gravel, Very Stiff		3	SS	100/5		140						
140.2			4	AS	-								
3.1	Weathered Shale Bedrock		5	RC EXL	74% REC		138						
			6	RC EXL	96% REC								
136.0	End of Borehole												
7.3	* Note: This borehole completed prior to Bridge #9 construction, and does not necessarily represent existing subsurface conditions.												

+3, x5: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No 8*

METRIC 47

W P 127-66-80 LOCATION Co-ords. N 4 834 734.6; E 294 876.3 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & AXT Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 16 CHECKED BY GP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
150.6	Ground Surface													
0.0	Fill													
149.1	Silty Clay, some Sand & Gravel, trace of Organics Stiff		1	SS	10		150							
1.5	(Glacial Till)		2	SS	44		148							
	Silty Clay with Sand and Gravel		3	SS	100/13	cm	146							
	Detached Slabs and Fragments of Weathered Shale and Limestone		4	SS	100/5	cm	144							
	Hard		5	SS	100/13	cm	142							
			6	SS	100/15	cm	140							
			7	SS	160/8	cm	138							
			8	SS	100/13	cm								
			9	SS	100/8	cm								
140.1			10	RC	17%									
10.5	Weathered Shale Bedrock		11	AXT	REC									
			12	RC	93%									
137.0				AXT	REC									
13.6	End of Borehole													
<p>* Note: This borehole completed prior to Bridge #9 construction, and does not necessarily represent existing subsurface conditions.</p>														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 21 *

METRIC 48

W P 127-66-80 LOCATION Co-ords. N 4 834 692.2; E 294 838.2

ORIGINATED BY J.B.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger & Rock Core

COMPILED BY J.B.

DATUM Geodetic DATE 1973 11 14

CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
143.0	Ground Surface												
0.0	Sand and Gravel trace of Silt Compact to Dense		1	SS	26		142						
140.9			2	SS	38								
2.1	Grey Weathered Shale Bedrock occ. bands of Limestone		3	SS	100/113	cm	140						
			4	SS	50/5	cm							
138.4			5	RC	70% REC								
4.6	End of Borehole												
* Note: This borehole completed prior to Bridge #9 construction, and does not necessarily represent existing subsurface conditions.													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

METRIC 49

DATUM Geodetic DATE 1973 11 14 CHECKED BY [Signature]

* Note: This borehole completed prior to Bridge #9 construction, and does not necessarily represent existing subsurface conditions.

15 ϕ 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 104

METRIC 50

W P 127-66-80 LOCATION Co-ords, N 4 834 668.8; E 294 811.7
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers ORIGINATED BY V.P.
DATUM Geodetic DATE 82 01 22 COMPILED BY V.P.
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						60	80	100
								SHEAR STRENGTH							WATER CONTENT (%)		
154.1	Ground Surface																
0.0	Fill (Reworked glacial till) Silty Clay, some Sand varying amounts of Gravel		1	SS	7												
			2	SS	11												
			3	SS	67												
			4	SS	12												
			5	SS	11												
	Angular Shale and Limestone fragments		6	SS	19												
	Firm to very stiff		7	SS	14												
			8	SS	27												
			9	SS	29												
144.0	(Glacial Till) Silty Clay, some Sand varying amounts of Gravel		10	SS	43												
	Very Stiff to Hard		11	SS	28												
140.8																	
13.3	Grey		12	SS	126/20 cm												
			13	SS	110/13 cm												
	Weathered																
	Shale Bedrock with thin layers of Limestone		14	SS	100/8 cm												
134.4																	
19.7	End of Borehole																
	* Note: W.L. not established																

RECORD OF BOREHOLE No 201

METRIC 51

W P 127-66-80 LOCATION Co-ords. N 4 834 725.5; E 294 871.0 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 14 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
149.7	Ground Surface												
0.0	Fill (Reworked Till) Silty Clay some Sand trace of Gravel Stiff		1	SS	10								
			2	SS	10								
146.8			3	SS	12								6 14 48 32
2.9	(Glacial Till) Silty Clay, some Sand and varying amounts of Gravel		4	SS	59								30 18 36 16
			5	SS	28								
			6	SS	49								36 29 27 8
	Detached slabs and fragments of Shale and Limestone		7	SS	116								
	Very stiff to Hard		8	SS	102								
141.0													
8.7	Grey Weathered Shale Bedrock		9	SS	95								
138.6			10	SS	101								
11.1	Refusal to augers on intact bedrock End of Borehole												

+3, x5: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 202

METRIC 52

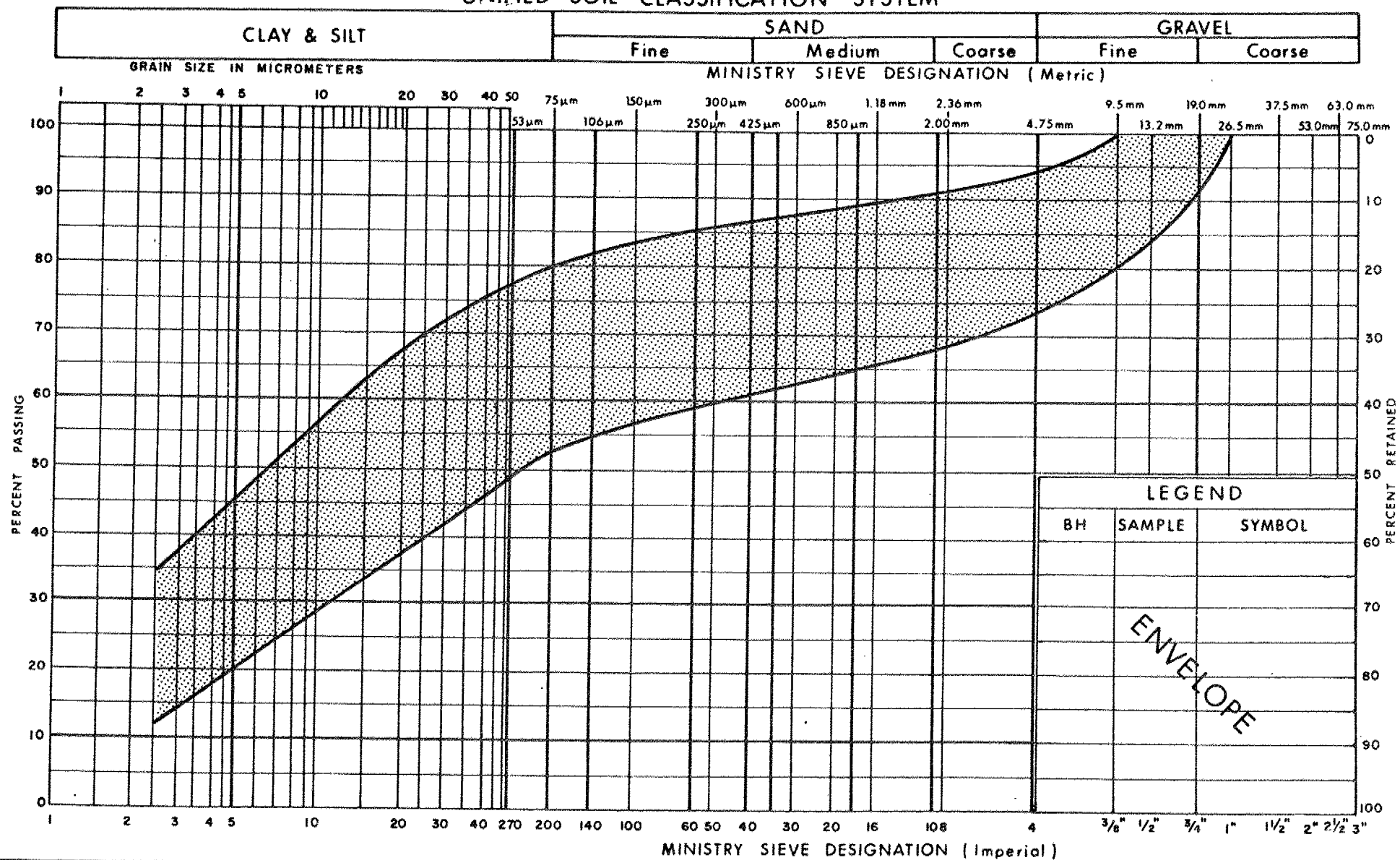
W P 127-66-80 LOCATION Co-ords. N 4 834 711.7; E 294 853.0 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 20 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
143.8	Ground Surface																
0.0	Fill (Reworked Till) Silty Clay with Sand and trace of Gravel Very Stiff		1	SS	22		142										14 33 42 11
141.7	2.1 (Glacial Till) Silty Clay, Some Sand with slabs & fragments		2	SS	19												
140.1	of Shale Hard		3	SS	58												
3.7	Grey		4	SS	37		140										
			5	SS	122												
			6	SS	103												
	Weathered Shale Bedrock with thin interbedded layers of Limestone		7	SS	100/8	cm	138										
			8	SS	100/5	cm	136										
			9	RC BXL	100Z REC		134										
133.3	End of Borehole																
10.5																	

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

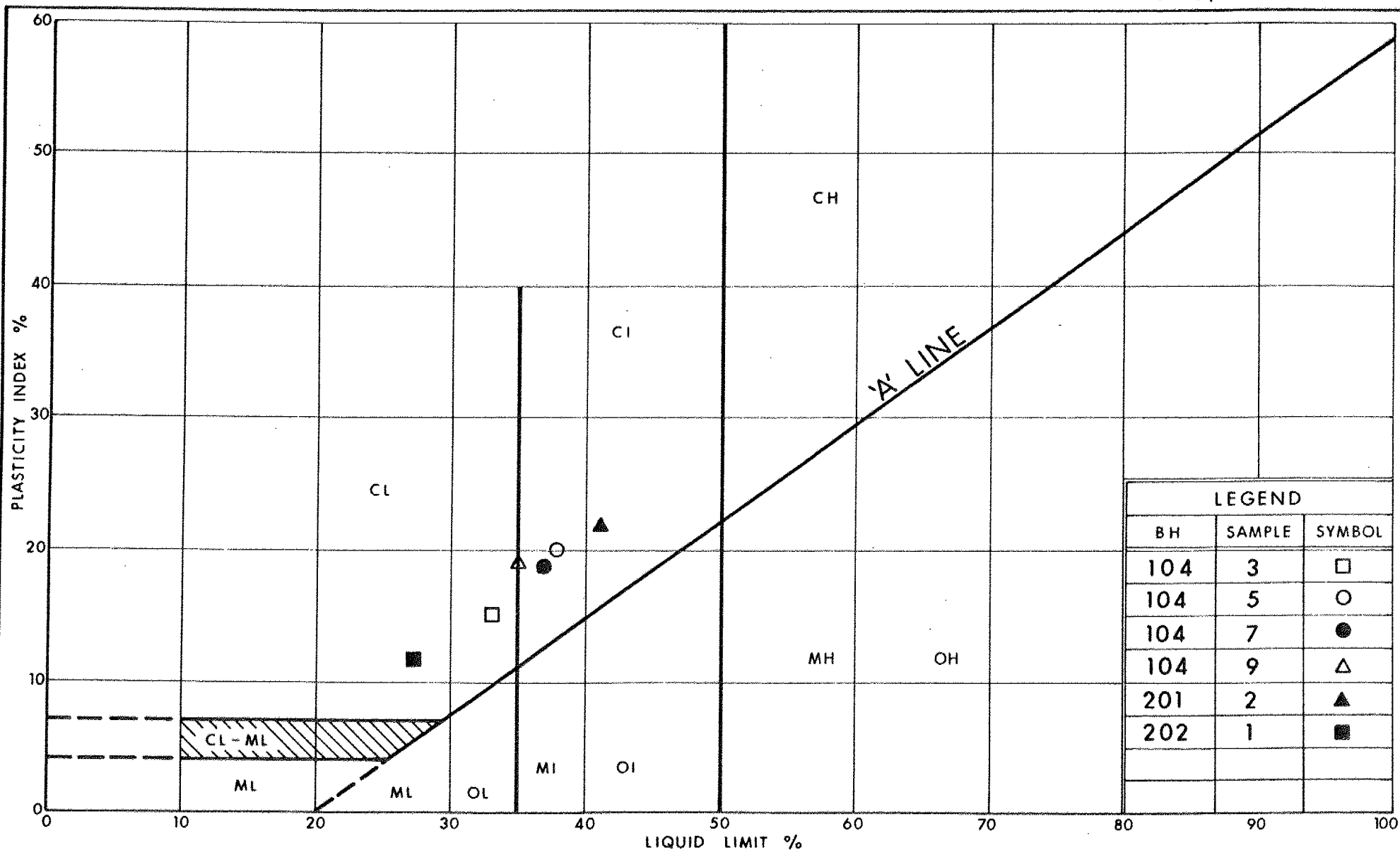


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GRAIN SIZE DISTRIBUTION
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-80

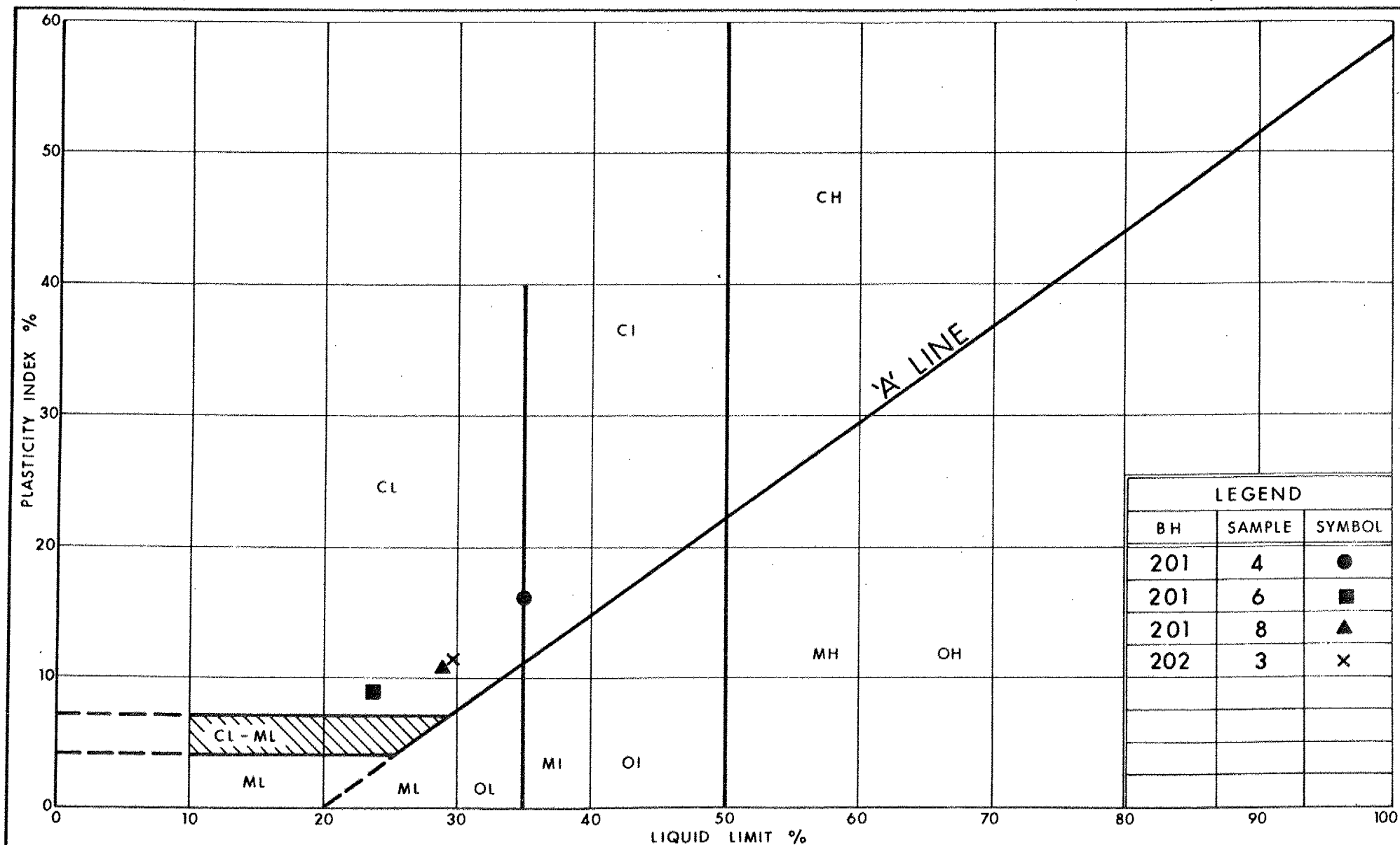


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PLASTICITY CHART
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 2

W P 127-66-80



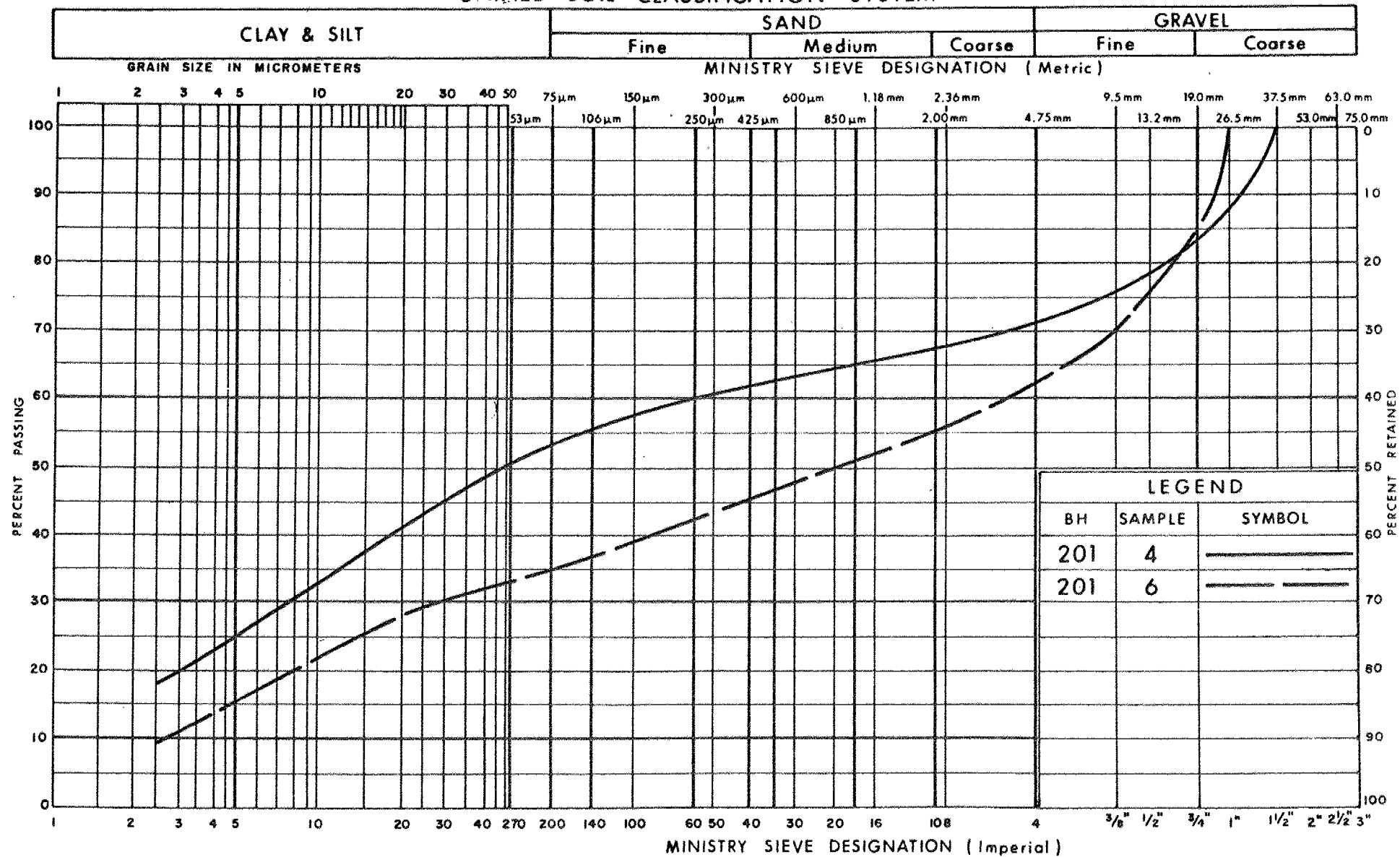
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PLASTICITY CHART Glacial Till SILTY CLAY Matrix

FIG No 3

W P 127-66-80

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL
(Glacial Till)

FIG No 4

W P 127-66-80



Ministry of
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Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 127-66-26

DIST 6

HWY 401

STR SITE 24-81-184C

Bridge #10, Highway 401 W.B. Collector
Over Etobicoke Creek

DISTRIBUTION

G. C. E. Burkhardt (3)

R. D. Gunter

F. Norman

J. Smrcka (2)

K. Bassi

B. J. Giroux

R. Hore

R. Fitzgibbon (Cover Only)

J. Anderson (Cover Only)

T. J. Kovich (Cover Only)

Files

FOUNDATION INVESTIGATION REPORT

For

Bridge #10

Highway 401 W.B. Collector

Over Etobicoke Creek

W.P. 127-66-26, Site 24-81-184C

Hwy. 401, 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 in two stages:

- i) a total of 4 sampled borings (BH#13 to #16), all accompanied by dynamic cone penetration tests, were originally advanced between 73-03-06 and 73-03-21 as part of the field investigation for the existing Bridge #9, Hwy. 401 Core over Etobicoke Creek. Subsequently a Foundation Report was issued under W.P. 127-66-28 dated 73-05-29 and the bridge constructed under Contract 74-109. These borings ranged in depth from 6.1 to 9.5 metres, with bedrock being cored in all borings for a maximum depth 4.8 metres.
- ii) The second stage of the field investigation consisted of 4 sampled borings advanced between 82-01-15 and 82-01-21 for depths ranging from 5.5 to 14.1 metres. Bedrock was augered in all boreholes and cored in one for 1.2 metres.

SITE DESCRIPTION AND GEOLOGY

The area under investigation is located at the crossing of Hwy. 401 and Etobicoke Creek in the City of Mississauga, Regional Municipality of Peel. Topographically, the area can best be described as a broad plain with the Etobicoke Creek cutting deep into the overburden. The resulting valley is approximately 125 metres wide with a depth of 12.5 metres. The land is primarily used for farming purposes, with Toronto International Airport located immediately north of the site.

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 a cohesive glacial till whose thickness is quite variable. In the region, the Credit River, Oakville and Etobicoke Creeks have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

Subsurface Conditions

In general, the extent and composition of the overburden is uniform across the site. The predominate surficial deposit is a cohesive glacial till consisting of silty clay with sand and varying amounts of gravel extending for a maximum depth of 3.8 metres. Borings in the vicinity of the creek channel encountered a deposit ranging from a gravel to gravelly sand with fines for a maximum thickness of 2.9 metres. In boreholes put down through the approach embankments of the existing Etobicoke Creek Bridge, fill material up to 8.3 metres thick, composed of the parent glacial till material of the area was found to overly the till and/or shale bedrock. Weathered shale bedrock was encountered in all borings at elevations ranging from 140.1 to 141.9.

The boundaries between the various soil types as encountered at the time of investigation, 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 four estimated stratigraphical sections based on borehole data, are shown on Drawing No. 1276626-A.

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

Embankment Fill Material

Borings advanced through the existing approach embankments indicate the fill material to be predominately derived from the parent glacial

till of the area, consisting of a silty clay of low plasticity with sand and varying amounts of gravel. This fill was encountered for thickness ranging from 7.3 to 8.3 metres at the abutment locations, and some 2 metres at the pier locations during the recent field investigation. At one pier boring location the fill was found to consist of a compact to dense gravelly sand some silt and a trace of clay-sized particles, possibly originating from the creek alluvium which was identified in the early investigation in BH14 as a compact to very dense gravel with sand and some silty clay.

Typical grainsize distribution curves for the cohesive fill material are plotted in envelope form on Figure 1. Results of water content and Atterberg Limit testing on recent samples are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w) %	13-19	16
Liquid Content (W_L) %	26-31	28
Plastic Limit (W_p) %	13-17	16
Plasticity Index (I_p) %	9-15	12

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

Based on Standard Penetration Test 'N' values generally averaging 8 to 10 blows/0.3 metre, it is estimated that the fill material has undergone a relatively moderate degree of compaction.

Silty Clay, Sand, and Gravel (Glacial Till)

The natural surficial deposit across the site is a glacial till composed of silty clay of low plasticity with sand and varying amounts of gravel. As a result of previous construction activity, this till is often reworked and difficult to distinguish from the derived embankment fill material. Where identified, it ranges from 1.7 to 3.8 metres in thickness, and contains an increasing frequency of fragments and detached slabs of shale in its lower portion.

Results of identity testing indicate the cohesive matrix of the till material to consist of a inorganic silty clay of low plasticity. Typical grain size distribution curves are shown on Figure 3.

Based on interpretation of 'N' values ranging 5 to 78 blows per 0.3 metres and augering operation, the consistency of this deposit ranges from firm to hard.

Bedrock

Bedrock surface was encountered immediately below the glacial till and embankment fill material at depths corresponding to elevations ranging from 140 to 141.4 during the recent investigation. These elevations closely relate to elevations of 140.1 to 141.9 encountered during the earlier investigation. The surface of bedrock appears to be relatively flat across the site and can be expected to exhibit minor undulations across the footing locations.

Based on visual examination of BXL rock cores, bedrock is described as a thin to medium bedded dark grey shale with occasional thin layers of limestone and silty limestone of the Dundas Formation. 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 badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock. The depth of weathering varied from 0.7 metres to in excess of 3 metres across the site.

Groundwater Conditions

Readings of stabilized water levels taken in open boreholes, indicate a water table ranging between elevations 141.6 and 142.6, but averaging an approx. elevation of 142.5 across the site during the recent investigation. This elevation roughly corresponds with the creek water level, and can be expected to fluctuate accordingly.

DISCUSSION AND RECOMMENDATION

In order to accomodate the upgrading of Hwy. 401 west of Hwy. 427 to a collector/core network, East and West Bound Collector Bridges over Etobicoke Creek are required. The proposed W.B. structure (Bridge #10) will be designed as a 3 span (25 - 29.3 - 25 metres) concrete girder structure with a total width of 24 metres, accomodate 5 driving lanes and 2 break down lanes. A proposed Hwy. 401 W.B. Collector profile grade of 155.5 and Etobicoke Creek bed of same 142 will necessitate approach fills in the order of 13.5 metres, however a majority of these approach embankments have been in place since 1974 as part of the adjacent core structure construction.

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

STRUCTURE FOUNDATIONS

Abutments

Considering the height of the approach embankment, abutments elements should be perched within the approach fills and supported on end-bearing piles driven into the weathered bedrock. Assuming a 110HP310 steel 'H' section pile equipped with the standard M.T.C. reinforced tips (welded flange plates) and driven to a minimum set of 15 blows/25mm for the last 75 mm with a hammer capable of delivering a minimum energy of 48,000 joules/blow, the following design parameters are recommended

Factor Capacity at U.L.S.	1650 kN
Capacity at S.L.S. Type II	1000 kN
Ultimate Capacity	3000 kN

Based on the previously mentioned pile driving criteria, piles should penetrate to the following minimum tip elevations.

West Abutment	Elev. 140.0
East Abutment	Elev. 139.5

Gradation of fill in the zone of pile penetration should be restricted to a maximum size of 75 mm.

Piers

In consideration of the proximity of weathered bedrock to the creek bottom, it is recommended that the proposed piers be supported on spread footings founded within the weathered shale bedrock. For footings founded at or below elevation 140.5 for the east pier and elevation 139.5 for the west pier within the weather shale zone the following design parameters are given

Factored Capacity at U.L.S.	1000 kPa
Capacity at S.L.S. Type II	Not Applicable

In order to insure minimum settlement of footings, the base of footing excavations into the weathered shale should be covered with a thin working slab of lean concrete immediately after the completion of the footing excavations.

A minimum of 1.3 metres of earth cover is required for frost protection considerations for all footings and pier pile caps.

Embankment Stability and Settlement

No deep seated rotational/sliding-type of movement are anticipated considering the proximity of competent till and level bedrock surface beneath the embankment. However, due to the high fill heights contemplated, stability of the embankment material itself is of concern. Stability analysis of the fill based in terms of total and effective stresses as carried out for the original report indicate that for fills ranging in height from 10.6 to 13.7 metres will be stable with 3:1 slopes in both the longitudinal and transverse direction. Alternatively, standard 2:1 slopes with a mid height beam of sufficient length so that the overall slope is not steeper than 3:1 is acceptable.

North transverse slopes for the west embankment should be constructed to as shallow a slope angle as possible (approx. 2.75:1) without infringing on the storm sewer outfall channel. No stability problems are anticipated for this slope geometry since 60% of the approach fill has been in place for some 8 years allowing for dissipation of pore pressures and consolidation of the fill. The toe of the embankment should be protected from future scour action by the use of an adequately designed riprap scheme.

All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill.

In addition, all new fill material should be properly benched in the existing slopes as per current M.T.C. standards.

In order to minimize post construction maintenance problems as a result of settlements within the embankment fill material, it is recommended that fills be constructed and left in place for as long a period as possible prior to final grading and paving operations.

Other Considerations

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

To ensure the placement of pier footings "in the dry", maintain the integrity of the existing creek banks and prevent softening and/or undermining of the existing Bridge #9 pier footings, it will be necessary to carry out the excavations for the new pier foundations within a sheeted cofferdam or alternatively, a staged braced excavation carried out in conjunction with creek flow diversion. However, pumping from sumps will be required to control water infiltration in either schemes. Anticipated driving depths of steel sheeting is no greater than weathered shale surface.

Temporary cut slopes for placement of abutment piles will be stable at a 1.5:1 geometry, however care must be exercised not to disturb or undermine the existing Bridge #9 abutment pile cap.

MISCELLANEOUS

The fieldwork for the original investigation (dated 73-03) was carried out under the supervision of Mr. V. Korlu, Project Foundations Engineer. The recent fieldwork was supervised by Mr. V. Parker, Field Technician, utilizing equipment owned and operated by Atcost Soil Drilling, Concord.

This report was written by Mr. T. J. Kazmierowski, Foundation 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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Communications

RECORD OF BOREHOLE No 1

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 775.4: E 294 804.5 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 15 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
148.7	Ground Surface												GR SA SI CL
0.0	Fill		1	SS	20		148						4-24-51-21
			2	SS	8								
			3	SS	10								
	Brown Grey		4	SS	8		146						16-30-39-15
			5	SS	10								
			6	SS	11		144						
	Silty Clay With Sand Some Gravel Stiff to Very Stiff		7	SS	16		142						30-28-30-12
	Fragments and Detached Slabs of Shale		8	SS	110								
141.4			9	SS	102	16 cm	140						
7.3	Weathered												
	Shale Bedrock												
138.4													
10.3	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 754.5 E 294 791.3 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.
DATUM Geodetic DATE 82 01 18 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
143.7	Ground Surface																
0.0	(Fill)																
	Gravelly Sand		1	SS	38												31-40-22-7
	Some Silt																
	Trace of Clay																
141.7	Compact to Dense		2	SS	23		142										25-48-19-8
2.0	(Glacial Till) Brown		3	SS	11												24-35-28-13
	Silty Clay Grey																
	With Sand and		4	SS	8												
140.0	Gravel Stiff																
3.7	Grey		5	SS	57		140										
			6	SS	65	15 cm											
	weathered																
			7	SS	65	5 cm	138										
	Shale																
	Bedrock						136										
			EXL	REC													
133.6			8	RC	100%		134										
10.1	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 3

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 733.2; E 294 776.6 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 21 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
143.8	Ground Surface																
0.0	Grey (Glacial Till) Silty Clay with Sand Varying amounts of Gravel																
	Hard		1	SS	46		142										47-27-20-6
	Fragments and detached Slabs of Shale		2	SS	43												
140.0			3	SS	68												14-22-50-14
3.8	Weathered Shale		4	SS	115		140										
138.3	Bedrock		5	SS	46												
5.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 4

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 736.3; E 294 729.6 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Gendetic DATE 82 01 21 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	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
149.0	Ground Surface																	
0.0																		
			1	SS	6		148											
	Grey		2	SS	28													30 29 28 13
	Brown		3	SS	8													
	Fill		4	SS	9		146											9 27 45 19
	Silty Clay		5	SS	8													
	with Sand		6	SS	6		144											3 24 43 30
	Varying Amounts																	
	of Gravel																	
	Firm		7	SS	8													
							142											
	Detached Fragments and		8	SS	69													
140.7	Slabs of Shale																	
8.3																		
	Grey		9	SS	145		140											
	Weathered																	
	Shale		10	SS	100/	13 cm	138											
	Bedrock																	
			11	SS	100/	8 cm	136											
134.9			12	SS	100/	5 cm												
14.1	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 711.4; E 294 765.4 ORIGINATED BY V.K.
 DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
 DATUM Geodetic DATE 73 03 06 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
144.5	Ground Surface												
0.0	Fill												
143.0	Silty Clay, Sand & Gravel, trace orgs. Stiff		1	SS	13								
1.5	(Glacial Till)		2	SS	5								
	Silty Clay, Sand and Gravel		3	SS	78								
140.9	Firm to Very Stiff		4	SS	100								
3.6	Weathered Shale Bedrock Sound		5	RC BXL	90% REC								
138.4													
6.1	End of Borehole												

+3, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 729.0; E 294 789.8 ORIGINATED BY V.K.
 DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
 DATUM Geodetic DATE 73 03 13 CHECKED BY SP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
143.0	Ground Surface													
0.0	Gravel With Sand and Some Silty Clay Compact to Very Dense		1	SS	27		142							72 17 (11)
			2	SS	100	13 cm								
140.1			3	SS	100	5 cm	140							
2.9	Weathered		4	AS	-									
	Shale Bedrock Sound		5	RC BXL	100% REC		138							
136.9														
6.1	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 15

METRIC

W P 127-66-26 LOCATION Co-ords. N 4 834 742.2; E 294 811.1 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 73 03 14 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L 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						
145.2	Ground Surface										
0.0	Fill Silty Clay Some Sand & Gravel Firm to Very Stiff		1	SS	16		144				
142.8	(Glacial Till) Silty Clay, Sand and Gravel		2	SS	7		142				
2.4	Hard		3	SS	50						24 19 41 16
140.6	Weathered — —		4	RC BXL	30% REC		140				
4.6	Shale Bedrock Sound		5	RC BXL	60% REC		138				
			6	RC BXL	98% REC						
136.7	End of Borehole										
8.5											



RECORD OF BOREHOLE No 16

METRIC

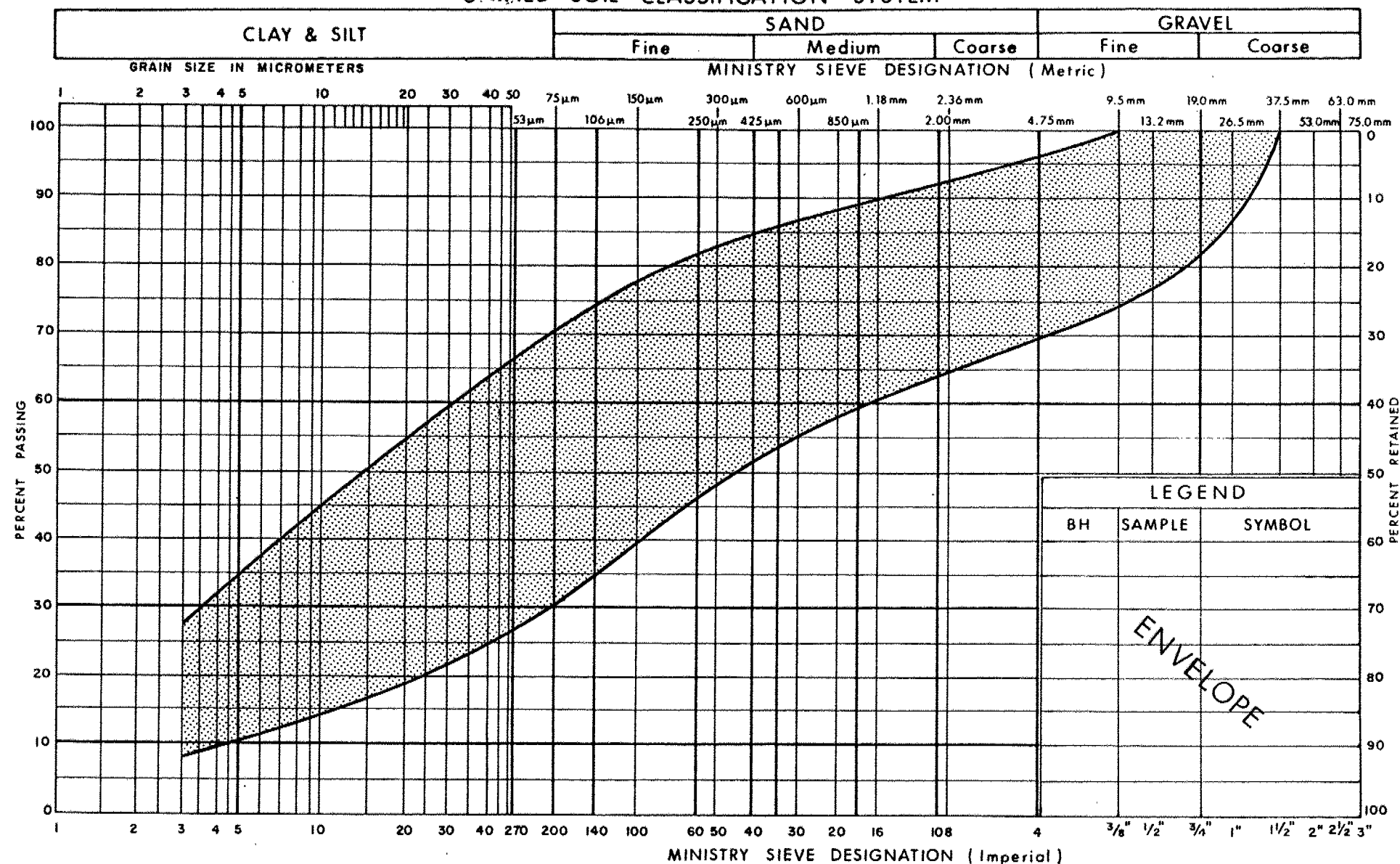
W P 127-66-26 LOCATION Co-ords. N 4 834 754.4; E 294 830.0 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Ceodetic DATE 73 03 21 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
146.6	Ground Surface											
0.0	Fill Silty Clay with Sand Some Gravel trace of organics Firm to Stiff		1	SS	14	15 cm	146					17 55 21 7
			2	SS	9		144					6 29 46 19
			3	SS	4							
			4	SS	6							
141.9			5	SS	100/			142				
4.7	Weathered		6	RC BXL	21% REC		140					
			7	RC BXL	45% REC							
	Shale Bedrock Sound		8	RC BXL	100% REC		138					
137.1												
9.5	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

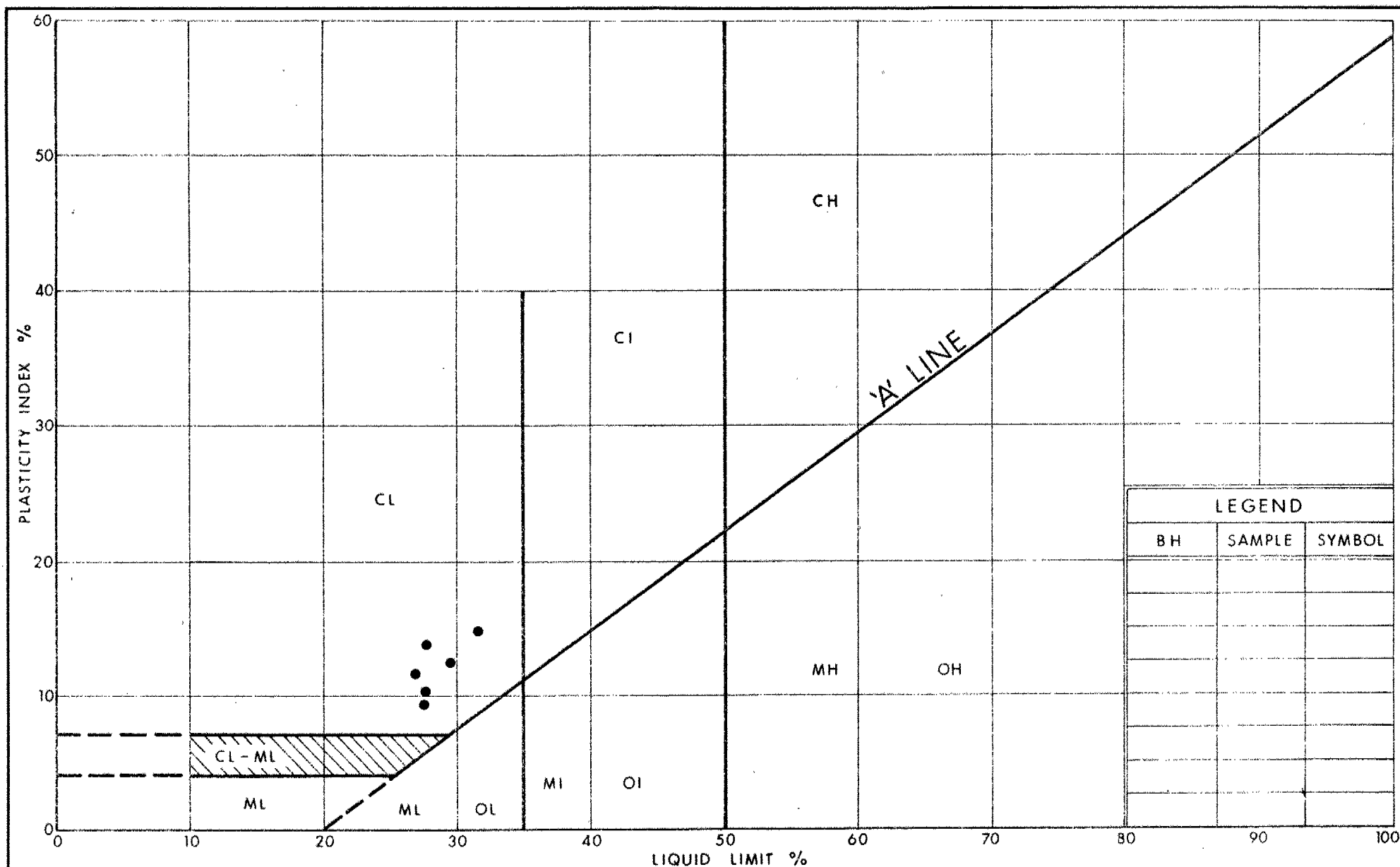


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GRAIN SIZE DISTRIBUTION
(FILL)
SILTY CLAY WITH SAND & VARYING AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-26



LEGEND		
BH	SAMPLE	SYMBOL



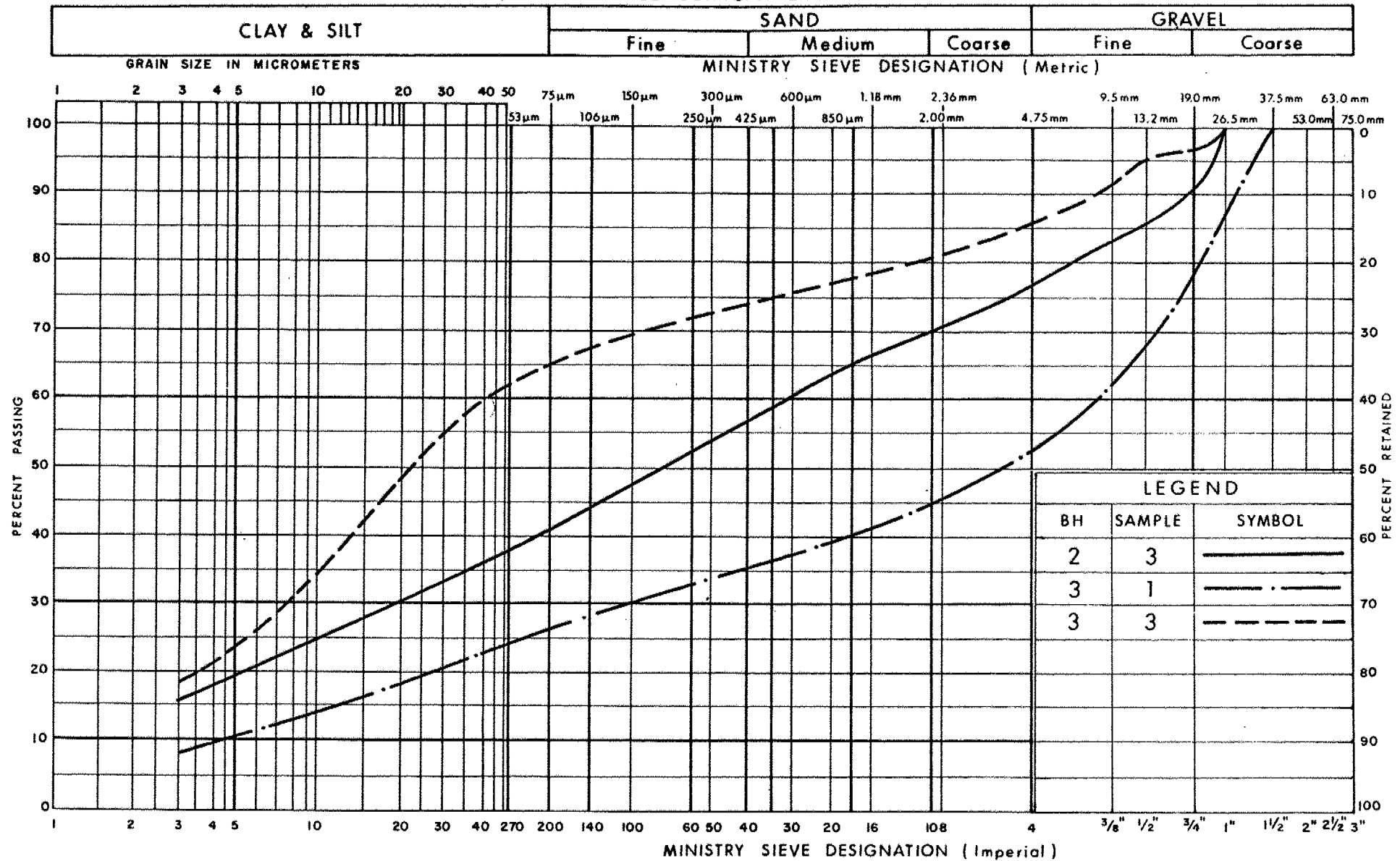
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PLASTICITY CHART
FILL (Reworked Glacial Till)
SILTY CLAY Matrix

FIG No 2

W P 127-66-26

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 127-66-26

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

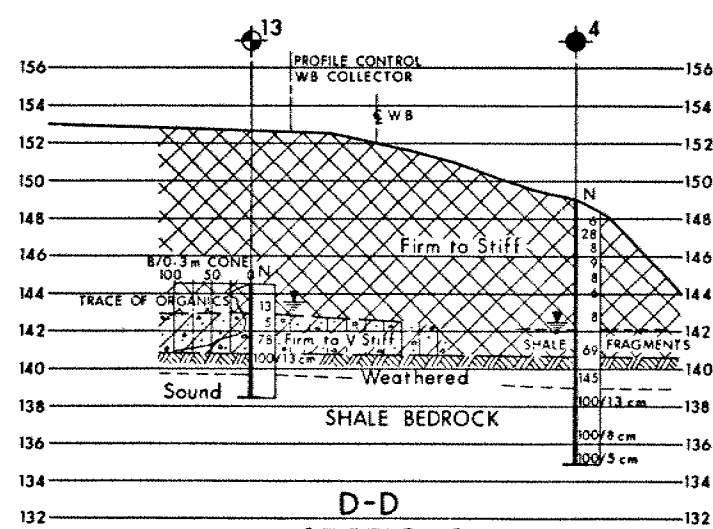
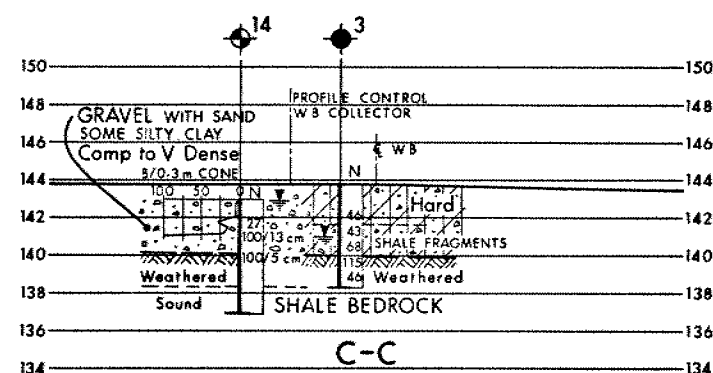
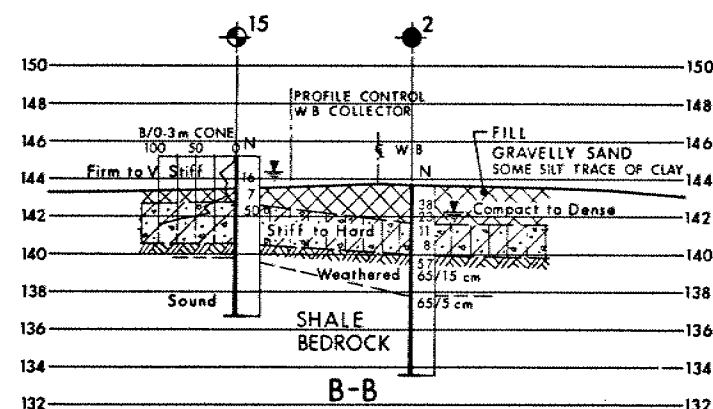
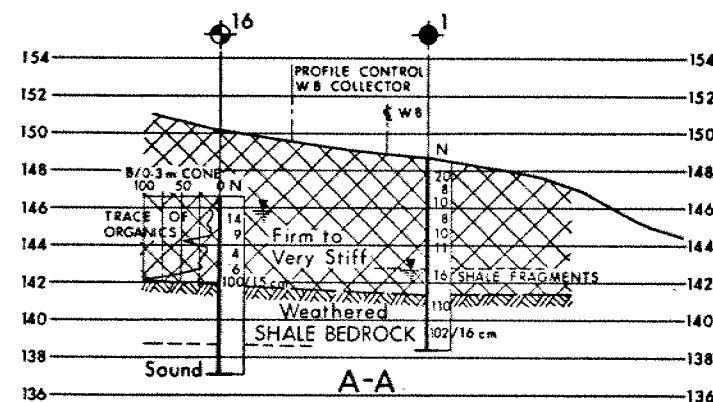
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

MECHANICAL PROPERTIES OF SOIL

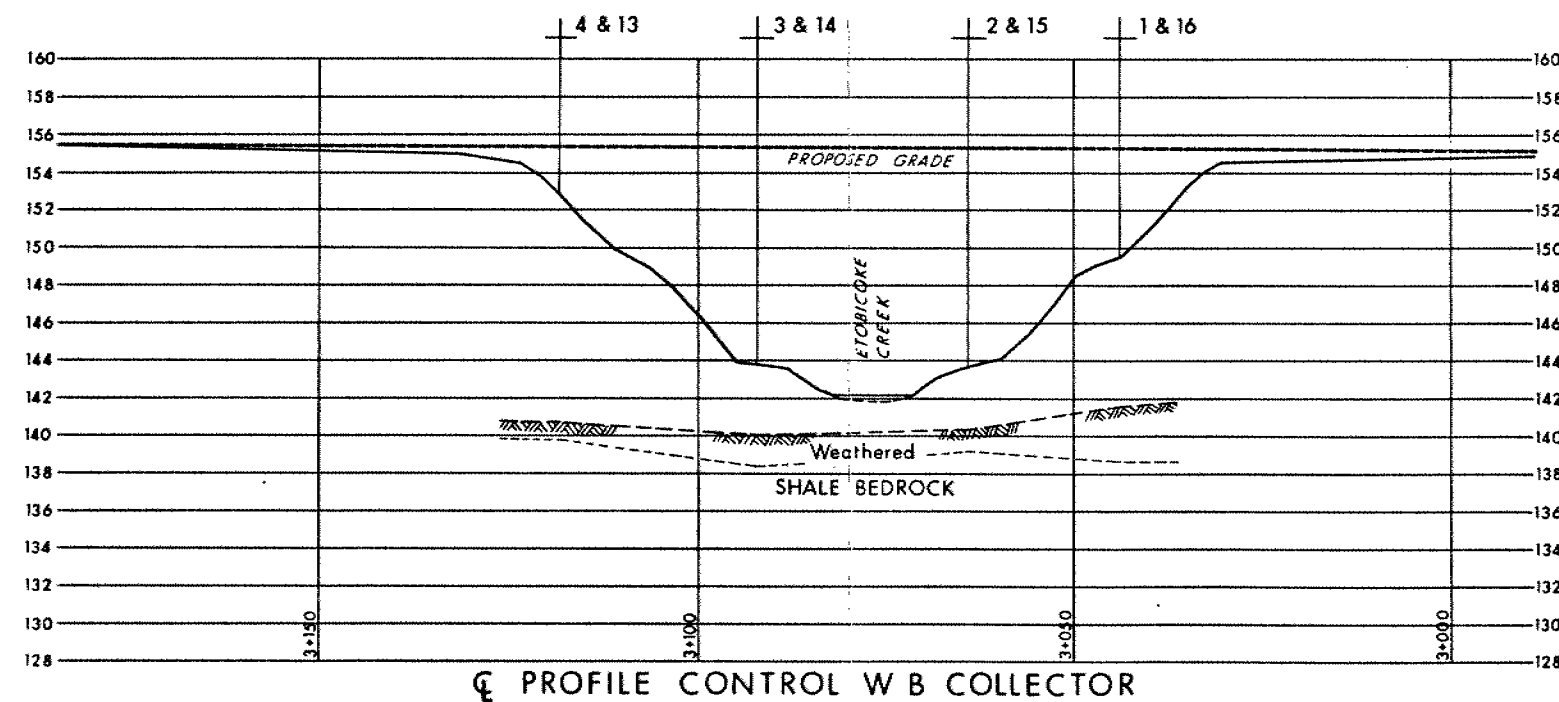
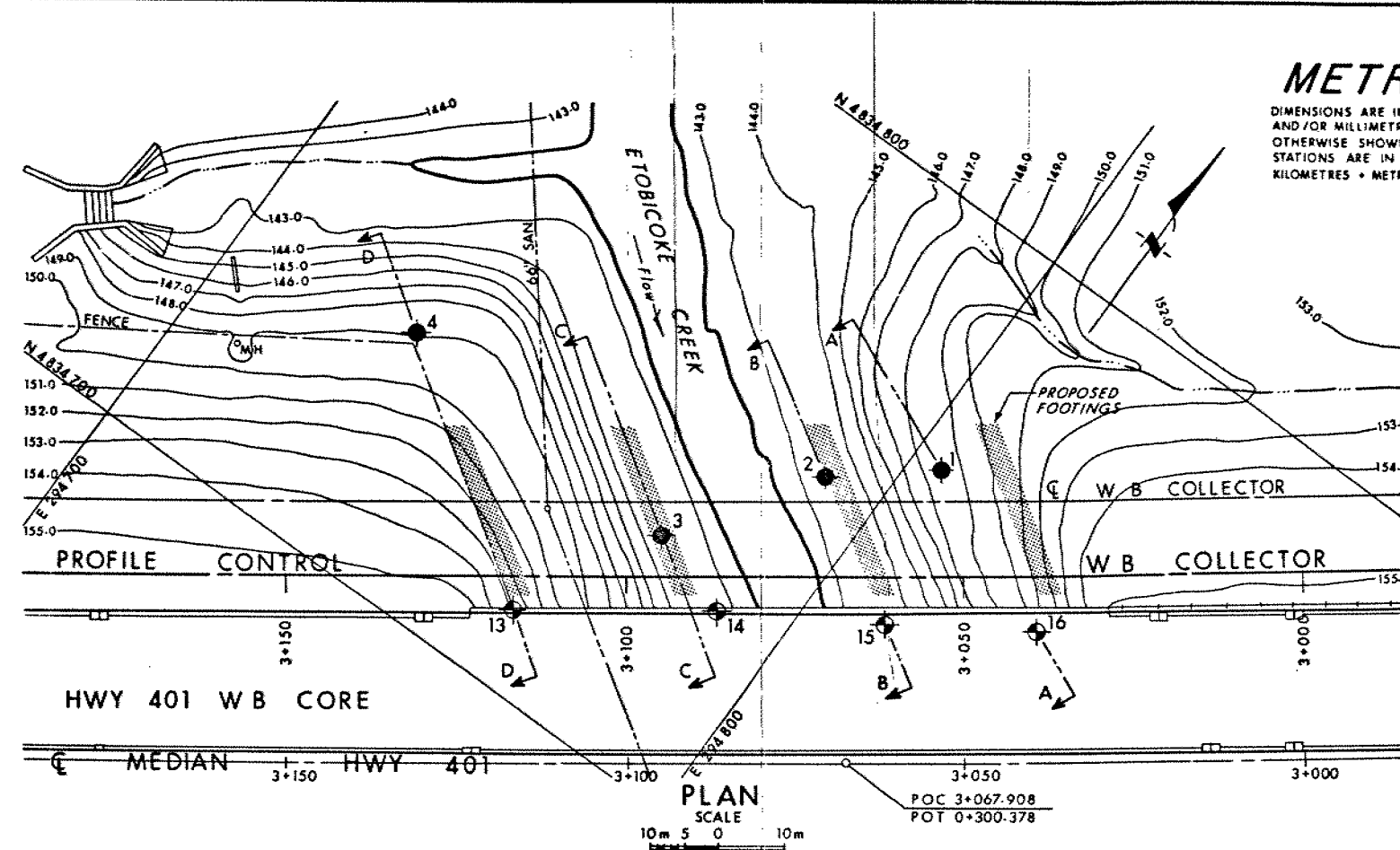
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

PHYSICAL PROPERTIES OF SOIL

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



D-D
SECTIONS
SCALE
HOR 10m 5 0 10m
VERT 4m 2 0 4m



SOIL STRATIGRAPHY LEGEND

- FILL, Firm to Very Stiff
SILTY CLAY WITH SAND
VARYING AMOUNTS OF GRAVEL
- SILTY CLAY, SAND & GRAVEL
(Glacial Till) Firm to Hard

METRIC

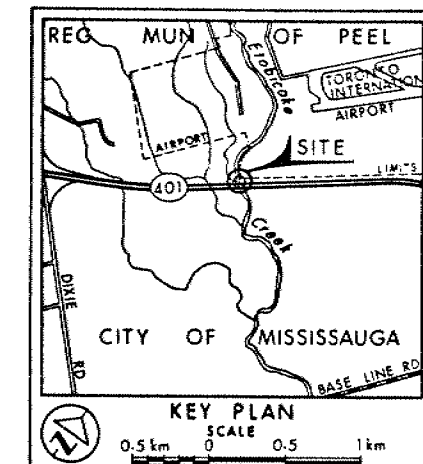
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN.
STATIONS ARE IN
KILOMETRES + METRES.

CONT No
WP No 127-66-26

HWY 401 W.B. COLLECTOR OVER
ETOBICOKE CREEK (BRIDGE No 10)
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 for Boreholes 1, 2, 3 and 4
1982 01
- WL for Boreholes 13, 14, 15 and 16
1973 03

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	148.7	4 834 775.4	294 804.5
2	143.7	4 834 754.5	294 791.3
3	143.8	4 834 733.2	294 776.6
4	149.0	4 834 736.3	294 729.6
13	144.5	4 834 711.4	294 765.4
14	143.0	4 834 729.0	294 789.8
15	145.2	4 834 742.2	294 811.1
16	146.6	4 834 754.4	294 830.0

Elevations for Boreholes 13, 14, 15 and 16
as of 1973 03 under WP 127-66-28

NOTE

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

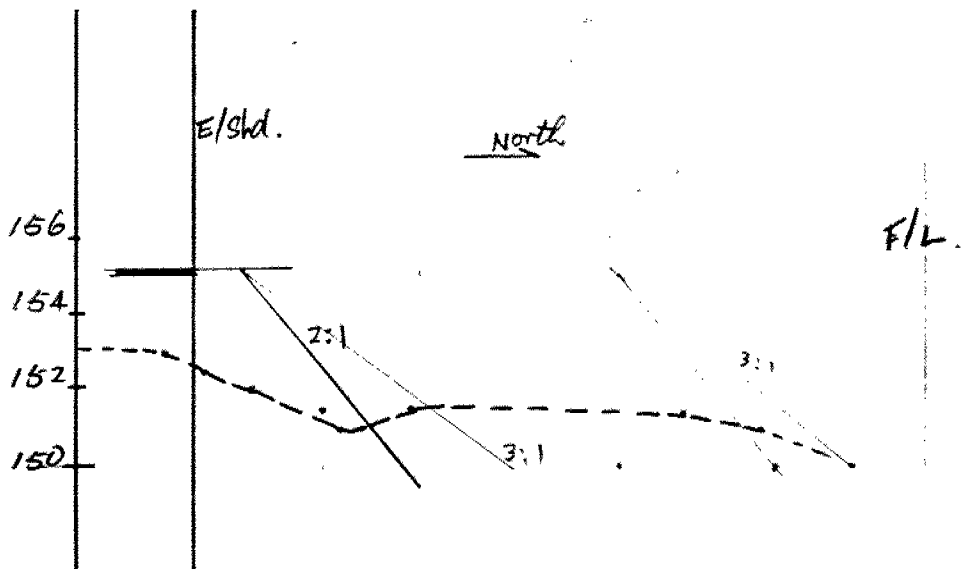
REVISIONS	DATE	BY	DESCRIPTION

Geocres No 30M12-153

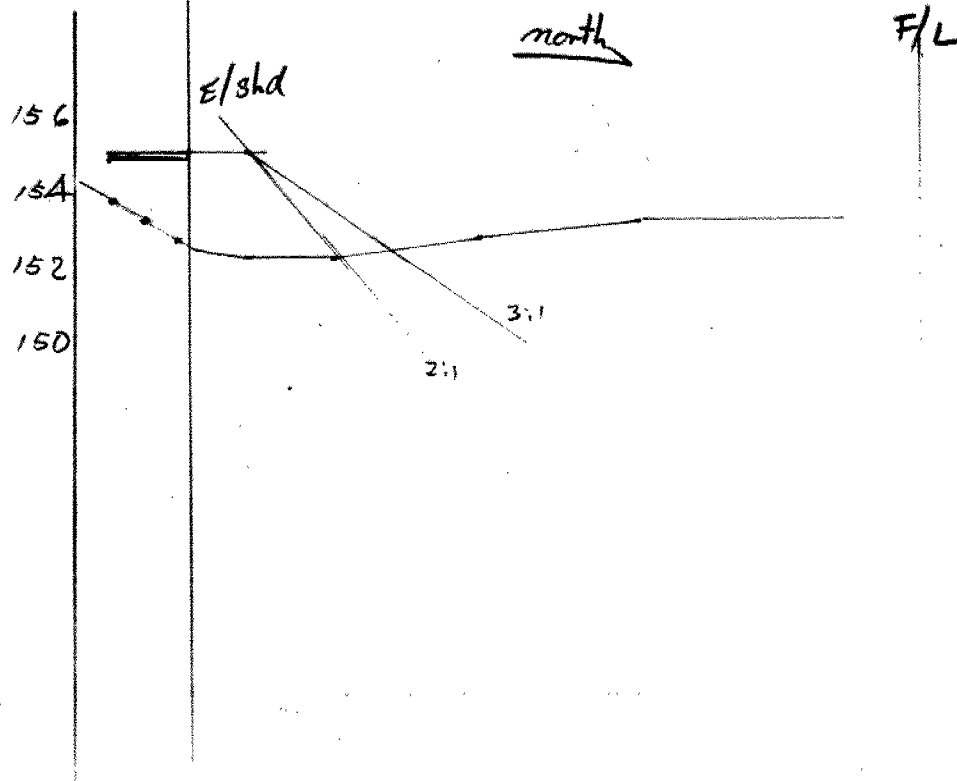
HWY No 401	CHECKED	DATE 1982 03 15	DIST 6
SUBMITTAL	CHECKED	DATE 1982 03 15	SITE 24-81-184C
DRAWN	CHECKED	DATE 1982 03 15	DWG 1276626-A

Bridge #10 North East approach embankment

3+025



3+000

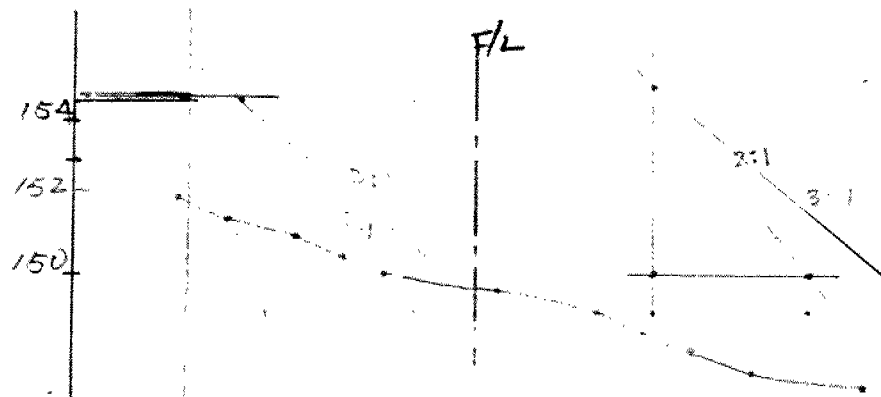


5.15
 150.00
 10

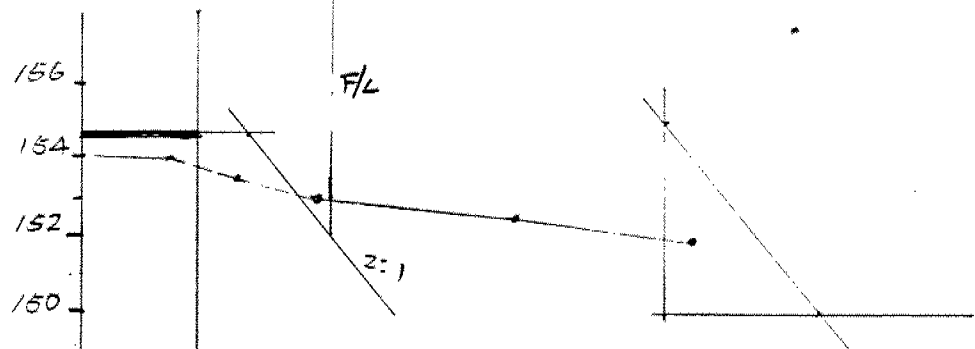
BR # 8

South EAST Embankment slope:

STATION 3+00



STATION 2+975

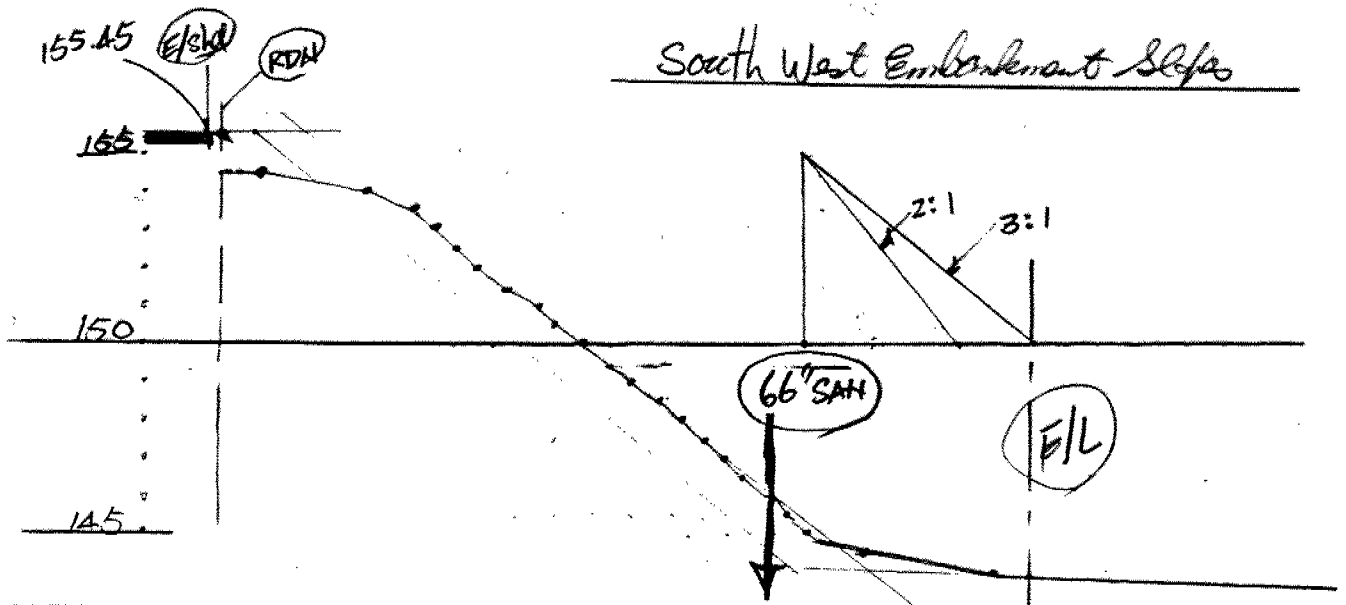


$$\begin{array}{r} 154.8 \\ 151.0 \\ \hline 3.8 \times z = 7.6 \end{array}$$

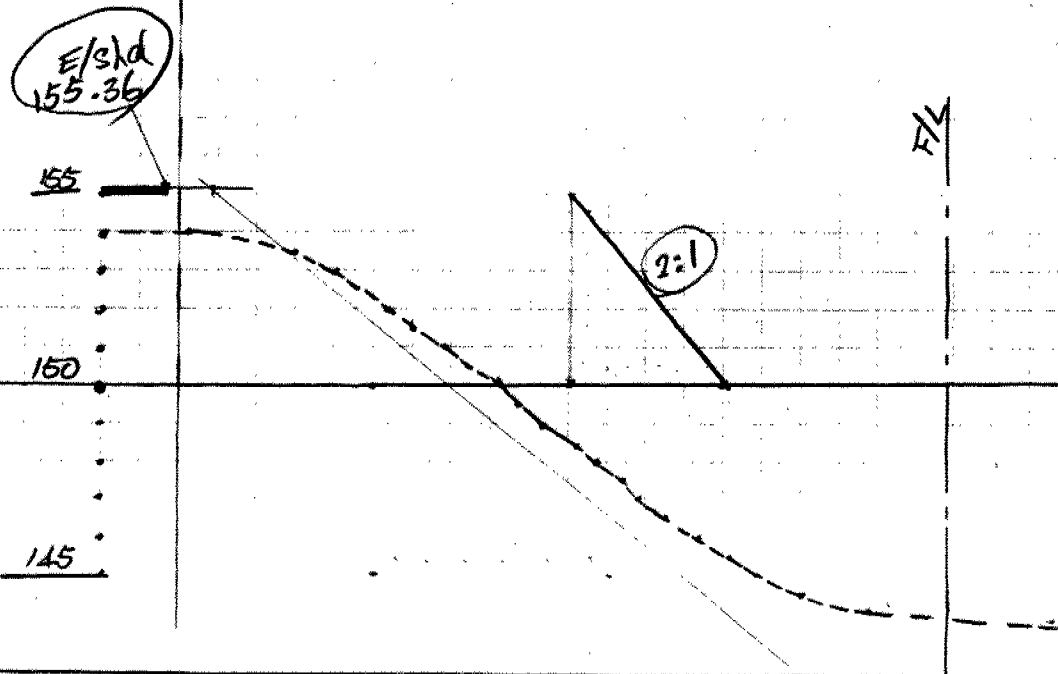
BR# 8 Sections

South West Embankment Slope

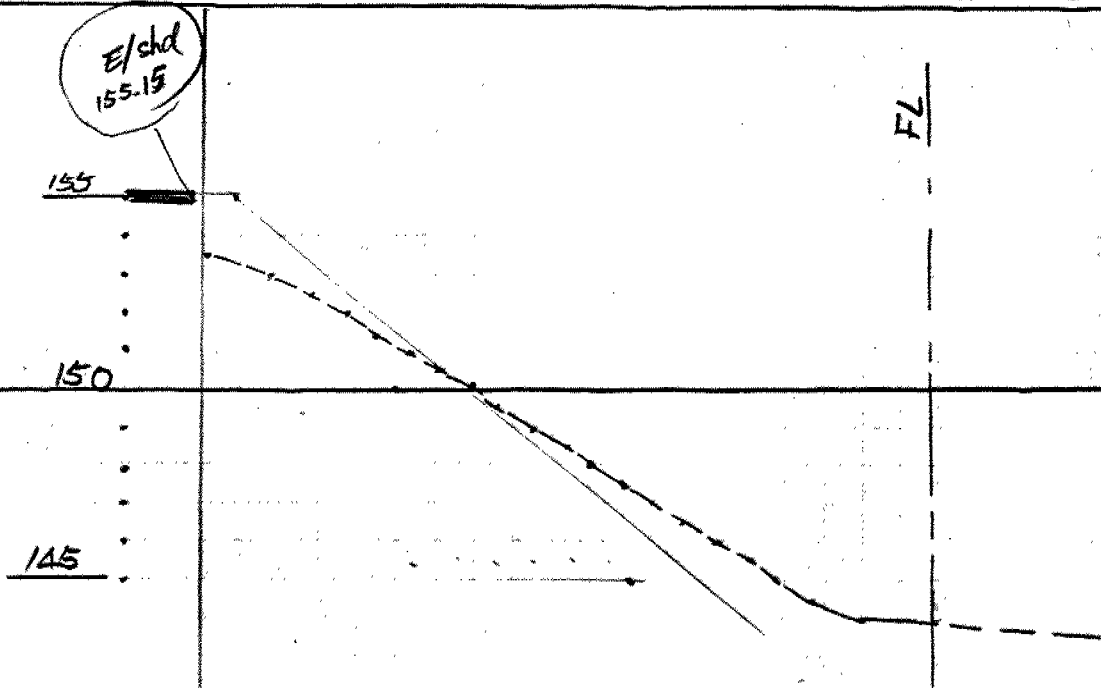
3+150



3+125



3+100



15.5
18.5
7.0m

