

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-108

DIST. 6 REGION _____

W.P. No. 88-78-15 &
88-78-32

CONT. No. 92-40

W. O. No. _____

STR. SITE No. 37-953

HWY. No. 407

LOCATION Hwy 407 & Humber River
E.B. & W.B.

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No. 6
CONT. No.
WP. No. 88-78-15/32
HIGHWAY 407-HUMBER RIVER BRIDGE
WP. No. 88-78-15 WBL
WP. No. 88-78-32 EBL
GENERAL ARRANGEMENT



SHEET

Morrison Hershfield Limited
Consulting Engineers

WORKS NOT INCLUDED IN THIS CONTRACT
1. APPROACH SLABS
2. ASPHALT AND WATERPROOFING SYSTEM

LEGEND

T/F - TOP OF FOOTING
T/C - TOP OF CONCRETE
T/P - TOP OF PAVEMENT
WP - WORKING POINT
HWL - HIGH WATER LEVEL
NWL - NORMAL WATER LEVEL

GENERAL NOTES:

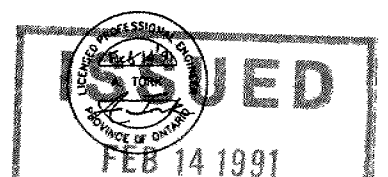
- CLASS OF CONCRETE**
PRESTRESSED GIRDERS AND DIAPHRAGMS AT PIERS 45 MPa
REMAINDER 30 MPa
- CLEAR COVER TO REINFORCING STEEL**
FOOTINGS 100±25
PIER COLUMNS AND CAP BEAMS 80±20
ABUTMENTS AND WINGWALLS 80±20
FRONT FACE BACK FACE 70±20
DECK SLAB TOP 70±20
BOTTOM 40±10
REMAINDER 70±20
UNLESS OTHERWISE NOTED
- REINFORCING STEEL**
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED.
BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS
- CONSTRUCTION NOTES:**
IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCED STEEL TO SUIT THE ACTUAL HEIGHTS.
COMPACTED FILL, MAXIMUM GRAIN SIZE 75mm SHALL BE PLACED UP TO THE BOTTOM OF THE ABUTMENT WALL FOOTING ELEVATION PRIOR TO DRIVING PILES.
A LAYER OF COMPACTED GRANULAR TYPE B MATERIAL 300 mm THICK SHALL BE PLACED UNDERNEATH EACH FOOTING AT THE ABUTMENTS AND THE PIERS AND EXTENDED 500 mm BEYOND THE EDGES OF THE FOOTINGS ON PLAN.
PILING FOR ABUTMENT FOOTINGS SHALL NOT COMMENCE UNTIL 3 MONTHS AFTER THE PLACEMENT OF FILL BELOW THE FOOTINGS.
- CONSTRUCTION SEQUENCE:**
REFER TO DWG. 18

LIST OF DRAWINGS:

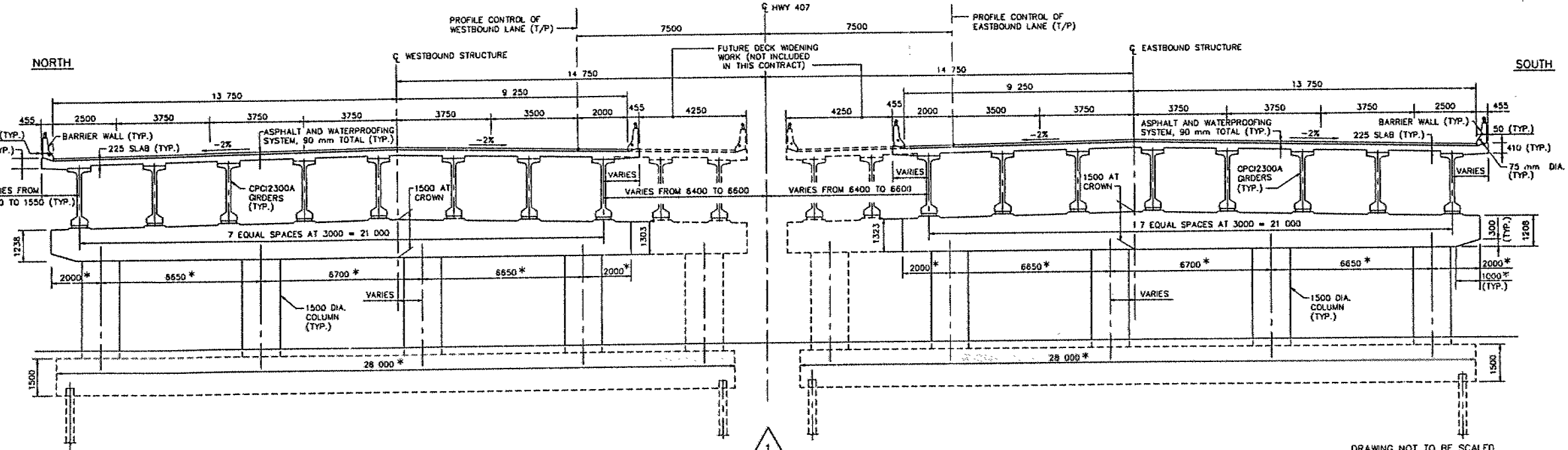
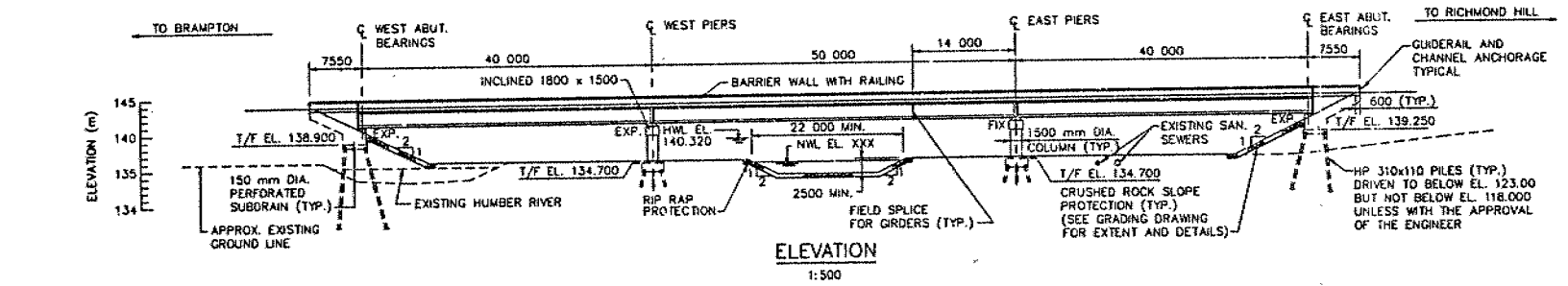
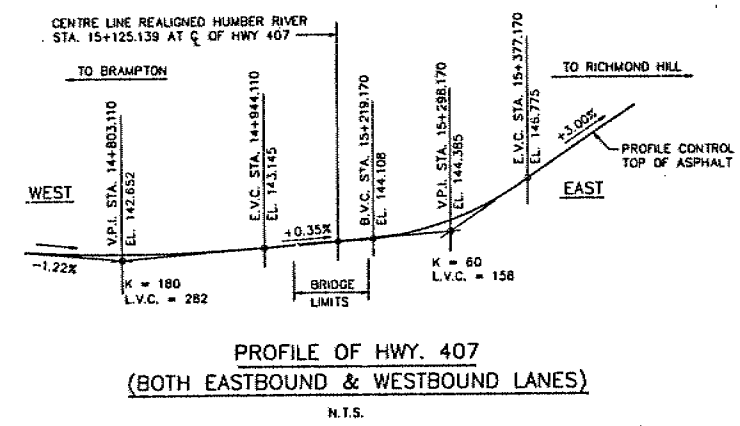
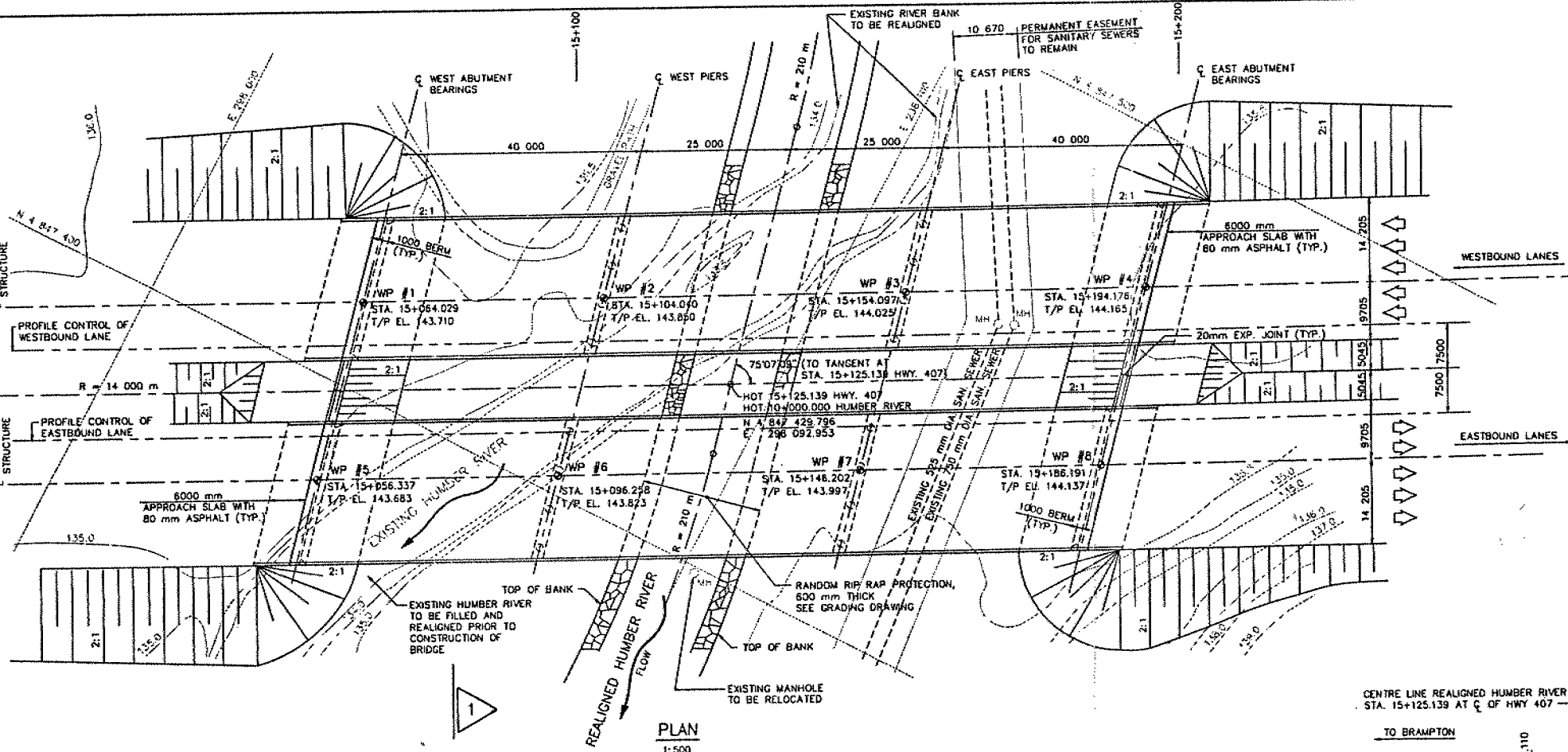
- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- FOOTING LAYOUT
- EAST ABUTMENT FOOTING DETAILS
- WEST ABUTMENT FOOTING DETAILS
- EAST PIERS FOOTING DETAILS
- WEST PIERS FOOTING DETAILS
- EAST ABUTMENT - I
- EAST ABUTMENT - II
- WEST ABUTMENT - I
- WEST ABUTMENT - II
- WINGWALL DETAILS
- EAST PIERS DETAILS
- WEST PIERS DETAILS
- BEARING DETAILS
- GIRDER LAYOUT
- GIRDER DETAILS
- GIRDER REINFORCEMENT
- DECK LAYOUT AND SCREED ELEVATIONS
- DECK REINFORCING - I
- DECK REINFORCING - II
- BARRIER WALL WITH RAILING
- RAILING FOR BARRIER WALL
- EAST ABUTMENT, JOINT ANCHORAGE AND ARMOURING
- WEST ABUTMENT, JOINT ANCHORAGE AND ARMOURING
- 8000 mm APPROACH SLAB
- AS CONSTRUCTED ELEVATIONS & DIMENSIONS - I
- AS CONSTRUCTED ELEVATIONS & DIMENSIONS - II
- PILE DRIVING - STEAM AND DIESEL HAMMERS
- STANDARD DETAILS - I
- STANDARD DETAILS - II
- ELECTRICAL EMBEDDED WORK
- QUANTITIES STRUCTURE - I
- QUANTITIES STRUCTURE - II
- QUANTITIES STRUCTURE - III
- QUANTITIES STRUCTURE - IV

APPLICABLE STANDARD DRAWINGS:

DD - 3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	EL	CHK. ATC	CODE DBBC-83 (LOAD CLASS A) DATE FEB/91
DRAWN	HT	CHK. ATC	SITE 37-973 STRUCT. SCHEME DWG. 1



BM 151.914
GEODETIC DATUM
Nail in E Road 0.3 Elm
58.6 RL 15+297.7

* DIMENSION MEASURED ALONG THE LENGTH OF THE PIER

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No.
CONT. No.
WP. No. 88-78-15/32



HIGHWAY 407-HUMBER RIVER BRIDGE
WP. No. 88-78-15 WBL
WP. No. 88-78-32 EBL
FOOTING LAYOUT

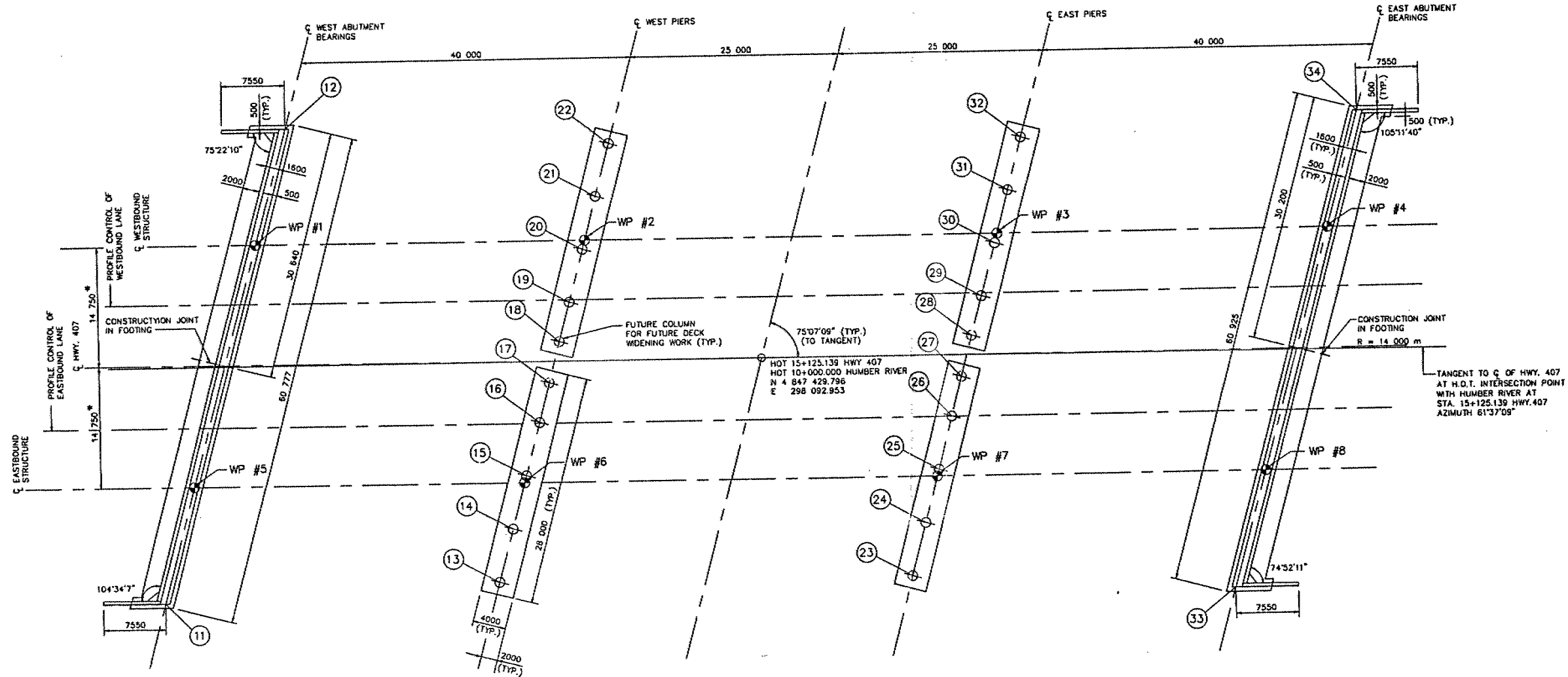
SHEET

Morrison Hershfield Limited
Consulting Engineers



NOTE:

1. (15) DENOTES REFERENCE POINT 15.



PLAN
1:300

* ALL DIMENSIONS ARE RADIAL DIMENSIONS

CO-ORDINATES OF WORKING POINTS			
WORKING POINT	STATION	NORTH CO-ORDINATE	EAST CO-ORDINATE
1	15+064.029	4 847 413.874	298 032.171
2	15+104.040	4 847 432.769	298 067.391
3	15+154.097	4 847 456.550	298 111.378
4	15+194.176	4 847 475.704	298 146.537
5	15+056.337	4 847 384.230	298 039.287
6	15+096.258	4 847 403.103	298 074.513
7	15+146.202	4 847 426.855	298 118.507
8	15+186.191	4 847 445.986	298 153.671

CO-ORDINATES OF REFERENCE POINTS		
REF. POINT	NORTH CO-ORDINATE	EAST CO-ORDINATE
11	4 847 369.957	298 042.714
12	4 847 428.150	298 028.743
13	4 847 391.187	298 077.374
14	4 847 397.653	298 075.822
15	4 847 404.168	298 074.258
16	4 847 410.634	298 072.706
17	4 847 415.496	298 071.539
18	4 847 420.312	298 070.329
19	4 847 425.393	298 069.162
20	4 847 431.859	298 067.610
21	4 847 438.374	298 066.048
22	4 847 444.840	298 064.494
23	4 847 414.953	298 121.364
24	4 847 421.419	298 119.812
25	4 847 427.934	298 118.248
26	4 847 434.400	298 116.696
27	4 847 439.262	298 115.529
28	4 847 444.297	298 114.319
29	4 847 449.359	298 113.152
30	4 847 455.625	298 111.600
31	4 847 462.140	298 110.036
32	4 847 468.606	298 108.484
33	4 847 431.678	298 157.108
34	4 847 490.015	298 143.101



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No.
CONT. No.
WP. No. 88-78-15/32



HIGHWAY 407-HUMBER RIVER BRIDGE
WP. No. 88-78-15 WBL
WP. No. 88-78-32 EBL
EAST ABUTMENT FOOTING DETAILS

Morrison Hershfield Limited
Consulting Engineers

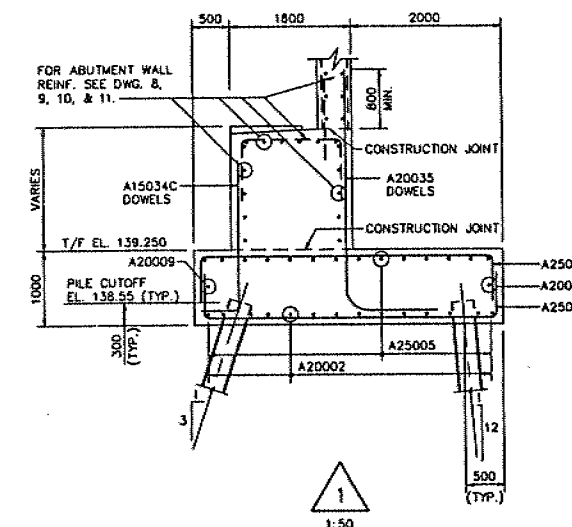
NOTES:

- LAYOUT DIMENSIONS FOR PILES ARE GIVEN AT THE UNDERSIDE OF PILE CAPS.
- PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTH BELOW CUT-OFF AND TO EL. 120.00.
- ALL PILES SHALL BE HP310x110.
PILE DESIGN DATA FOR HP310x110:
CAPACITY AT S.L.S. TYPE II = 1050 kN/PILE
FACTORED CAPACITY AT U.L.S. = 1300 kN/PILE
- PILES TO BE DRIVEN IN ACCORDANCE WITH DWG. 30, USING AN ULTIMATE CAPACITY OF 1300 kN PER PILE BUT MUST BE DRIVEN BELOW EL. 123.00 AND NOT BELOW EL. 118.00 WITHOUT APPROVAL OF THE ENGINEER.
- FOR FOOTING LAYOUT DETAILS SEE DWG. 3.

LEGEND:

EQ. SP. - EQUALLY SPACED
EA. F. - EACH FACE
I.F. - INSIDE FACE
O.F. - OUTSIDE FACE
T/EL. - TOP ELEVATION
T/F - TOP OF FOOTING
T - TOP LAYER
B - BOTTOM LAYER

PILE DATA				
LOCATION		No. REQ'D	APPROX. LENGTH (mm)	BATTER
EAST ABUTMENT	WESTBOUND STRUCTURE	21	21 700	1: 3
	EASTBOUND STRUCTURE	21	20 600	1: 12
EAST ABUTMENT	WESTBOUND STRUCTURE	21	21 700	1: 3
	EASTBOUND STRUCTURE	21	20 600	1: 12



APPLICABLE STANDARD DRAWING

DD-3301 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'H'-PILES



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	PS	CHK. ATC	CODE OHBDC-83 LOAD CLASS A DATE FEB./91
DRAWN	DT	CHK. ATC	SITE 37-973 STRUCT. SCHEME DWG. 4

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No.
CONT. No.
WP. No. 88-78-15/32



HIGHWAY 407-HUMBER RIVER BRIDGE
WP. No. 88-78-15 WBL
WP. No. 88-78-32 EBL
WEST ABUTMENT FOOTING DETAILS

SHEET

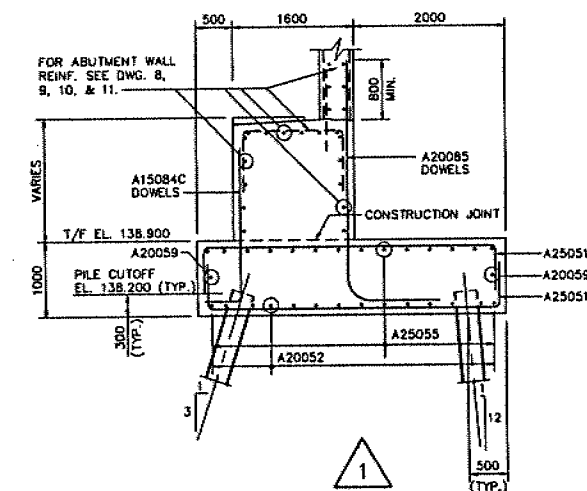
Morrison Hershfield Limited
Consulting Engineers



NOTE:

1. FOR FOUNDATION NOTES REFER TO DWG. 4.

PILE DATA				
LOCATION	No. REQ'D	APPROX. LENGTH (mm)	BATTER	
WEST ABUTMENT	WESTBOUND STRUCTURE	21 8	21 300 20 300	1: 3 1:12
	EASTBOUND STRUCTURE	21 9	21 300 20 300	1: 3 1:12



APPLICABLE STANDARD DRAWING

DD-3301 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'H'-PILES



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	PS	CHK. ATC	CODE DHBDC-83 LOAD CLASS A DATE FEB./91
DRAWN	PS	CHK. ATC	SITE 37-973 STRUCT. SCHEME DWG. 5

WEST ABUTMENT FOOTING PLAN

1:75

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No.
CONT. No.
WP. No. 88-78-15/32



HIGHWAY 407-HUMBER RIVER BRIDGE
WP. No. 88-78-15 WBL
WP. No. 88-78-32 EBL
EAST PIER FOOTING DETAILS

SHEET

Morrison Hershfield Limited
Consulting Engineers



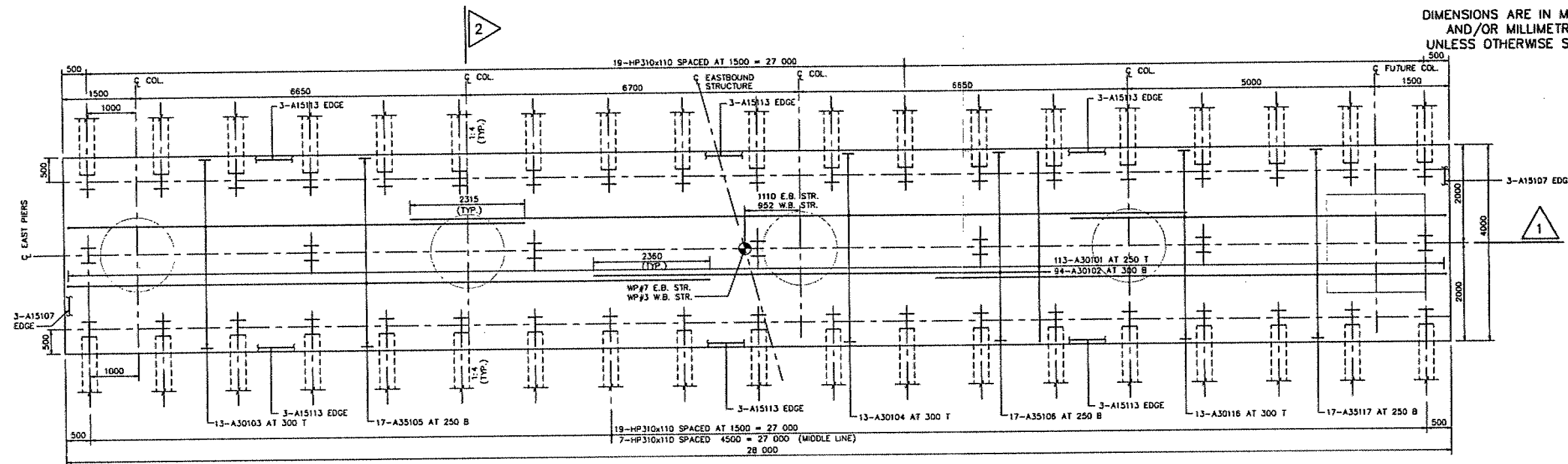
NOTE :

- FOR FOUNDATION NOTES AND LEGEND REFER TO DWG. 4.

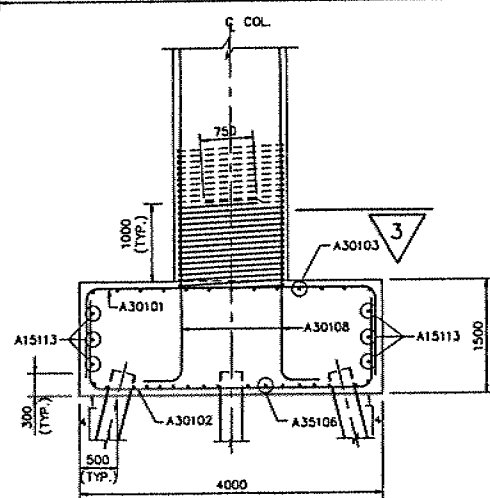
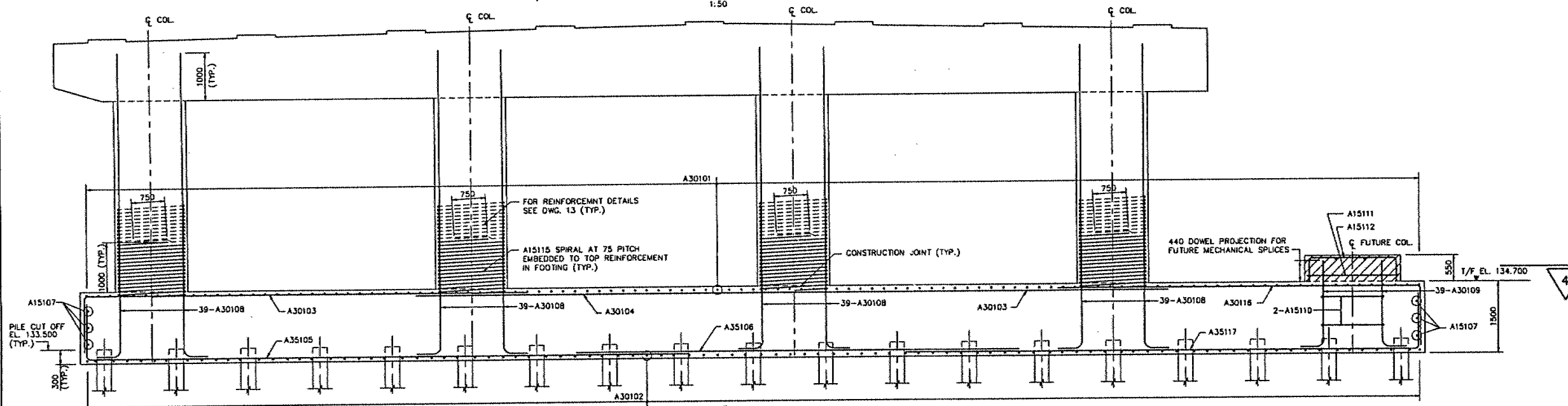
PILE DATA				
LOCATION	No. REQ'D	APPROX. LENGTH (mm)	BATTER	
EAST PIERS	WESTBOUND STRUCTURE	38 7	16 000 15 500	1 : 4 -
	EASTBOUND STRUCTURE	38 7	16 000 15 500	1 : 4 -

LEGEND

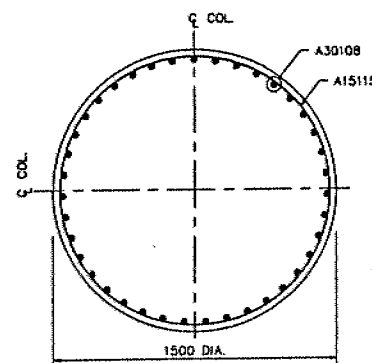
W.B. STR. - WESTBOUND STRUCTURE
E.B. STR. - EASTBOUND STRUCTURE



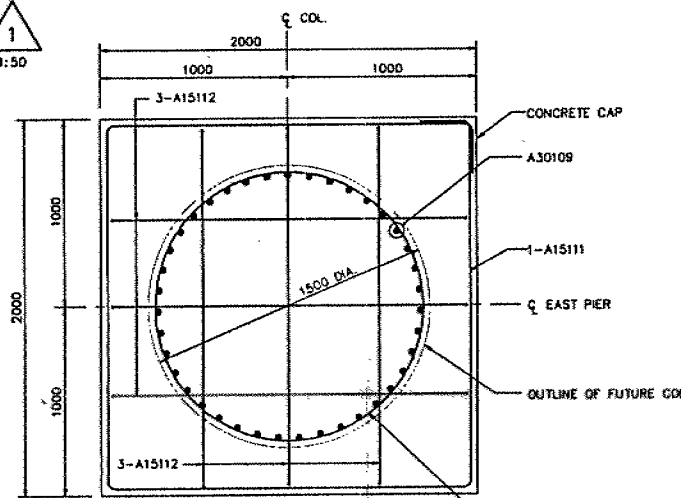
PILE CAP PLAN OF EAST PIER
(EASTBOUND STRUCTURE SHOWN, WESTBOUND STRUCTURE SIMILAR BUT OPPOSITE HAND)
1:50



2
1:50



3
1:20



4
1:20



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

APPLICABLE STANDARD DRAWINGS

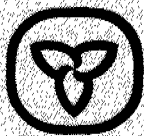
DD-3301 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'H'-PILES

REVISIONS	DATE	BY	DESCRIPTION
DESIGN EL	CHK. ATC	CODE	04B0C-83 LOAD CLASS A DATE FEB./91
DRAWN DT	CHK. ATC	SITE	37-973 STRUCT. SCHEME DWG. 6

RE	DATE	BY	DESCRIPTION				
DESIGN	EL	CHK. ATC	CODE	OHBCD-83	LOAD CLASS A	DATE	FEB./91
DRAWN	DT	CHK. ATC	SITE	37-973	STRUCT.	SCHEME	DWG. 7

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 92-40



Ontario

**Ministry of
Transportation**

1

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	C.P.R. Subway
	W.P. 88-78-16, Site 37-1327
	Hwy. 407, District 6 (Toronto)
	Islington Ave.
	W.P. 88-78-18, Site 37-73-1120
	Hwy. 407, District 6 (Toronto)
	Pine Valley Drive
	W.P. 88-78-20, Site 37-1328
	Hwy. 407, District 6 (Toronto)
	Excavation Cuts (Islington Ave. to
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	W.P. 141-87-00 A , Site -
	Hwy. 407, District 6 (Toronto)
	Hwy. 407 Cut & Detention Pond (Islington Ave.
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	W.P. 141-87-00(A), Site -
	Hwy. 407, District 6 (Toronto)
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	Hwy. 407, District 6 (Toronto)

- 2 -

Jersey Creek Culvert
W.P. 141-87-00C, Site -
Hwy. 407, District 6 (Toronto)

C.P.R Detour
W.P. 141-87-00D, Site -
Hwy. 407, District 6 (Toronto)

High Mast Lighting
W.P. 141-87-00P, Site -
Hwy. 407, District 6 (Toronto)

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

3

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_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 ³	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

GEOTECHNICAL INVESTIGATION
HWY 407 - HUMBER RIVER BRIDGE
EASTBOUND LANES - W.P. 88-78-32
WESTBOUND LANES - W.P. 88-78-15
SITE 37-973, DISTRICT 6, TORONTO

1.0 INTRODUCTION

The Ministry of Transportation of Ontario has retained Golder Associates Ltd. to carry out a geotechnical investigation for the proposed bridge to carry Highway 407 over the Humber River in Vaughan, Ontario. The purpose of the investigation is to determine the subsurface conditions at the site.

The investigation was carried out in accordance with the terms of reference as outlined in Golder Associates Ltd. letters dated February 9 and April 20, 1990.

2.0 SITE DESCRIPTION AND GEOLOGY

The site is located within the Humber River floodplain approximately 0.7 km north of Steeles Avenue and 1.4 km south of Highway 7 in the Town of Vaughan. The floodplain at the proposed Hwy 407 crossing extends about 100 m east of the river to the base of the CP Rail embankment which runs approximately north-south. To the west of the river, the Humber River valley connects with the Rainbow Creek valley.

The site is located within the physiographic region known as the Peel Plain. The surficial soils are comprised of recent floodplain deposits consisting of sands and silts which grade with depth to lacustrine clays and clay tills. The lacustrine clays in this area are known to contain zones of reworked till and the clays are thought to be derived from the underlying till deposit. Water well records indicate that the site is located within a deep

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depression in the bedrock surface. Shale bedrock of the Dundas Formation has been found in the area at depths of 40 m to 60 m below ground surface.

3.0 SUBSURFACE CONDITIONS

The detailed stratigraphy encountered in the boreholes put down during this investigation is shown on the attached Record of Borehole sheets and summarized on Drawing Numbers 887832-A* and 887815-A*. It should be noted that the stratigraphic boundaries indicated on the borehole logs and stratigraphic sections represent transitions between soil types and are not intended to define exact planes of geologic change. The subsurface conditions have been identified at the borehole locations only and will vary between and beyond the boreholes.

The locations of the boreholes are shown on Dwg. No.'s 887832-A* and 887815-A*. The results of laboratory testing carried out on representative samples obtained during the investigation are shown on the Record of Borehole sheets and on Figures 1 to 13. In general, the subsoils at the site consist of surficial loose granular deposits ranging from sandy silt to sand and gravel overlying a deposit of stiff to very stiff clayey silt interlayered with silty clay and silt. The clays and silts are underlain by a complex sequence of interlayered hard clayey silts and very dense silts. A sand and gravel deposit was encountered underlying the hard/very dense strata; the lower granular deposit is under artesian pressure with piezometric head up to about 5 m above ground surface. The following is a summary of the strata encountered at the borehole locations.

* DWG NO'S 2 & 2A OF THE CONTRACT DWG'S (SHEET NO'S 252 & 252-1)

3.1 Surficial Sandy Silt to Silty Sand

In all of the boreholes, about 0.7 m to 1.8 m of a deposit which ranges in composition from sandy silt to silty sand was encountered underlying about 0.3 m to 1.6 m of topsoil. The deposit is in a loose to very loose state of packing with Standard Penetration ('N') values ranging from 2 to 11 blows per 0.3 m of penetration. The measured water content of samples of this deposit range from 18 to 27 percent with an average of 23 percent for nine samples.

In Boreholes 1 and 17, the sandy silt deposit is underlain by about 0.5 m to 0.8 m of organic silt. Measured water contents of two samples of the organic silt were 28 percent and 44 percent. The organic content of one sample of organic silt from Borehole 17 was 3 percent.

3.2 Upper Sand to Sand and Gravel

In all of the boreholes, except Boreholes 1 and 11, the surficial sands and silts are underlain by about 0.5 m to 1.7 m of a deposit which varies in composition from sand containing some gravel to sand and gravel (see Figure 1). The deposit is generally in a loose to compact state of packing with 'N' values ranging from 3 to 22 blows per 0.3 m of penetration. Two measured water contents of the sand portions of the deposit were 10 and 18 percent.

3.3 Upper Clayey Silt

The granular deposits are underlain at all borehole locations by about 3.3 m to 9.7 m of a deposit which consists primarily of clayey silt with a trace of sand but which varies in overall composition across the site. The

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upper 3.3 m to 6.5 m of the deposit exhibits little stratification and contains a variable proportion of coarse sand sizes with occasional fine gravel. These components give this portion of the deposit a till-like texture. The lower 1.6 m to 5.6 m of the deposit contains silty clay interlayers which differ mainly in plasticity and is stratified with frequent silt partings. The upper and lower portions of the clay stratum in Boreholes 1, 2, 4, 5, 6, 7 and 9, are separated by about 0.7 m to 3 m of a deposit consisting mainly of silt but which contains interlayers of clayey silt and silty sand. The natural water content measured on six samples of the silt ranged from 18 to 28 percent with average of 23 percent.

The results of laboratory testing on the clayey silt deposit are as follows:

Natural Water Content	# of tests	range	average
Massive to till-like layers	29	16 to 31%	23%
Stratified layers	17	20 to 26%	23%
Atterberg Limits			
(see Figures 10 and 11)	# of tests	range	average
Liquid Limit	8	24 to 37%	29%
Plastic Limit	8	19 to 26%	20%
Plast. Index	8	5 to 14%	9%

The above Atterberg Limits test results indicate a silt to clay of low plasticity and clay of low plasticity.

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The piezocone penetration tests carried out adjacent to Boreholes 6 and 17 and indicate the extreme variability of stratification within the deposit which is not evident by routine sampling. The stratification consists mainly of silt layers and till-like zones. Although not detected in the samples obtained at all of the borehole locations, it is probable that this layering exists across the site.

The measured consistency of the layered deposit is also variable at the borehole locations. 'N' values range from 4 to 24 blows per 0.3 m of penetration. Undrained shear strength values, measured by in-situ vane tests, range from 42 kPa to 103 kPa (sensitivity ranging from 2 to 4) with higher strength values indicated by refusal to turning of the vane. Interpretation of the piezocone penetration test results also indicate extremely variable undrained shear strength profiles across the site. Over the depth of each clayey silt layer, the undrained shear strength is relatively constant, ranging from about 25 kPa to 135 kPa at the three piezocone penetration test locations. There does not, however, appear to be a consistent correlation with depth across the site.

Two consolidation tests were carried out on samples of this deposit obtained at a depth of about 3.5 m in Borehole 5 and at 7.2 m in Borehole 17. Preconsolidation pressures of 220 kPa and 270 kPa were calculated from the results of tests carried out on samples from Boreholes 5 and 17, respectively (see Figures 12 and 13). These values correspond to over-consolidation ratios of 6 and 5, respectively.

The trend of preconsolidation pressure, interpreted from the piezocone traces, indicate that there two distinct

geologic layers present within this clayey silt deposit. In the upper 1 m to 2 m, the preconsolidation pressure decreases with depth reaching a minimum at the top of a silt stratum which separates the two clayey silt layers. Within the lower portion of the deposit, the preconsolidation pressure commences at a higher value than the minimum of the upper layer, decreases to a minimum at about 8 m to 9 m depth below ground surface and then increases below that depth.

3.4 Middle Silts

In Boreholes 7, 8, 11, 12, 14, 15, 16 and 17, the clayey silt stratum is underlain by about 1.8 m to 5.3 m of a deposit consisting of silt to silty sand (see Figure 3 and 4). Blowing of the fine granular materials occurred within this deposit at most of the borehole locations. Based on observations during drilling, it is considered that the deposit is in a loose to compact state of packing. Measured 'N' values range from 1 to 20 blows per 0.3 m of penetration with an average value of 7. The natural water content measured on 8 samples of this deposit ranged from 14 to 26 percent with an average of 23 percent.

3.5 Lower Till, Clayey Silts and Silts

The clayey silt and silt deposits are underlain at depths of about 11.4 m to 14.6 m by a complex sequence of hard clayey silt to very dense silt strata containing a variable proportion of sand and gravel. Grain size distribution curves carried out on samples of these strata are shown on Figures 5 to 9. The till deposits encountered range in composition from a heterogeneous mixture of silt, sand and gravel to clayey silt containing some sand. The tills are

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interlayered and underlain by silt to stratified clayey silt strata.

The surface of the hard/very dense deposit was generally encountered at about Elevation 120.6 m to 123 m in the boreholes located on the east side of the river and at Elevation 123.3 m to Elevation 124.7 m in the boreholes on the west side of the river. 'N' values measured in this deposit were generally greater than 100 blows per 0.3 m of penetration. 'N' values of 25 to 87 blows per 0.3 m of penetration were measured, however, in the upper 5.2 m of the clayey silt and silt strata in Borehole 9 and the upper 2.8 m in Borehole 4 (at the south limits of Pier 1 and the west abutment, respectively). For the total of 47 'N' values obtained within these strata, 12 were less than 100 blows with an average of 60 blows per 0.3 m of penetration.

The following table summarizes the results of laboratory tests carried out on samples of the hard/very dense strata.

Stratum	Test	# of tests	range	average
Clayey Silt	Water Content	15	10 to 17%	14%
	Atterberg Limits (Figures 10 and 11)			
	Liquid Limit	5	23 to 29%	25%
	Plastic Limit	5	16 to 20%	18%
Silt	Water Content	9	14 to 19%	16%
Till	Water Content	9	7 to 11%	9%

3.6 Lower Sand and Gravel

The tills and silts were penetrated in Boreholes 15 and 17 on the east side of the river and were found to be underlain by a sand and gravel deposit which was encountered at about Elevation 115 m and Elevation 116 m (19.5 m and 20.5 m below ground surface) in Boreholes 15 and 17, respectively. The sand and gravel deposit is in a very dense state of packing with 'N' values greater than 79 blows per 0.3 m.

3.7 Groundwater Conditions

During drilling of Boreholes 15 and 17, artesian pressure conditions were encountered as soon as the tills and silts overlying the sand and gravel deposit were penetrated. The head of water was estimated to be about 4.6 m above ground surface at the location of Borehole 17 based on the height to which the water level rose within the hollow stem augers which were installed at ground surface. Because of the high water pressure, these two boreholes had to be packed off with mechanical packers and cement grout was pumped into the hole below the packers until the flow was stopped. Artesian pressure conditions were also noted in Boreholes 9, 11, 12 and 16 which were terminated within the till or the underlying silt strata; in these boreholes, the water level rose to ground surface within a few hours of completion of the drilling. With the relatively low flow of water, it was possible to install a grout plug at the bottom of these boreholes to stop the flow without the use of mechanical packers. All of the above boreholes, where artesian conditions were encountered, are located on the east side of the river.

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Piezometers were installed into ten of the boreholes, sealed into the various strata encountered during the drilling. The water level in the piezometer installed in the upper sand and gravel layer in Borehole 12 was at about 1.2 m below ground surface, coincident with the adjacent river water level. All of the remaining piezometers registered artesian pressure conditions.


The head measurements for the piezometer installations which were sealed into the lower hard/dense tills and silts indicate a piezometric level in these strata at about Elevation 136.4 m to Elevation 140.7 m (about 1.4 m to 5.2 m above ground surface) on both sides of the river. Piezometers sealed into the overlying loose silts and stiff clayey silt deposits indicate the piezometric level to be about Elevation 135.8 m to 138.6 m (about 0.5 m to 2.5 m above ground surface) dependant on the elevation of the tip. These results reflect an overall upward gradient through the strata present between the lower sand and gravel deposit and the surficial sands.

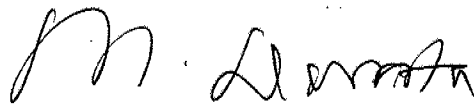
Subsequent to measuring the water levels in the piezometers which registered artesian head, the installation were capped using the procedure outlined below. It should be noted that the tubing is only blocked to a depth of about 0.6 m below ground surface; excavations during construction extending below this depth will remove the seal to the piezometers and further blocking will be required.

- o A shallow hole was dug around each installation and the 50 mm diameter PVC piezometer tubing was cut off at about 0.2 m below ground surface; bentonite gravel was then forced down the tube until the tubing was bridged.

- o Powder cement was poured into the tubing and a PVC cap was glued onto the top of the tubing.
- o A concrete cap of Type 10 Portland cement, minimum thickness of 150 mm, was placed in the hole surrounding the installation sealing the PVC cap in place. This concrete is exposed at ground surface.

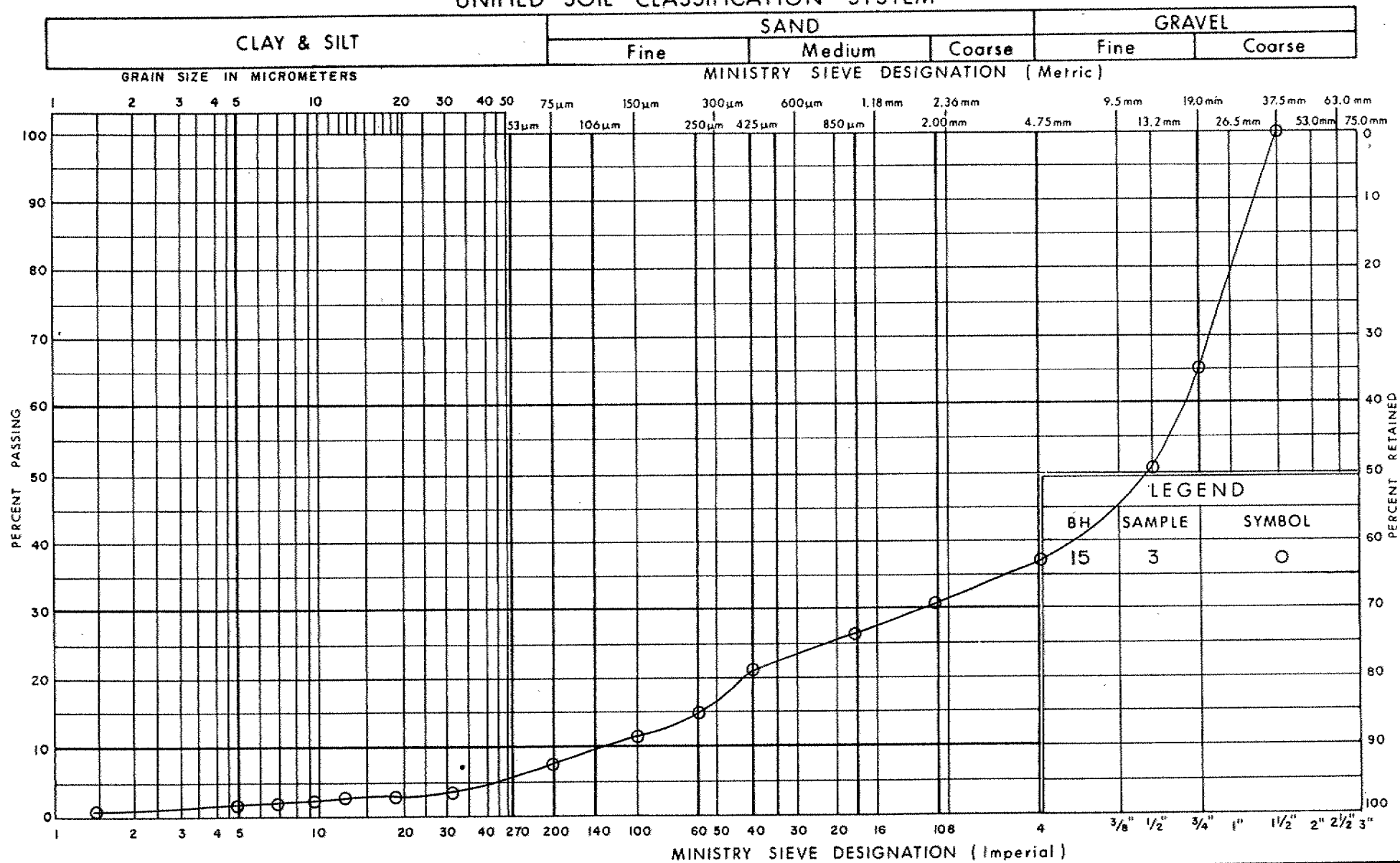
Note: The preceding report is a copy of the factual information from the Foundation Report prepared by GOLDER ASSOCIATES (consulting geotechnical engineers for this project), under the technical supervision of the M.T.O. Foundation Design Section.


for Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

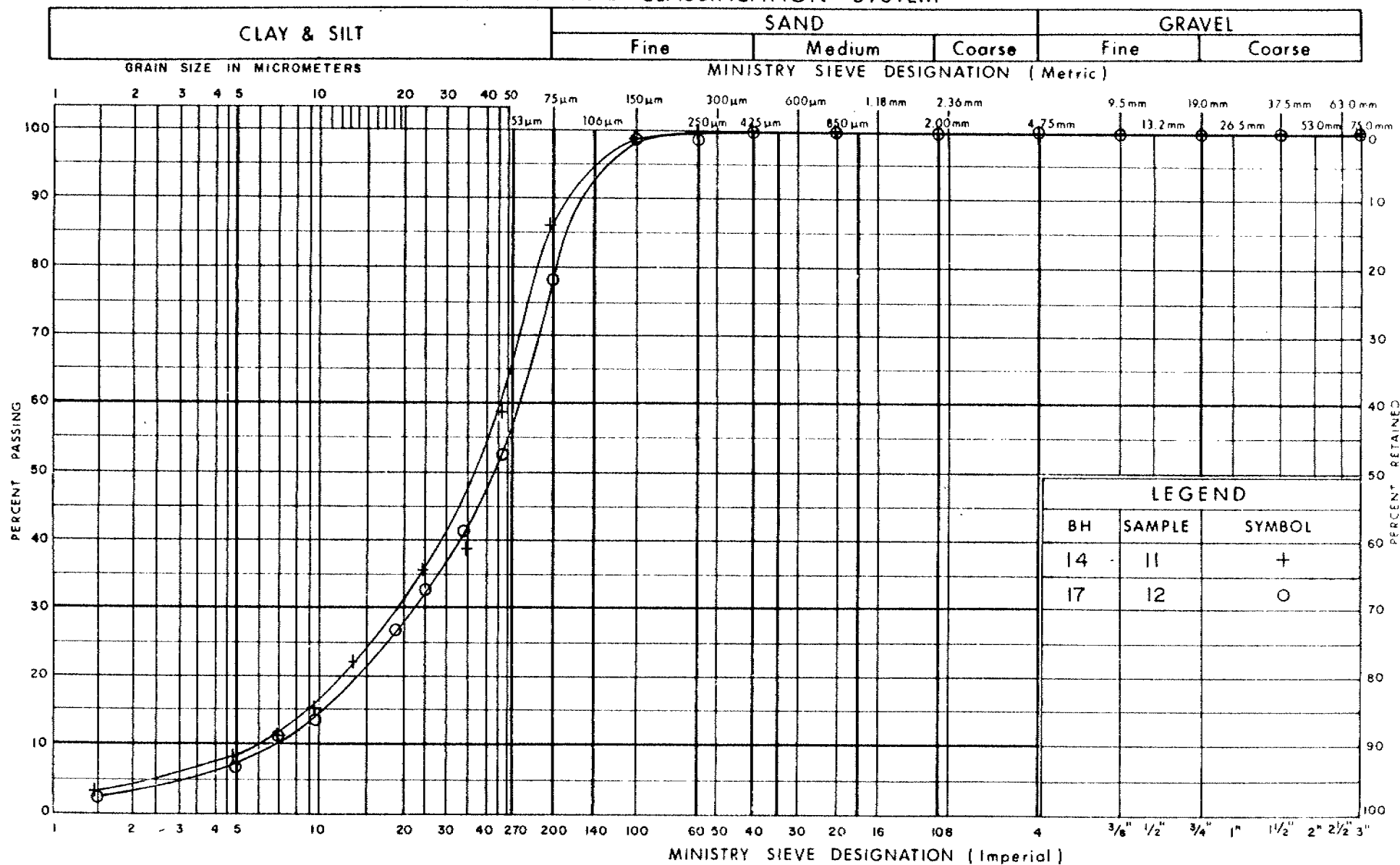
Ministry of
TransportationGRAIN SIZE DISTRIBUTION
SAND AND GRAVEL

FIG No 1.

W P 88 - 78 - 32
88 - 78 - 15

51

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

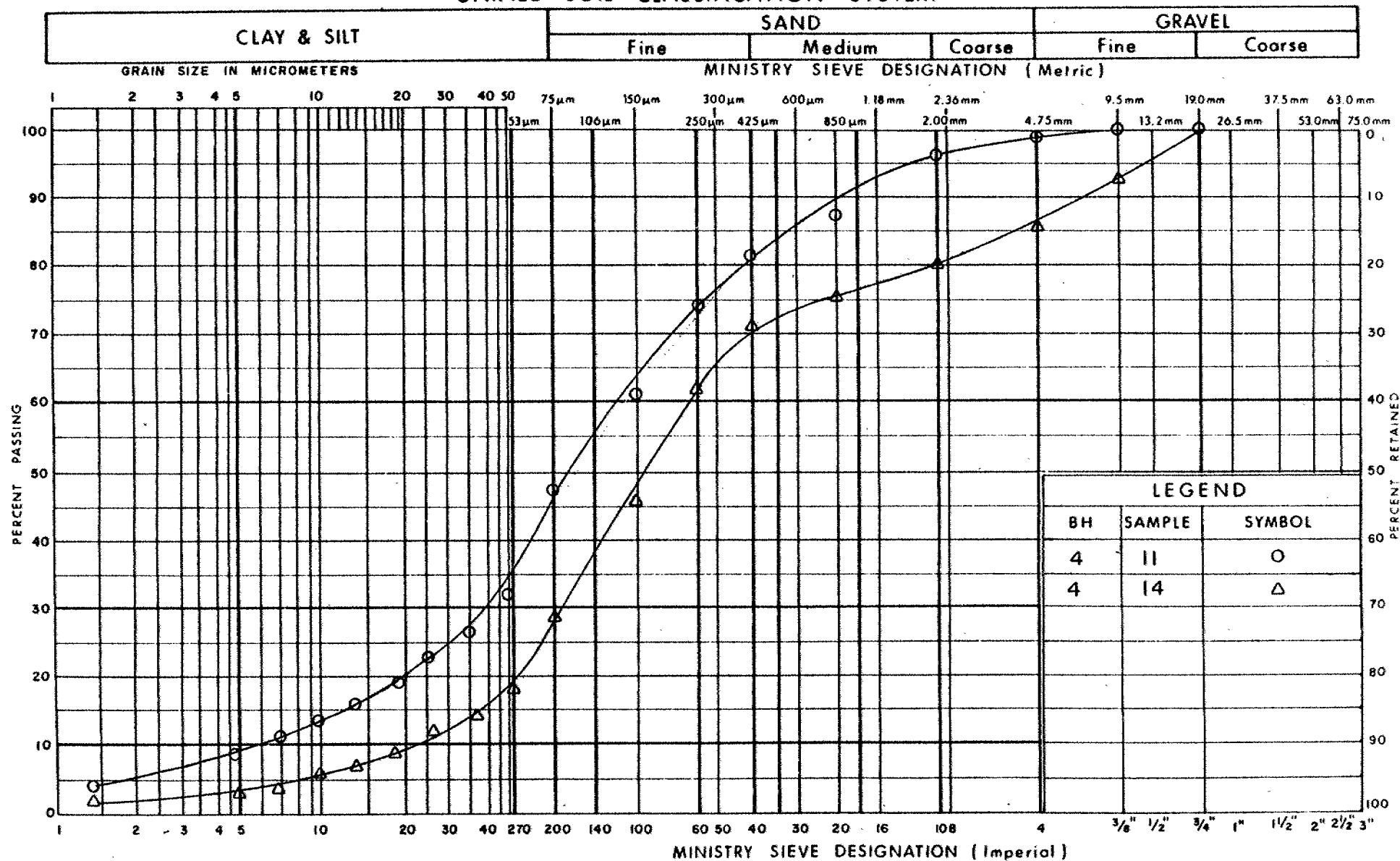
SILT

FIG No 3.

W P 88 - 78 - 32
88 - 78 - 15

16

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

SILT AND SAND TO SILTY SAND

FIG No 4

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

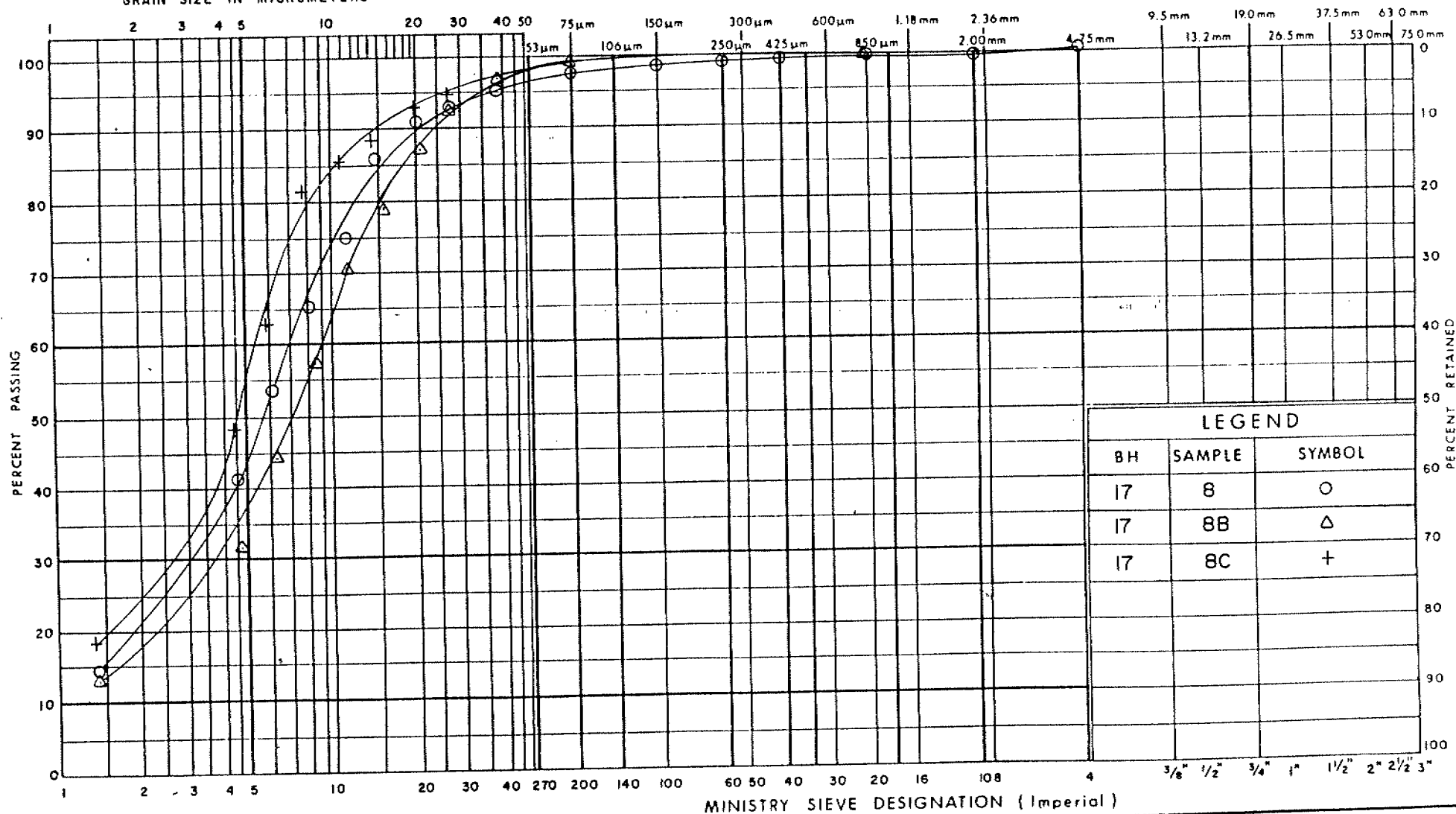
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

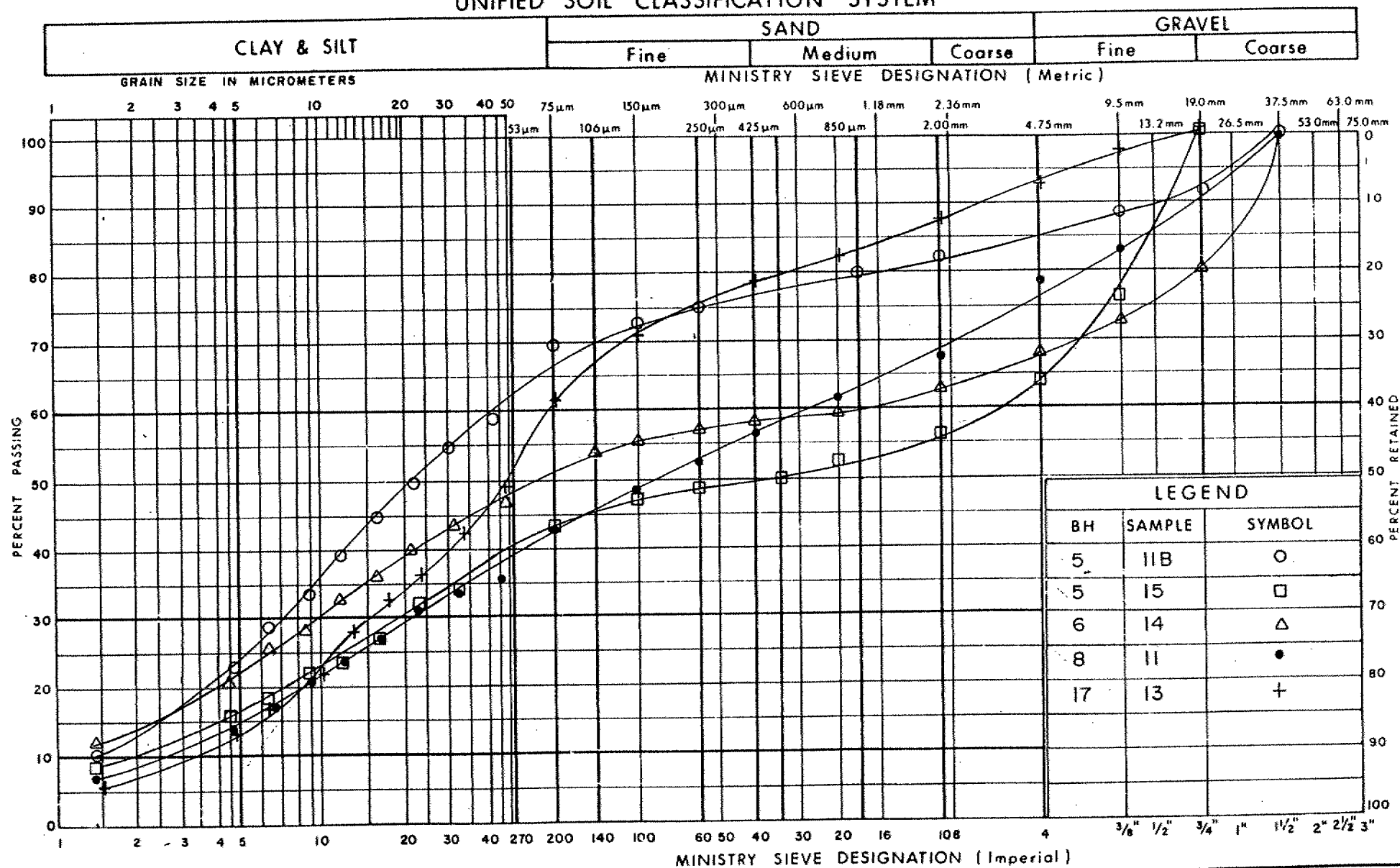
BH	SAMPLE	SYMBOL
17	8	○
17	8B	△
17	8C	+

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY

FIG No 2.

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

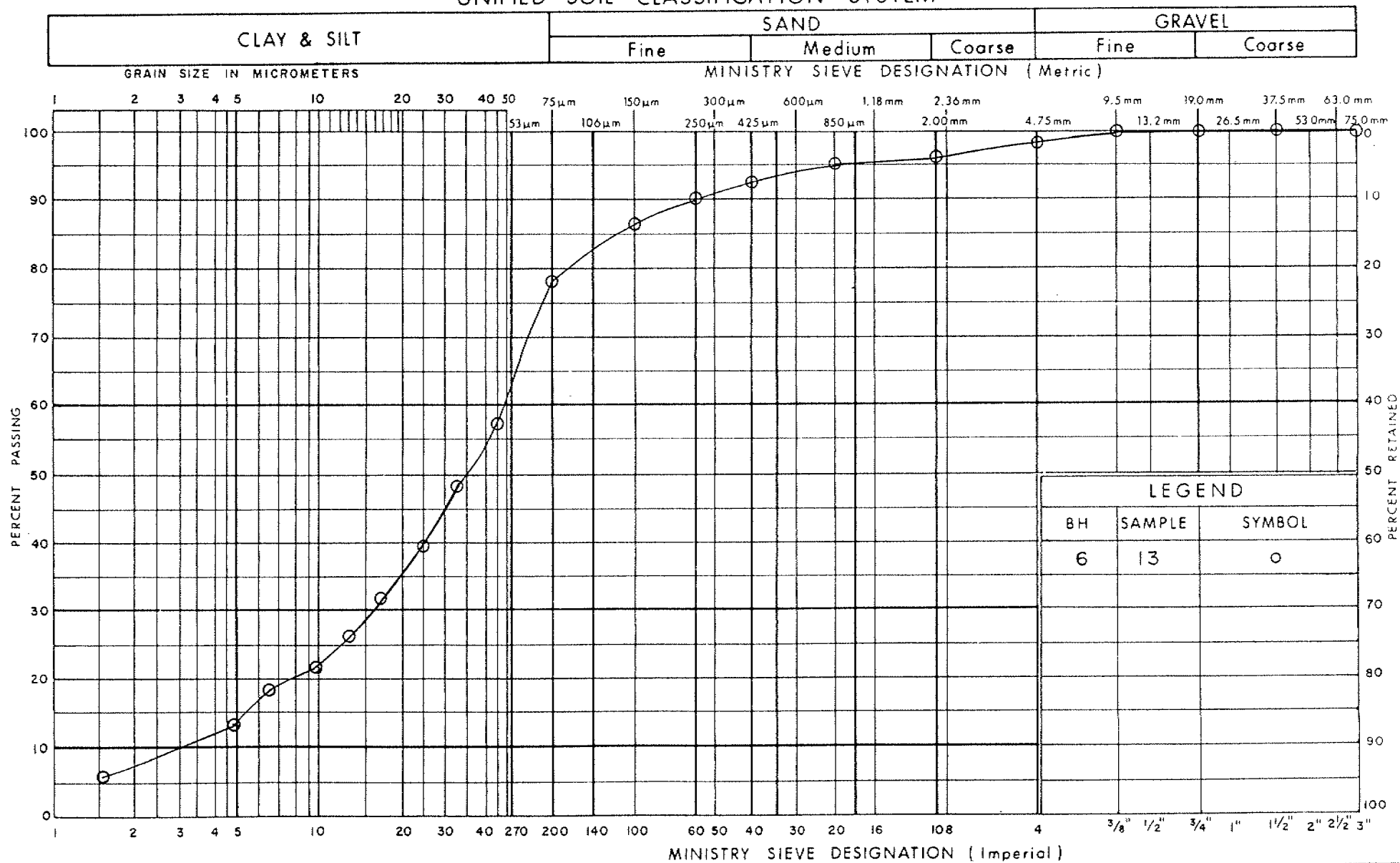
GRAIN SIZE DISTRIBUTION

SILT TILL

FIG No 5.

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

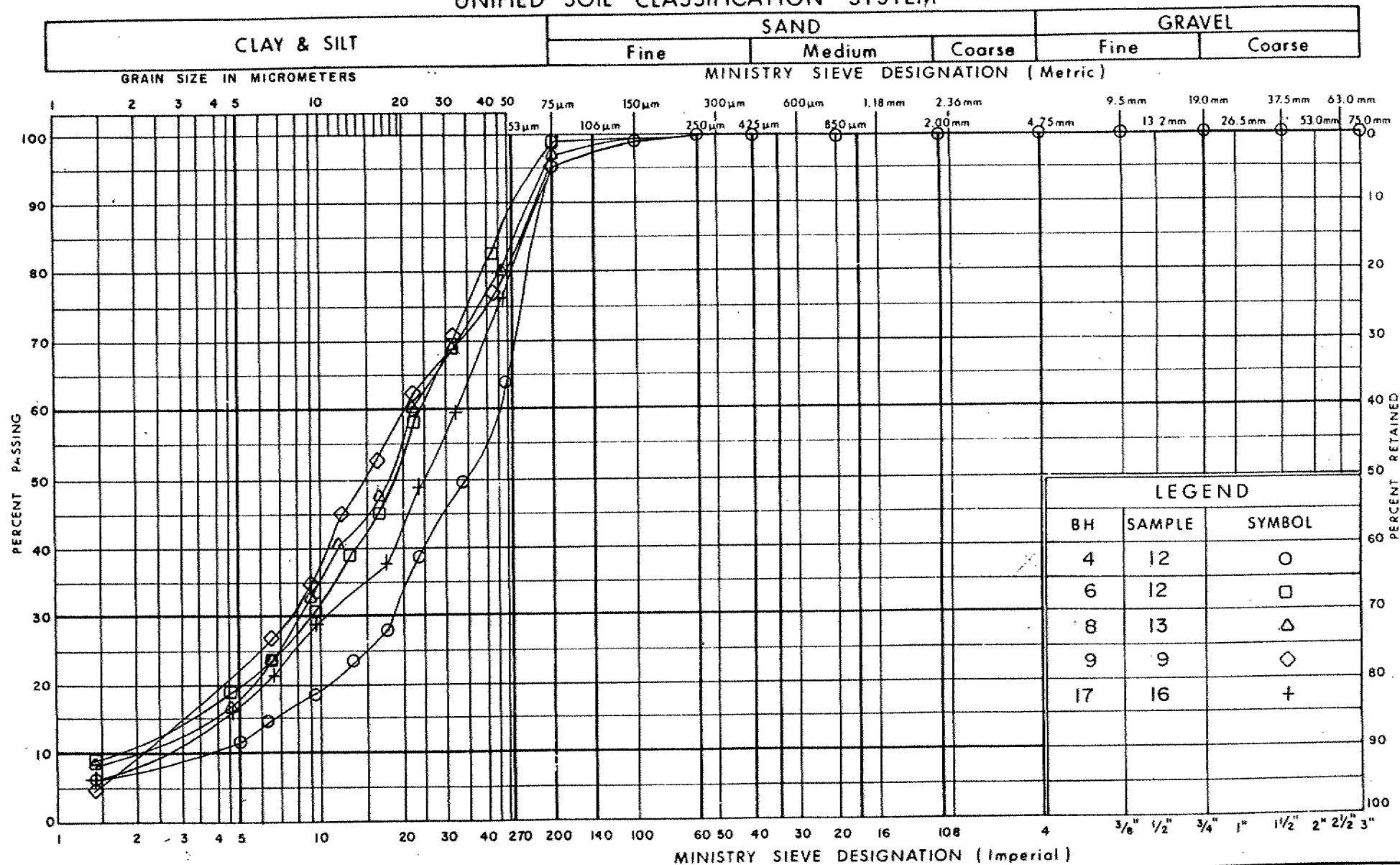
GRAIN SIZE DISTRIBUTION

SANDY SILT

FIG No 6.

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

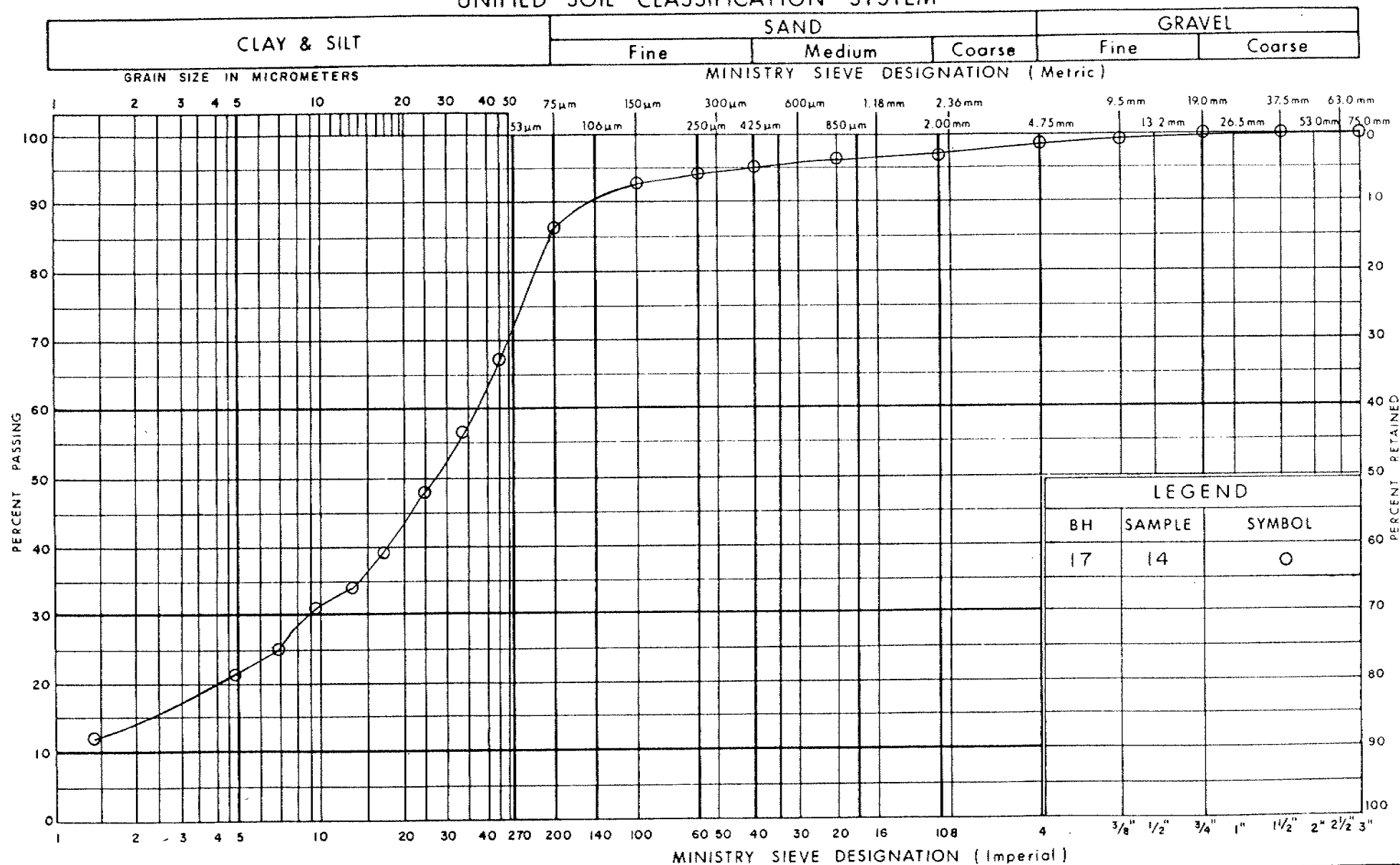
GRAIN SIZE DISTRIBUTION

SILT

FIG No 7.

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



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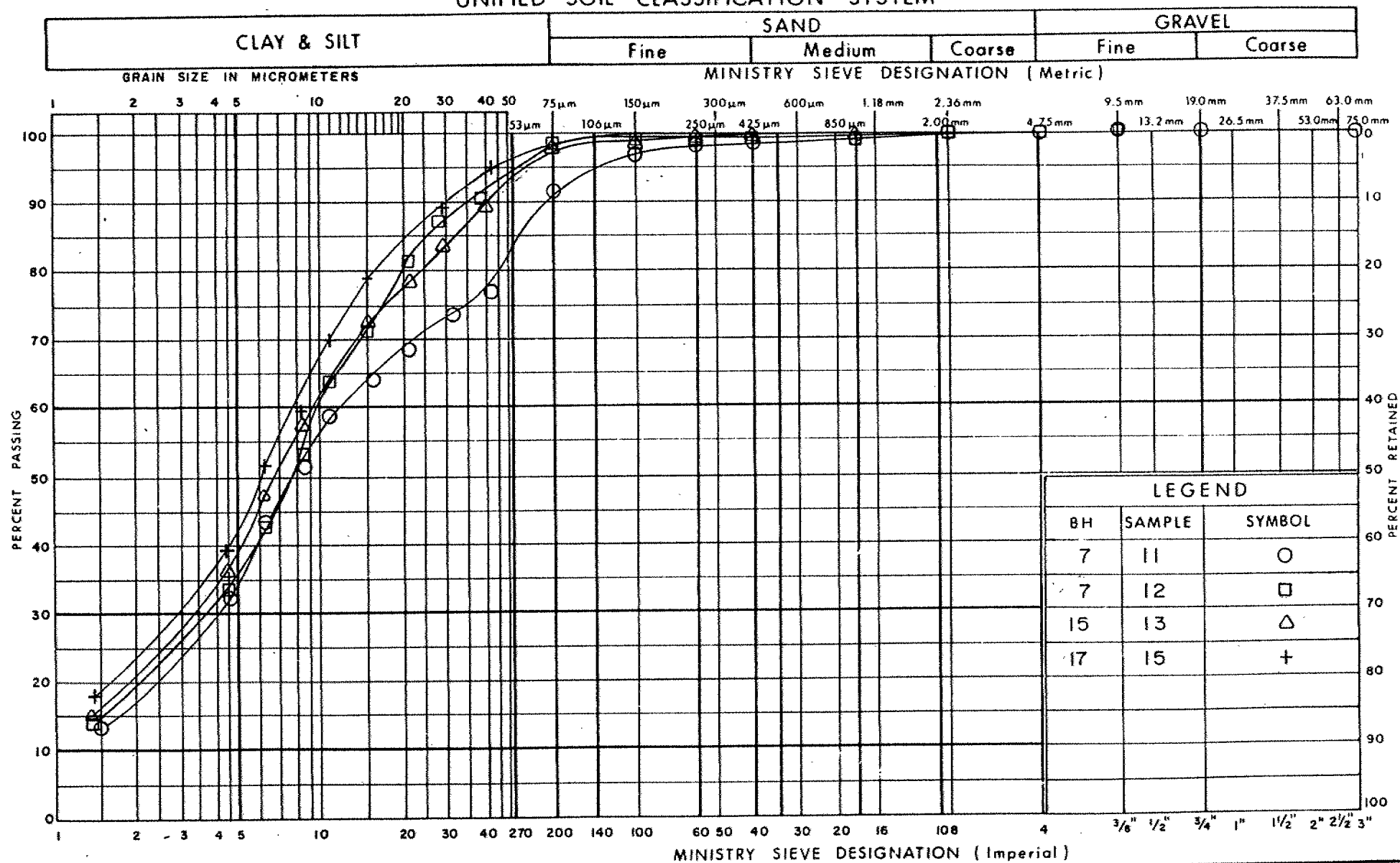
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

FIG No. 8.

W P 88 - 78 - 32
88 - 78 - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



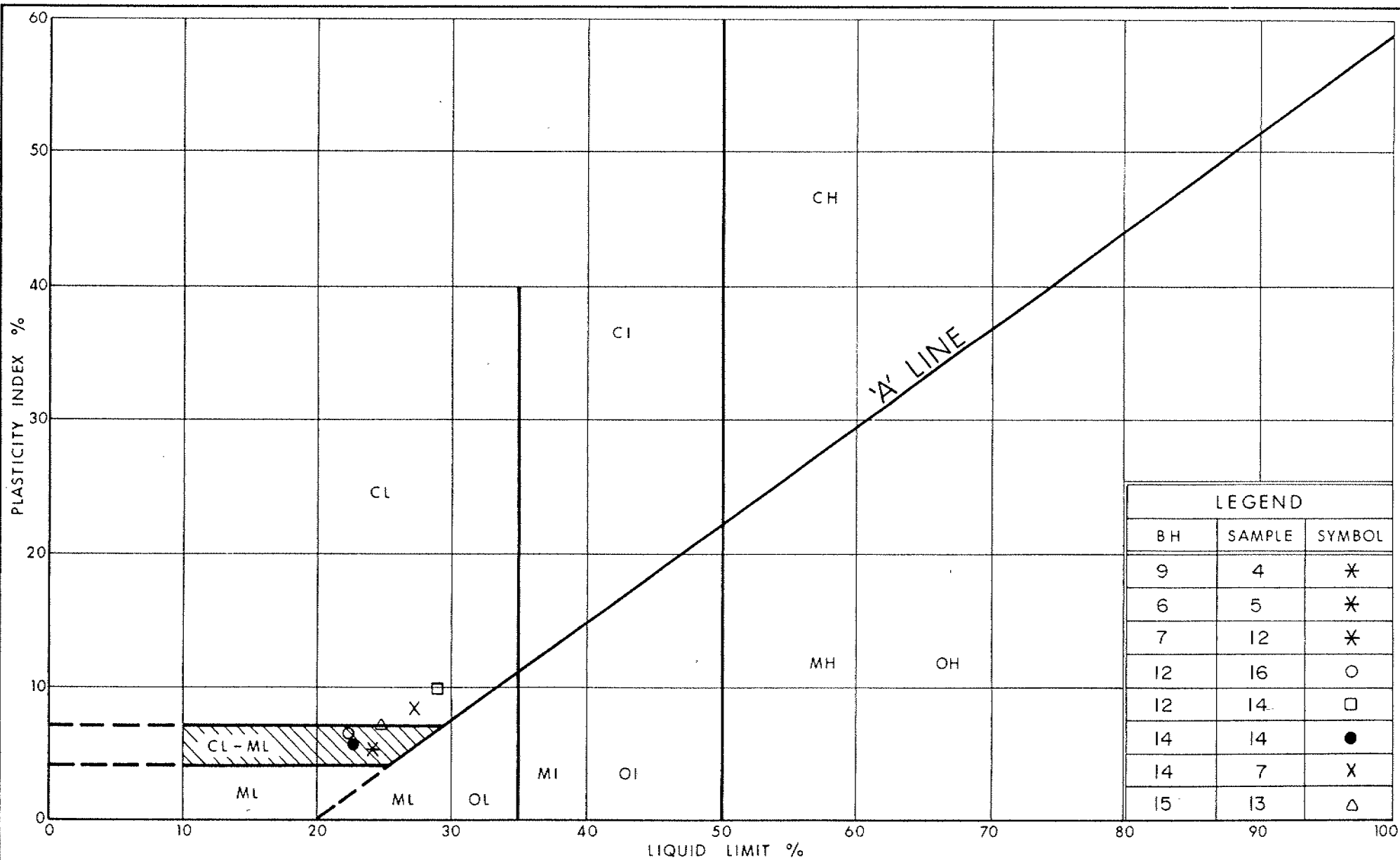
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GRAIN SIZE DISTRIBUTION

CLAYEY SILT TO SILTY CLAY

FIG No 9.

W P 88 - 78 - 32
88 - 78 - 15



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Transportation

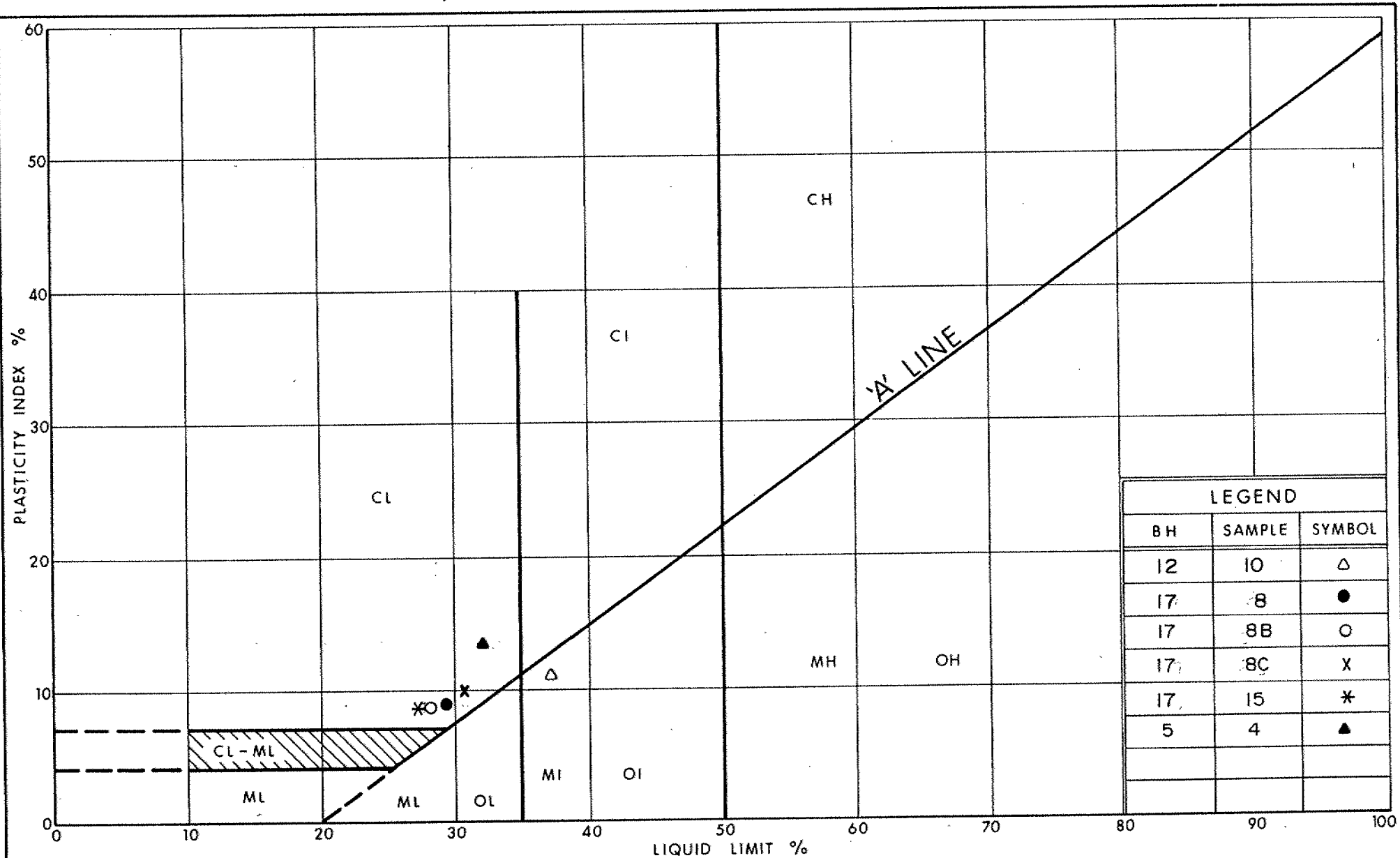
Ontario

PLASTICITY CHART

FIG No 10.

W P 88 - 78 - 32

88 - 78 - 15



Ministry of
Transportation

Ontario

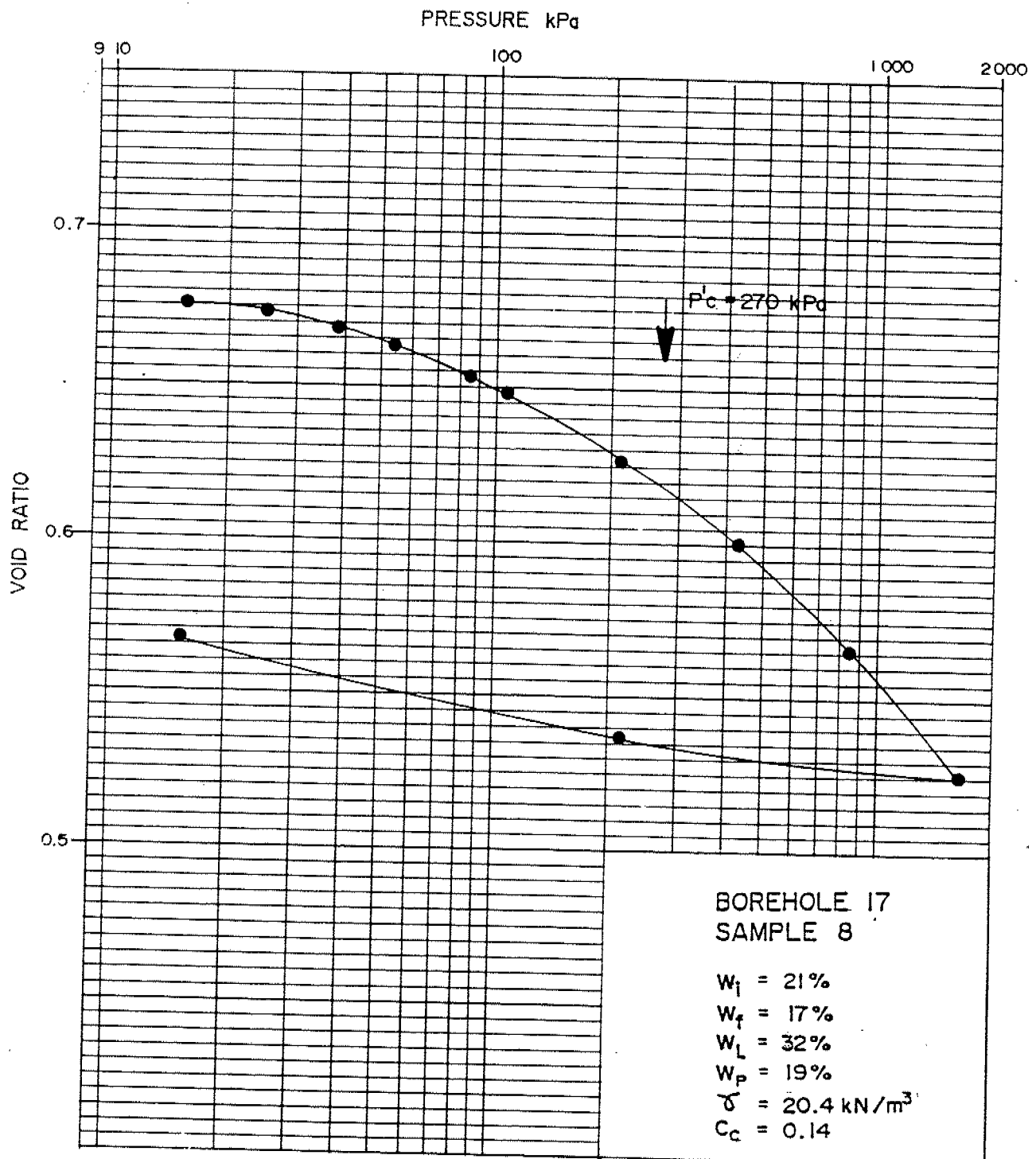
PLASTICITY CHART

FIG No II.

W P 88-78-32
88-78-15

VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

26
FIGURE 12..



Date APRIL 26, 1990

Project 901-1314

Golder Associates

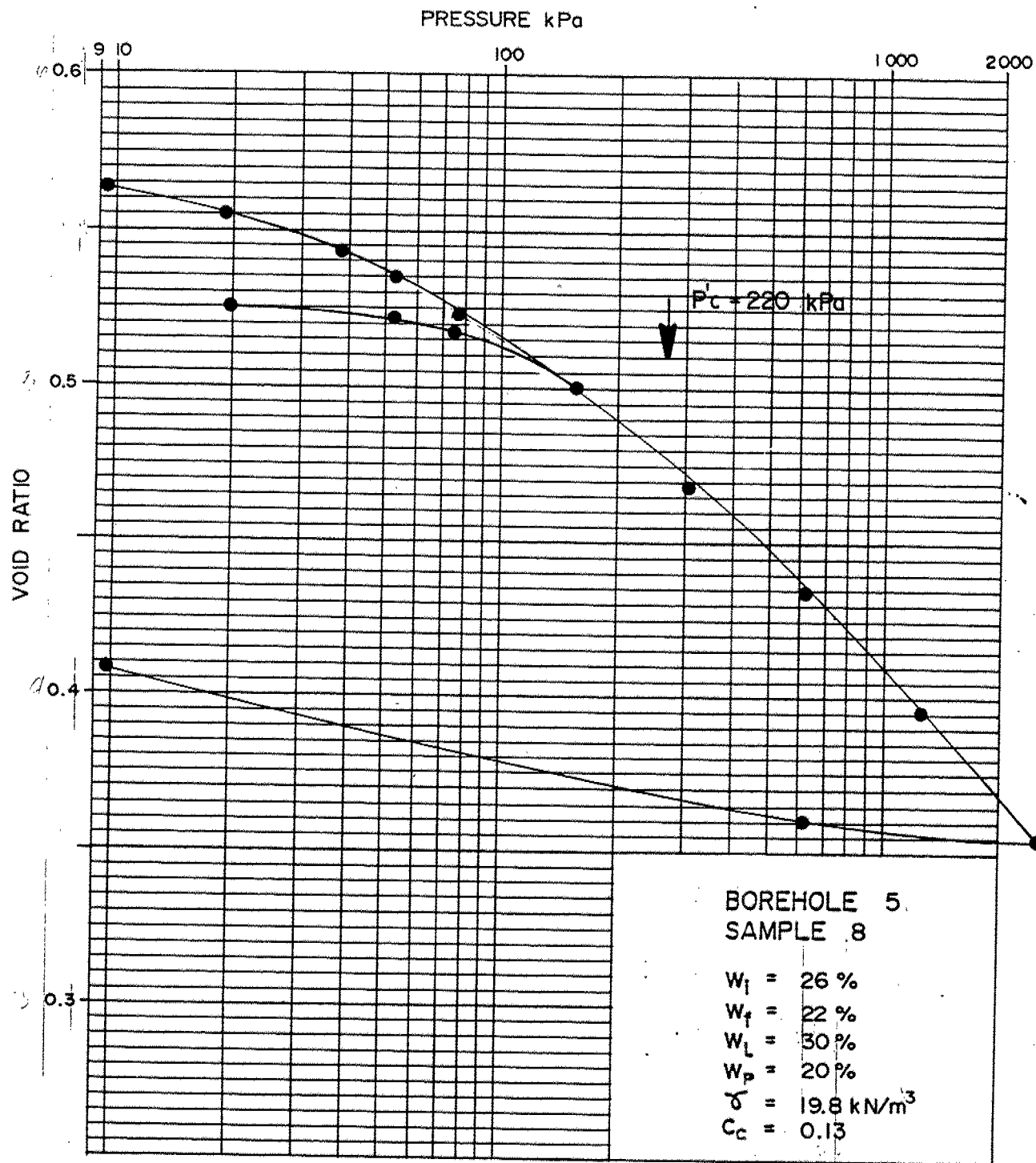
Drawn R.B.C.

Chkd.

VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

27

FIGURE 13.



Date APRIL 26, 1990

Project 901-1314

Golder Associates

Drawn R.B.C.

Chkd.

RECORD OF BOREHOLE No 1

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,389.6N;297,984.7E
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers
 DATUM Geodetic DATE March 22, 1990
 ORIGINATED BY RF
 COMPILED BY ASP
 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
135.78	Ground Surface																
0.00	Sandy Silt (Topsoil)		1	SS	2												
134.18	Very loose Brown		2	SS	5		134										
1.60	Clayey Silt, trace organics Firm		3	SS	19												
133.36	Organic Sandy silt		4	SS	20												
132.82	Clayey Silt, trace sand, occasional gravel (Till-like texture)		5	SS	26		132										
2.90	Very stiff Grey		6	SS	25												
			7	SS	21		130										
128.78	Silt, trace sand; inter-layered with silt and sand, fine occasional clayey silt seam.		8	SS	13		128										
7.00	Compact Grey		9	SS	20												
126.18	End of Borehole																
9.60																	

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

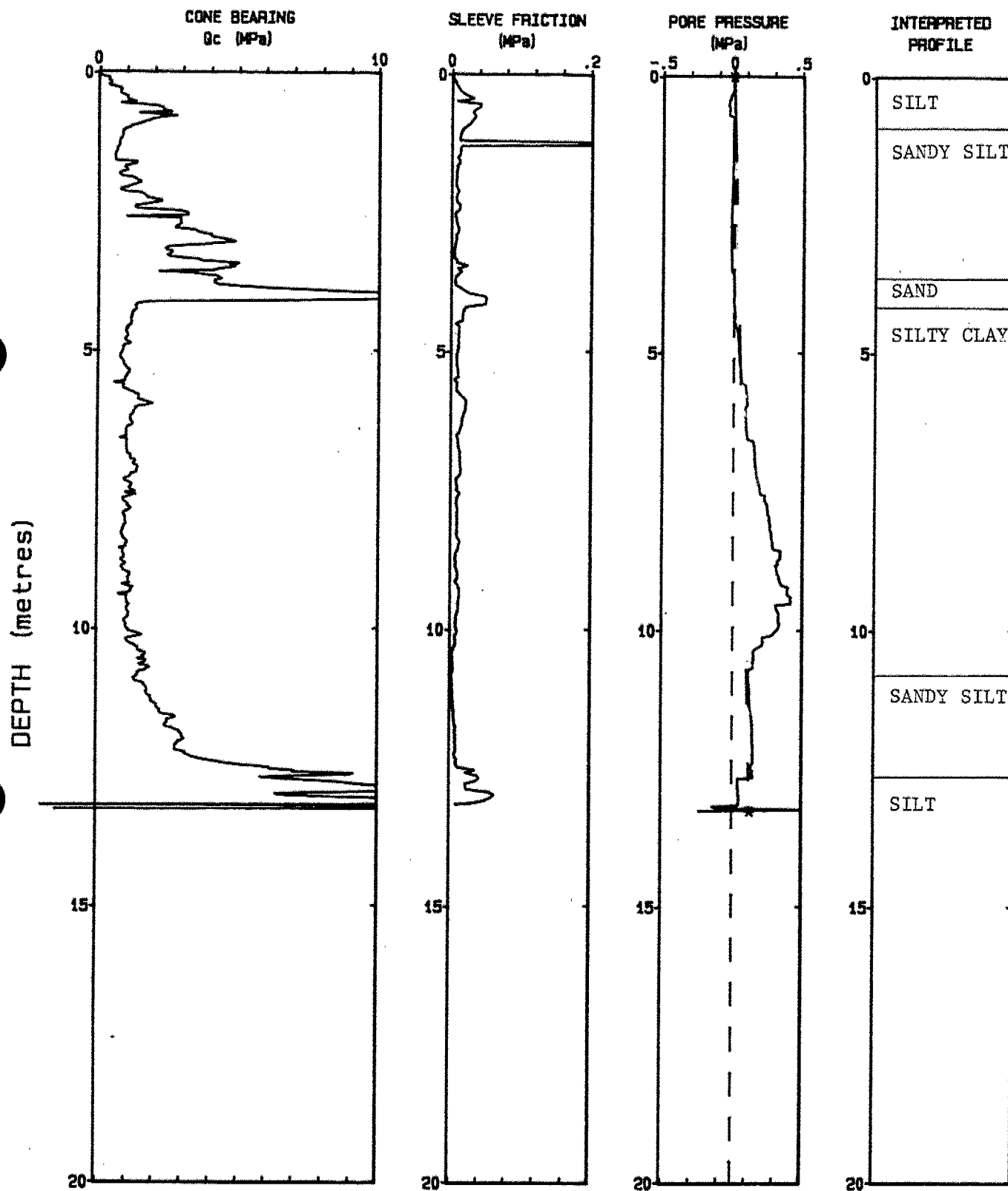
RECORD OF CPT 1

29

Location: SEE FIGURE 2
 Prebore Depth: 0.0m

DATE 90-03-19
 Cone: 3015

Page No: 1 / 1
 Project No: 901-1314



Depth Increment : .025 m

Max Depth : 13.275 m

RECORD OF BOREHOLE No 2

METRIC 30

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,372.8N;298,011.6E

ORIGINATED BY AJW

DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers

COMPILED BY ASP

DATUM Geodetic DATE March 23, 1990

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
135.11	Ground Surface															
0.00	Organic Silt.															
133.81	Firm Brown		1	SS	6		134									
1.30	Sandy Silt, trace clay, some organics.		2	SS	9		Water Level Elev. 135.8 m April 5, 1990.									
133.01	Loose Brown															
2.10	Sand and gravel, trace silt		3	SS	21											
132.21	Compact Grey															
2.90	Stratified Silty Clay and clayey silt, trace sand, frequent silt partings.		4	SS	11											
	Very Stiff Grey		5	SS	16											
			6	SS	15											
			7	SS	14											
127.81																
7.30	Silt, trace clay interlayered with clayey silt and sandy silt.		8	SS	17											
125.51	Loose to compact Grey		9	SS	8											
9.60	End of Borehole.															

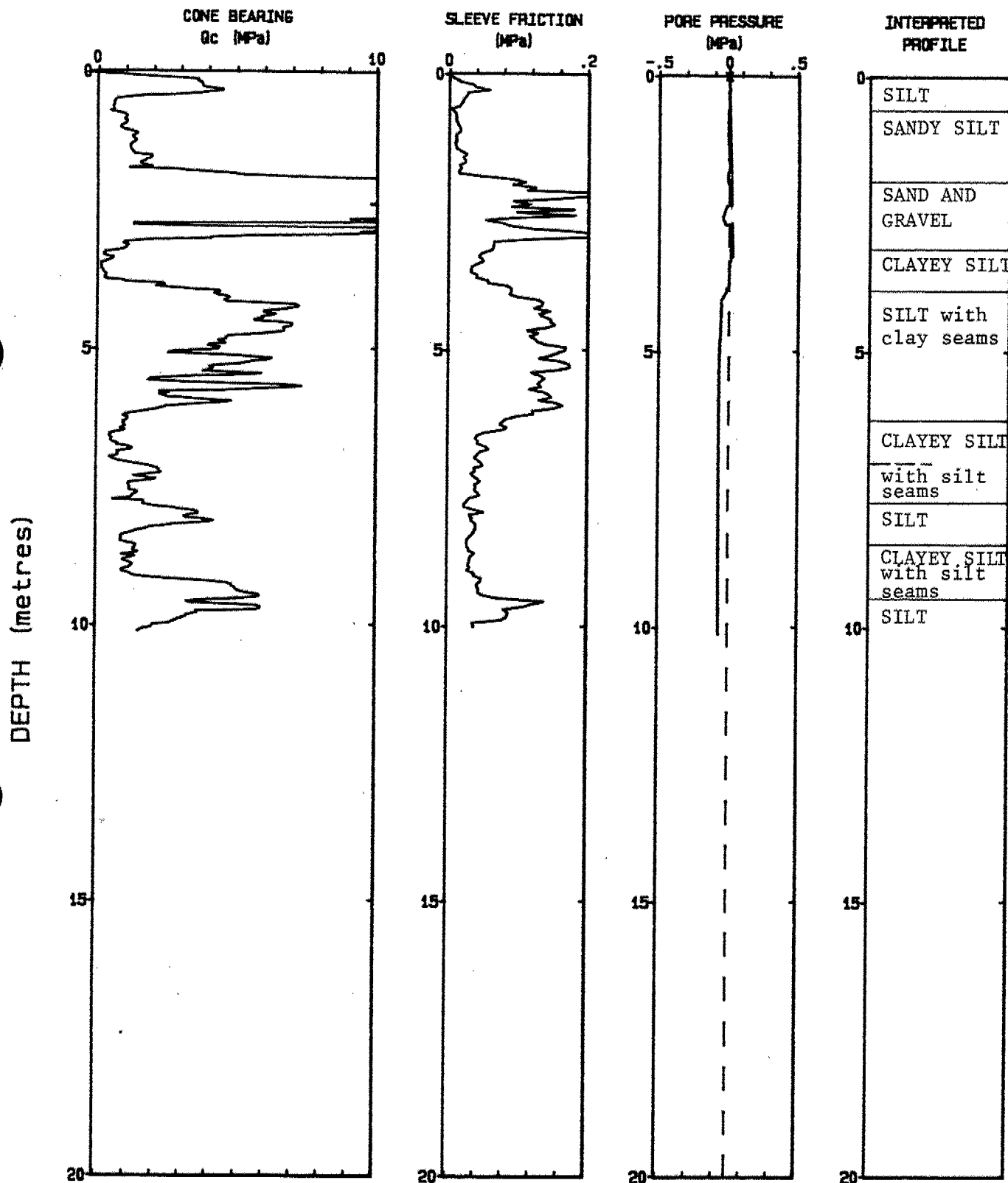
RECORD OF CPT2

31

Location: SEE FIGURE 2
 Prebore Depth: 0.0m

DATE 90-03-19
 Cone: 3015

Page No: 1 / 1
 Project No: 901-1314



Depth Increment : .025 m

Max Depth : 10.125 m

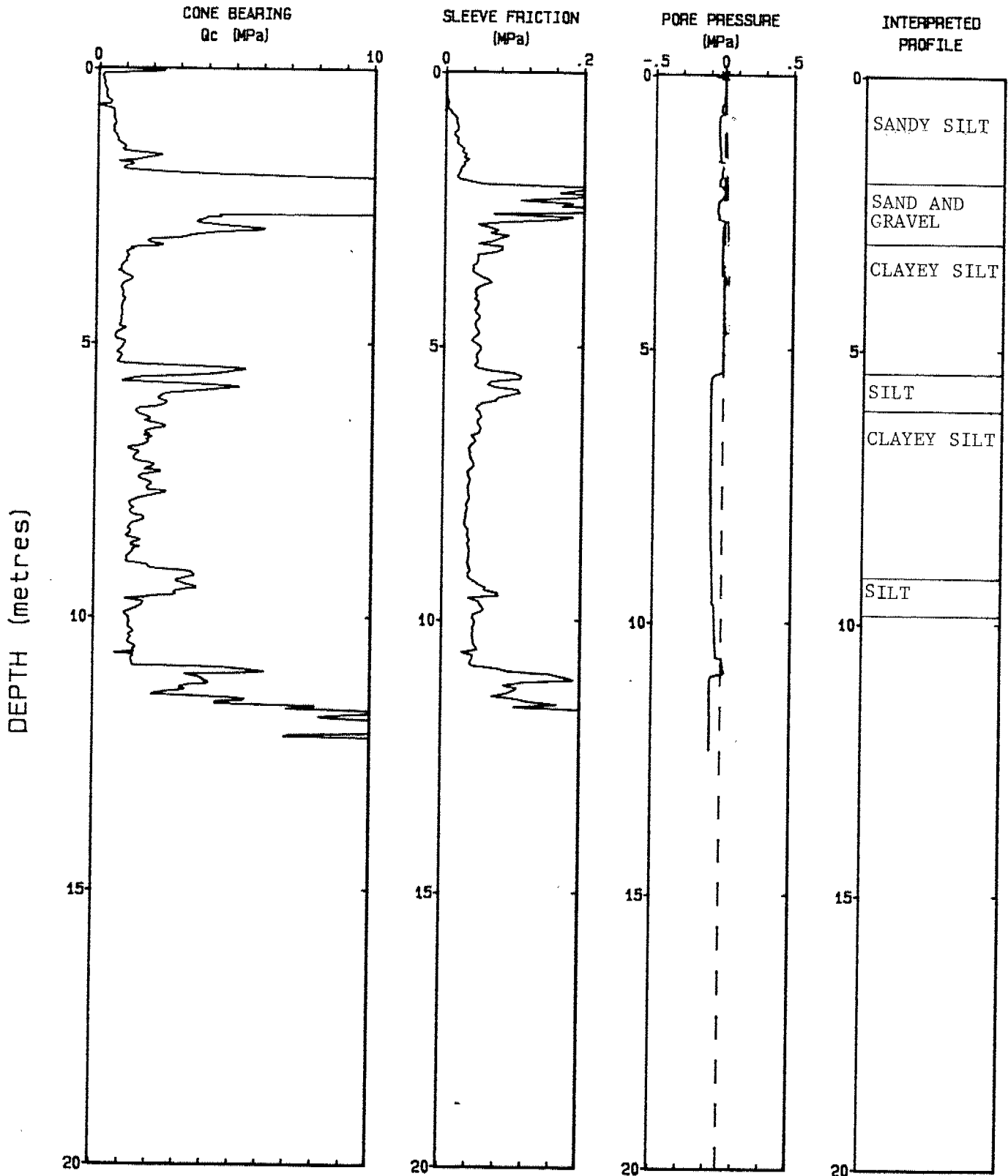
RECORD OF CPT3

32

Location: SEE FIGURE 2
 Prebore Depth: 0.0m

DATE 90-03-19
 Cone: 3015

Page No: 1 / 1
 Project No: 901-1314



Depth Increment : .025 m

Max Depth : 12.325 m

RECORD OF BOREHOLE No 4										METRIC				
W P 88-78-32; 88-78-15		LOCATION Co-ords. 4,847,374.1N;298,036.6E				ORIGINATED BY RF								
DIST 6 HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ASP								
DATUM Geodetic		DATE March 21, 1990				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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
135.08	Ground Surface													
134.43	Topsoil													
0.65	Sand, fine, some silt to sandy silt, trace clay & organics		1	SS	3									
133.08	Very loose Brown		2	SS	2									
132.58	Sand and Gravel.		3	SS	3									
2.50	Clayey Silt, trace sand, occasional gravel (Till-like texture)													
	Stiff to very stiff Grey		4	SS	5									
			5	SS	14									
129.58	Silt, trace sand, some silty sand interlayers.													
5.50	Loose Grey		6	SS	7									
			7	SS	4									
126.58	Clayey Silt, trace sand, occasional gravel (Till-like texture). Occasional silt seams.													
8.50	Stiff to hard Grey		8	SS	4									
			9	SS	11									
			10	SS	74									
121.98	Silt and Sand, trace clay.													
13.10	Compact Grey		11	SS	25									1 51 42 6
120.18	Silt, trace sand and clay.													
14.90	Very dense Grey		12	SS	159									0 3 90 7
			13	SS	188									
117.48	Silty Sand, some gravel trace clay (Till)													
17.60	Very dense Grey		14	SS	130									15 56 27 2
116.33	End of Borehole													
18.75														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 88-78-32;88-78-15

LOCATION Co-ords. 4,847,391.7N;298,034.2E

ORIGINATED BY RF

DIST 6 HWY 407

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY ASP

DATUM Geodetic

DATE March 19 and March 20, 1990

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
135.20	Ground Surface															
0.00	Topsoil															
134.60	0.60 Sandy Silt, trace clay, some organics, occasional shell fragments.		1	SS	4		134									
133.20	Loose Brown		2	SS	7											
2.00	Sand and Gravel															
132.60	2.60 Clayey Silt, trace sand, occ. gravel (Till-like texture)		3	SS	22											
	Stiff Grey		4	TW	PH											
			5	SS	6											
			6	SS	4											
129.40	5.80 Silt, some sand, occ. clayey silt seam.															
128.50	6.70 Compact Grey		7	SS	11											
	Stratified Clayey silt and silty clay, trace sand, frequent silt seams.															
	Stiff to very stiff Grey		8	SS	5											
			9	SS	5											
			10	SS	13											
122.90	12.30 Clayey Silt, some sand & gravel (Till).		11	SS	93											
121.80	Hard Grey															
121.40	13.40 Clayey Silt, trace sand & interlayered with silt and silty sand.		12	SS	53											
120.60	Hard Grey															
14.60	Silt, trace clay and sand.															
	Very dense Grey		13	SS	134											
119.00																
16.20	Heterogeneous mixture of silt and gravel, some sand and clay (Till).		14	SS	100/100 mm											
	Very dense Grey		15	SS	182											
116.00																
19.20	Silty Sand, some gravel trace clay (Till)															
115.08	very dense Grey		16	SS	142											
20.12	End of Borehole															

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,427.6N;298,029.1E ORIGINATED BY SB
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ASP
DATUM Geodetic DATE March 9, March 15 and March 16, 1990. CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	10 20 30	10 20 30	10 20 30					
135.12	Ground Surface															GR SA SI CL
134.32	Topsoil															
0.80	Sandy Silt, trace clay.		1	SS	6	Water Level Elev. 136.3 m April 15, 1990.									49.7	
133.31	Loose Brown		2	SS	11											
1.80	Sand and Gravel, some silt.		3	SS	14											
132.22	Compact Brown/Grey		4	SS	6											
2.90	Clayey Silt, trace to some sand, occasional gravel (Till-like texture).		5	SS	12											
	Very Stiff Grey		6	SS	12											
			7	SS	5											
127.92			8	SS	3											
7.20	Silt, trace clay, interlayers of sandy silt and clayey silt.		9	SS	8											
	Very loose to loose Grey		10	SS	19											
125.12			11	SS	70											
10.00	Clayey silt, some silt partings		12	SS	17											
123.52	Very Stiff Grey		13	SS	43											
11.60	Clayey Silt, trace to some sand, trace gravel.		14	SS	176/225 mm											
122.02	Hard Grey		15	SS	92											
13.10	Silt to sandy silt, trace clay.		16	SS	75											
	Dense to very dense Grey		17	SS	34											
118.92																
16.20	Clayey Silt, and gravel some sand (Till).															
117.62	Hard Grey															
17.50	Sandy Silt, some gravel (Till).															
	Very Dense Grey															
115.92																
19.20	Silty sand, trace gravel.															
114.85	Dense Grey															
20.27	End of Borehole															

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

RECORD OF BOREHOLE No 7

METRIC

W P 88-78-32; 88-78-15

LOCATION Co-ords. 4,847,447.0N;298,067.7E

ORIGINATED BY JR

DIST 6 HWY 407

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY ASP

DATUM Geodetic

DATE March 20 and March 21, 1990

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
134.96	Ground Surface														
134.66	Topsoil														
0.30	Sandy Silt, trace clay														
133.56	Very loose Brown		1	SS	3		134								
1.40	Sand, some silt & gravel to sand and gravel, trace silt, occ. org. pockets		2	SS	10		Water Level Elev. 136.4 m April 4, 1990								
132.06	Compact Grey		3	SS	13										
2.90	Clayey Silt, trace sand.		4	SS	14										
131.26	Very stiff Grey														
3.70	Silt, trace clay.		5	SS	30										
130.56	Dense Grey & Brown														
4.40	Clayey Silt, trace sand, occ. gravel.		6	SS	19										
	Stiff Grey														
			7	SS	8										
127.36															
7.60	Silt, trace sand interlayered with clayey silt.		8	SS	5										
126.16	Loose Grey														
8.80	Silt and Sand, fine.														
	Compact Grey		9	SS	12										
124.66															
10.30	Heterogeneous mixture of sand and silt, some gravel, trace clay (Till). Dense Grey		10	SS	39										
123.36															
11.60	Clayey Silt, trace sand (Till-like texture) to stratified clayey silt and silty clay.		11	SS	129										
	Hard Grey														
			12	SS	125										
120.36															
14.60	Silt, trace clay and sand.														
	Very dense Grey		13	SS	103										
118.86			14	SS	115										
16.15	End of Borehole														

+³, x⁶: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

0 9 69 22

0 2 78 20

RECORD OF BOREHOLE No 8

METRIC

W P 88-78-32: 88-78-15 LOCATION Co-ords. 4,847,423.9N;298,059.6E ORIGINATED BY JR
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ASP
 DATUM Geodetic DATE March 20 and March 21, 1990 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							WATER CONTENT (%) 10 20 30			
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
134.74	Ground Surface																	
0.00	Topsoil																	
134.24	Silty Sand, trace org.																	
0.50	Loose Brown		1	SS	5		134											
133.54	Sand and Gravel, trace to some silt.		2	SS	22													
1.20	Compact Grey		3	SS	22													
131.84	Clayey Silt, some gravel.		4	SS	14		132											
2.90	Sand and Gravel.		5	SS	24													
131.14	Compact		6	SS	22													
3.60	Clayey Silt, some sand, occasional gravel.		7	SS	10		130											
130.54	Very stiff Grey		8	SS	10													
4.20	Stratified Silt, silt and sand, fine, trace clay.		9	SS	1													
128.54	Very loose to loose Grey		10	SS	1		128											
6.20																		
							126											
							124											
123.34	Heterogenous mixture of sand and silt, some gravel, trace clay (Till).		11	SS	79													
11.40	Very dense Grey		12	SS	122		122							21 34 35 10				
121.64	Silt, trace to some clay.		13	SS	156													
13.10	Very dense Grey						120											
119.04																		
15.70	End of Borehole													0 0 88 12				

RECORD OF BOREHOLE No 9

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,391.3N;298,079.6E ORIGINATED BY JR
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger; BX Core COMPILED BY ASP
DATUM Geodetic DATE March 6 and March 7, 1990 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
135.44	Ground Surface													
0.00	Topsoil													
134.44														
1.00	Silty Sand, trace clay and organics.		1	SS	8									
133.34	Loose Brown		2	SS	6									
2.10	Sand and Gravel, trace silt and organics.		3	SS	13									
132.54	Compact Grey													
2.90	Clayey Silt, trace to some sand, occasional gravel (Till-like texture).		4	SS	15									
	Very stiff Grey		5	SS	19									
			6	SS	21									
			7	SS	19									
128.14														
7.30	Silt, trace clay and sand.		8	SS	13									
	Compact Grey													
			9	SS	12									
125.44														
10.00	Clayey Silt, trace sand, frequent silt seams.		10	SS	12									
	Very stiff Grey													
122.94														
12.50	Silty Clay to clayey silt, trace to some sand, trace gravel, occasional silt and sand seams (Till-like texture).		11	SS	14									
	Hard Grey		12	SS	36									
			13	SS	87									
119.24														
16.20	Silt, some fine sand, trace clay.		14	SS	50									
	Very dense Grey													
117.74														
17.70	Clayey Silt, some sand, trace gravel (Till). Boulder at 21.2 m to 22 m depth.		15	SS	225									
			16	SS	171									
			17	RC BX	Rec. 22%									
			18	RC BX	Rec. 53%									
113.19														
22.25	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,430.8N;298,094.8E ORIGINATED BY RF
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ASP
 DATUM Geodetic DATE March 26, 1990 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa						
135.62	Ground Surface														
135.32	Topsoil														
0.30	Silty Sand grading to sand, some silt, occ. organics.		1	SS	4										
133.52	Loose Brown		2	SS	5										
2.10	Sand and gravel, trace silt.		3	SS	14										
132.72	Compact Grey		4	SS	18										
2.90	Clayey Silt, trace sand, occ. gravel (Till-like texture).		5	SS	20										
	Very Stiff Grey		6	SS	19										
			7	SS	19										
128.32			8	SS	10										
7.30	Stratified Silty Clay and clayey silt, trace sand, frequent silt and sandy silt seams.		9	SS	8										
	Stiff Grey														
125.41															
10.21	End of Borehole.														

METRIC

ORIGINATED BY JR

COMPILED BY ASP

CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 12

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,433.8N; 298,157.4E ORIGINATED BY JR
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger; Wash Boring COMPILED BY ASP
 DATUM Geodetic DATE February 23 to February 27, 1990. CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
135.0	Ground Surface													
0.00	Topsoil													
0.50	Sandy Silt, trace clay and gravel. Loose		1	SS	7									
1.40	Sand and Gravel, trace silt.		2	SS	6									
132.60	Loose to Compact Grey		3	SS	14									
2.90	Clayey Silt, trace to some sand, occasional to trace gravel (Till-like texture). Very Stiff Grey		4	SS	23									
			5	SS	24									
			6	SS	19									
			7	SS	14									
			8	SS	16									
126.10			9	SS	17									
9.40	Silty Clay, stratified with silt partings. Very Stiff Grey		10	SS	14									
123.90			11	SS	2									
11.60	Silt and Sand, fine, trace clay. Very Loose Grey		12	SS	48									
122.10			13	SS	140									
13.40	Clayey Silt to silty clay, trace to some sand (Till-like texture). Hard Grey		14	SS	142									
			15	SS	146									
118.10			16	SS	134									
17.40	Clayey Silt Hard													
117.67														
17.83	End of Borehole.													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 13

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,398.4N; 298,105.4E
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers
 DATUM Geodetic DATE March 23, 1990
 ORIGINATED BY SB
 COMPILED BY ASP
 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH kPa						
135.45	Ground Surface							○ UNCONFINED + FIELD VANE		WATER CONTENT (%)				
0.00								● QUICK TRIAXIAL × LAB VANE		20 40 60 80 100				
134.92	Topsoil									10 20 30				
0.53	Sandy Silt grading to silty sand, trace gravel, occ. organics.		1	SS	3		Water Level 134 Elev. 136.3 m on April 4, 1990.							
133.35	Very Loose Brown		2	SS	2									
2.10	Sand, some gravel, trace silt and clay.		3	SS	10									
132.10	Compact Grey		4	SS	13									
3.35	Clayey Silt, trace sand, occ. gravel (Till-like texture). Occasional silty clay interlayer.		5	SS	9									
	Very Stiff Grey		6	SS	11				2 + 					

+³, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14

METRIC

W P 88-78-32; 88-78-15 LOCATION Co-ords. 4,847,406.1N; 298,129.0E ORIGINATED BY JR
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers; Wash Boring COMPILED BY ASP
DATUM Geodetic DATE March 2, 1990 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	x LAB VANE								
								20 40 60 80 100									
135.17	Ground Surface																
134.77	Topsoil																
0.40	Sandy Silt, trace clay & organics.		1	SS	8		134										
	Loose Brown		2	SS	4												
133.37																	
2.10	Sand, some gravel, trace silt, occasional clayey silt seam.		3	SS	6												
	Loose to Compact Brown		4	SS	16		132										
131.72																	
3.45	Clayey Silt, trace sand, occ. gravel (Till-like texture). Occ. silty clay inter- layer.		5	SS	21												
	Very Stiff Grey		6	SS	17		130										
			7	SS	17												
							128										
127.17			8	SS	15												
8.00	Stratified Silty Clay, clayey silt and silt.		9	TW	PH												
125.87	Stiff Grey						126										
9.30	Silt, some sand, trace clay.		10	SS	12												
	Very Loose Grey		11	SS	1		124									0 15 80 5	
123.17																	
12.00	Sand, trace silt. Grey		12	WS	-		122										
120.57																	
14.60	Clayey Silt, trace sand (Till-like texture).		13	SS	146		120										
118.97	Hard Grey																
16.20	Clayey Silt, trace sand; sandy silt seams																
117.95	Hard Grey		14	SS	118		118										
17.22	End of Borehole.																

RECORD OF BOREHOLE No 15

METRIC

W P 88-78-32; 88-78-15 LOCATION CO-ords. 4,847,433.8N; 298,118.1E ORIGINATED BY JR
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ASP
DATUM Geodetic DATE March 8 to March 10, 1990 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
135.41	Ground Surface													
0.00	Topsoil													
134.81	0.60 Sand, some silt.													
134.01	Loose Brown		1	SS	7									
1.40	Sand, some gravel to sand and gravel, trace silt.		2	SS	8									
132.51	Loose to Compact Brown		3	SS	17									
2.90	Clayey Silt, trace sand (Till-like structure).		4	SS	23									
	Very Stiff Grey		5	SS	21									
			6	SS	18									
			7	SS	23									
128.41	7.00 Stratified Silty Clay and clayey silt, frequent silt and sandy silt seams.		8	SS	20									
	Stiff Grey		9	SS	13									
125.01	10.40 Silt and Sand, fine, trace clay, occasional clayey silt seam.		10	SS	14									
	Loose to Compact Grey		11	SS	5									
122.01	13.40 Clayey Silt, some sand, trace gravel (Till).		12	SS	131									
121.01	Hard Grey		13	SS	157									
14.40	Stratified Clayey Silt and silty clay, trace sand.		14	SS	168									
	Hard Grey		15	SS	70									
117.11	18.30 Silt, trace clay.		16	SS	178									
	Very Dense Grey													
115.91	19.50 Sand and Gravel.													
115.29	Very Dense													
20.12	End of Borehole.													

RECORD OF BOREHOLE No 16

METRIC

W P 88-78-32; 88-78-15

LOCATION Co-ords. 4,847,461.9N; 298,112.3E

ORIGINATED BY JR

DIST 6 HWY 407

BOREHOLE TYPE Hollow Stem Augers; Wash Boring

COMPILED BY ASP

DATUM Geodetic

DATE March 5 and March 6, 1990

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
135.65	Ground Surface															
0.00			1	SS	17											
135.05	Topsoil		2	SS	6											
0.60	Sandy Silt, trace clay & organics.		3	SS	4											
134.25	Loose Brown		4	SS	5											
1.40	Silty Sand, fine, grading to sand, fine to med., trace silt, some org. Loose Brown		5	SS	17											
132.75	Clayey Silt, trace sand, occ. gravel (Till-like texture). Gravel layer (0.2 m thick) at 4.0 m depth.		6	SS	35											
	Grey		7	SS	29											
			8	SS	24											
128.65			9	SS	22											
7.00	Stratified Clayey Silt and silty clay with silt seams.		10	SS	7											
127.15	Very Stiff Grey		11	SS	7											
8.50	Silt and Sand, fine to sandy silt, trace clay.		12	SS	18											
	Loose Grey		13	SS	131											
124.05			14	SS	138											
11.60	Silty Sand, trace clay.		15	SS	120											
	Compact Grey															
122.25																
13.40	Clayey Silt, some sand, trace gravel (Till).															
	Hard Grey															
120.45																
15.20	Stratified Silty Clay, clayey silt and silt.															
119.04	Hard Grey															
16.61	End of Borehole.															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17

METRIC

W P 88-78-32; 88-78-15

LOCATION Co-ords. 4,847,490.3N; 298,144.9E

ORIGINATED BY JR

DIST 6 HWY 407

BOREHOLE TYPE Hollow Stem Auger; BW Casing - Wash Boring

COMPILED BY ASP

DATUM Geodetic

DATE February 14 to February 20, 1990

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa									
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	WATER CONTENT (%)							
								20 40 60 80 100		10 20 30							
135.48	Ground Surface																
0.00																	
134.88	Topsoil																
0.60	Sandy Silt, trace clay and organics. Compact		1	SS	11	Artesian Head at Elev. 140 m on completion of drilling							44 Org. 2.9%				
134.08																	
1.40	Silty Sand, trace organics. Loose		2	SS	6												
133.38																	
2.10	Organic Silt with peat seams. Soft		3	SS	2												
133.58																	
2.90	Silty Sand and gravel, occ. organics.		4	SS	15		132										
131.08	Compact Grey		5	SS	10												
4.40	Silty Clay and clayey silt, trace sand.		6	SS	11												
	Interlayered with frequent silt partings and seams.		7	SS	7		130										
	Occasional interlayer of sandy silt, trace of clay.		8	TW	PH		128										
			9	SS	7												
	Stiff to very stiff.		10	SS	9		126										
124.81	Grey		11	TW	PH												
10.67	Silt, some sand, trace clay.		12	SS	9												
123.88	Loose Grey						124										
11.60	Sandy Silt, trace gravel and clay.																
122.68	Compact Grey		13	SS	20												
12.80	Clayey Silt to silty clay, trace to some sand, trace gravel. (Till-like texture)		14	SS	172		122										
	Hard Grey		15	SS	130		120										
118.68																	
16.80	Silt, trace clay and sand.						118										
	Very dense Grey		16	SS	115		116										
114.78																	
20.70	Sand and Gravel, trace silt.		17	SS	79		114										
112.98	Very dense Grey																

22.00 Borehole Continued

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 17

METRIC

W P 88-78-32; 88-78-15

LOCATION Co-ords. 4,847,490.3N; 298,144.9E

ORIGINATED BY RF

DIST 6 HWY 407

BOREHOLE TYPE Hollos Stem Auger; BW Casing - Wash Boring

COMPILED BY ASP

DATUM Geodetic

DATE February 14 to February 20, 1990

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					
112.98	Continued													
22.50	Sand and Gravel, trace silt.													
111.10	Very dense Grey													
24.38	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
For
Hwy. 407/CPR Subway
(Between Islington Avenue and Humber River)
W.P. 88-78-16, Site No. 37-1327
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a two span structure that will carry the existing track plus an additional track to the west over the proposed Hwy. 407. Equal span lengths of 32 metres and a bridge width of 10.47 metres is proposed for the CPR structure. The proposed Hwy. 407 grade has a proposed profile grade of approximately 145 metres at the proposed CPR subway structure. The CPR profile will remain similar to the existing with a top of rail elevation ranging from 153.2 m at the proposed north abutment location to 153.5 m at the proposed south abutment location.

This report describes the subsurface conditions encountered at the site.

SITE DESCRIPTION AND GEOLOGY

The site is located along and adjacent to the existing CPR tracks approximately 0.3 km northwest of the CPR - Islington Avenue level crossing in the Town of Vaughan, Regional Municipality of York. The site is characterized by a meandering valley that supports side slopes of approximately 2.5H:1V and trends in a general southwesterly direction. The crest of the valley is approximately 200 metres in width and the valley depth is approximately 20 metres. The valley houses the Jersey Creek that runs its course at the valley floor and is approximately 2 metres in width and normally flows at 1 metre depths. The Jersey Creek flows into the Humber River located in a floodplain immediately west of the site.

The valley slopes are densely covered with trees, brush, tall grasses and shrubs. There is no evidence of slope creep or displacement indicating that the valley slopes are stable at its present geometry.

The existing CPR track at the site is supported by an earth embankment spanning the valley crest width. The railroad embankment, supposedly constructed in the early 1900's supports side slopes approximately 1.5H:1V. Trees and low lying shrubs and grassland cover the existing constructed slopes. There appears to be no evidence of slope instability other than a localized area at the northeastern portion of the embankment. Rip-rap and armour stone was placed on the slope to retard surficial erosion at this location.

A concrete culvert is located at the base of constructed embankment, constructed to facilitate the Jersey Creek outflow beneath the embankment. Again, no visible signs of distress in the culvert were apparent.

Land use surrounding the site consists of residential lots located east of the site, a hydro corridor consisting of transmission towers just north of the site and forestland elsewhere. A CPR two span structure is located approximately 0.3 km north of the site along the same track alignment. The structure spans the Humber River at this location. In addition, a CNR rigid frame overhead exists approximately 0.2 km south of the site to facilitate CN Rail traffic in a east-west direction over the CPR track.

Physiographically, the site lies within the region known as the South Slope (Chapman and Putman, 1984). The South Slope formation at the site consists of a ground moraine, scoured at intervals by valleys tributary to the Humber River systems. The valleys accentuate the hilly moraine topography. The glacial landforms and deposits were formed by the advance and retreat of the Winsconsinan ice sheet that covered the area during the Pleistocene epoch (over 5000 years ago).

The overburden is underlain by the grey shales of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 89 10 21 and 89 11 30 and consisted of 8 sampled boreholes advanced to depths ranging from 6.6 m to 49.1 m below ground surface. The fieldwork for the proposed realigned Jersey Creek culvert and CPR detour in conjunction with the CPR Subway was also carried out within this time period and consisted of 4 and 2 sampled boreholes respectively.

Four of the eight boreholes were advanced through the overburden using hollow stem augering techniques to the depths of the lower sand with some silt deposit (approximately 39 metres below ground surface). Beyond that depth, the boreholes were advanced using conventional diamond drilling techniques (casing and washboring) to overcome torquing restriction imposed on the hollow stem augers. The NW casing used was advanced by both driven and rotary methods. The drilling equipment used was a track mounted CME 55.

In consideration of the importance of establishing the composition of the CPR embankment fill, a total of four boreholes were advanced in the existing embankment fill. Two of the boreholes were advanced from the crest of the embankment using the track-mounted CME and conventional hollow stem augering techniques. The other two boreholes were advanced at mid-slope, on the west side of the embankment (BH's 4A and 6A). These boreholes were advanced using conventional diamond drilling techniques via a tripod apparatus.

In general, subsoil samples were retrieved at 1.5 m intervals for the upper 27-30 metres and at 3.0 m intervals thereafter. A project pilot borehole (BH D-1), however, was advanced with subsoil retrieval at increased frequency, namely 0.7 m intervals for the surficial 6.0 metres and 1.5 m intervals thereafter.

Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved in the surficial till deposit using a shelby tube sampler in accordance with standard practice (ASTM D1587). In situ vane tests

were also conducted in the cohesive surficial deposit, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

Bedrock was cored at four of the eight boreholes advanced in conjunction with the proposed structure. The location of the four rock core boreholes coincide with the structure foundation locations (BH D-1, D-2, D-4 and D-8). Bedrock was cored using conventional rock coring methods in NQ size.

All subsoil samples and rock core were identified in the field and then returned to the laboratory for further examination and applicable testing.

Water levels were obtained in the open boreholes and also in a sealed piezometer installed at BH D-8. Groundwater levels were monitored throughout the duration of the investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limit
- 2) Grain Size Analyses
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Unconfined Compression Tests
- 6) Unconsolidated Undrained Tests
- 7) Multi-stage consolidated undrained tests with pore pressure measurements
- 8) Consolidation Test

In view of the general uniformity of soil types found in the general site area, including the proposed Jersey Creek culvert structure and the proposed detour, all laboratory results for similar soil strata have been integrated for the different structure locations. Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The native subsoil of the original valley at the site consists of a surficial deposit composed of a clayey silt to silty clay with occasional sand seams and traces of gravel. The stratum is a till deposit of glacial origin and extends to a maximum thickness of 13.7 metres at the crest of the valley. The thickness of this deposit decreases down the valley slope and does not exist at the valley floor. The consistency of this deposit ranges from firm to hard.

Underlying the surficial deposit, exists a deposit of clayey silt that extends for a considerable thickness ranging from 18.3 m to 28 m. The consistency of this stratum also varies from firm to hard.

The clayey silt deposit is in turn underlain by a cohesionless deposit of sand with a trace to some silt. Random zones of silt also exist in this deposit. Gravel, boulders and cobbles are also components of the lower depths of the deposit. The thickness of this deposit ranges from 4.2 m to 15.8 m with an average thickness of approximately 10 metres. The denseness of this deposit varies from compact to very dense. This cohesionless deposit overlies shale bedrock of the Georgian Bay shale formation.

Two types of fill material was used to construct the CPR embankment. Surficially and within a zone above and immediately adjacent to the existing concrete culvert, a cohesionless backfill material consisting of a sand with some silt to sandy silt was used. Beneath the surficial sand material and beyond the culvert backfill wedge zone, the embankment fill material consists of a clayey silt with interbedded layers of sand. The thickness of the surficial cohesionless fill material, which also exists on the embankment slopes, ranges

from 2.0 to 4.6 metres. The maximum depth of the embankment fill explored was 13.9 metres at BH D-6, located at the proposed pier location. At BH's D-1, D-2, located in the area of the south abutment, only 1.5 to 2.4 metres of granular fill was encountered, confirming the valley crest location. At BH D-4, the location of the proposed north abutment, 12.2 metres of clayey silt fill material with interbedded layers of sand exists.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 887816-A* & 887816-B.*

A detailed description of the subsurface conditions encountered is given below.

Sand, some Silt (Fill)

As previously mentioned, the surficial embankment fill material and backfill material to the existing concrete culvert consists generally of a brown sand with some silt. Occasional layers of sandy silt and clayey silt are also present in the fill material and traces of fine gravel are also randomly intermixed. A grain size distribution envelope illustrating the gradation of the fill is provided in Figure 1 in the Appendix. The surficial thickness of the fill material varies from 1.5 to 2.4 metres and the maximum thickness explored was 16.2 metres at which depth the existing concrete culvert roof was encountered.

Standard Penetration tests carried out in the cohesionless fill material revealed 'N' values ranging from 2 blows/0.3 m to 21 blows/0.3 m indicating a very loose to compact state of condition.

Clayey Silt (Fill)

Beneath the surficial cohesionless fill and beyond the culvert cohesionless backfill material, the CPR embankment fill consists of a brown, cohesive clayey

* DWG NO'S 2 & 2A OF THE CONTRACT DWG'S (SHEET NO'S 297 & 297-1)

silt. The maximum thickness of the clayey silt fill encountered was 12.2 metres at the proposed north abutment location. Interbedded layers of fine sand ranging in thickness from 50 mm to 150 mm are also present randomly in the cohesive matrix. A grain size distribution envelope for this material as determined by mechanical sieve and hydrometer analysis is given in Figure 2.

Atterberg Limits were obtained to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 3. A summary of the indices is provided in Table 1 below. Unit weights are also included.

Table 1 - Clayey Silt (Fill)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-24	8
Liquid Limit (w_L %)	21-32	8
Plastic Limit (w_p %)	13-19	8
Unit Weight (kN/m^3)	19.2-20.2	4
Undrained Shear Strength (c_u) (kPa)	80->120	5

The test results reveal that the cohesive fill material is of low plasticity and hence can be categorized as clayey silt.

Undrained shear strength measurements (c_u) were obtained in situ by conducting field vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 1 above. However, in consideration of the interbedded layers of sand, consistencies ranging from stiff to very stiff which is representative of the determined shear strength values cannot be implicitly assumed.

Silty Clay to Clayey Silt (Glacial Till)

The native surficial deposit present at the site consists of a cohesive silty clay to clayey silt with traces of sand and gravel and occasional random interbedded sand seams. The thickness of the deposit explored in the

investigation ranges from 11.3 to 13.7 and the interbedded sand seams are generally 50 to 100 mm in thickness. At BH D-4, the approximate location of the proposed north abutment, this deposit does not exist indicating that the deposit decreases in thickness from the crest of the valley to the valley floor. The deposit is generally oxidized (brown) for the upper 1.5 to 3.5 metres and unoxidized (grey) for its lower thickness. The deposit is a till of glacial origin.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 25-61% and 35-61% respectively, confirming the range in behaviour of the fine grained portion of the deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 5. A summary of the indices is provided in Table 2. Unit weights are also included.

Table 2 - Silty Clay to Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-29	14
Liquid Limit (w_L %)	22-47	14
Plastic Limit (w_p %)	12-20	14
Unit Weight (kN/m^3)	18.8-20.3	9
Undrained Shear Strength (cu) (kPa)		
- Field Vane	35->120	28
- Laboratory*	41-82	4
Sensitivity	2-3	28

*Unconfined Compression Tests

*Unconsolidated Undrained Tests

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay).

Undrained shear strength measurements (c_u) of the soil were obtained both by in situ vane tests and by laboratory tests, namely unconfined compression tests and unconsolidated undrained tests (quick triaxial). Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2. A Shear Strength vs Elevation profile is also provided in Figure 6. Based on shear strength values ranging from 35-120 kPa, it is considered that the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 3 indicating that the soil has a low sensitivity.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 3.

Table 3

Sample	BH D-1, TW5
Elevation (m)	147.0
Liquid Limit	47
Plastic Limit	20
Natural Moisture Content (w%)	26
Effective Angle of Internal Friction (ϕ°)	29.5
Effective Shear Strength Intercept (c') (kPa)	10

For design purposes, a reduced angle of internal friction (ϕ°) of 26° and a shear strength intercept of 5 kPa was selected to account for the fact that the sample tested was not saturated.

In conjunction with the proposed detour, (BH D-5, WP 141-87-00D) located immediately west of the proposed CPR Subway, a consolidation test was conducted to evaluate the compressibility characteristics of this same deposit. The results (e-log p curve) of the test are illustrated in Figure 7 in the Appendix. The results reveal that this cohesive stratum has been preconsolidated in the past to an effective pressure 200 kPa in excess of the existing overburden pressure.

The coefficient of consolidation (cv) used to determine the time rate of consolidation settlement was computed using Taylor's Method (1948). The results reveal values ranging from 0.004 m²/day to 0.005 m²/day for loadings ranging from 100 to 200 kPa.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 15 blows/0.3 m

Clayey Silt

Underlying the surficial native clayey silt to silty clay deposit at a depth ranging from 10.7 m to 13.7 m below the ground surface (Elevation 140.0 to 135.2) and extending for a maximum thickness of 18.3 metres, exists a cohesive, grey deposit of clayey silt. This stratum also contains traces of sand and random zones of silt. A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 8. The envelope reveals clay and silt percentages ranging from 12-31% and 60-88% respectively.

Atterberg Limit tests were carried out to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 9 and summarized in Table 4 below. Unit weights are also included:

Table 4

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	14-35	13
Liquid Limit (w _L %)	22-30	13
Plastic Limit (w _p %)	14-18	13
Unit Weight (kN/m ³)	20-22	6

The test results reveal that the deposit is predominantly of low plasticity.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 76 blows/0.3 m indicating that the deposit ranges in consistency from firm to hard. In general, in the upper 10 metres or so, 'N' values ranged from 20 blows/0.3 m to 25 blows/0.3 m, indicating a very stiff consistency, but in the lower depths of the deposit, 'N' values ranged from 10 blows/0.3 m to 20 blows/0.3 m and the soil can be categorized as having a stiff consistency.

Sand, some Silt

Underlying the clayey silt deposit and extending to bedrock a cohesionless deposit of sand with some silt exists. The thickness of the deposit ranges from 4.2 m to 15.8 m, but is generally in the order of 10 metres in thickness. Random zones of silt are also present within this deposit. In addition, gravel, boulders and cobbles exist as a heterogeneous mixture in the main deposit at the lower depths immediately above the bedrock. At BH's D-4 and C-3, approximately 2.5 metres of the coarser grained gravel, boulders and cobbles were encountered. A grain size distribution envelope for this deposit is provided in Figure 10 in the Appendix.

This cohesionless deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 10 blows/0.3 m to 120 blows/.08 m indicating that the deposit ranges in denseness from compact to very dense. In view of the fact that the lower 'N' values may be attributable to sampling disturbance induced by unbalanced hydrostatic head as mentioned above and the higher 'N' values not necessarily representing the state of denseness because of the large boulders and cobbles, the deposit can be generally categorized as dense.

Bedrock

The cohesionless sand with some silt deposit is directly underlain by shale bedrock of the Georgian Bay shale formation. The bedrock surface is generally flat with surface elevations ranging from 105.9 m to 107.7 m. The bedrock was cored by NQ size up to 2.8 metres in thickness.

The shale bedrock is grey in colour and is very fine grained and thinly laminated. The rock is generally slightly to moderately weathered and contains occasional clay seams, approximately 50 to 100 mm in thickness. Minor beds of argillaceous limestone are also present in the rock formation. Detailed descriptions of the bedrock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Rock recoveries varied between 60 and 100% while RQD's varied between 0 and 15%. The shale bedrock is weak to very weak rock.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring the level in a piezometer installed at BH D-8 (pier location). The piezometer was installed in the clayey silt deposit with bentonite seals above and below the piezometer tip. Measurements obtained at the time of the investigation revealed levels as tabulated in Table 5 below.

Table 5 - Groundwater Levels

Depths (m)	Elevations (m)	BH's	Location
2.0-4.0 m	148.2-150.6	D-1 D-2 D-3	Valley Crest (South Abutment, 40 m north of North Abutment)
6.2	144.4	D-8	Pier
16	136.1	D-4	North Abutment (12.2 m of embankment fill).


In all cases, the groundwater level was not found in the boreholes advanced in the embankment fill.

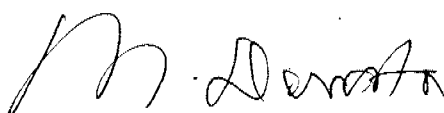
Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Marathon Drilling. The description of bedrock core samples was carried out by S. Senior, Geological Engineer.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

for 
Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

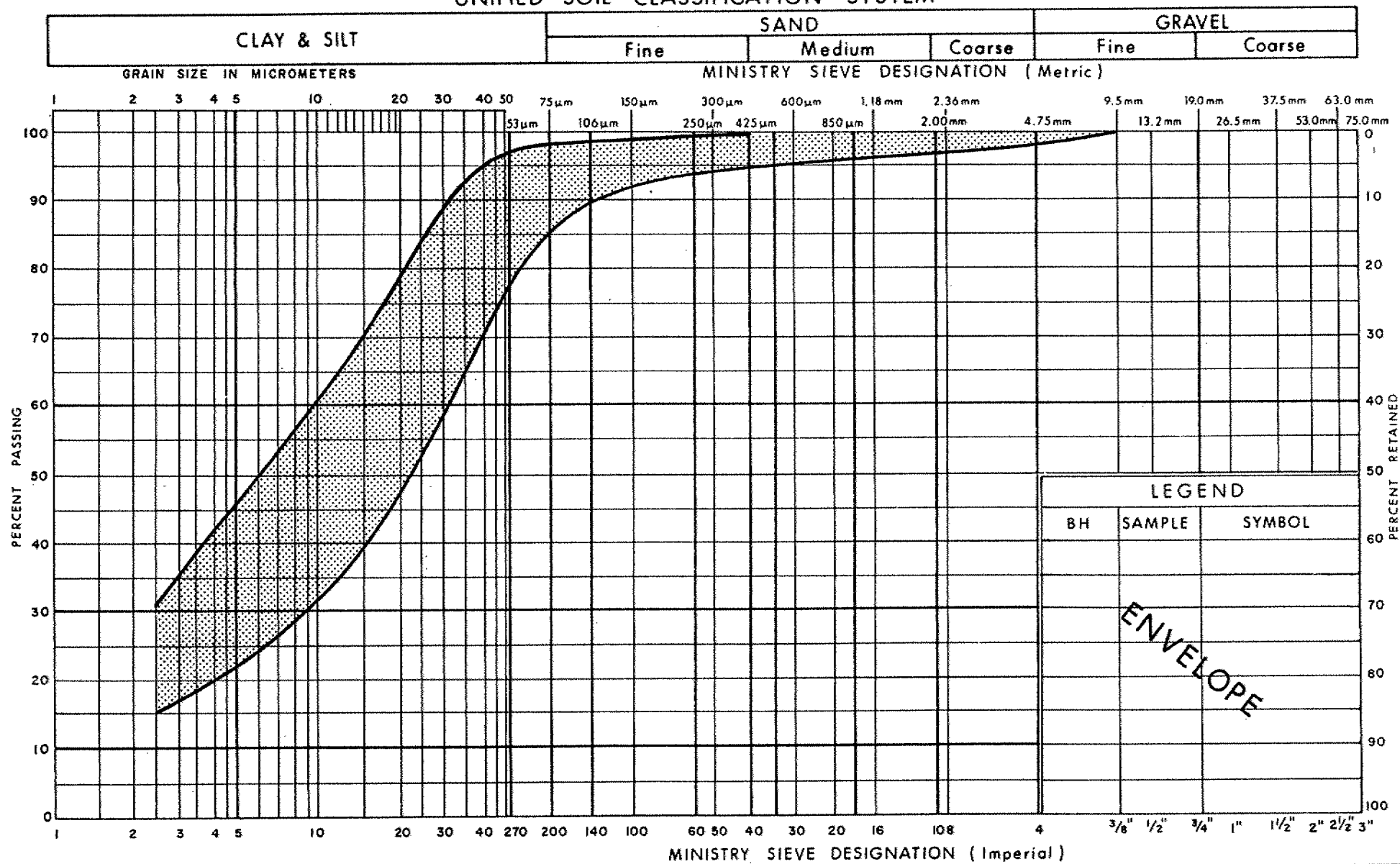
APPENDIX



GRAIN SIZE DISTRIBUTION
(FILL MATERIAL)

W P 88-78-16

UNIFIED SOIL CLASSIFICATION SYSTEM

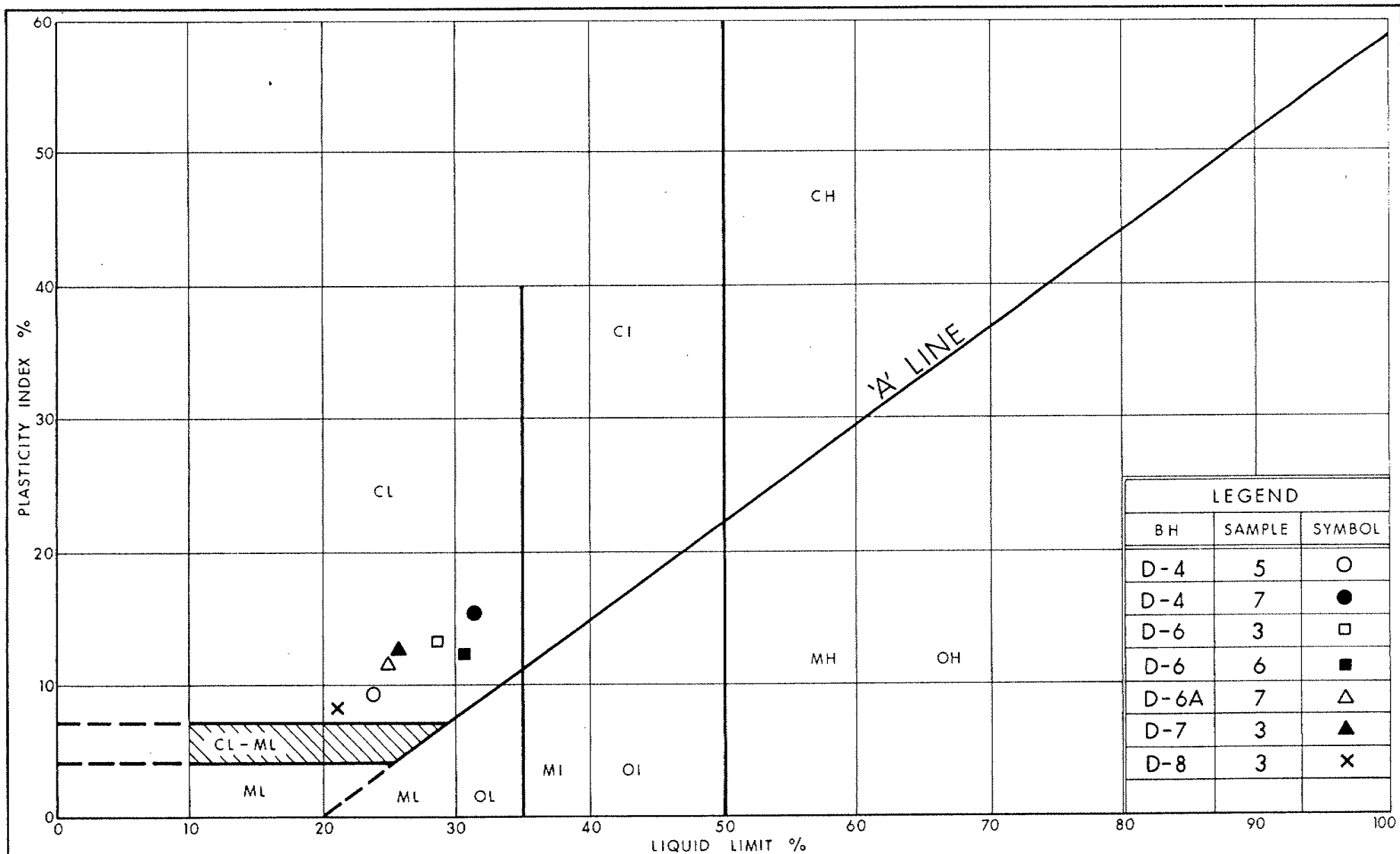


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION CLAYEY SILT (FILL)

FIG No 2

W P 88-78-16



Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT (FILL)

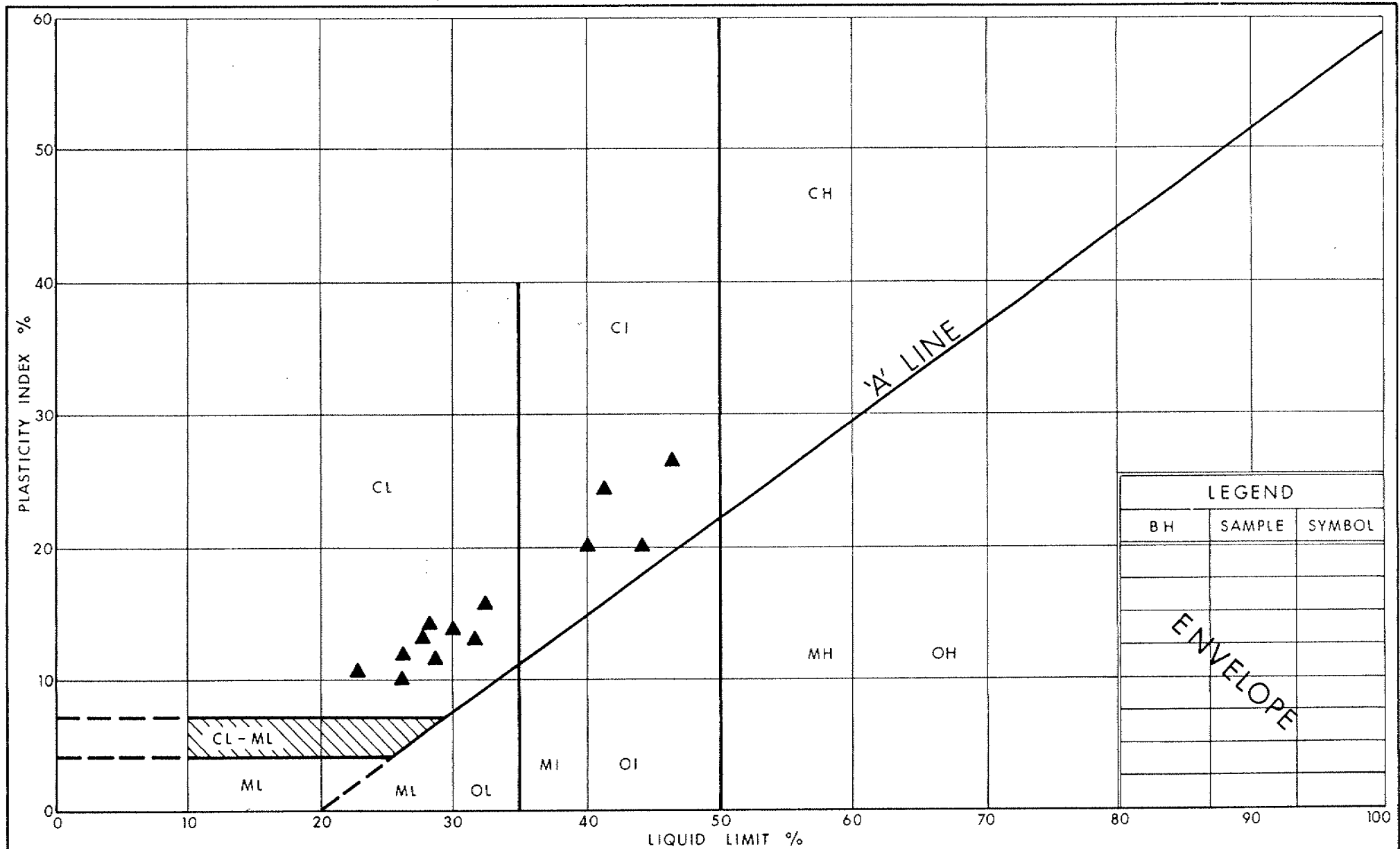
FIG No 3

W P 88-78-16



GRAIN SIZE DISTRIBUTION SILTY CLAY TO CLAYEY SILT (Glacial Till)

W P 88-78-16

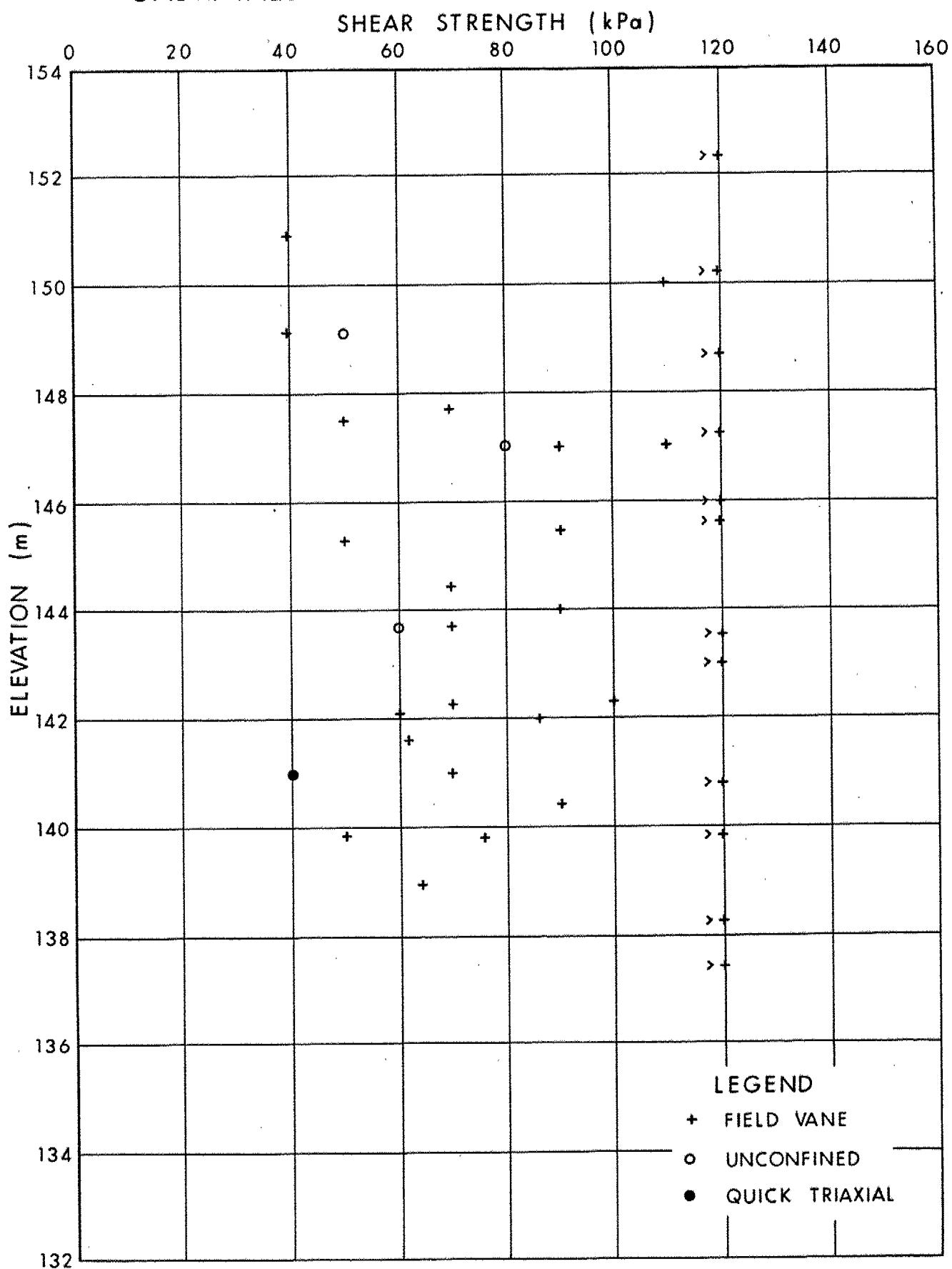


Ministry of
Transportation

PLASTICITY CHART
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

FIG No 5

W P 88-78-16

UNDRAINED SHEAR STRENGTH V_s ELEVATION

W P 88-78-16

Fig 6

VOID RATIO - PRESSURE CURVES

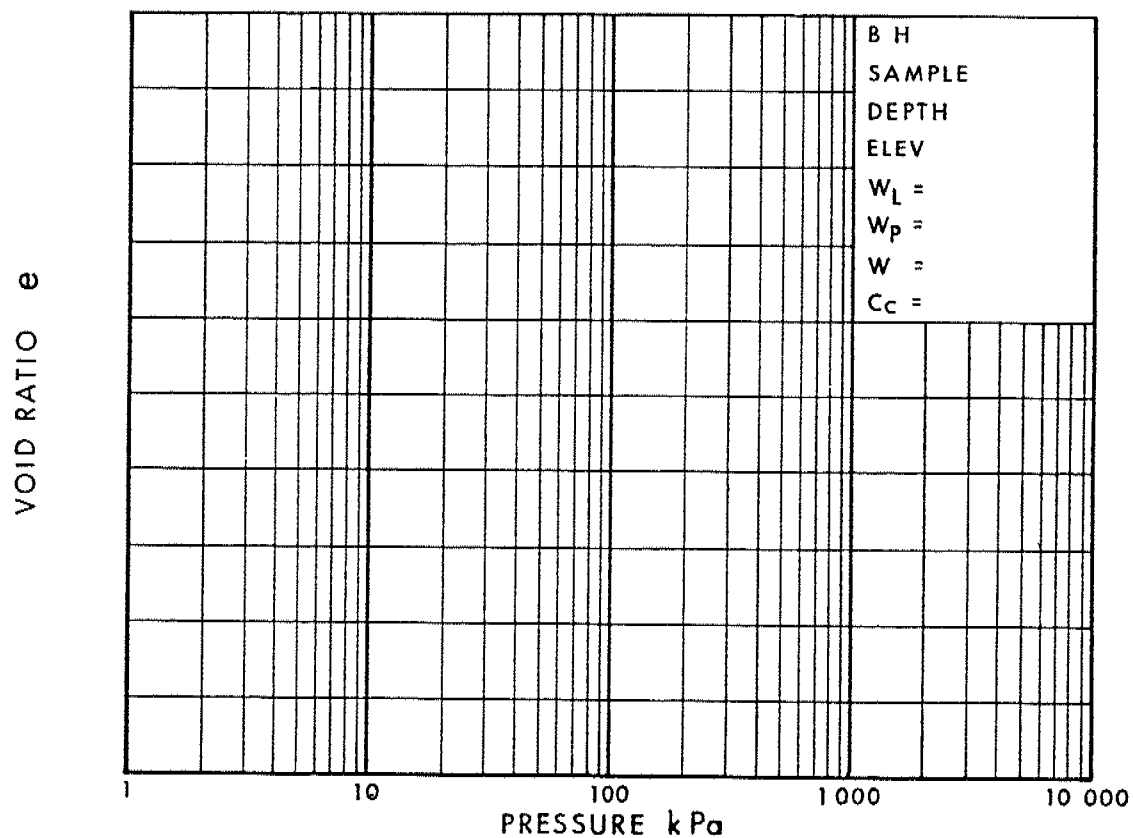
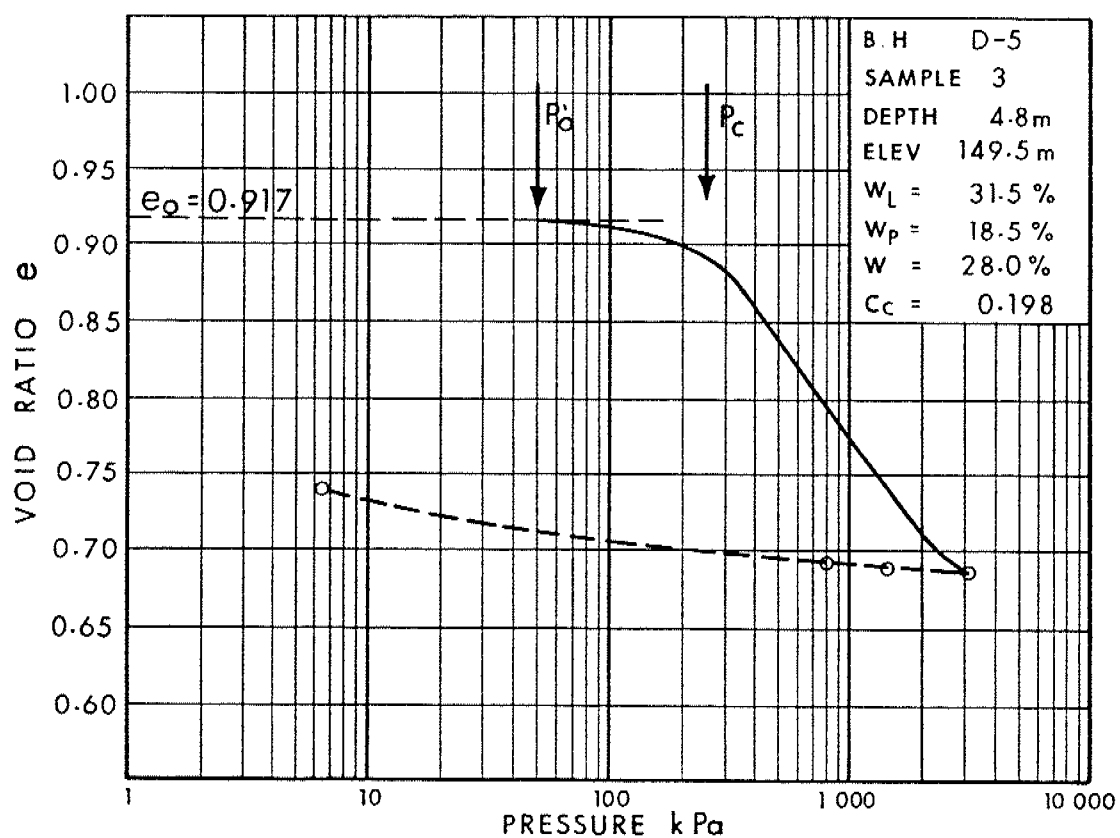
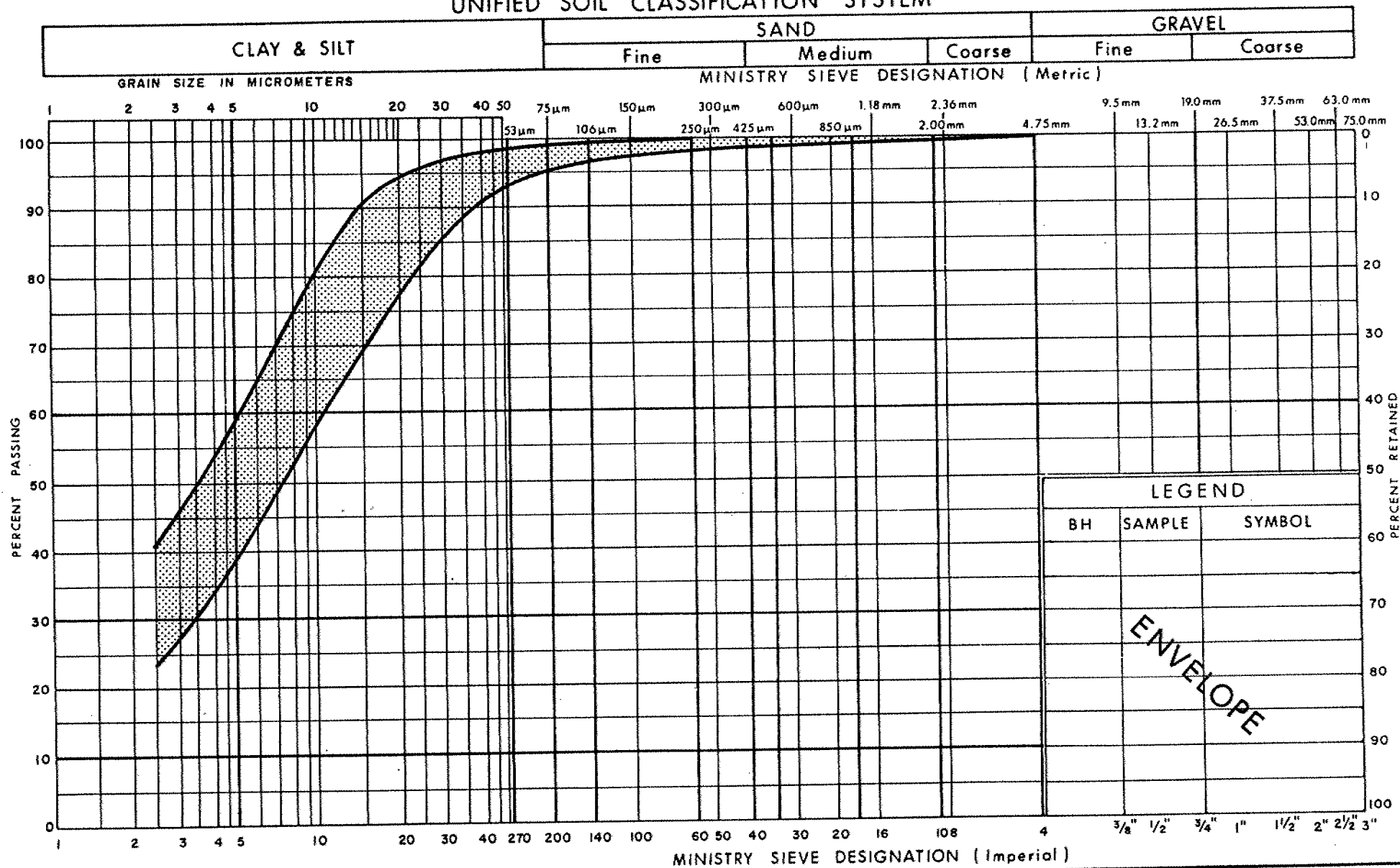


Fig 7

W P 88-78-16

UNIFIED SOIL CLASSIFICATION SYSTEM



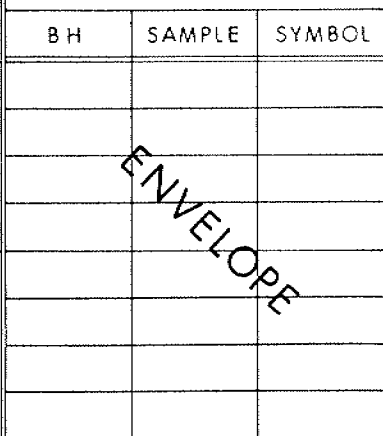
Ontario

Ministry of
Transportation

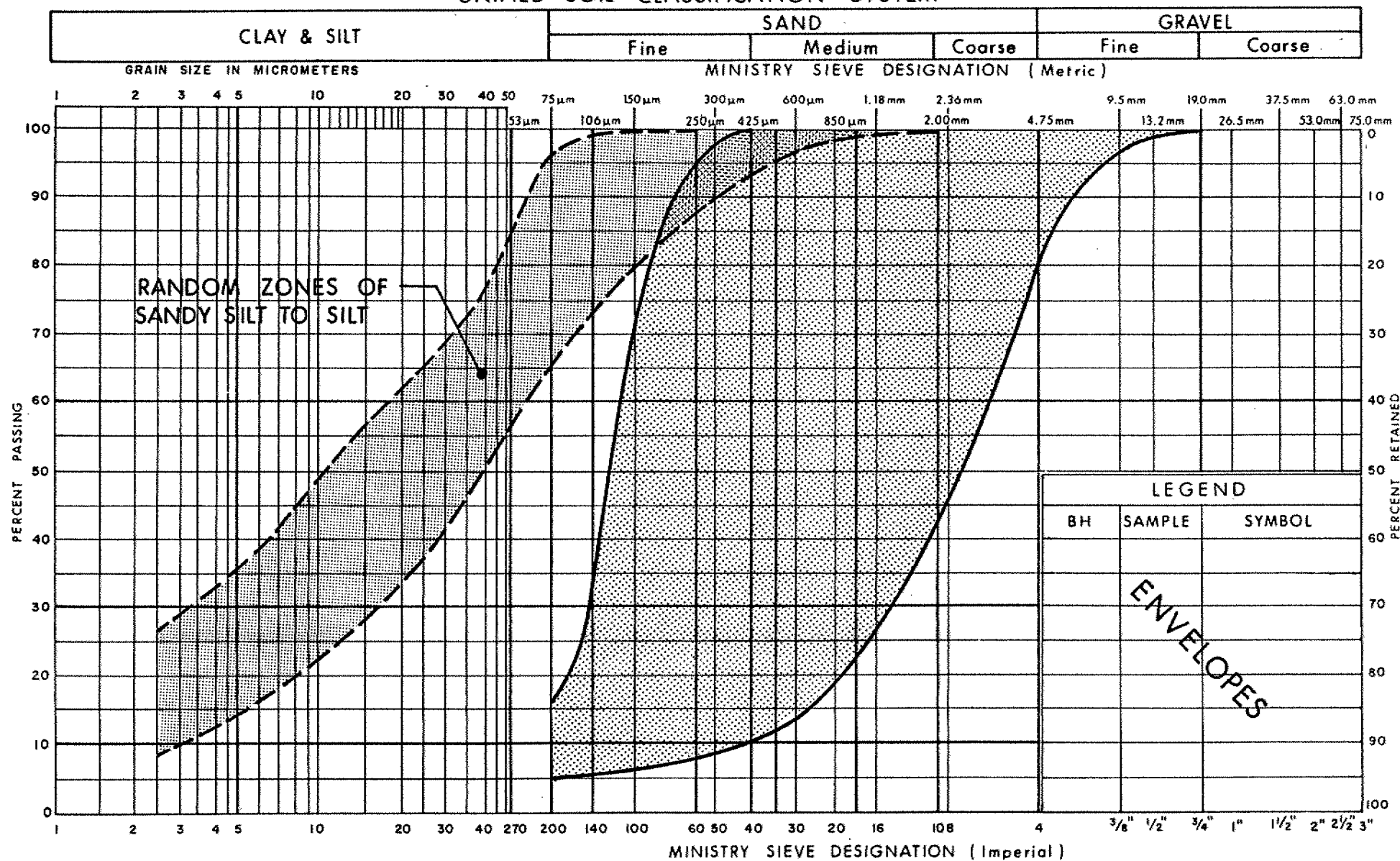
GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIG No 8

W P 88-78-16



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, SOME SILT

FIG No 10

W P 88-78-16

ROCK CORE DESCRIPTION

WP 88-78-16

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
D-1	34	46.10-47.22	73	0	46.10-48.90	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (5%).
	35	47.22-48.90	100	0		
D-2	22	47.55-49.07	92	7	47.55-49.07	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered, intensely weathered sections at 47.60m and 48.18m; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (8%).
D-4	22	44.81-46.33	60	8	44.81-44.98	OVERBURDEN , cobbles, weathered, bedrock.
					44.98-46.33	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; moderately weathered to highly weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (20%).
D-8	25	42.98-44.65	100	15	42.98-44.65	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (11%).

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

ROCK CORE DESCRIPTION

Page 1 of 1.

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C-3	27	45.67-47.19	60	10	45.67-46.28	OVERBURDEN , gravel, cobbles, weathered bedrock.
					46.28-47.19	SHALE , medium grey to medium dark grey; very fine grained, very thinly laminated; weak to medium strong rock; slightly to medium weathered; extremely close spaced fractures.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

RECORD OF BOREHOLE No C-1

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 519.6; E 298 137.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 24 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)		
136.5	Ground Surface													
0.0	Trace Organics		1	SS	7									
			2	SS	9									
	Firm to Stiff		3	SS	11									
	Stiff to Hard	Brown Grey	4	SS	22									
			5	SS	30									
			6	SS	32									
	Clayey Silt													
	Trace of Sand		7	SS	28									
			8	SS	30									
			9	SS	12									
125.8														
10.7	Sandy Silt		10	SS	12									
			11	SS	18									
			12	SS	120									
	Compacted v. Dense													
			13	SS	120/15cm									
	Occ. Gravel Seams													
			14	SS	90									
			15	SS	94									
	Gravel, Boulders and Cobbles													
111.8			16	AS	-									
24.7	End of Borehole													
	*Artesian Head 3.0m Above Ground Surface													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-2

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 540.1; E 298 173.9 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 11 28 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					
147.4	Ground Surface															
0.0	Sand, Trace Silt															
	Trace Gravel		1	SS	5											
	(Fill)															
	Brown, V. Loose		2	SS	4											10 81 (9)
	to Loose															
142.4			3	SS	7											
5.0																
	Silty Clay		4	SS	5											
	to															
	Clayey Silt		5	SS	10											
	Trace Gravel															
	Occ. Sand Seams		6	TW	PH											
	Firm to V. Stiff		7	TW	PH											
	(Glacial Till)															
135.2																
12.2			8	SS	9											
			9	SS	15											
	Clayey Silt		10	SS	14											0 4 66 30
	Trace Sand		11	SS	15											
	Grey		12	SS	13											
			13	SS	11											
			14	SS	12											
			15	SS	13											
			16	SS	10											
	Stiff		17	SS	7											
	Firm															
124.5																
22.9	Sand		18	SS	5											
	Some Silt															
122.6	Grey, Loose		19	SS	8											
24.8	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-3 Cont'd

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
122.0	Continued													
121.7	Clayey Silt													
30.5			23	SS	10									
	Sand													
	Some Silt													
	Grey, Compact to Dense		24	SS	39									
			25	SS	28									
			26	SS	46									
	Occ. Cobbles Boulders and Gravel													
105.9														
46.3	Bedrock													
105.0	Shale		27	RC	REC 60%									RQD = 10%
47.2	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-4

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 580.0; E 298 204.5 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
DATUM Geodetic DATE 1989 11 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
147.0	Ground Surface													
0.0														
	Brown Grey		1	SS	12		146							
	Clayey Silt		2	SS	6		144							
	Some Sand, Tr. Gravel						142		2					
	Stiff to V. Stiff		3	SS	7		140		2				8 17 47 28	
	Occ. Sand Seams (Glacial Till)		4	SS	5		138		2					
			5	SS	5		136							
136.3			6	SS	13		134							
10.7			7	SS	22		132							
	Clayey Silt		8	SS	13		130							
	Grey, Stiff to Hard		9	SS	34		128							
	Random Zones of Silt		10	SS	39		126						0 1 73 26	
			11	SS	25		124							
			12	SS	23									
			13	SS	19								0 3 67 30	
			14	SS	18									
			15	SS	15									
			16	SS	14									
			17	SS	10									
122.2			18	SS	11									
24.8	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-1

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & COMPILED BY TS
DATUM Geodetic DATE 89 10 21-30 Cone Test CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	kN/m ³	GR SA SI CL		
152.0	Ground Surface													
0.0	Sand (Fill) Brown, Compact		1	AS	-									
150.5			2	SS	10									
1.5			3	SS	10									
	Brown Grey		4	SS	6									
			5	TW	PH									
	Silty Clay to Clayey Silt		6	SS	9									
			7	SS	9									
	Some Sand		8	SS	9									
	Stiff		9	SS	7									
	Occ. Sand Seams		10	TW	PH									
	(Glacial Till)		11	SS	4									
138.3			12	SS	21									
13.7	Clayey Silt		13	SS	21									
	V. Stiff		14	SS	32									
	to		15	SS	30									
	Hard		16	SS	26									
			17	SS	32									
			18	SS	19									
			19	SS	18									
			20	SS	20									
			21	SS	16									
			22	SS	18									
121.8														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued



RECORD OF BOREHOLE No D-1, Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & COMPILED BY TS
DATUM Geodetic DATE 89 10 21-30 Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
121.8 30.2	Continued		23	SS	16		120					
	Clayey Silt		24	SS	16							
	Very Stiff to Hard		25	SS	76		118					
			26	SS	45		116					
115.4 36.6			27	SS	15							0 86 (14)
	Sand		28	SS	59		114					
	Tr. Silt		29	SS	58		112					
	Compact to		30	SS	65		110					1 89 (10)
	V. Dense		31	SS	33		108					8 85 (7)
	Tr. Gravel		32	SS	44		106					RQD = 34%
105.9 46.1	Bedrock		33	SS	129/23cm		104					RQD = 0%
	Shale		34	BXL RC	73%							
	Weak to Very Weak		35	BXL RC	100%							
103.1 48.9	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-2

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 1989 11 08-11 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
153.0	Ground Surface												
0.0	Irregular Mixture of Silt, Sand, Slag Ballast (Fill)		1	SS	11								
150.6	Brown-Black, Compact												
2.4			2	SS	7				2				
			3	SS	7				2				
	Brown Grey		4	SS	8								
	Silty Clay to Clayey Silt		5	TW	PH							21.0	1 13 58 28
	Some Sand, Trace Gravel Firm to V. Stiff		6	TW	PH								
	Occ. Sand Seams		7	SS	4								4 13 35 48
	(Glacial Till)		8	SS	4								
139.3			9	SS	22								0 4 79 17
13.7	Clayey Silt		10	SS	20								
	Firm to		11	SS	23								
	V. Stiff		12	SS	12								
			13	SS	20								
			14	SS	18								
			15	SS	13								
122.8													
30.2													

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-2 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 1989 11 08-11 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			20	40	60	80	100				
122.8 30.2	Continued		16	SS	9	122									
	Clayey Silt					120									
	Firm to Very Stiff		17	SS	5	118									
116.1 36.9			18	SS	50	116									
	Sand					114									
	Tr. Silt		19	SS	20	112									
	Compact to					110									
	V. Dense		20	SS	56	108									
	Occ. Gravelly					106									
	Seams		21	SS	50	104									
105.5 47.5	Bedrock		22	RC	REC										
103.9 49.1	Shale														
	Weak to Very Weak														RQD = 20%
	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-3

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 504.0; E 298 204.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 27 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
136.0	Ground Surface												
0.0	Interbedded Layers of Sand and Gravel Brown Grey Tr. Organics		1	SS	4		134						
			2	SS	2								
			3	SS	14								
			4	SS	12								
			5	SS	22		132						0 5 61 34
			6	SS	19								
	Clayey Silt		7	SS	27		130						
	Tr. Sand, Tr. Gravel		8	SS	20		128						0 0 77 23
	Stiff to Hard		9	SS	20		126						
124.9			10	SS	15								
11.1	Silt Tr. Clay, Tr. Sand		11	SS	7		124						
	Loose V. Dense		12	SS	85		122						
			13	SS	100/	15cm							0 5 85 10
119.1			14	SS	120/	10cm	120						
16.9	End of Borehole												

RECORD OF BOREHOLE No D-4

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 13-21 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 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
152.1	Ground Surface																
0.0							152										
	Clayey Silt With		1	SS	2		150										
	Interbedded Layers		2	SS	3		148										0 32 64 4
	of Sand		3	SS	3		146										
	(Fill)		4	SS	6		144									20.0	0 2 78 20
	Brown to Grey		5	SS	6		142										
	V. Soft to Stiff		6	SS	8		140										
			7	SS	15		138									20.2	4 22 49 25
139.9			8	SS	20		136										
12.2			9	SS	25		134										
	Clayey Silt		10	SS	30		132									22.0	0 1 79 20
	Grey, Stiff to Hard		11	SS	53		130										
			12	SS	32		128										
	Sandy Silt		13	SS	17		126										
			14	SS	11		124										
			15	SS	13		122										0 0 88 12
121.9																	
30.2																	

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 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 Y KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
121.9 30.2	Continued		16	SS	10		120									
	Clayey Silt Grey Stiff to Hard															
118.6 33.5			17	SS	45		118									
	Sand Some Silt Grey, Compact to V. Dense		18	SS	20		116									
			19	SS	72		114									
			20	SS	120/8 cm		112									0 85 14 1
	Occ. Cobbles Boulders and Gravel		21	SS	65		110									
107.1 45.0	Bedrock Shale		22	NQ RC	REC 60%		108									RQD = 8%
105.8 46.3	End of Borehole						106									

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 520.0; E 298 212.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 30 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					
143.5	Ground Surface																
0.0	Sand, Tr. Gravel (Fill)		1	SS	6	*	142										
	Brown, Loose to Compact		2	SS	21		140										
138.9	Clayey Silt With Interbedded Layers of Sand (Fill)		3	SS	37		138										
136.9	Brown, Stiff to Hard		4	SS	22												
6.6	End of Borehole *Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-5

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 605.0; E 298 115.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 16-17 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							W _p W W _L		
								SHEAR STRENGTH kPo							WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	× LAB VANE								
154.3	Ground Surface							20 40 60 80 100		10 20 30							
0.0	Silty Clay to Clayey Silt Trace Gravel Grey, Firm to V. Stiff Occ. Sand Seams (Glacial Till)					*	154						19.5	0 4 61 35			
			1	SS	7		152										
			2	SS	3		150	2									
			3	TW	PH		148	2	Q								
			4	TW	PH		146										
			5	SS	11		144										
			6	SS	8		142										
			7	SS	10		140										
			8	SS	5		138										
	9	SS	10		136												
139.1	Clayey Silt Grey, Stiff to V. Stiff		10	SS	12		138						20.1	6 7 60 27			
15.2			11	SS	22												
			12	SS	32												
			13	SS	22												
134.0	End of Borehole *Borehole Dry												20.0	0 2 74 24			
20.3																	

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 511.1; E 298 240.4 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
152.5	Ground Surface																
0.0	Sand, Tr. Silt (Fill) Brown, V. Loose					*	152										
150.5			1	SS	4												
2.0			2	SS	6		150										
	Clayey Silt With Interbedded Layers of Sand (Fill) Brown, Firm		3	SS	6		148										0 5 73 22
			4	SS	5		146										19.4 0 2 84 14
			5	SS	7		144										19.2 0 14 64 22
			6	SS	6												
141.8			7	SS	4		142										1 79 15 5
10.7	Sand, Some Silt (Fill) Brown, Very Loose to Loose		8	SS	6		140										
138.6			9	SS	7												6 72 18 4
13.9	Clayey Silt, Tr. Gravel Tr. Organics Grey, Firm to Stiff						138										
136.8			10	SS	14												
15.7	End of Borehole *Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 504.0; E 298 229.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
DATUM Geodetic DATE 1989 11 29 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					
143.5	Ground Surface																
0.0			1	SS	2	*											
	Sand, Some Gravel, Trace Silt		2	SS	6		142						o				20 77 (3)
	(Fill)		3	SS	8												
	Brown, V. Loose to Compact		4	SS	9		140						o				26 59 (15)
			5	SS	12												
138.9																	
4.6	Clayey Silt (Fill) Brown, V. Stiff		6	SS	19		138										
137.3	Clayey Silt																
136.6	Grey, Tr. Organics		7	SS	29												4 6 65 25
6.6	End of Borehole																
	* Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-7

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 530.8; E 298 232.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
 DATUM Geodetic DATE 89 11 20 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
152.5	Ground Surface															
0.0																
			1	SS	2											11' 62 23 4
			2	SS	3											
	Clayey Silt Brown, Firm		3	SS	8											0 12 66 22
			4	SS	4											
	Silty Sand to Sandy Silt (Fill) V. Loose to Loose		5	SS	5											2 41 54 3
			6	SS	5											
			7	SS	8											
			8	SS	9											0 30 66 4
			9	SS	9											1 63 31 5
			10	SS	8											4 73 19 4
136.3																
16.2	End of Borehole Auger Refusal Probable Culvert Roof *Borehole Dry															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-8

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
150.6 0.0	Ground Surface													
	Sand, Some Silt With Interbedded Layers of Clayey Silt Brown, Loose (Fill)		1	SS	9		150							14 56 29 1
			2	SS	6		148							
			3	SS	4		146							0 13 75 12
144.5 6.1	Clayey Silt Grey, Firm to Stiff Occ. Sand Seams (Glacial Till)		4	SS	4		144							0 7 52 41
			5	SS	8		142						20.2	
			6	SS	12									
			7	SS	4		140							
139.9 10.7	Clayey Silt Grey, Firm to Hard		8	SS	17									
			9	SS	22									
			10	SS	19		138						20.3	2 1 72 25
			11	SS	22									
			12	SS	28		136						21.6	
			13	SS	25									
			14	SS	23		134							
			15	SS	19		132							
			16	SS	16		130							0 5 60 35
			17	SS	14		128							
			18	SS	18		126							
			19	SS	10		124							
							122							

120.4
30.2

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-8 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L		
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
										WATER CONTENT (%) 10 20 30				
120.4 30.2	Continued		20	SS	9		120							
	Silt, Tr Sand V. Dense		21	SS	107		118			OH				0 7 79 14
	Clayey Silt Grey Firm to Hard		22	SS	36		116							
111.9 38.7	Sand With Silt Grey, Compact		23	SS	12		114							
							112							
107.7 42.9	Some Gravel		24	SS	120	15 cm	110							
	Bedrock Shale Weak to Very Weak		25	NQ RC	REC 100%		108							17 38 31 14
105.9 44.7	End of Borehole						106							RQD = 15%

FOUNDATION INVESTIGATION
GRADE SEPARATION AT HIGHWAY 407
AND ISLINGTON AVENUE

W.P. 88-78-18

DISTRICT 6

1.0 INTRODUCTION

The Ministry of Transportation and Communications has retained Golder Associates to carry out a geotechnical investigation for the proposed grade separation at Highway 407 and Islington Ave. in the Town of Vaughan, Ontario. The purpose of the investigation was to determine the subsurface conditions at the site.

2.0 SITE AND PROJECT DESCRIPTION

Details of the project were provided on a plan entitled "Islington Avenue Preliminary Plan & Profile" prepared by Marshall Macklin and Monaghan Limited. Subsequently, Plan E-6030-1 prepared by the Ministry of Transportation and Communications was received on July 9, 1983.

The site is located on Islington Avenue about one half kilometer north of Steeles Avenue in the Town of Vaughan, Regional Municipality of York. At this location, the proposed Highway 407 will cross below Islington Avenue at a depth of about 8 metres below existing grade. A new multi-span bridge structure will be constructed along a relocated centreline of Islington Avenue which will correspond roughly to the westerly edge of the existing asphaltic pavement.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The site is located in a level glacio-lacustrine sand plain formed east of the Humber River Valley. The surficial soils consist of sands and silts which, with depth, change to lacustrine clays and clay till. The lacustrine clays in this area are known to contain zones of reworked till and the clays are thought to be derived from the underlying till deposit. Water well records indicate that the site is located in a deep depression in the bedrock surface. Shale bedrock of the Dundas formation has been found at depths of 40 to 60 metres in the area.

3.2 Soil Stratigraphy

3.2.1 Sand

In the upper 2.1 metres of Borehole 2, sand with a trace of silt and some gravel was found. The soil has been weathered to a brown colour and is in a compact condition based on penetration resistance, 'N' values of 15 and 20 measured in the deposit. The water content of laboratory samples of the soil was about 15 per cent.

3.2.2 Sandy Silt to Silty Clay

Predominantly silty soils were encountered to depths of 7.3 to 8.5 metres in Boreholes 3 and below the upper sand in Borehole 2. The deposit consists of sandy silt to silt with layers of silty clay. The frequency of the silty clay layers increases with depth. Grain size distribution curves of these materials are shown on Figures 1 and 2. The upper weathered zone of the deposit is brown in colour, the unweathered zone below about elevation 156 is grey,

The silty soil was found to be in a compact state at Boreholes 1 and 2 based on 'N' values of 10 to 21. At Borehole 3 lower 'N' values, generally between 3 and 7, were recorded and are indicative of very loose to loose conditions. In the lower portions of the deposit where the silty clay layers were more frequent, in situ vane tests measured undrained shear strengths of 84 kPa or more.

The results of drained simple shear tests on a remoulded sample of the silty soil from Borehole 2 at a depth of 6.4 metres are presented on Figure 15. The tests measured an effective angle of internal friction of 34 degrees. From the unit weights of the sample measured after testing, it is considered that the sample was put into the shear box in a more dense state than its in situ condition. Therefore, the design angle of internal friction has been assumed to be 30 degrees.

The water content of laboratory samples of the soil varied from 21 to 27 per cent. The sandy portions of the silt were found to be nonplastic while zones containing some clay had liquid limits of 21 to 27 per cent and plasticity indices of 3 to 8 per cent, indicative of silts and clays of low plasticity.

3.2.3 Upper Clay

Below the upper silty soils, an irregularly, horizontally layered clay was encountered in Boreholes 1 and 2 to about elevation 143. The layers within the clay contain a higher proportion of silt and occasional thin partings of silt were noted. The clay has zones of light grey silt nodules and traces of gravel giving it a till-like texture in places. A typical grain size distribution curve of the clay is shown on Figure 3.

In situ vane tests in the clay measured undrained shear strengths between 34 and 80 kPa. Laboratory vane tests on shelby tube samples gave strengths as low as 28 kPa at elevation 147. The undrained shear strengths generally increase above and below this elevation. The clay has a sensitivity of about 2 to 5.

The results of a series of consolidated undrained triaxial tests with pore pressure measurements on a sample of the clay from elevation 149 in Borehole 2 are presented on Figure 16. The stress paths followed by each test vary somewhat, probably due to shearing through layers having various silt contents. The minimum effective angle of internal friction of 30 degrees was measured in sample C which was consolidated well in excess of the existing overburden pressures. From this it is concluded that the angle of internal friction for design when failure will take place on a vertical or near vertical plane can be taken as 30 degrees.

A series of three drained direct shear tests were carried out on a sample of the clay from elevation 144.5 in Borehole 2. The specimens were oriented so that shear failure would occur parallel to the layers. The results indicate that the effective angle of internal friction of the clay on horizontal planes is 24 degrees.

The water content of the clay varies from 18 to 44. Atterberg limit tests on the samples measured liquid limits and plasticity indices of 21 to 48 and 9 to 24 respectively indicating the clay to have intermediate plasticity (refer to Figure 11). The unit weight of the clay is generally about 18.7 kN/cu.m.

3.2.4 Silty Clay Till

Below the clay in Boreholes 1 and 2 and below the upper silty soils in Borehole 3, silty clay till was encountered to about elevation 131 to 134. Typical grain size distribution curves of the till are shown on Figure 4.

The till has a firm to hard consistency as in situ vane shear strengths of about 40 kPa or higher were measured within the deposit. The till generally has a low sensitivity of less than 2 although sensitivities as high as 4 were measured in Borehole 3. Penetration 'N' values between 10 and 21 were measured in the till.

The till has low plasticity as the liquid limit is generally about 27 and the plasticity index is between 9 and 12. The water content of the till is generally between 15 and 20 per cent. The unit weight of the soil was measured to be about 21 kN/cu.m.

3.2.5 Lower Silt

The silty clay till changes gradually in composition with depth to silt which extends to elevation 128 to 129. The silt has traces of clay and sand and the deposit contains pockets of sand and silty clay. A grain size distribution of the silt is shown on Figure 5.

Penetration values within the deposit were measured to be generally between 10 and 35 indicative of compact to dense conditions. Clayey zones within the soil were found to have a very stiff consistency.

The water content of the soil was measured to be near 20 per cent.

3.2.6 Lower Silts, Sands and Clays

Below elevation 128 to 129 a complex succession of silts, sands and clays were encountered. The strata vary from layered silty clay to sand with some gravel and trace silt. A 2.7 metre thick zone of limestone cobbles or slabs with a silty sand matrix was encountered between elevations 125.3 and 128.0 in Borehole 2.

Within the soil strata, 'N' values of between 10 and 58 were measured above elevation 125 while below this level values were generally in excess of 50 indicating very dense or hard conditions in the lower zone of the deposit. Water contents measured within the strata are typically between 15 and 25 per cent. At elevation 117, the water content of a layered silty clay strata was measured to be 30 per cent. The liquid limit and plasticity index of this lower clay were measured to be 34 and 13 respectively indicating it to be of intermediate plasticity.

3.3 Groundwater Conditions

The groundwater level in the upper sandy and silty soils was at about elevation 157 at the time of the investigation. It appears to be subject to seasonal fluctuations.

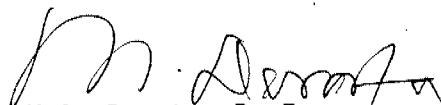
Deep piezometers installed in Boreholes 1 and 2 indicate that the water level in the lower sands and silts is at about elevation 141. Therefore, there is a downward seepage gradient at the site.

Note: The preceding report is a copy of the factual information from the Foundation Report prepared by GOLDER ASSOCIATES (consulting geotechnical engineers for this project), under the technical supervision of the M.T.O. Foundation Design Section.



for

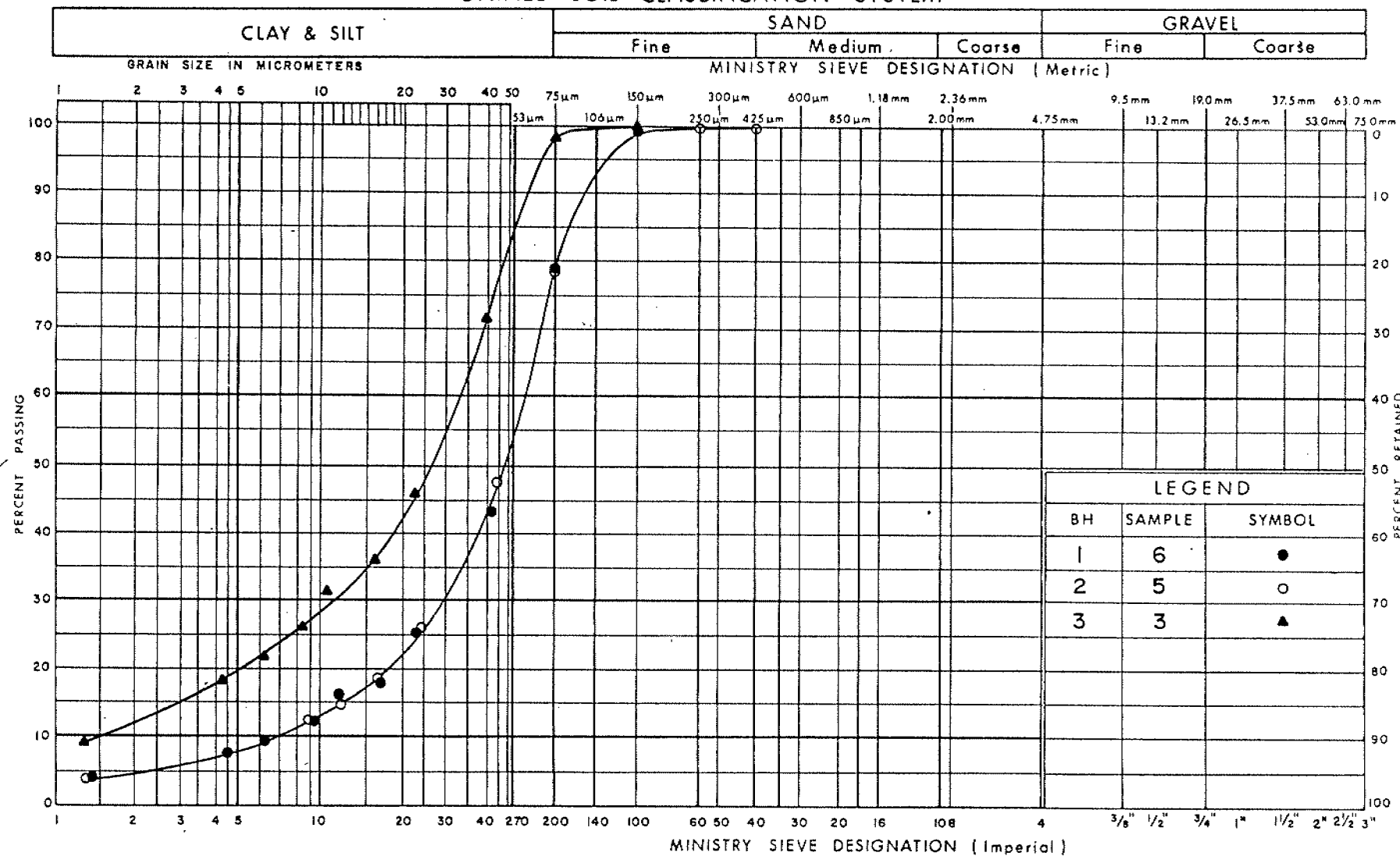
Dr. B. Iyer, P. Eng.
Senior Foundation Engineer



M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

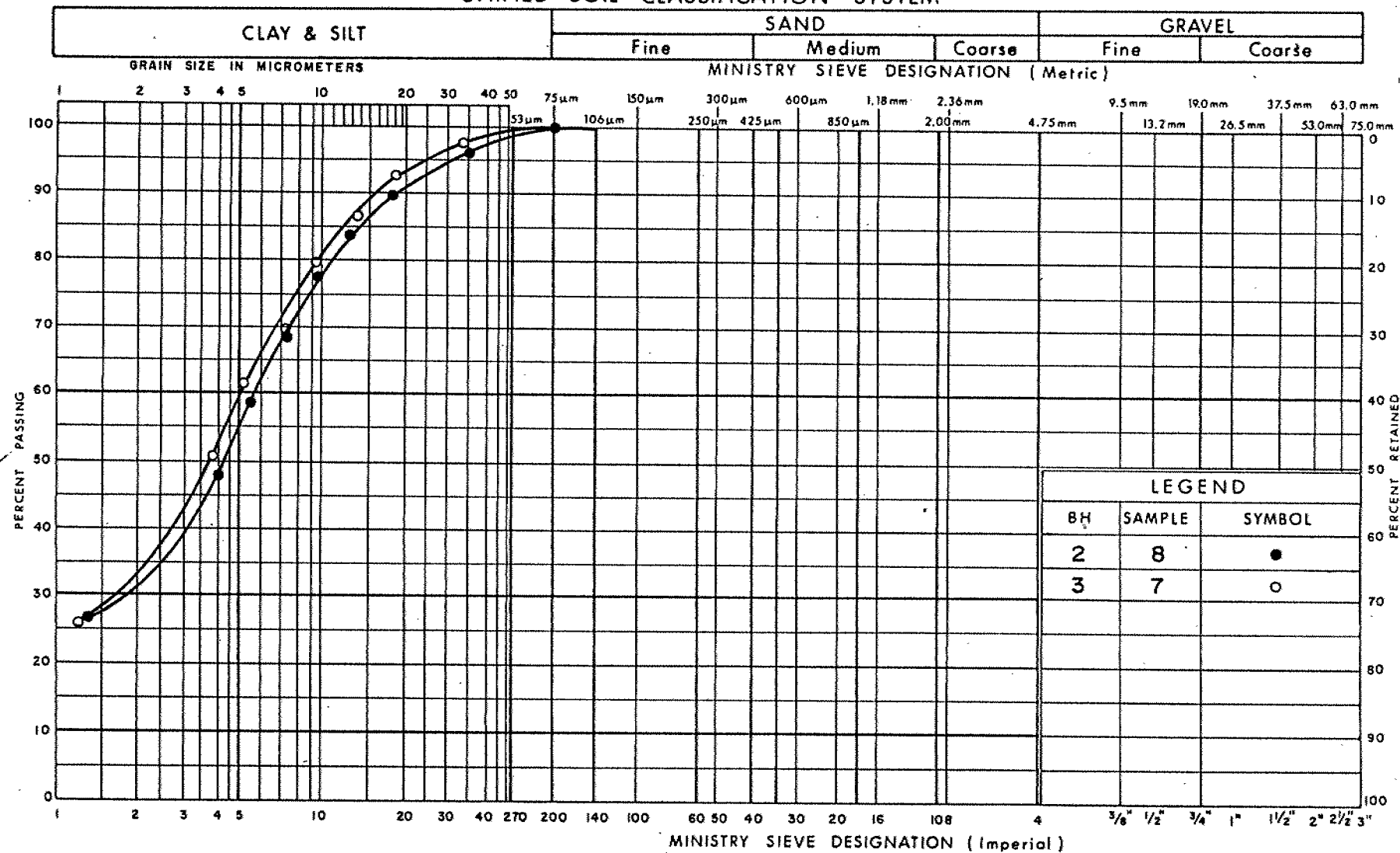


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Communications

GRAIN SIZE DISTRIBUTION
UPPER SANDY SILT TO SILT

FIG No 1
W P 88-78-18

UNIFIED SOIL CLASSIFICATION SYSTEM



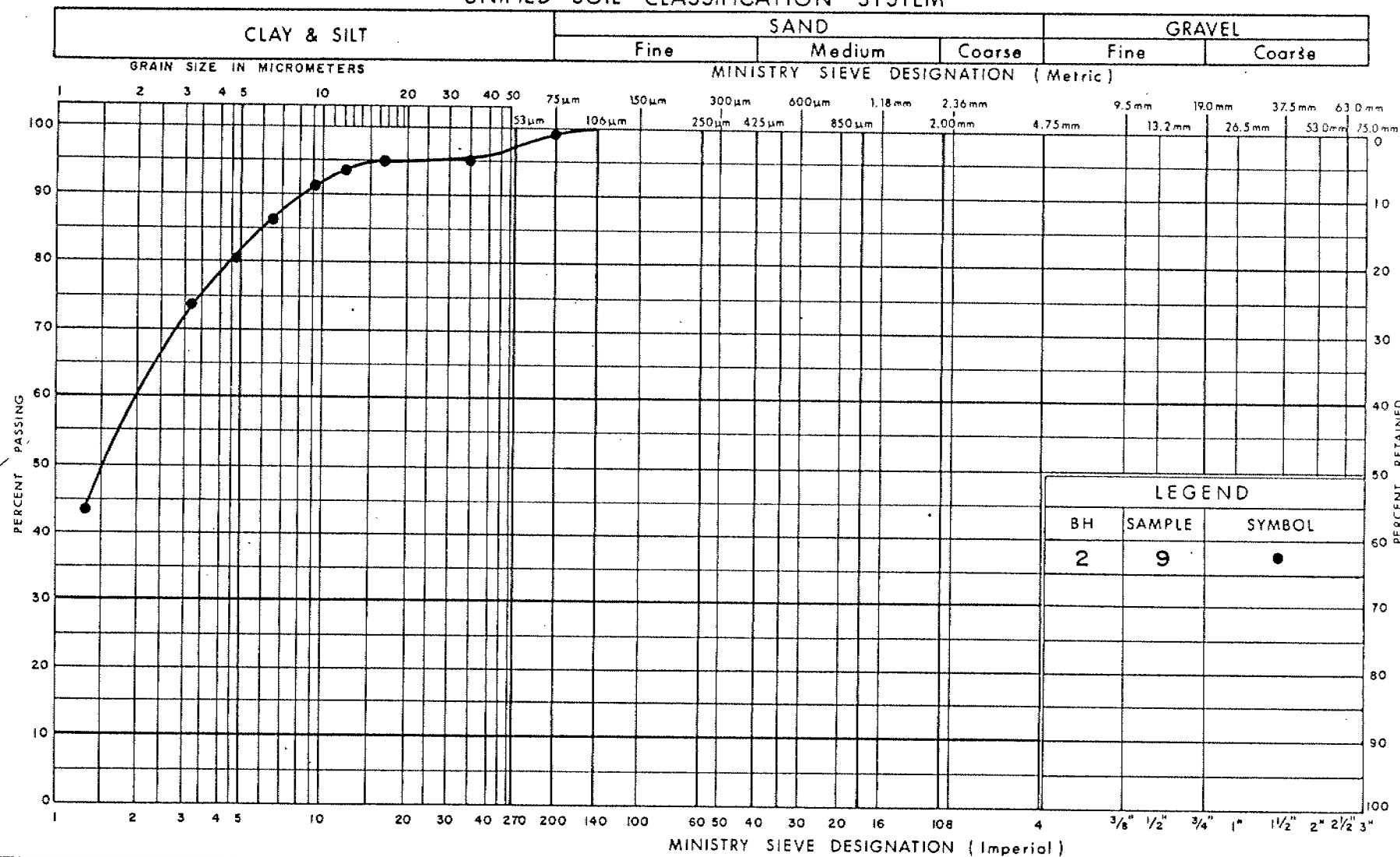
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GRAIN SIZE DISTRIBUTION
UPPER SILTY CLAY

FIG No 2

WP 88-78-18

UNIFIED SOIL CLASSIFICATION SYSTEM



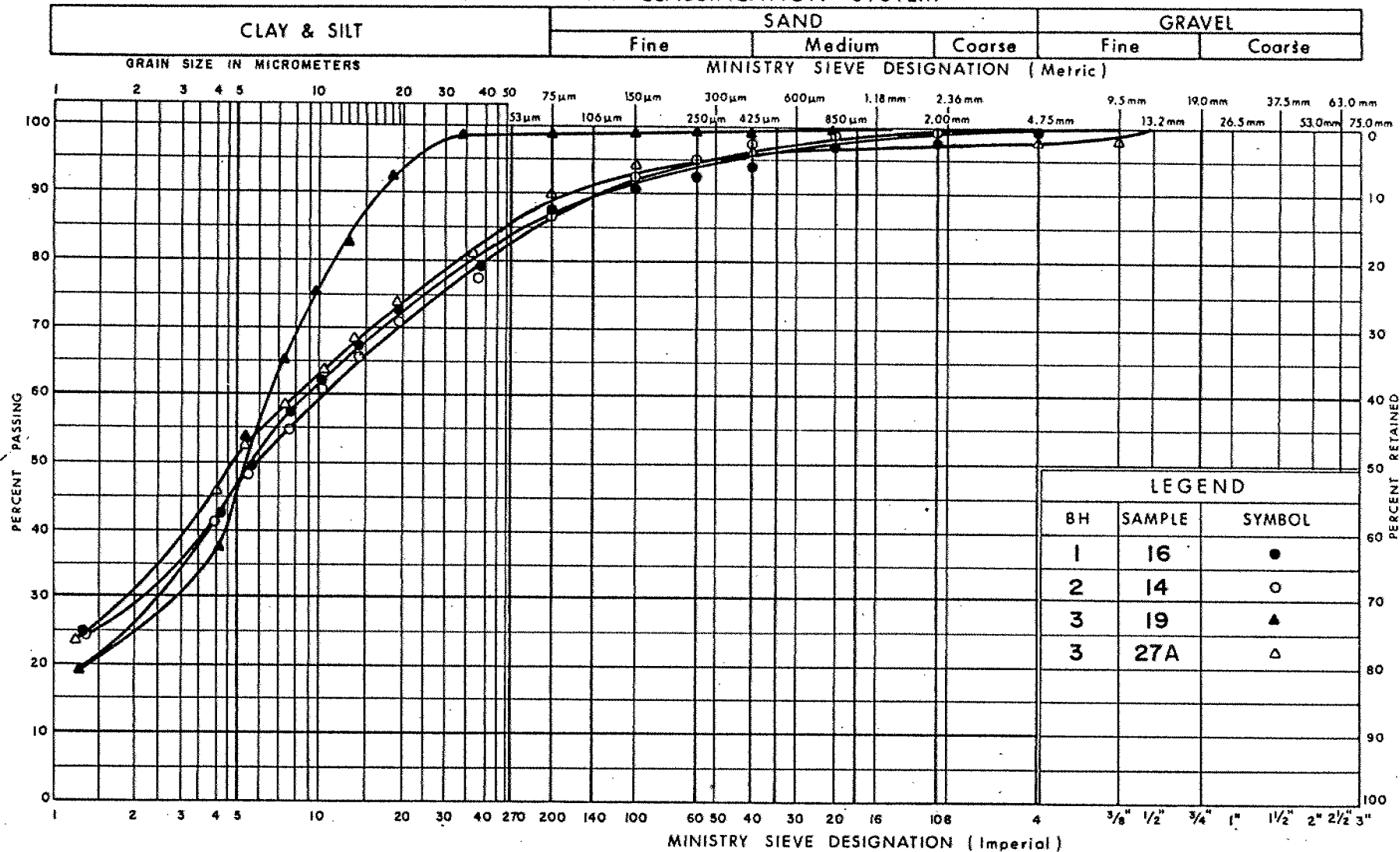
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GRAIN SIZE DISTRIBUTION UPPER CLAY

FIG No 3

W P 88-78-18

UNIFIED SOIL CLASSIFICATION SYSTEM



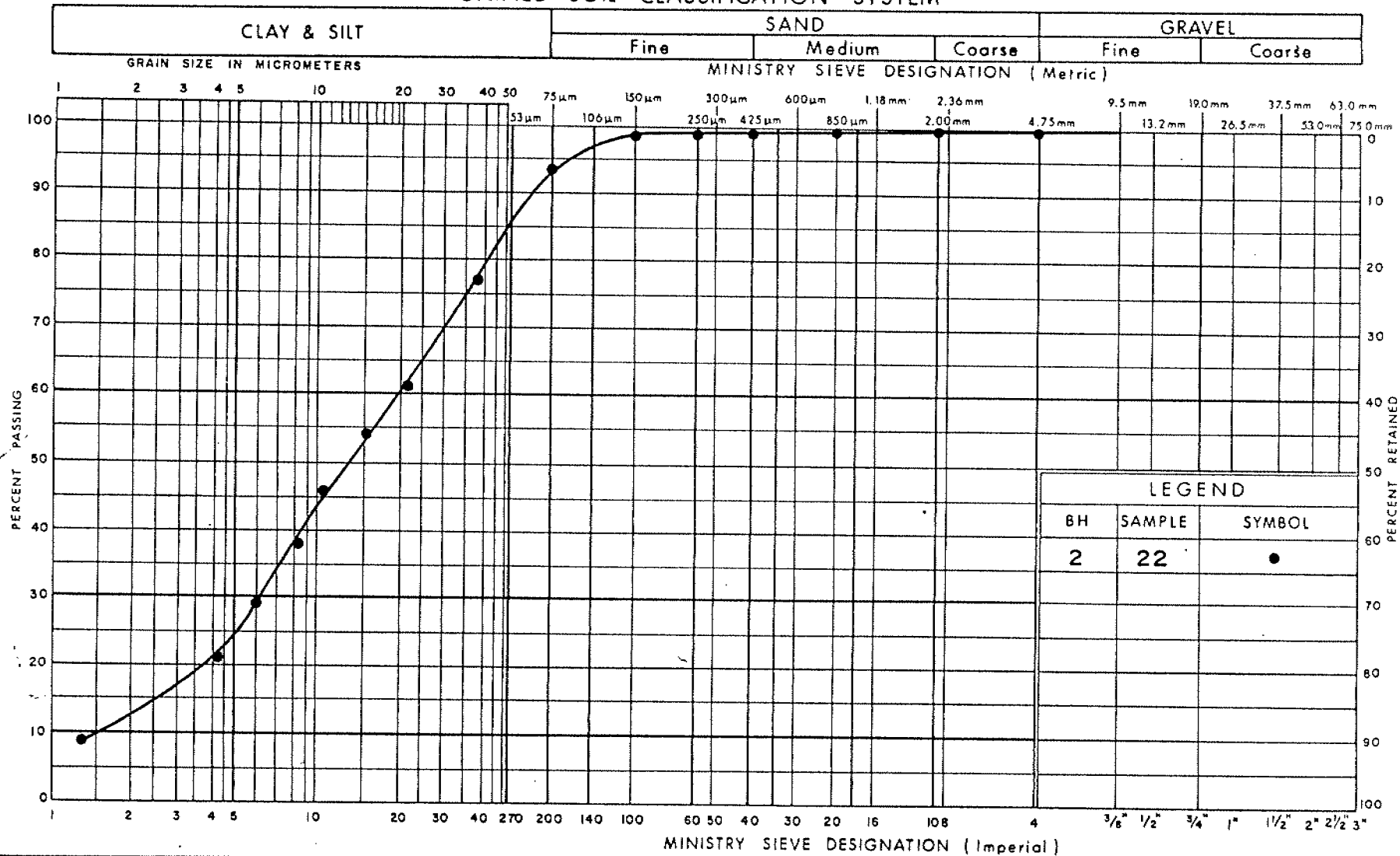
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GRAIN SIZE DISTRIBUTION
SILTY CLAY TILL

FIG No 4

W P 88-78-18

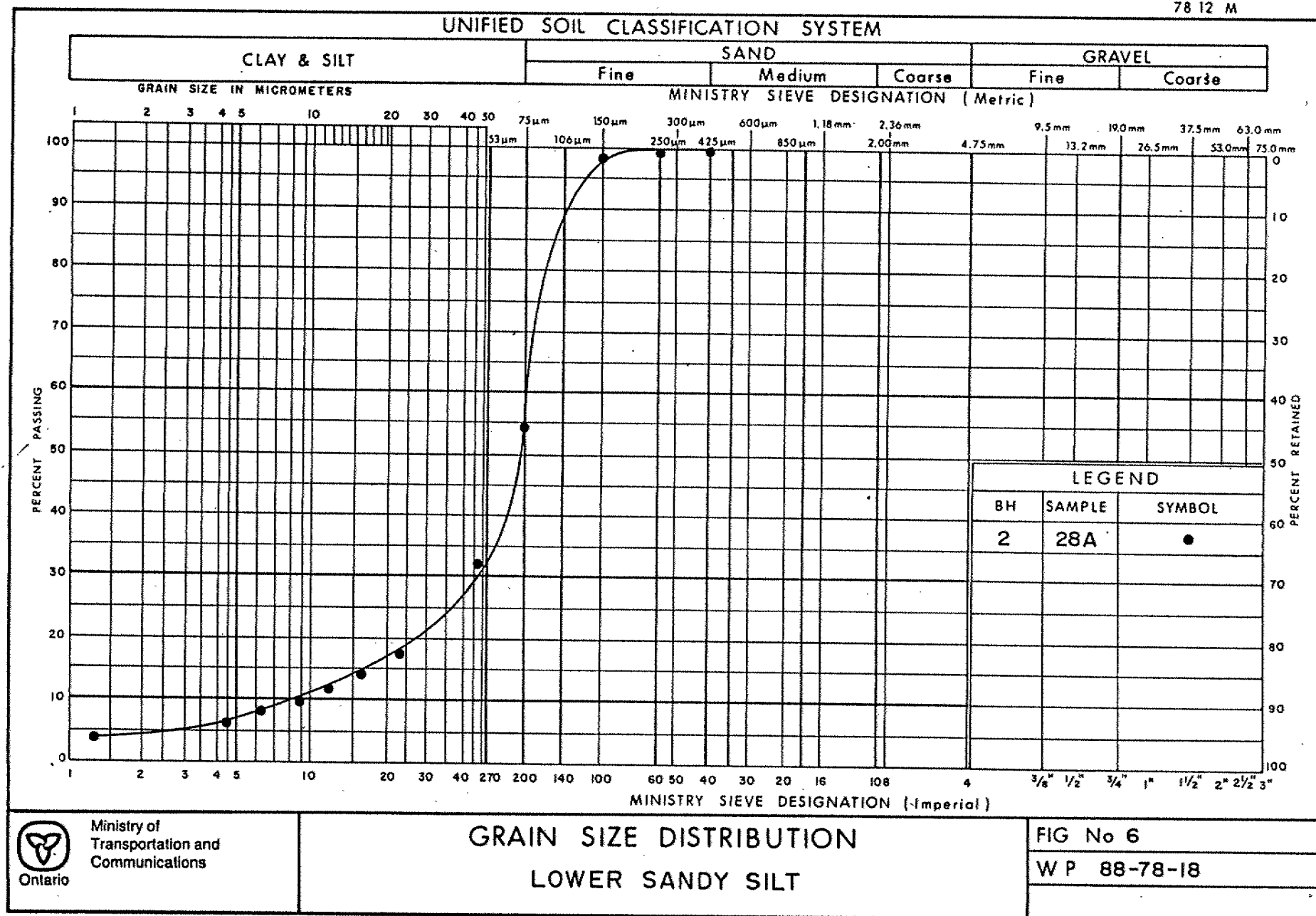
UNIFIED SOIL CLASSIFICATION SYSTEM

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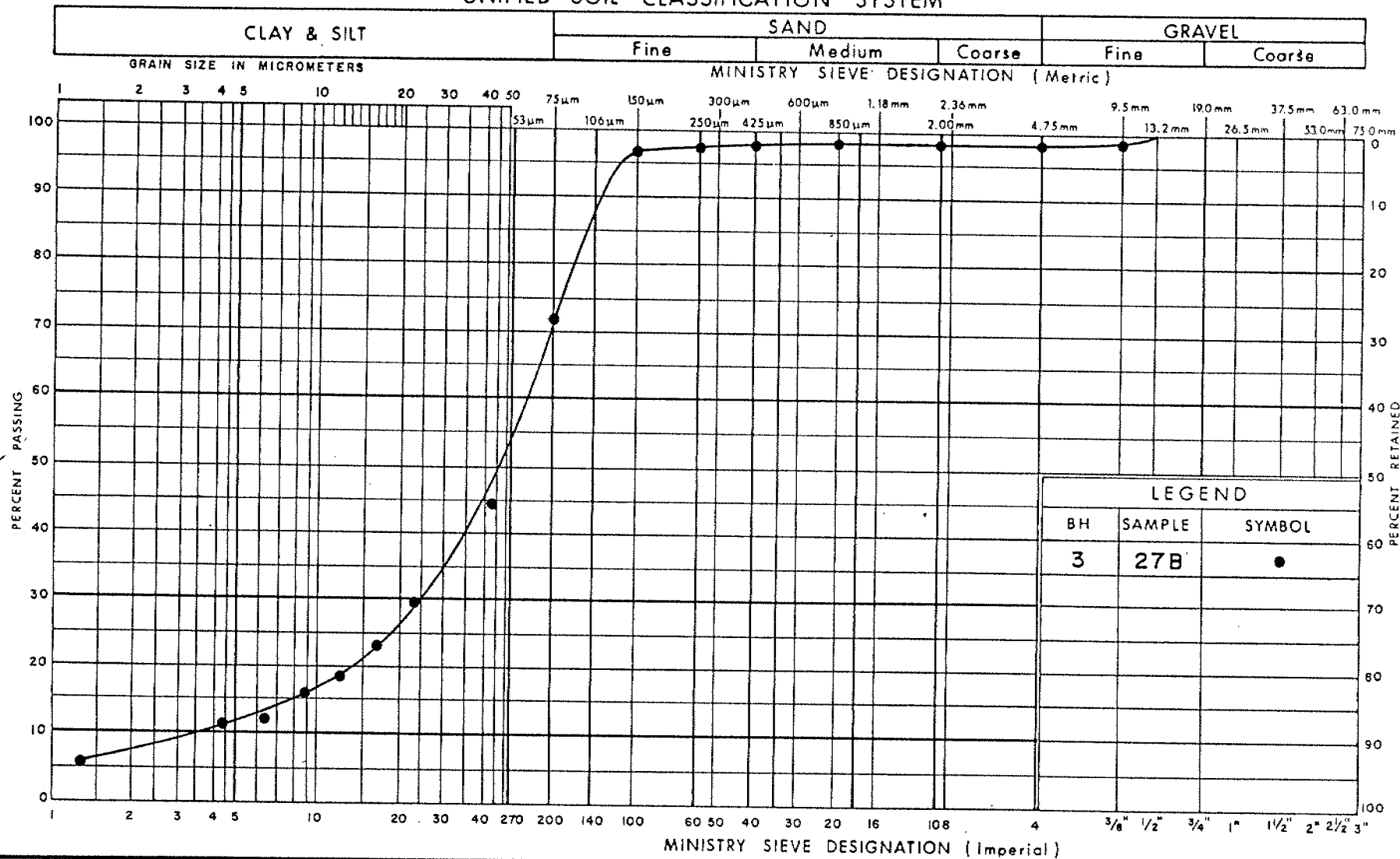
GRAIN SIZE DISTRIBUTION
SILT

FIG No 5

W P 88-78-18



UNIFIED SOIL CLASSIFICATION SYSTEM



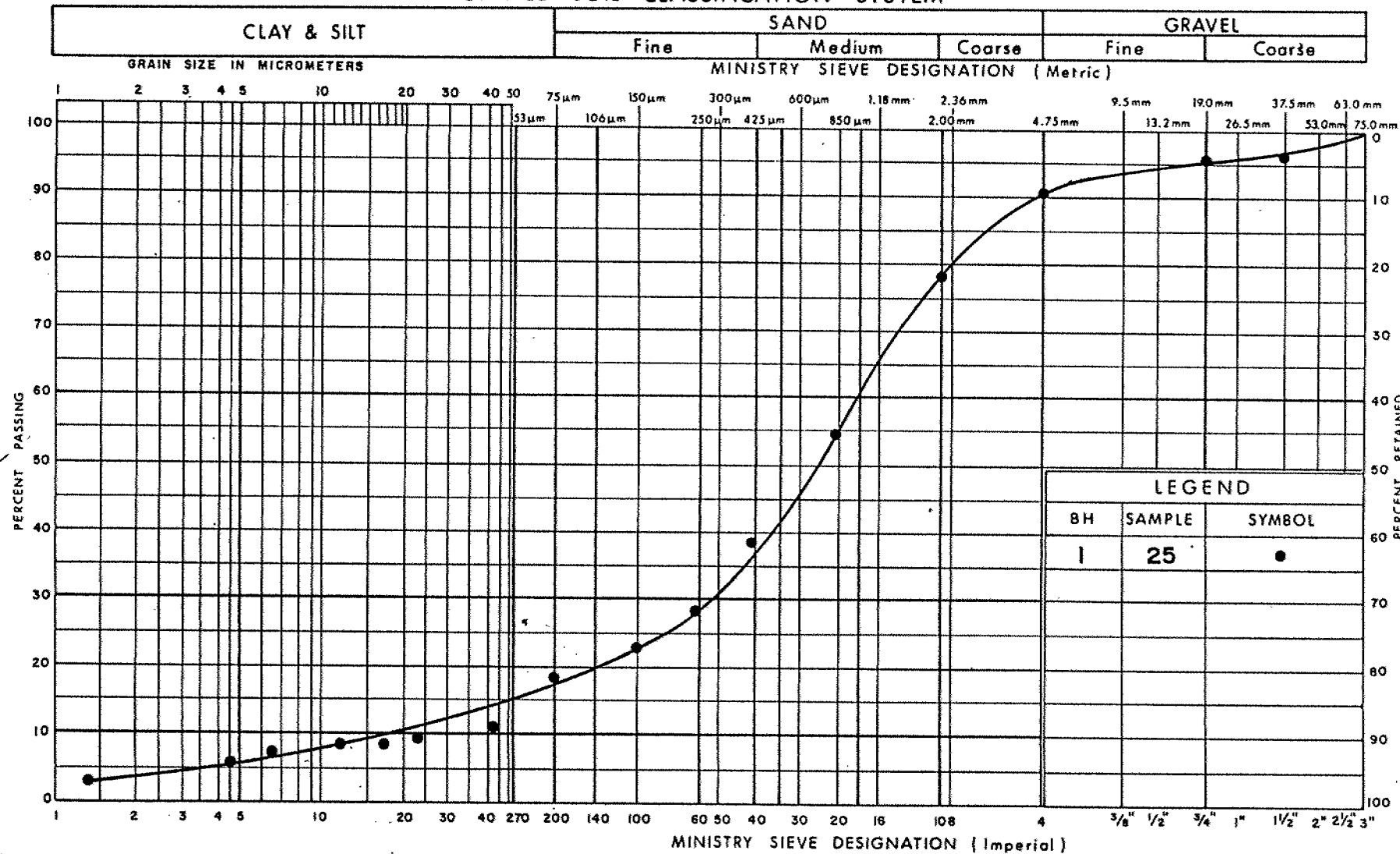
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GRAIN SIZE DISTRIBUTION SILT LAYER WITHIN TILL

FIG No 7

W P 88-78-18

UNIFIED SOIL CLASSIFICATION SYSTEM

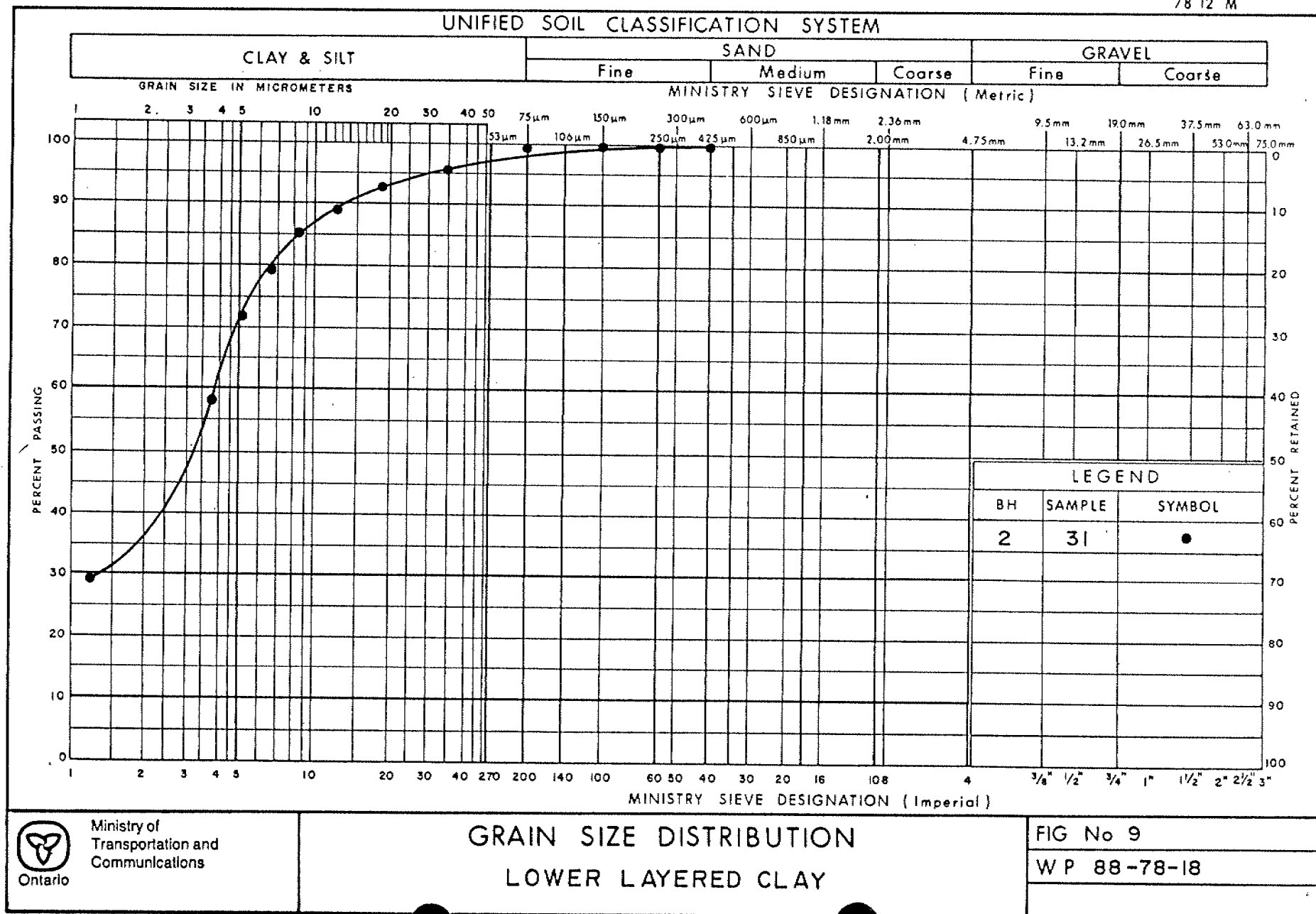


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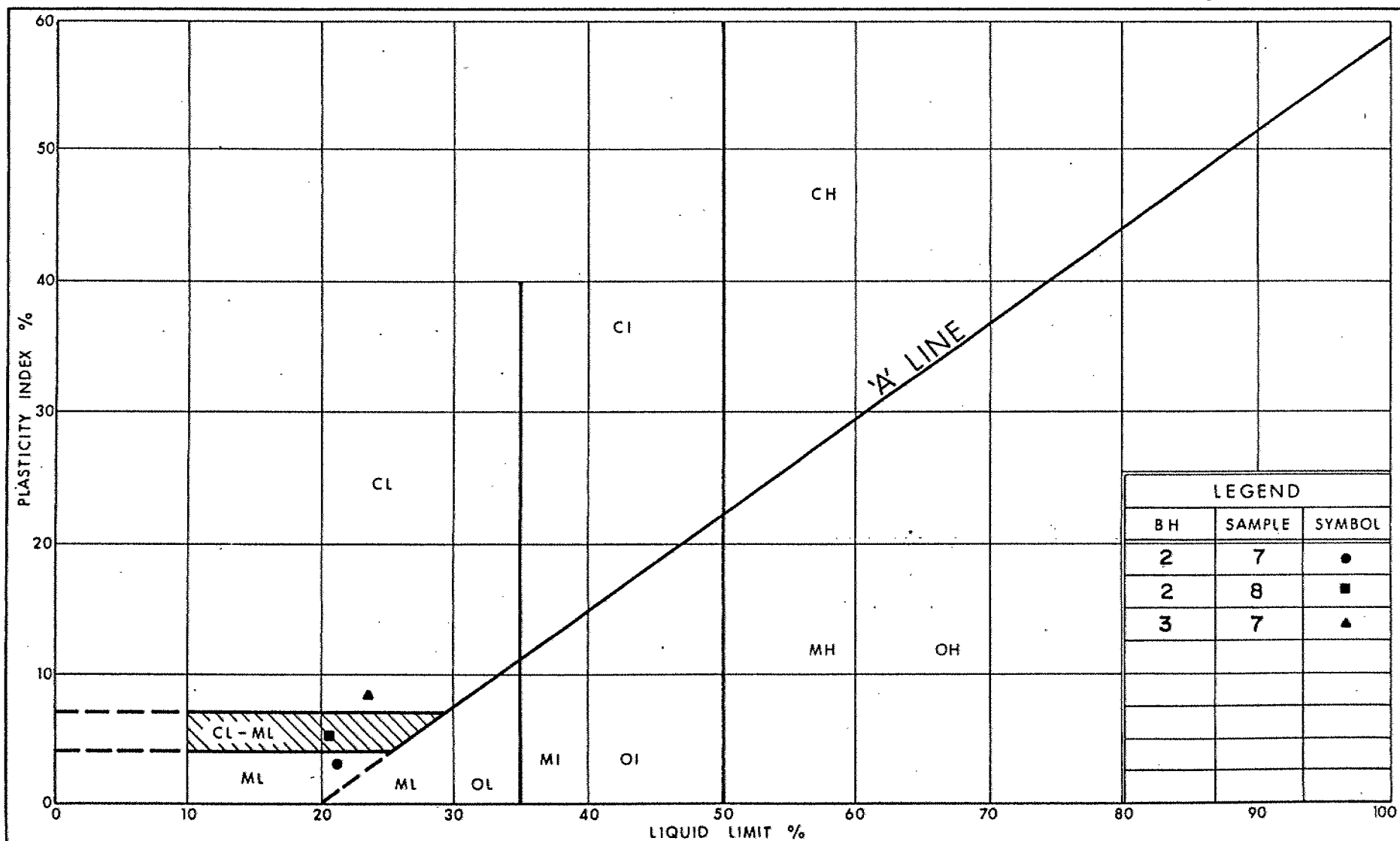
GRAIN SIZE DISTRIBUTION LOWER SAND

FIG No 8

W P 88-78-18



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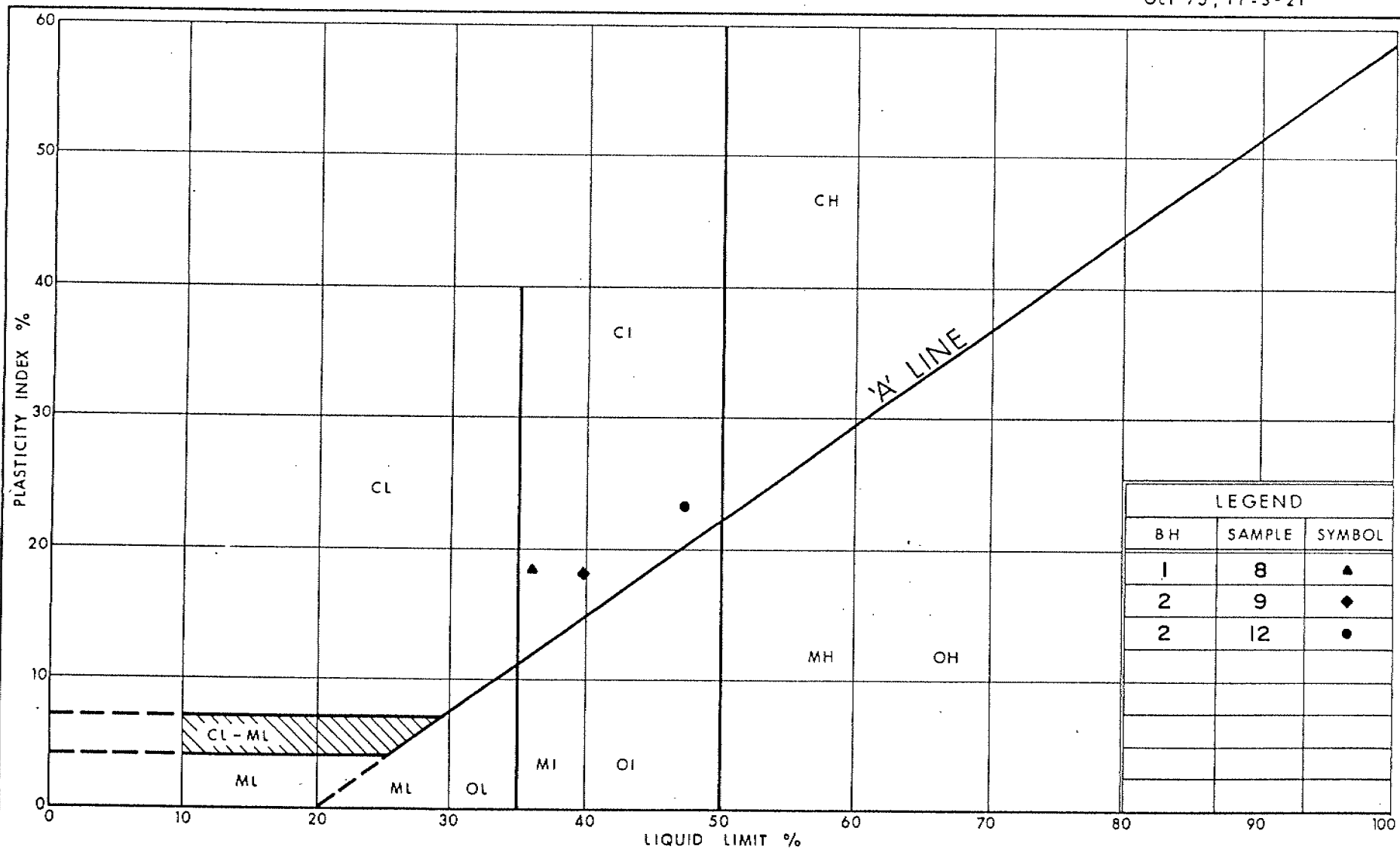


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PLASTICITY CHART UPPER SILTY CLAY

FIG No 10

W P 88-78-18

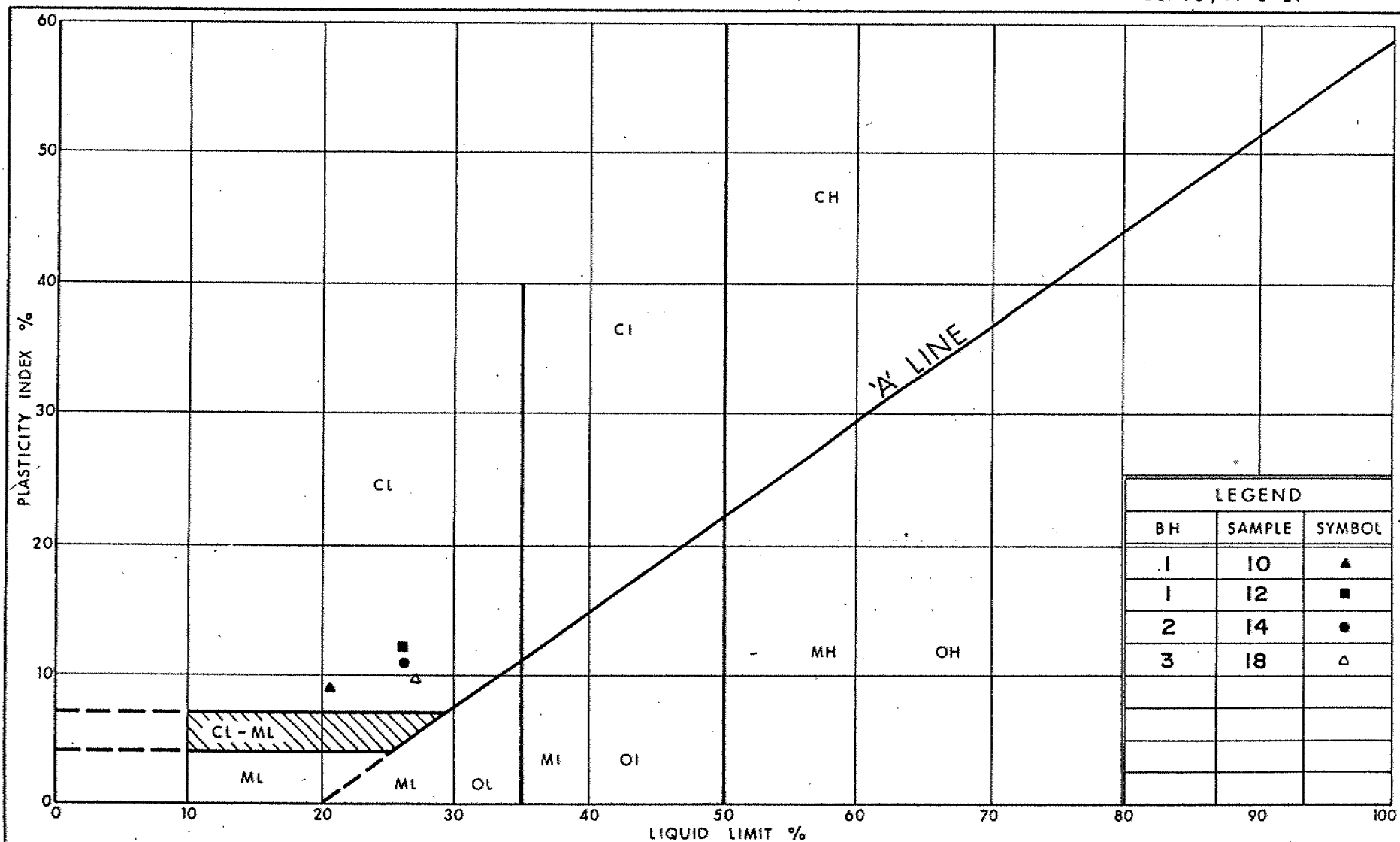


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PLASTICITY CHART CLAY

FIG No II

W P 88-78-18

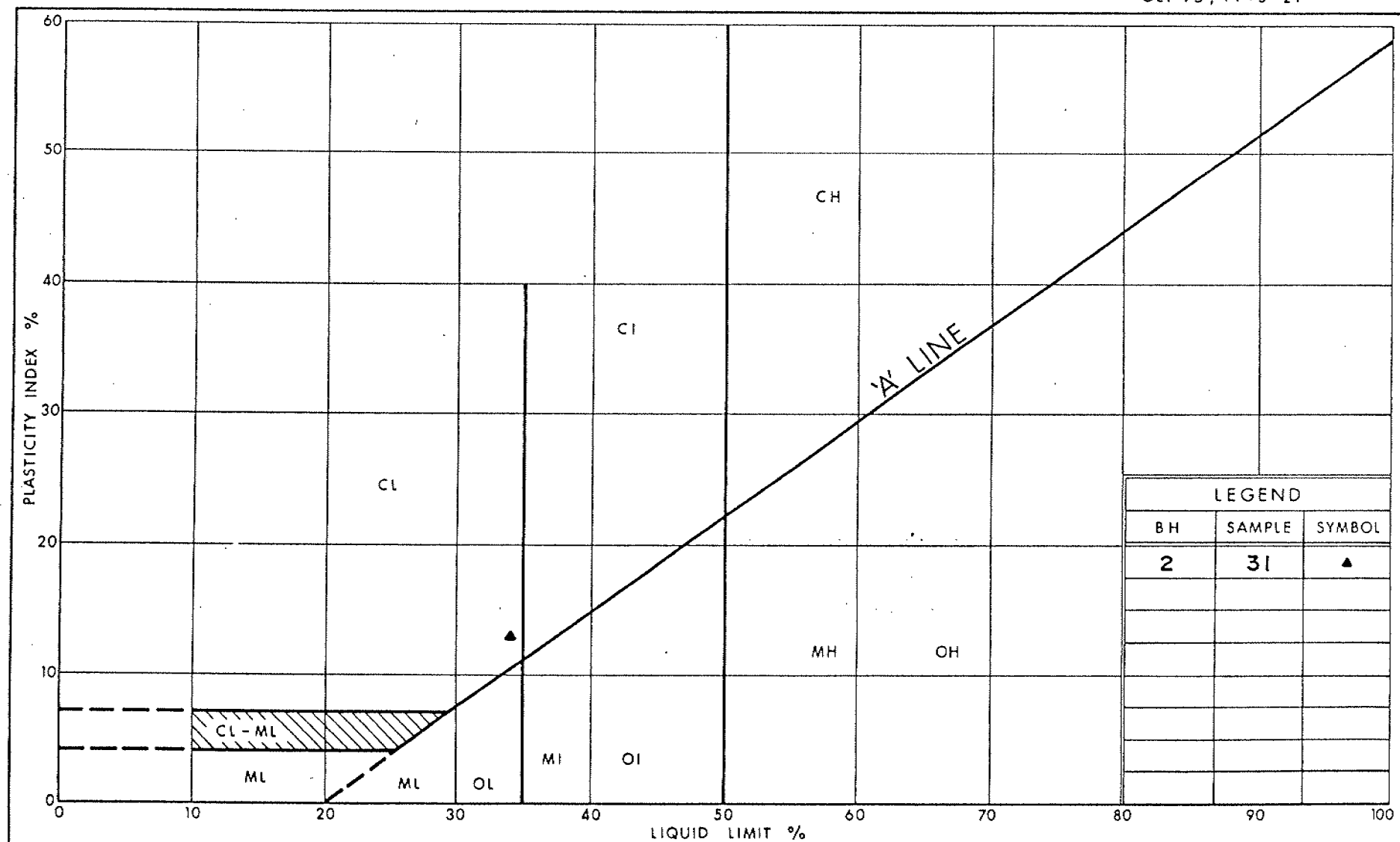


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PLASTICITY CHART
SILTY CLAY TILL

FIG No 12

W P 88-78-18



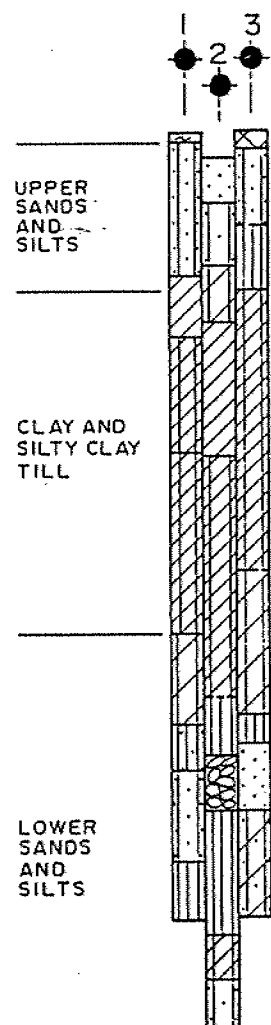
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PLASTICITY CHART LOWER LAYERED CLAY

FIG No 13

W P 88-78-18

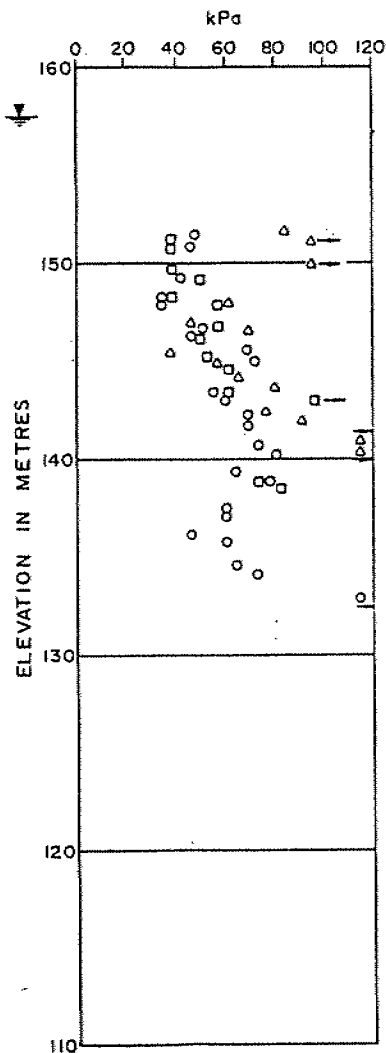
STRATIGRAPHY



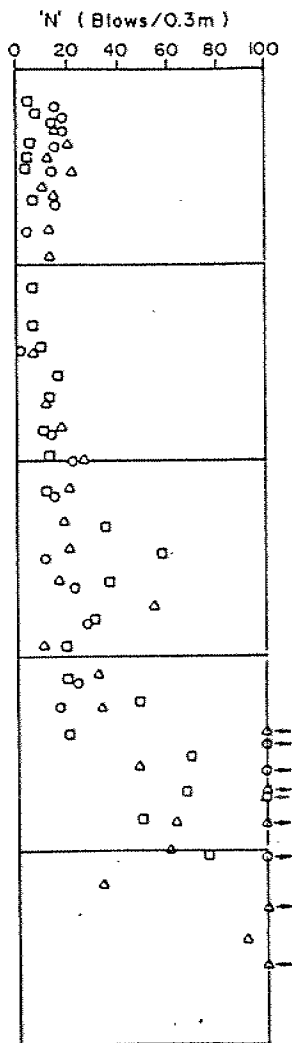
LEGEND

- BOREHOLE 1
- △ BOREHOLE 2
- BOREHOLE 3

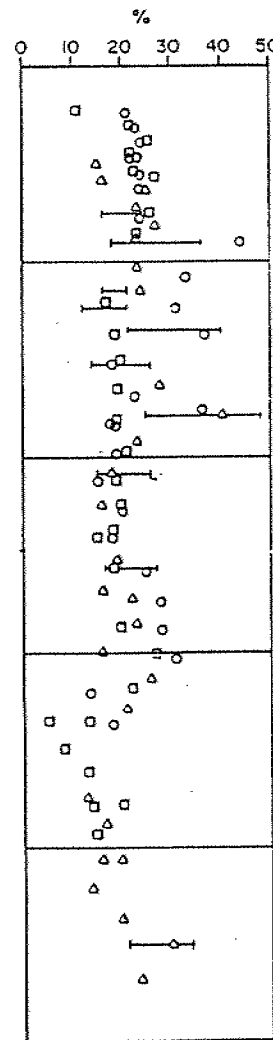
IN SITU UNDRAINED SHEAR STRENGTH



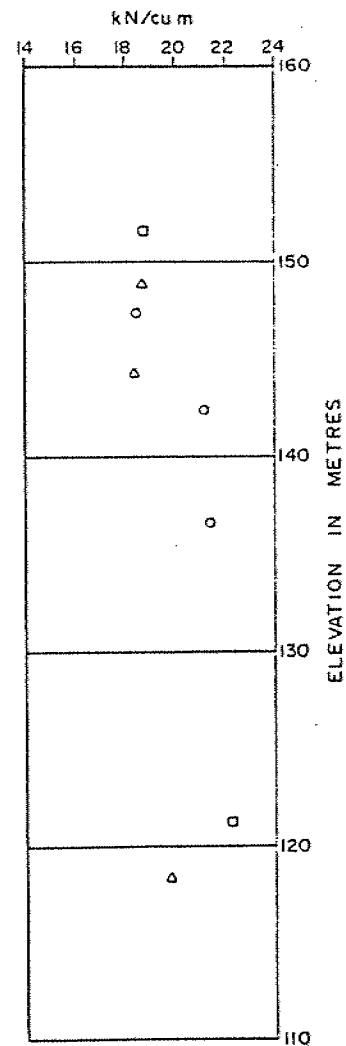
PENETRATION RESISTANCE



WATER CONTENT AND ATTERBERG LIMITS



BULK UNIT WEIGHT

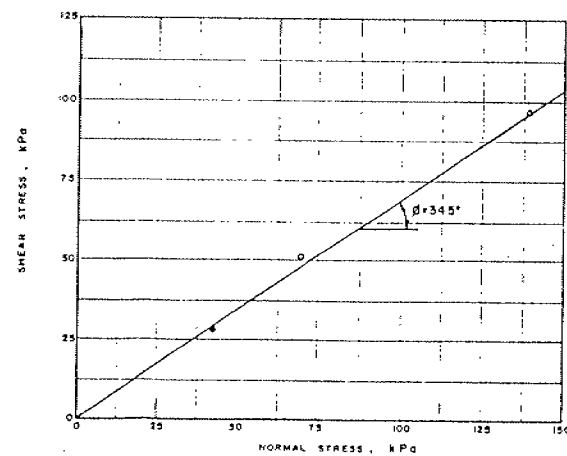
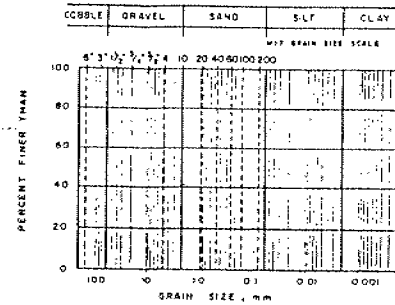
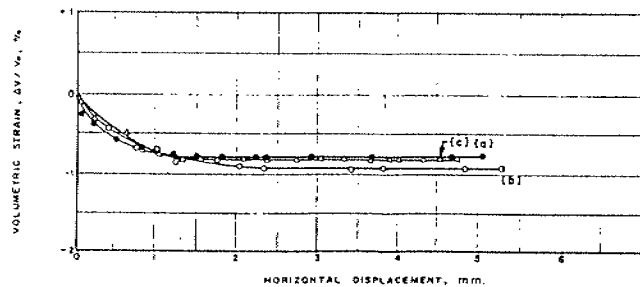
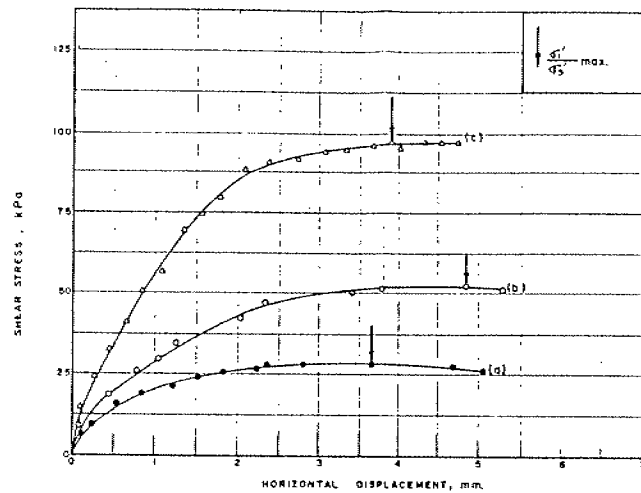


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SUMMARY OF SOIL PROPERTIES

FIG No 14

WP 88-78-18



CONSOLIDATED DRAINED DIRECT SHEAR TESTS

FIGURE 15

	A	B	C	D
BOREHOLE NUMBER	2	2	2	
SAMPLE NUMBER	7	7	7	
SAMPLE DEPTH, m	6.4	6.4	6.4	

SPECIMEN WIDTH, mm	59.4	59.4	59.4	
SPECIMEN HEIGHT, mm	25.2	23.9	23.5	

WATER CONTENT, BEFORE CONSOLIDATION, %				
NORMAL (CONSOLIDATION) STRESS, kPa	34	69	139	
WATER CONTENT, AFTER CONSOLIDATION, %				
AVERAGE RATE OF STRAIN, % / hr.	0.5	0.5	0.5	
TIME TO FAILURE, days	1	1	1	
WATER CONTENT, AFTER TEST, %				

PEAK SHEAR STRESS, kPa	28.0	51.8	97.1	
RESIDUAL SHEAR STRESS, kPa, FIRST PASS				
SECOND PASS				
THIRD PASS				
HORIZONTAL DISPLACEMENT AT PEAK SHEAR STRESS, mm	3.7	4.9	3.3	
HORIZONTAL DISPLACEMENT AT RESIDUAL SHEAR STRESS, mm, FIRST PASS				
SECOND PASS				
THIRD PASS				

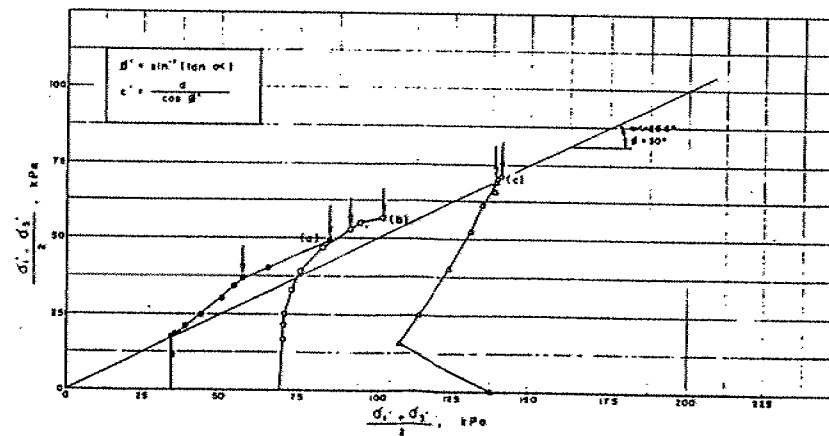
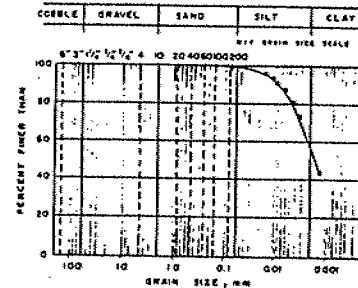
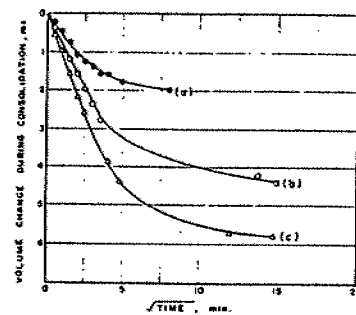
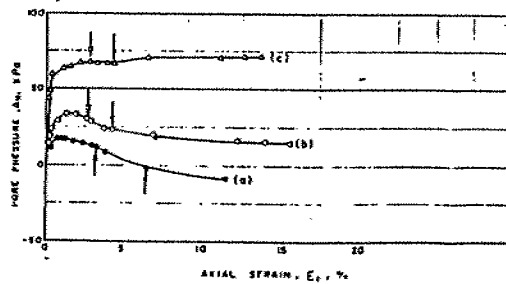
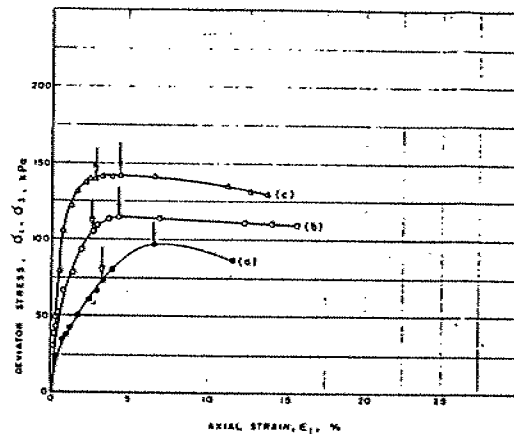
NATURAL WATER CONTENT, w, %	23			
LIQUID LIMIT, w _L	22			
PLASTIC LIMIT, w _p	19			
DENSITY, ρ , Mg / m ³	2.06	2.17	2.22	

REMARKS:
SILT REMOULDED IN SHEAR BOX.

Date: SEPT. 18, 1985
Number: 93-1591

Golder Associates

Drawn: EFG
Checked: EFG



TR TESTS CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TESTS WITH PORE PRESSURE MEASUREMENTS

FIGURE 16

	A	B	C	D	FAILURE SKETCH
BOREHOLE NUMBER	2	2	2		(A)
SAMPLE NUMBER	9	9	9		(B)
SAMPLE DEPTH, m.	9.4	9.6	9.8		(C)
SPECIMEN DIAMETER, mm	500	510	508		(D)
SPECIMEN HEIGHT, mm	995	1014	1011		

WATER CONTENT, BEFORE CONSOLIDATION, %	34	35	35
CELL PRESSURE, σ_3 , kPa	234	200	269
BACK PRESSURE, kPa	200	131	131
PORE PRESSURE PARAMETER 'B'	0.96	0.97	0.98
CONSOLIDATION PRESSURE, σ_c , kPa	34	69	138
VOLUME CHANGE DURING CONSOLIDATION, ΔV , ml	2.0	4.4	5.8
WATER CONTENT, AFTER CONSOLIDATION, %	34	34	33
AVERAGE RATE OF STRAIN, % / hr.	0.5	0.5	0.5
AVERAGE LOAD INCREMENT, kPa			
AVERAGE LOAD DURATION, hr.	1	1	1
TIME TO FAILURE, days			
WATER CONTENT AFTER TEST, %	34	34	33

MAX. DEVIATOR STRESS ($\sigma_1 - \sigma_3$) max, kPa	920	1143	1407
AXIAL STRAIN AT ($\sigma_1 - \sigma_3$) max, %	65	42	43
MAX. EFFECTIVE PRINCIPAL STRESS RATIO (σ_1' / σ_3') max, kPa	4.25	3.73	2.99
AXIAL STRAIN AT (σ_1' / σ_3') max, %	33	2.6	2.8
PORE PRESSURE PARAMETER, A_f	-0.21	-0.20	-0.475

NATURAL WATER CONTENT, w, %	33	35	34
LIQUID LIMIT, w_L	40		
PLASTIC LIMIT, w_p	21		
DENSITY, ρ_s , Mg / m ³	1.91	1.89	1.91

REMARKS
 σ_1 / σ_3 max.
 $\sigma_1 - \sigma_3$ max.
 CLAY WITH IRREGULAR SILT BEAMS, SOME FINE GRAVEL.
 FILTER DRAINS USED.

DATE: MAY 15, 1963
 BY: J.E. H. H.

Golder Associates

DATE: MAY 15, 1963
 BY: J.E. H. H.

RECORD OF BOREHOLE No. 1

W P 88-78-18 LOCATION N 4,847.645 E 298.404 ORIGINATED BY HCO
DIST 6 HWY 407 BOREHOLE TYPE Wash Boring, Hollow Stem Augers, Solid Stem Augers COMPILED BY RWR
DATUM Geodetic DATE June 20 to 23, 1983 CHECKED BY HCO

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE			20	40	60	80	100	W _p	W	W _L		
159.5	Ground Surface														GR SA SI CL
0.4	Topsail - brown, sandy Sandy silt, trace clay, layers of firm to stiff sandy and silty clay in- creasing in frequency with depth Compact Brown becoming Grey at Elevation 157.1 m	1	SS 15		Water Level Elev. 157.5 m July 7/83 Piezometer dry Aug. 24/83										
		2	SS 18												
		3	SS 18												
		4	SS 15												
		5	SS 11												
		6	SS 14												0 22 73 5
		7	SS 15												
152.2															
7.3	Clay, occasional gravel and sand pockets Stiff to Grey Firm	8	SS 4												
		9	SS WR												
149.1															
10.4	Interbedded silty clay with some silt nodules and gravel (Till-like) and Clay Firm to Grey Stiff	10	SS PH												
		11	TW PH												
		12	SS 1												
		13	SS WR												
143.2															
16.3		14	TW PH												
	Silty clay some sand trace gravel (TILL) Stiff Grey	15	SS 13		Water Level Elev. 141.4 m Aug. 7/83										
		16	SS 21												
		17	SS 14												
		18	TW PF												
		19	SS 10												
133.9															
25.6	Silt trace sand and clay to silty clay layered Very Grey Stiff	20	SS 22												
		21	SS 27												
		22	SS 11												
129.5															

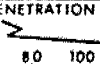
30.0 Continued on next sheet

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No.1 cont.

W P 88-78-18 LOCATION N 4,487,645 ORIGINATED BY HCO
 DIST 6 HWY 407 BOREHOLE TYPE Wash Boring COMPILED BY RWR
 DATUM _____ DATE June 20 and 21, 1983 CHECKED BY HCO

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					
129.5	Continued																
30.2	As above		23	SS	23												
126.9	Sandy silt, some gravel, trace clay (TILL). Occasional sand seams		24	SS	16												
32.6	Compact Grey																
	Silty sand, some gravel to gravelly sand some silt, trace clay		25	SS	131												
	Very Grey Dense		26	SS	94/25 mm												
122.2			27	SS	127/225 mm												
37.3	Silt, some sand, trace clay and gravel		28	SS	109												
	Very Grey Dense																
119.4			29	SS	162/275 mm												
40.1	End of Borehole																

RECORD OF BOREHOLE No 2

W P 88-78-18 LOCATION N 4,847,575 E 298,428 ORIGINATED BY HCO
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Wash Boring COMPILED BY FEO
DATUM Geodetic DATE July 7-11, 1983 CHECKED BY HCO

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					
158.5	Ground Surface																
0.0	Sand, trace silt some gravel Compact Brown		1	SS	15												
156.4			2	SS	20												
2.1	Sandy silt, trace clay layered Compact Brown be- coming Grey at Elev. 155.3 m		3	SS	12												
			4	SS	21												
			5	SS	10												
			6	SS	15												
153.0																	
5.5	Silt, some clay to silty clay, trace fine sand, layered Stiff Grey		7	SS	13												
			8	SS	13												
150.0																	
8.5			9	TW	PH												
	Clay with zones con- taining silt nodules and traces of gravel, layered Firm to Grey Stiff		10	TW	PH												
			11	SS	6												
			12	TW	PH												
143.3																	
15.2			13	SS	11												
	Silty clay with some sand and trace gravel (TILL) Stiff to Hard Grey		14	SS	17												
			15	SS	26												
			16	SS	20												
			17	SS	18												
			18	SS	20												
			19	SS	16												
			20	SS	54												
131.0																	
27.5	Silty clay, trace to some fine sand Compact Grey to Dense		21	SS	10												
			22	SS	31												
128.5																	

30.0 Continued on next sheet

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 cont.

W P 88-78-18 LOCATION N 4,847,575 E 298,428 ORIGINATED BY HCO
 DIST 6 HWY 407 BOREHOLE TYPE Wash Boring COMPILED BY EFO
 DATUM Geodetic DATE July 7-11, 1983 CHECKED BY HCO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
128.5	Continued															
128.0	As Above															
30.5	Limestone cobbles with silty sand		23	SS	33											
	Dense Grey		24	SS	100/150											
125.3			25	WS	-											
33.2	Silt, some sand and gravel some clay with occasional sand layers (TILL)		26	SS	48											
	Hard Grey		27	SS	97/750											
			28	SS	63											
			29	SS	60											
118.7			30	SS	33											
39.8	Silty clay layered occasional silty sand seams		31	SS	117											
116.4	Hard Grey		32	SS	91											
42.1	Sand and silt, some gravel		33	SS	100/750											
114.1	Dense Grey		34	SS	100/750											
44.4	End of Borehole															

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 3

W P 88-78-18 LOCATION N 4,847,617 E 298,429 ORIGINATED BY HCO
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Wash Boring COMPILED BY FEO
 DATUM Geodetic DATE July 12-13, 1983 CHECKED BY HCO

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					
159.6	Ground Surface															
0.0	Fill - sand and gravel															
158.8																
0.8	Silt with sand and clay. Layers of silt, some clay increasing in frequency with depth		1	SS	5											
			2	SS	7											
			3	SS	15											
	Very Loose Brown to Compact becoming Grey at Elev.		4	SS	5											
			5	SS	4											
154.7	155.9 m		6	SS	3											
4.9	Silt, trace clay and fine sand to silty clay with silt nodules trace gravel		7	SS	6											
	Stiff Grey															
151.7			8	TW	PH											
7.9			9	TW	PH											
			10	SS	6											
	Silty clay trace to some sand and gravel (TILL)		11	SS	6											
	Firm to Grey Stiff		12	SS	9											
			13	SS	16											
			14	SS	12											
			15	SS	10											
			16	SS	12											
			17	SS	11											
137.1			18	SS	34											
22.5	Silt, trace clay and sand to silty clay trace sand and gravel. Occasional layers and pockets of sand. Sand content increasing with depth.		19	SS	58											
			20	SS	36											
			21	SS	30											
			22	SS	19											
129.7	As below															
30.0	Continued on next sheet															

+3, +5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 cont.

W P 88-78-18 LOCATION N 4,847,617 E 298,429 ORIGINATED BY HCO
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger, Wash Boring COMPILED BY EFO
 DATUM Geodetic DATE July 12-13, 1983 CHECKED BY HCO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION [%] GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					W _p	W	W _L		
								SHEAR STRENGTH									
129.6	Continued																
30.0	Silt, some fine sand, trace clay		23	SS	19												
127.9	Compact Grey																
31.7	Sand some gravel and silt with pockets of silty sand		24	SS	48												
	Compact Grey to Dense		25	SS	20												
125.2																	
34.4	Interlayered Silty Clay and Sandy Silt with trace to some gravel and clay (TILL)		26	SS	69												
	Dense to Grey Very Dense		27	SS	67												
			28	SS	49												
119.5			29	SS	76												
40.1	End of Borehole																

FOUNDATION INVESTIGATION REPORT

For

Pine Valley Drive - Hwy. 407 Underpass

W.P. 88-78-20, Site No. 37-1328

Hwy. 407, District 6, TorontoINTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a four span structure that will carry Pine Valley Drive over the proposed Hwy. 407. A combination of approximately 4 metre excavation cuts in the native subsoil and up to 3 m of approach fills will be required to facilitate the overpass. The structural cross-section will require 6 lanes (including two ramps) and Pine Valley is to be revised from a two lane roadway to a four lane roadway.

This report describes the subsurface conditions encountered at the site.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 0.5 km north of the Pine Valley-Steeles intersection south of Hwy. 7 in the Town of Vaughan, Regional Municipality of York. Pine Valley Drive is a two lane roadway bounded by 2-2.5 m unpaved shoulders and 5-6 m outer sodded drainage swales.

CNR tracks are present approximately 0.3 km south of the site running in a eastwest direction and supported on embankment fills approximately 7 m high. A rigid frame-steel girder structure carries the tracks over the existing Pine Valley Drive. A hydro corridor comprised of overhead transmission towers and cable also exists between the site and the existing CNR right-of-way.

The land surrounding the site is generally flat and consists of agricultural farmland, residential and industrial developments. The sector of land east and west of the site is agricultural farmland, whilst a residential development (approximately 10 years or younger) exists north of the site and just south of Hwy. 7, and industrial units are present just south of the CNR tracks.

Physiographically, the site lies in the geological region known as the Peel Plain in the Bolton Area. The Peel Plain is characterized by bevelled till plains interbedded with glaciofluvial silts, sands and gravels. The interbeds are indicative of various stages of glacial advances and retreats that occurred during the Wisconsin glacial epoch of the Pleistocene epoch.

The Wildfield till deposit is the youngest till in the Bolton area. Although not encountered at the site, in some regions, the Wildfield till is overlapped by younger deposits of deltaic and lacustrine origin. The Wildfield till overlies the Halton Till, usually separated by varying thickness of stratified silts and sands.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 89 11 28 and 89 12 13 and consisted of a total of 7 sampled boreholes advanced to depths ranging from 9.6 m to 31.3 m accompanied by 5 dynamic cone penetration tests advanced to depths ranging from 2.1 m to 12.7 m. The boreholes were advanced at the proposed structure foundation locations and corresponding Hwy. 407 approach cut locations.

Conventional hollow stem augering techniques were used to advance the boreholes for the majority of the investigation. Rock coring methods, including the installation of NW casing and a standard NQ core barrel was used to advance the borehole through the boulders that exist at various depths in the stratigraphy. A track mounted CME 55 and CME 75 were both used to advance the boreholes at the site.

In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 5 to 6 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586).

All subsoil samples and rock core were identified in the field and returned to the laboratory for further examination and applicable testing.

Groundwater levels were obtained throughout the duration of the investigation in the open boreholes. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limit
- 2) Grain Size Distribution
- 3) Unit Weights
- 4) Natural Moisture Contents

Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The general subsurface profile across the site consists of interbedded glacial till and glaciofluvial deposits. Surficially, a till deposit consisting of a clayey silt matrix with some sand and trace of gravel exists. This deposit extends to a maximum thickness of 9.2 m and is generally of stiff consistency.

The surficial cohesive till deposit is underlain by a cohesionless silt with some sand deposit. This stratum extends to a maximum thickness of 4.1 m and is water bearing and generally in a compact state of condition.

A second till deposit composed of a heterogeneous mixture of clayey silt, sand and gravel is found underlying the cohesionless silt deposit. The thickness of this deposit ranges from 9.1 m to 13.6 m. Random modules of silt are also present in this deposit. The deposit is generally of very stiff to hard consistency.

The lower till deposit is in turn underlain by a second glaciofluvial deposit consisting of a silt matrix with traces of sand and gravel and random boulders intermixed in the host matrix. The deposit is generally very dense and was explored to a maximum thickness of 9.6 m.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole Sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 887820-A.*

A detailed description of the subsurface conditions encountered is given below.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till - Upper)

The native surficial deposit present at the site consists of a heterogeneous mixture of clayey silt, sand and gravel. The main component of the deposit is the clayey silt matrix that exhibits a cohesive behaviour. Occasional random interbedded sand seams approximately 25 to 50 mm in thickness are also present within the deposit. Traces of organics also exist within the surficial one metre of the deposit.

The thickness of the deposit explored in the investigation ranges from 3.7 m to 9.2 m, with the shallower thickness present in the approach area east of the proposed structure. The deposit is generally oxidized (brown) for the surficial 3 to 4 m and unoxidized (grey) in its lower depths.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 1. The envelope illustrates

* DWG NO 2 OF THE CONTRACT DWG'S (SHEET NO 351)

that clay and silt percentages in the deposit range from 26-40% and 38-53% respectively. Some sand and traces of gravel are also present in the deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1. Unit weights are also included.

Table 1 - Soil Properties (Upper Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	13-18	6
Liquid Limit (w _L %)	24-35	6
Plasticity Index (I _p %)	11-18	6
Unit Weight (kN/m ³)	19.8-22.8	5

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt. At random zones within the deposit, the soil behaves as a plastic silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 38 blows/0.3 m. In general, 'N' values were in the range of 15 blows/0.3 m to 25 blows/0.3 m for the surficial 3 to 3.5 m indicative of the desiccated very stiff upper crust of the deposit. However, 'N' values were significantly lower in the lower depths of the deposit, typically in the 5 blows/0.3 m to 15 blows/0.3 m range, representative of a firm to stiff consistency.

Silt, some Sand

Underlying the surficial deposit at the site, a stratum of silt with some sand exists. Random sand seams are also present in this deposit. A grain size distribution envelope illustrating the gradation of this stratum is provided in Figure 3 in the Appendix. A grain size distribution curve illustrating an interbedded sand seam is also included in the figure.

The stratum surface exists at an elevation ranging from 160.9 m to 152.4 m and extends for a thickness ranging from 2.1 m to 4.1 m. This cohesionless deposit is water bearing and consequently soil cave-in occurred in the open borehole when the stratum was penetrated due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 32 blows/0.3 m. However, the lower values may be attributed to increased sample disturbance induced by unbalanced hydrostatic head. In view of this, the stratum can be categorized as compact.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till - Lower)

Underlying the silt deposit at a depth ranging from 9.2 m to 12.2 m, or equivalently elevation 153.7 m to 149.4 m, a second till deposit exists consisting of a heterogeneous mixture of clayey silt, sand and gravel. Random zones and modules of silt are also present in this deposit. The deposit extends for a depth ranging from 7.6 m to 15 m.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 17-45% and 49-53% respectively. Some sand and gravel is also present in the deposit.

Atterberg Limit tests were also carried out to define the behaviour and plasticity of the soil. The results are plotted on Figure 5 and a summary of the indices is provided in Table 2.

Table 2 - Soil Properties (Lower Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	11-23	4
Liquid Limit (w_L %)	19-35	5
Plasticity Index (I_p %)	7-21	5
Unit Weight (kN/m^3)	20.9-22.6	3

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt. At random zones within the deposit, the soil behaves as a plastic silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 16 blows/0.3 m to 120 blows/.08 m. Average 'N' values are in the 35-45 blows/0.3 m throughout the deposit indicating a hard consistency.

Silt

The lower till deposit is underlain by a cohesionless silt deposit that contains some sand and traces of gravel. This stratum also contains random boulders and cobbles suspended in the silt matrix. Rock coring techniques were required to penetrate some of the boulders. The depth to the deposit varies from 24.2 to 25.8 m (El. 138.7 m to 136.3 m) at the proposed north abutment and north pier to 19.8-21.3 m at the centre pier to south abutment locations (El. 140.9 m to 142.7 m). The maximum thickness of the deposit investigated was 9.6 m. The extent of the deposit was not determined in the investigation.

A grain size distribution envelope illustrating the gradation of this stratum is provided in Figure 6 in the Appendix. A grain size distribution curve illustrating the gradation of an interbedded sand seam is also illustrated in the figure.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 28 blows/0.3 m to 120 blows/0.08 m. Although some of the higher 'N' values may be as a result of the larger gravel and boulder sizes, the silt material itself is in a very dense state of condition.

Groundwater Conditions


The groundwater table as obtained by monitoring the water levels in the open boreholes at the time of the investigation varied from elevation 158.1 m to 160.9 m or depths ranging from 3.0 m to 4.6 m below the natural ground surface.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

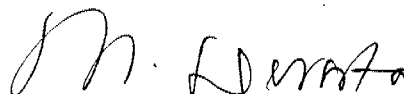
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano and Pamela Marks, Foundation Engineers, and B. Cung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Longyear Drilling.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.



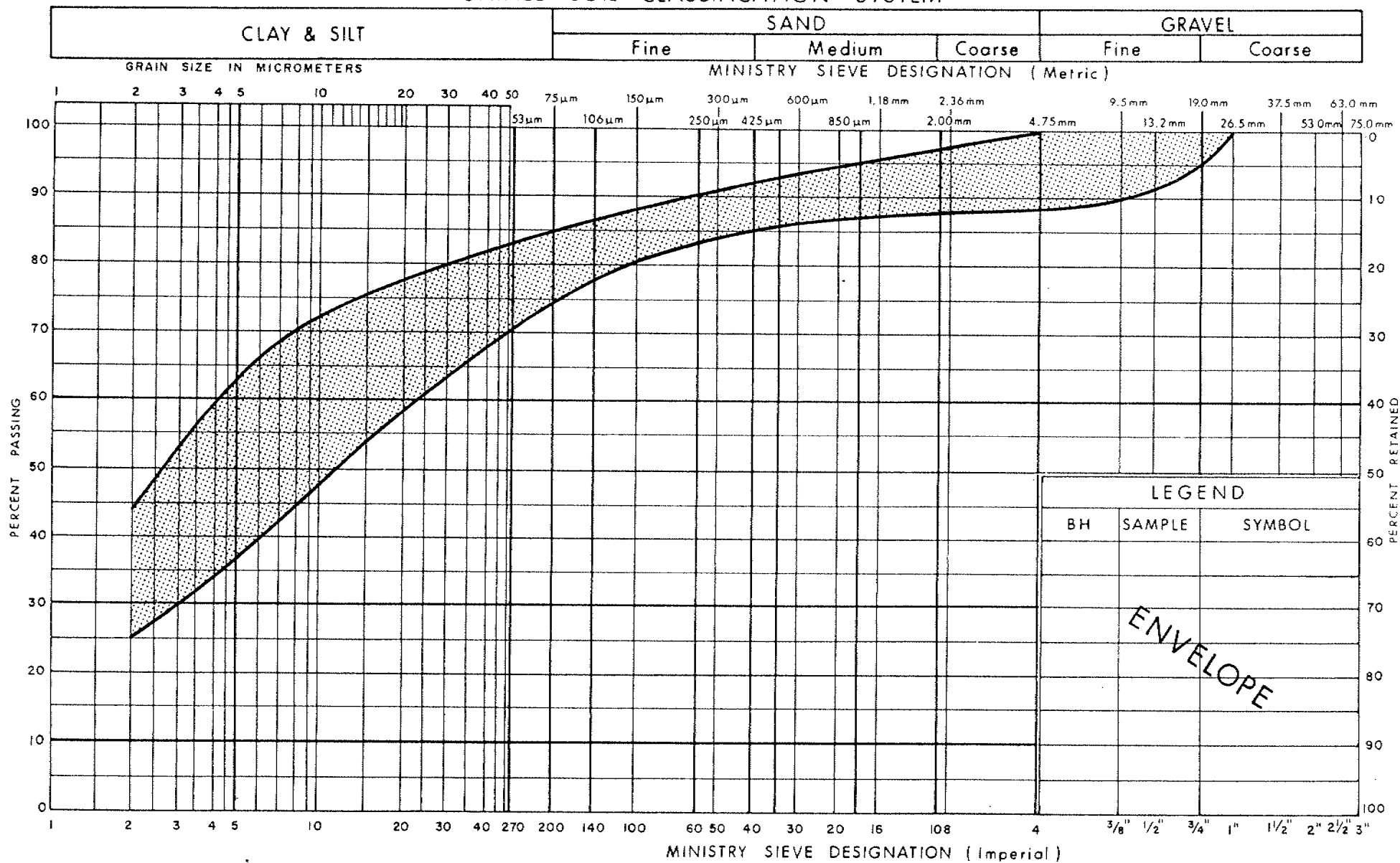
Dr. B. Iyer, P. Eng.
Senior Foundation Engineer



M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



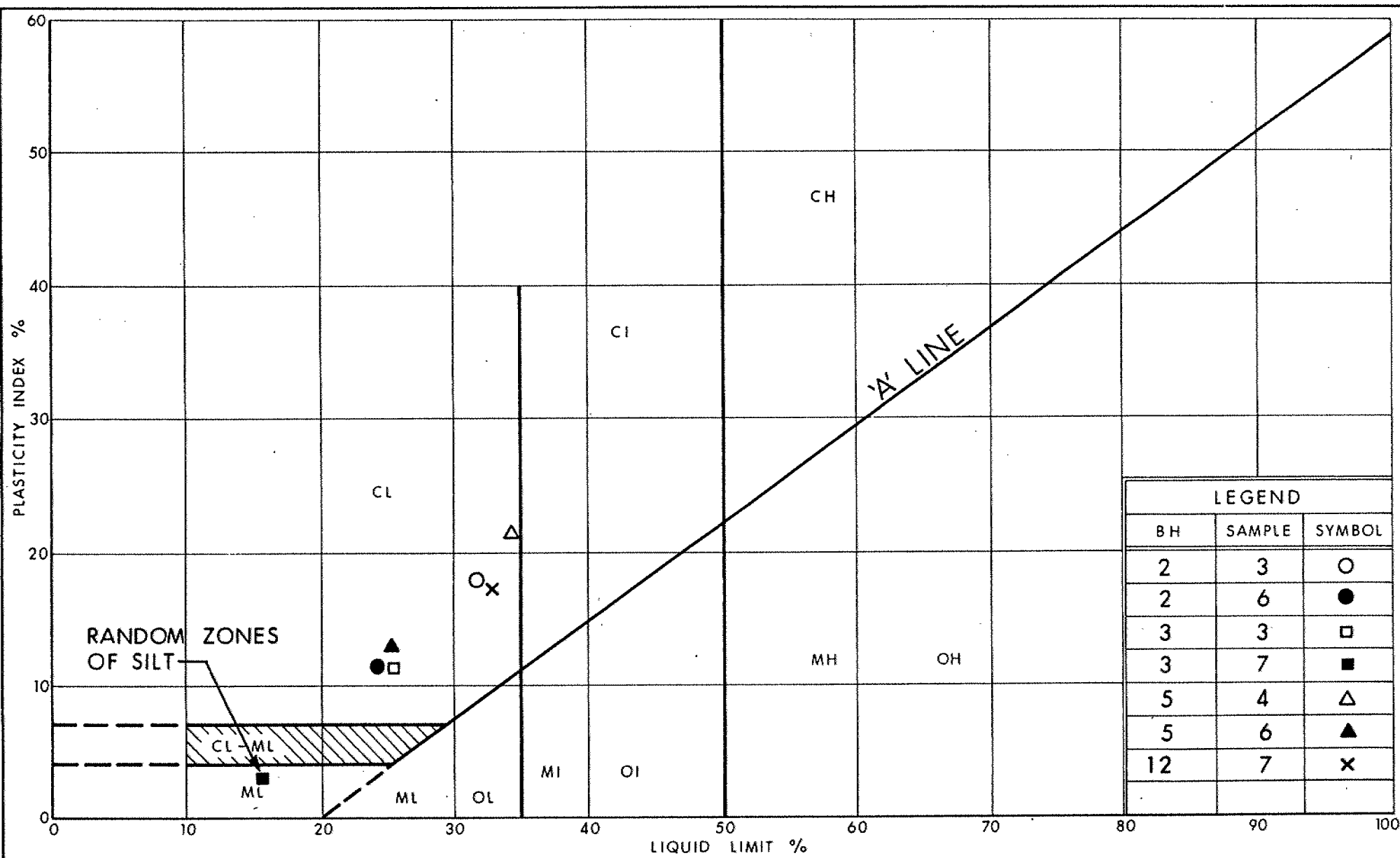
Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Upper)

FIG No 1

W P 88-78-20



Ministry of
Transportation

Ontario

PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Upper)

FIG No 2

W P 88-78-20

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

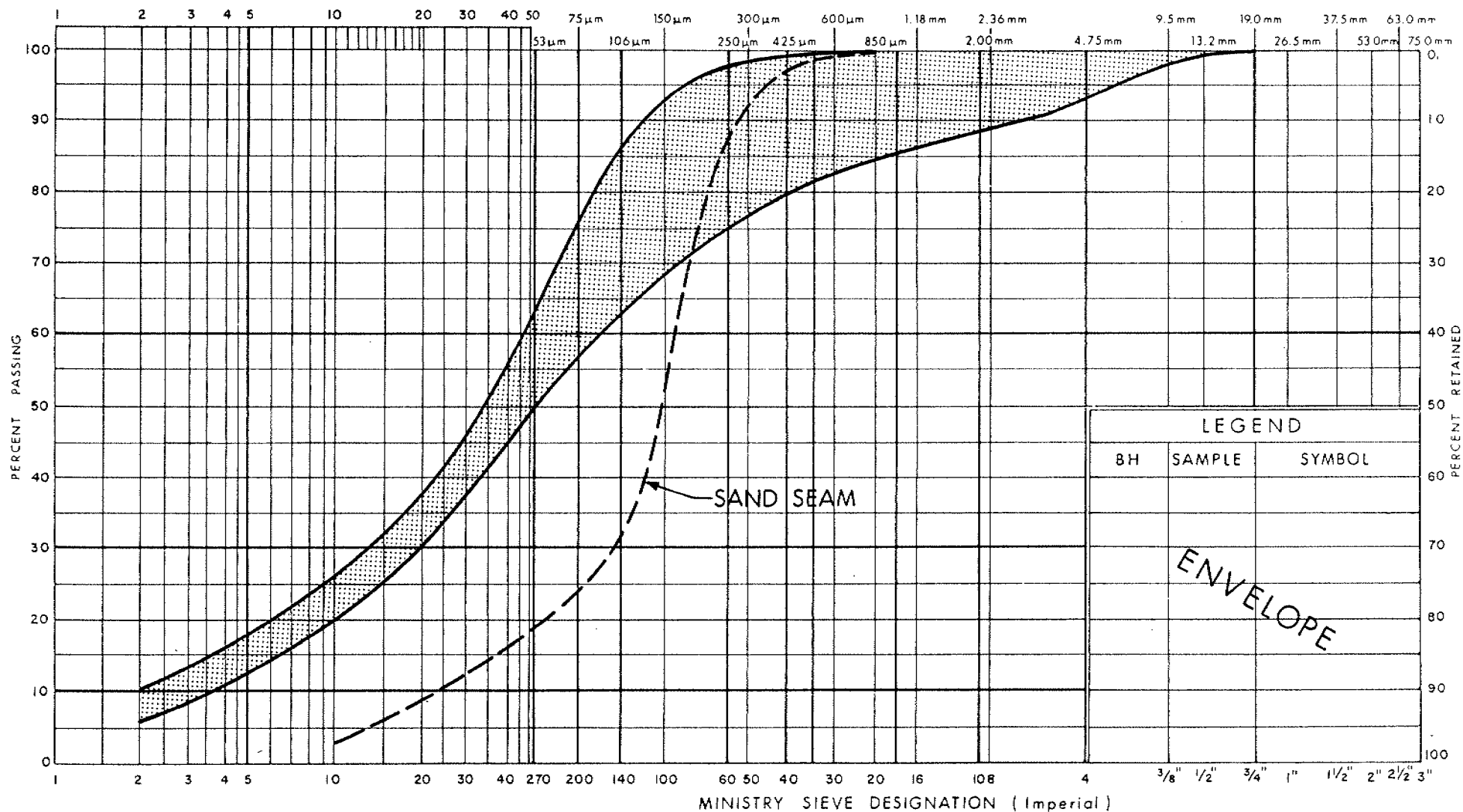
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH SAMPLE SYMBOL

ENVELOPE

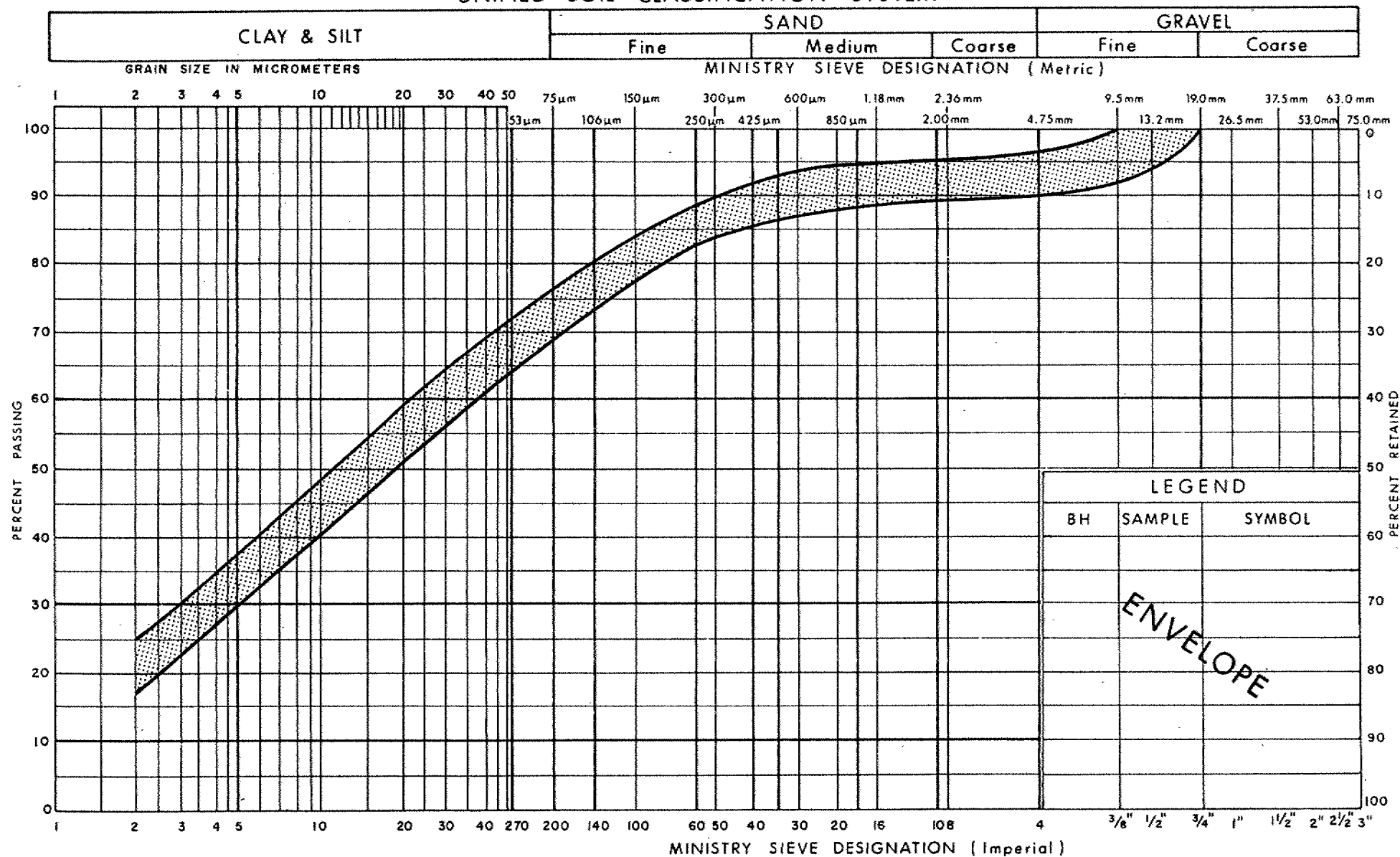
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, SOME SAND, OCC SAND SEAMS
(Upper)

FIG No 3

W P 88-78-20

UNIFIED SOIL CLASSIFICATION SYSTEM



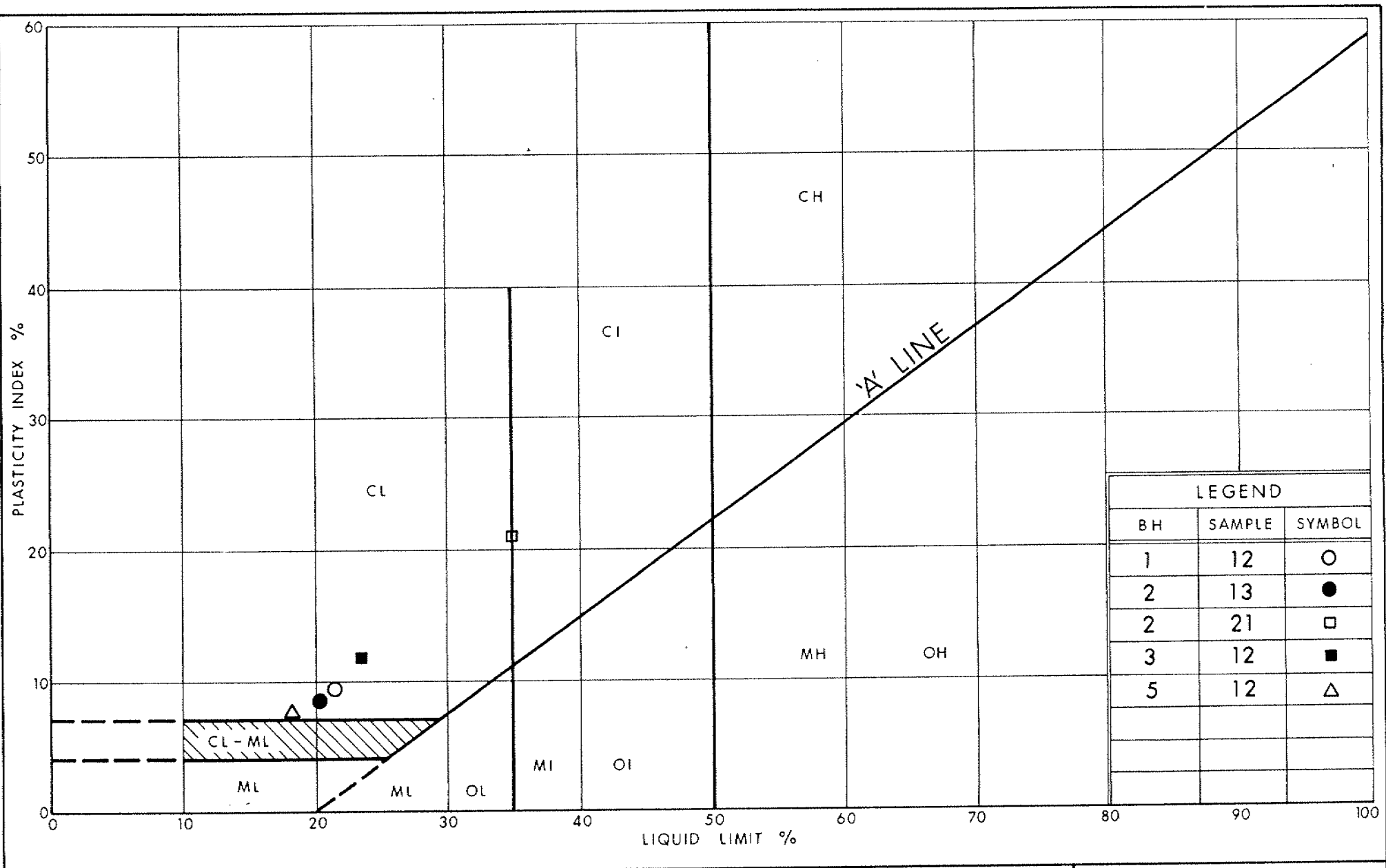
Ontario

Ministry of
Transportation

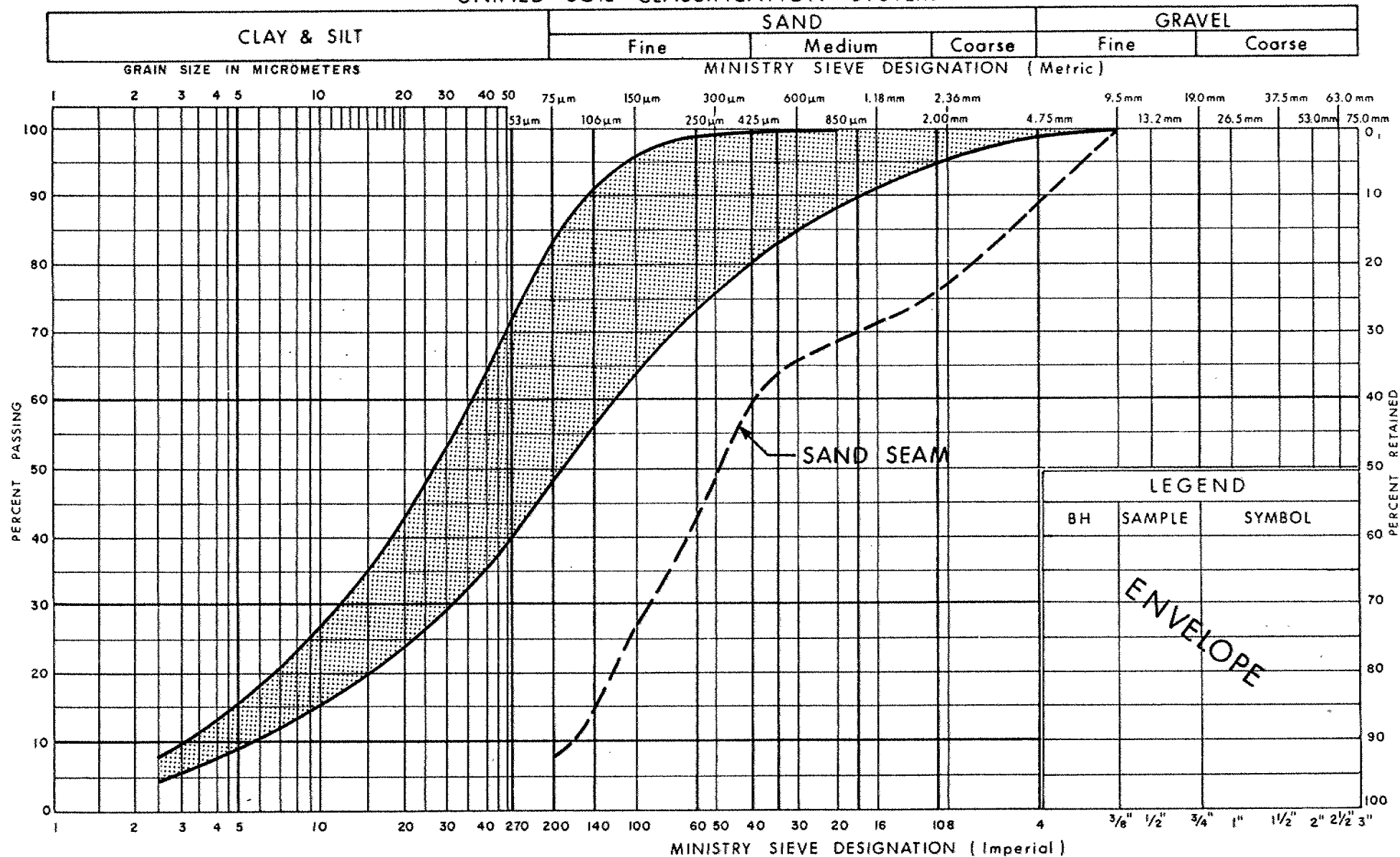
GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Lower)

FIG No 4

W P 88-78-20



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, SOME SAND, OCC SAND SEAMS
 (Lower)

FIG No 6

W P 88-78-20

RECORD OF BOREHOLE No 1

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 073.7; E 299 113.6 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 12 11 to 12 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
162.9 0.0	Ground Surface													
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		1	SS	21		162							
			2	SS	29									
			3	SS	24									
	Brown Grey		4	SS	15		160							
	(Glacial Till) Stiff to V. Stiff		5	SS	14									
157.6 5.3			6	SS	23		158							
	Silt, Some Sand		7	SS	20									
	Compact		8	SS	18		156							
			9	SS	12									
153.7 9.2			10	SS	32		154							
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		11	SS	120	8cm	152							
			12	SS	29									
	(Glacial Till)						150							
	Random Zones of Silt V. Stiff to Hard		13	SS	82		148							
			14	SS	65		146							
							144							
			15	SS	44		142							
							140							
138.7 24.2			16	SS	117		138							
	Silt and Sand Very Dense		17	SS	142									
135.4 27.5			18	SS	173	8cm	136							
	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 033.3; E 299 084.6 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, Rock Core, Cone COMPILED BY BC
DATUM Geodetic DATE 1989 11 28 to 89 12 05 test CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPo								WATER CONTENT (%) 10 20 30
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
162.1 0.0	Ground Surface															
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		1	SS	25											
			2	SS	27											
			3	SS	38											
	Brown Grey		4	SS	17											
	(Glacial Till)		5	SS	9											
			6	SS	15											
	Stiff to Hard		7	SS	16											
			8	SS	25											
154.0 8.1			9	SS	25											
	Silt, Some Sand Grey, Compact		10	SS	17											
			11	SS	26											
			12	SS	11											
149.9 12.2			13	SS	68											
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		14	SS	29											
			15	SS	40											
	(Glacial Till)		16	SS	23											
	V. Stiff to Hard		17	SS	56											
			18	SS	50											
	Random Zones of Silt		19	SS	37											
			20	SS	47											
			21	SS	34											
136.3 25.8			22	SS	45											
	Silt, Some Sand With Random Boulders and Cobbles		23	RC	REC 67%											
			24	SS	17											
	Clayey Silt		25	SS	91											
	Some Gravel		26	SS	120	5cm										
130.8 31.3	End of Borehole															

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 3

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 014.1; E 299 125.9 ORIGINATED BY PM
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 12 05 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
162.5 0.0	Ground Surface													
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	5		162							
			2	SS	17		160							1 24 40 35
			3	SS	23									
			4	SS	14									
			5	SS	8		158							
			6	TW	PH									
			7	SS	12		156							
			8	SS	9									
154.9 7.6	Silt, Some Sand Loose		9	SS	9		154							0 39 (61)
			10	SS	2									
151.8 10.7	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		11	SS	21		152							
			12	SS	27		150							
			13	SS	99									
			14	SS	33		148							
			15	SS	37		146							
			16	SS	19		144							
142.7 19.8	Silt, Some Sand Compact to Very Dense		17	SS	23		142							
			18	SS	28		140							0 31 (69)
			19	SS	30									
			20	SS	120		138							
			21	SS	118/23cm		136							7 33 54 6
			22	SS	130									
133.1 29.4	End of Borehole		23	SS	114		134							

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 959.8; E 299 099.1 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 12 06 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
161.6	Ground Surface													
0.0	Tr. Organics		1	SS	16									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		2	SS	17		160							
			3	SS	29									
	Brown Grey		4	SS	28		158							
			5	SS	19									
	(Glacial Till)		6	SS	7									
	Firm to V. Stiff		7	SS	14		156							
			8	SS	18									
			9	SS	28		154							
152.4			10	SS	6		152							
9.2	Silt Some Sand Loose to Compact		11	SS	26		150							
149.4			12	SS	25		148							
12.2	Het. Mixture of Clayey Silt, Sand and Gravel		13	SS	32		146							
	(Glacial Till)		14	SS	30		144							
	V. Stiff to Hard		15	SS	31		142							
141.8			16	SS	100	15cm	140							0 50 40 10
19.8	Silt, Some/With Sand Dense to Very Dense		17	SS	120	15cm	138							
			18	SS	120	13cm	136							0 10 (90)
133.9							134							
27.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 956.3; E 299 136.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, Rock Core, Cone COMPILED BY BC
DATUM Geodetic DATE 1989 11 29 Test CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
162.2 0.0	Ground Surface						162							
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown Grey Firm to Stiff		1	SS	7		162						21.5	9 7 48 36
			2	SS	7		160						19.8	4 20 49
			3	SS	28		158							
			4	SS	14		156							
			5	SS	7		154							
			6	SS	5		152							
			7	SS	8		150							
154.6 7.6	Silt Some Sand		8	SS	5		148							
	Loose		9	SS	8		146							
152.5 9.7	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) V. Stiff to Hard Random Zones of Silt		10	SS	46		144						20.9	3 27 53 17
			11	SS	24		142							
			12	SS	27		140							
			13	SS	72		138							
			14	SS	21		136							
			15	SS	16									
			16	SS	32									
140.9 21.3	Silt, Some Sand With Random Boulders and Cobbles V. Dense		17	SS	160									
			18	SS	120/15cm									
			19	RC	REC 20%									RQD = 6%
			20	SS	120/28cm									4 12 (84)
135.5 26.7	End of Borehole		21	SS	120/8cm									

RECORD OF BOREHOLE No 11

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 995.8; E 299 184.2 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
DATUM Geodetic DATE 1989 12 13 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
162.9	Ground Surface																
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		1	SS	28	*	162										
			2	SS	24												
	Brown Grey (Glacial Till)		3	SS	28		160										
			4	SS	10												
158.3	Random Zones of Silt		5	SS	10												
4.6	Silt, Some Sand Loose to Compact		6	SS	8		158										
			7	SS	6												
			8	SS	12		156										
155.3	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till), Hard		9	SS	36		154										
153.3			10	SS	59												
9.6	End of Borehole																
	* Water Level not Established																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 12

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 094.5; E 299 187.2 ORIGINATED BY GP
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 12 06 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

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					
164.6	Ground Surface													
0.0	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	28									
			2	SS	30									
			3	SS	20									
160.9	Very Stiff to Hard Brown Grey		4	SS	17									
2.7	Silt and Sand Grey		5	SS	36									
			6	SS	28									
			7	SS	30									
	Compact to Dense		8	SS	39									
157.0	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	42									
7.6														
155.0	V. Stiff to Hard		10	SS	26									
9.6	End of Borehole													

FOUNDATION INVESTIGATION REPORT
For
Hwy. 407 Excavation Cuts
Between
Stations 15+550+/- to 16+100 +/-
(Islington Avenue to Pine Valley Drive)
W.P. 141-87-00A, Hwy. 407
District 6, Toronto

INTRODUCTION

Subsequent to requests submitted by the Central Region Geotechnical Section dated 89 09 22 and 90 02 08, an investigation was carried out by this office to determine the geometry of the proposed cut slope including the drainage ditch on the north side of Hwy. 407.

Excavation cuts ranging in magnitude from approximately 4 to 10 m in the native overburden will be required to satisfy the proposed Hwy. 407 profile grade and adjoining drainage channel. The proposed Hwy. 407 grade slopes at a 3% gradient from approximate El. 156.5 m at Sta. 15+750± to El. 151.5 m at Sta. 15+550±. The proposed profile grade of Hwy. 407 east of Sta. 15+750 slopes at approximately 0.64% with an elevation grade of approximately 158 m at the eastern boundary of the site. The proposed drainage channel extends along the north side at the toe of the proposed excavated slopes. The drainage channel is a hydrological component that will direct storm water from the highway westwardly and eventually outflowing to the Humber River located west of the site. Excavation cuts ranging from 6 to 10 m will be required along the length of the north side of Hwy. 407 at the site to facilitate this drainage channel. The natural ground surface is relatively flat to gently sloping, increasing slightly from 160.0 to 161.0 m towards the east.

The investigation procedure, including the fieldwork procedures and laboratory analyses, and a detailed description of the subsurface conditions are also included in this report.

SITE DESCRIPTION AND GEOLOGY

The site is located along the proposed Hwy. 407 right-of-way bounded by Islington Avenue to the west and Pine Valley Drive to the east in the Town of Vaughan, Regional Municipality of York. Existing Hydro transmission towers intersect the site approximately 300 m east of Pine Valley Drive. Immediately north of the site, a one storey building used as a warehouse for agricultural supplies, equipment and products exists. A residential home neighbours this building and the hydro corridor mentioned earlier runs parallel to these buildings at that location.

A residential subdivision is located approximately 0.5 km north of the site and CNR tracks, supported by approximately 7 m of embankment fill, are located approximately 0.5 km south of the site.

The land at the site is generally flat to gently sloping. The natural ground surface increases slightly in elevation in an easterly direction.

Land use at the site is agricultural farmland. Major crops annually harvested include radishes, onions, spinach and parsley.

Physiographically, the site is located in the geological domain known as the Bolton area. At the site, deltaic and glaciolacustrine sands and silts, the products of Lake Peel (Karrow 1963), a body of water confined between a lobe of ice projecting up the Humber Valley and the surrounding higher elevation grounds, overly a glaciolacustrine Wildfield Till complex consisting of stratified silty clays, clayey silts and silt nodules, also depositions of Lake Peel. These deposits levelled out the former gently undulating surface of ground moraine, known as the "Peel Plain" (Putnam and Chapman, 1936).

The Bolton area features overburden deposited during the Wisconsin glacialiation of the Pleistocene era. The overburden is underlain by shale bedrock of the Dundas-Meaford formation. Water well records indicate that the bedrock is found at depths ranging from 40 to 60 m.

INVESTIGATION PROCEDURE

Soil data and inherent properties were obtained by in situ and laboratory testing. The procedures employed are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 90 01 11 and 90 01 17 and on 90 02 23 and consisted a total of 10 sampled boreholes advanced to depths ranging from 12.6 m to 18.7 m. The second mobilization was in response to a requested extension of the original scope of work. Three of the boreholes were accompanied by dynamic cone penetration tests, two of which were advanced at the bottom of the open borehole to overall depths ranging from 22.4 m to 23.0 m from the original ground surface. A dynamic cone test advanced from the natural ground surface penetrated to a depth of 17.3 m.

The boreholes were advanced in the overburden using conventional hollow stem augering techniques. Track mounted continuous flight auger drilling rigs were employed for the operation.

In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 6 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). A longer split spoon sampler (0.6 m) was used in an attempt to retrieve additional volumes of soil to facilitate pertinent backfill suitability tests (Standard Proctor Tests). Relatively undisturbed samples were also randomly retrieved in the cohesive clayey silt to silty clays and underlying moraine till deposit using a shelby tube sampler in accordance with standard practice (ASTM D1587). In situ vane tests were also conducted in the cohesive soils, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

All subsoil samples were identified in the field and returned to the laboratory for further examination and applicable testing.

Water levels were obtained in the open boreholes and also in sealed piezometers installed at BH's A-6 and A-1. Groundwater levels were monitored throughout the duration of the investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Multi-stage consolidated undrained tests with pore pressure measurements.

Laboratory test results have been summarized in the subsequent section of this report entitled Subsurface Conditions, and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The soil stratigraphy at the site consists of a surficial veneer of topsoil, brown in colour and of thickness equivalent to approximately 0.7 m. The topsoil is underlain by a cohesionless brown sand that contains traces/some silt and traces/some gravel. This deposit has a thickness ranging from 0.7 m to 2.9 m and generally has a compact denseness. A cohesionless deposit of non plastic, brown silt underlies the sand deposit and extends for a relatively shallow thickness ranging from 0.3 m to 1.6 m. Thicknesses of the sands and silts generally decline in an easterly direction across the site. The non plastic silt is underlain by a glacio-lacustrine deposit consisting of a cohesive, grey clayey silt to silty clay containing interbedded layers and random nodules of

silt within the soil matrix. The stratum can be categorized as having a stiff consistency and ranges in thickness from 2.6 m to 4.8 m.

The glaciolacustrine stratum is underlain by a cohesive unstratified glacial till deposit consisting of a clayey silt host material with traces/some sand and traces of gravel. The extent of this deposit was not fully explored across the entire site. For the area bounded by BH's 8 and BH's 7 (Sta. 15+975 to 15+500), the deposit was penetrated up to a maximum thickness of 11.1 m. At BH's 9 and 10, the thickness of the deposit is in the order of 5 to 6 m and is underlain by a cohesionless deposit of sand to silty sand. The extent of the underlying cohesionless deposit was not determined during the investigation.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1418700-A.*

A detailed description of the subsurface conditions encountered is given below.

Topsoil

A thin veneer of topsoil that is brown in colour, moist, and contains a rich, earthy odour is spread across the site. The thickness of this veneer is approximately 0.8 m.

Sand, trace Silt, trace/some Gravel

The surficial topsoil is underlain by a brown, cohesionless sand that contains traces of silt and traces/some gravel. A grain size distribution envelope for this deposit as determined by mechanical sieve analysis is provided in Figure 1 in the Appendix. The thickness of this native deposit varies from 0.7 m to 2.9 m extending to elevations ranging from El. 159.4 m to 156.4 m. The thickness decreases in an easterly direction and is typically in the 0.7 to 0.9 m ranges east of BH 8.

This cohesionless deposit was partially submerged below the groundwater table at

* SHEET NO 41-1 OF THE CONTRACT DWG'S

the time of investigation and soil cave was witnessed in the open borehole. Natural moisture contents determined in the laboratory range from 6.5 to 15.5%.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 6 blows/0.3 m to 28 blows/0.3 m indicating that the deposit ranges in denseness from loose to compact. In general, the deposit can be categorized as compact.

A Standard Proctor Test was carried out on material obtained by conglomerating individual samples into one representative volume batch. A grain size curve illustrating the gradation of the batch sample is illustrated on Figure 2. The Standard Proctor Test was carried out in accordance with Procedure 1 of the Method of Test for Moisture-Density Relationship of Soils outlined in the MTO Laboratory Testing Manual (LS 607). The results of the test are illustrated in Figure 3 in the Appendix. Based on the results, the soil has an optimum moisture content (w_{opt}) of 8.5% and a maximum dry density (γ_{dry}) of 1.96 g/cm^3 (19.2 kN/m^3). These results have been corrected to account for the effect of stone content.

SILT

The cohesionless sand deposit is underlain by a thin stratum of plastic silt ranging in thickness from 0.3 m to 1.6 m and found to extend to elevations ranging from 154.7 m to 158.4 m. The stratum is generally brown in colour although the stratum has been oxidized to grey at some locations. Figure 4 in the Appendix illustrates the gradation of this deposit on typical grain size distribution curves determined by mechanical sieve and hydrometer analysis.

The plasticity of the silt was confirmed by performing Atterberg Limit tests and the results are tabulated in Table 1 below and illustrated in Figure 5 in the Appendix. Natural moisture contents determined in the laboratory are also summarized in Table 1 and reveal values ranging from 21 to 22%.

Table 1 - Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	21-22	5
Liquid Limit (w_L %)	19-21	3
Plasticity Index (I_p)	3-4.5	3

The silt stratum was submerged beneath the groundwater table at the time of the investigation and soil sloughing in the open borehole is expected to have developed concurrent with the overlying sand deposit.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 9 blows/0.3 m to 47 blows/0.3 m indicating a range of denseness of loose to dense. In general, 'N' values were in the 15 blows/0.3 m to 25 blows/0.3 m equivalent to a compact denseness.

Clayey Silt to Silty Clay with random nodules/seams of Silt

Underlying the cohesionless silt deposit, a layer of clayey silt to silty clay with random nodules or zones and interbedded seams of silt exists. The surface of this stratum is at an elevation ranging from 158.4 m to 154.7 m and extends to an elevation ranging from 154.1 m to 151.7 m. The thickness of the stratum varies from 2.6 m to 4.8 m. The stratum is grey in colour with the silt nodules and seams present at a lighter grey hue.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 6 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 25-40% and 60-75% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 7. A summary of the indices is provided in Table 2. Unit weights are also included.

Table 2 - Clayey Silt to Silty Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	20-34	14
Liquid Limit (w _L %)	23-46.5	12
Plasticity Index (I _p)	9.5-28.5	12
Unit Weight (kN/m ³)	17.2-22.6	7
Undrained Shear Strength (cu) (kPa)		
- Field Vane	30->120	10
Sensitivity	2-4	10
SPT 'N' values (blows/0.3 m)	5-24	24

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay). Natural moisture contents range from 20-34% but are generally in the 20-25% range.

Undrained shear strength measurements (c_u) of the soil were obtained by conducting in situ vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2 above. The results reveal undrained shear strength values ranging from 30-120 and hence the soil can be classified as having a consistency ranging from firm to very stiff. In general, the soil can be categorized as stiff.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 4 indicating that the soil has a low sensitivity.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 24 blows/0.3 m as tabulated in Table 2. The range of values confirms the firm to very stiff categorization determined from the in situ vane test.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 3 below.

Table 3 - Effective Strength Parameters

Sample	BH A-5, Tw8
Elevation (m)	154.1
Liquid Limit (w_L %)	43
Plasticity Index (I_p %)	24
Natural Moisture Content	27
Effective Angle of Internal Friction (0°)	29
Effective Shear Strength Intercept (c')(kPa)	0

For design purposes, a reduced angle of internal friction (0) of 26° was selected to account for the fact that the sample tested was not saturated.

Two Standard Proctor Tests were carried out on material obtained by conglomerating individual samples into two representative volume batches. Grain size curves illustrating the gradation of the batch samples are illustrated in Figure 8.

The Standard Proctor Tests were carried out in accordance with Procedure 1 of the Method of Test for Moisture-Density Relationship of Soils outlined in the MTO Laboratory Testing Manual (LS 607). The results of the tests are illustrated in Figure 9 in the Appendix. Based on the results, the soil has an optimum moisture content (w_{opt}) of 13.2 to 13.8% and a maximum dry density (γ_{dry}) of 1.89 to 1.92 g/m³ (18.6 to 18.8 kN/m³).

Clayey Silt, trace/some sand, trace gravel (Glacial Till)

The clayey silt to silty clay stratum is underlain by a glacial till deposit consisting of a clayey silt host material combined with varying percentages (trace to some) of sand and traces of gravel. The extent of the deposit was not determined throughout the site area. For the area bounded by BH's 8 and 7, the deposit was explored to a maximum thickness of 11.1 m. At BH's 9 and 10, the thickness of the deposit is in the order of 5 to 6 m.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 10 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 26-41% and 58-65% respectively. The envelope also depicts percentages of sand up to 32% also comprise the deposit.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 11 in the Appendix. A summary of the indices is provided in Table 4 below. Unit weights are also included.

Table 4 - Clayey Silt Till

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-25	8
Liquid Limit ($w_L\%$)	19-34	8
Plasticity Index (I_p)	7-15	8
Unit Weight (kN/m^3)	18.3-20.8	6
Undrained Shear Strength (c_u) (kPa)		
- Field Vane	30->120	32
Sensitivity	2-4	32
SPT 'N' values (blows/0.3 m)	3-29	

The test results reveal that the fine grained portion of the deposit is predominantly of low plasticity and hence can be classified as clayey silt.

Undrained shear strength measurements (c_u) of the soil were obtained by conducting in situ vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 4 above. A shear strength (c_u) vs Elevation (m) profile is also provided in Figure 12 in the Appendix. Based on shear strength values ranging from 30->120 kPa, the consistency of the soil ranges from firm to very stiff. In consideration that the higher shear strength values determined may not be representative because of the presence of the sand and gravel components of the till, the deposit can be generally categorized as having a stiff consistency. As Figure 12 illustrates, however, the consistency does become stiffer with depth.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undistributed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 4 and identified in the Record of Borehole sheets. Sensitivity values range from 2 to 4 indicating that the soil has a low sensitivity.

Standard Penetration tests carried out in the stratum revealed 'N' values ranging from 3 blows/0.3 m to 29 blows/0.3 m as illustrated on the 'N' values vs Elevation (m) graph in Figure 13 in the Appendix. 'N' values generally increase

with depth in the deposit indicating that the consistency of the soil becomes stiffer with depth.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 5 below.

Table 5 - Effective Strength Parameters

Sample	BH A-6, Tw8
Elevation (m)	147.6
Liquid Limit (w_L %)	26
Plasticity Index (I_p %)	12
Natural Moisture Content	19
Effective Angle of Internal Friction (0°)	29
Effective Shear Strength Intercept (c')(kPa)	10

For design purposes, a reduced angle of internal friction (0) of 26° and a shear strength intercept of 5 kPa was selected to account for the fact that the sample tested was not saturated.

Sand to Silty Sand

At BH's A-9 and A-10, the till deposit is underlain by a cohesionless sand to silty sand deposit. The deposit exists at an elevation ranging from 149.5 m to 148.7 m or depths of 10.7 to 11.4 m below the natural ground surface. The extent of this deposit was not determined during the investigation.

The fact that sloughing of the borehole occurred upon penetration into this deposit indicates that the deposit is under subartesian head. "Blow back" in the order of 2 to 3 m was observed when sampling through this material. A head of water was required to balance the unbalanced hydrostatic head so that penetration through this soil could be achieved.

Standard Penetration tests carried out in this deposit revealed 'N' values in the order of 5-6 blows/0.3 m indicating a loose material denseness.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring water levels in piezometers installed in the surficial sand and silt deposits. The piezometers were installed with the tips at an approximate elevation of 156 m with a bentonite seal of 0.3 m thickness below the piezometer tip and a bentonite seal at the surface of equal thickness. Pea gravel (10 mm) was used to fill the annular space between the piezometer and the borehole.

Measurements obtained from the aforementioned sources at the time of the investigation revealed water levels ranging from 2 to 2.5 m below the natural ground surface (Elevation 157.8 m to 158.8 m). At BH's A-7 and A-4, water levels could not be obtained because of the sloughing of the boreholes at depths of 1.5 m to 2.1 m respectively.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

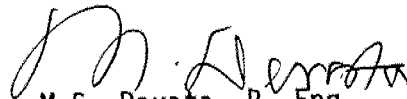
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, B. Cung, Engineering Trainee and J. Petruzzello, Engineering Technician, utilizing equipment owned and operated by Marathon Drilling and Master Soils Investigation.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief foundation Engineer.



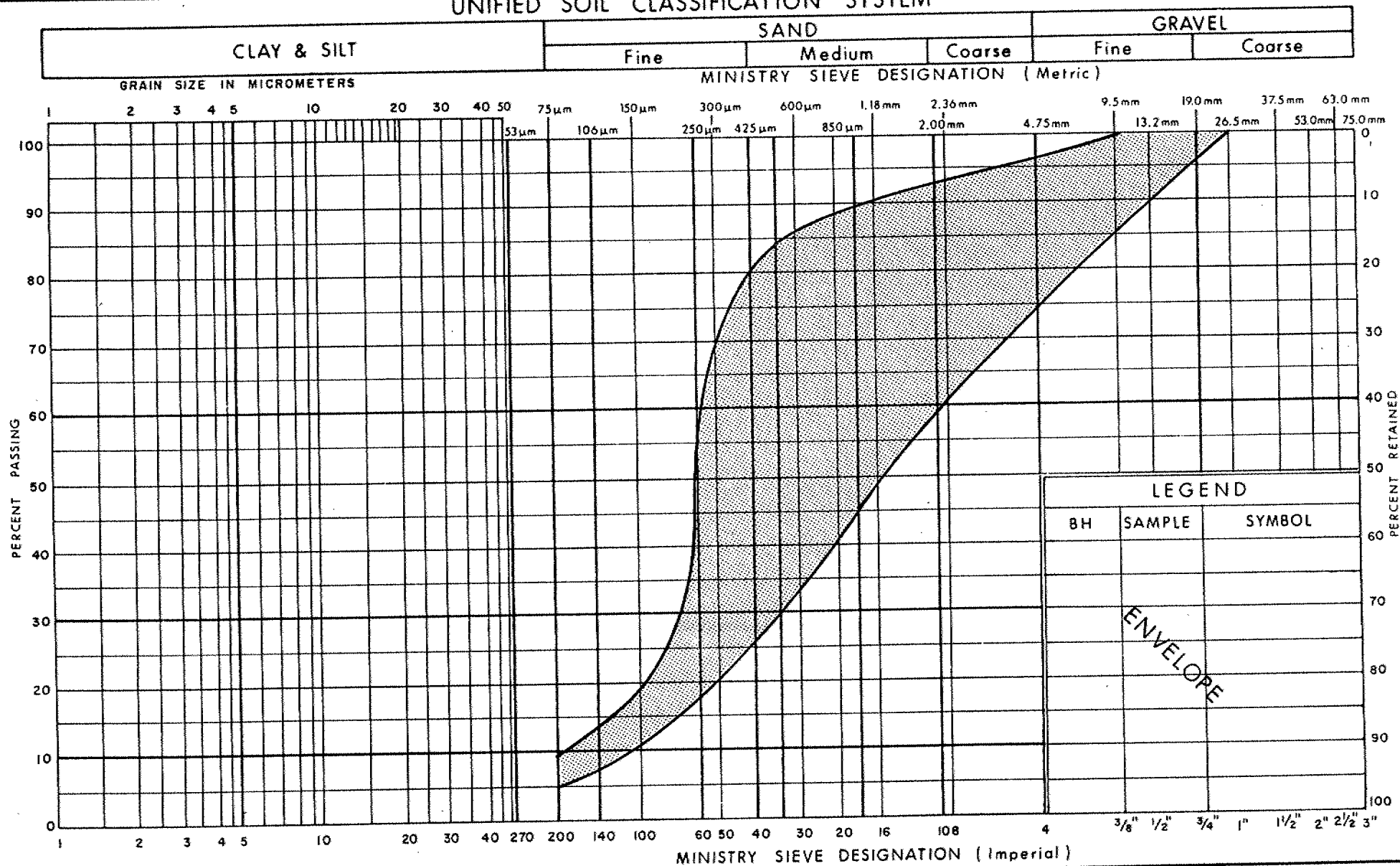
Dr. B. Iyer, P. Eng.
Senior Foundation Engineer



M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



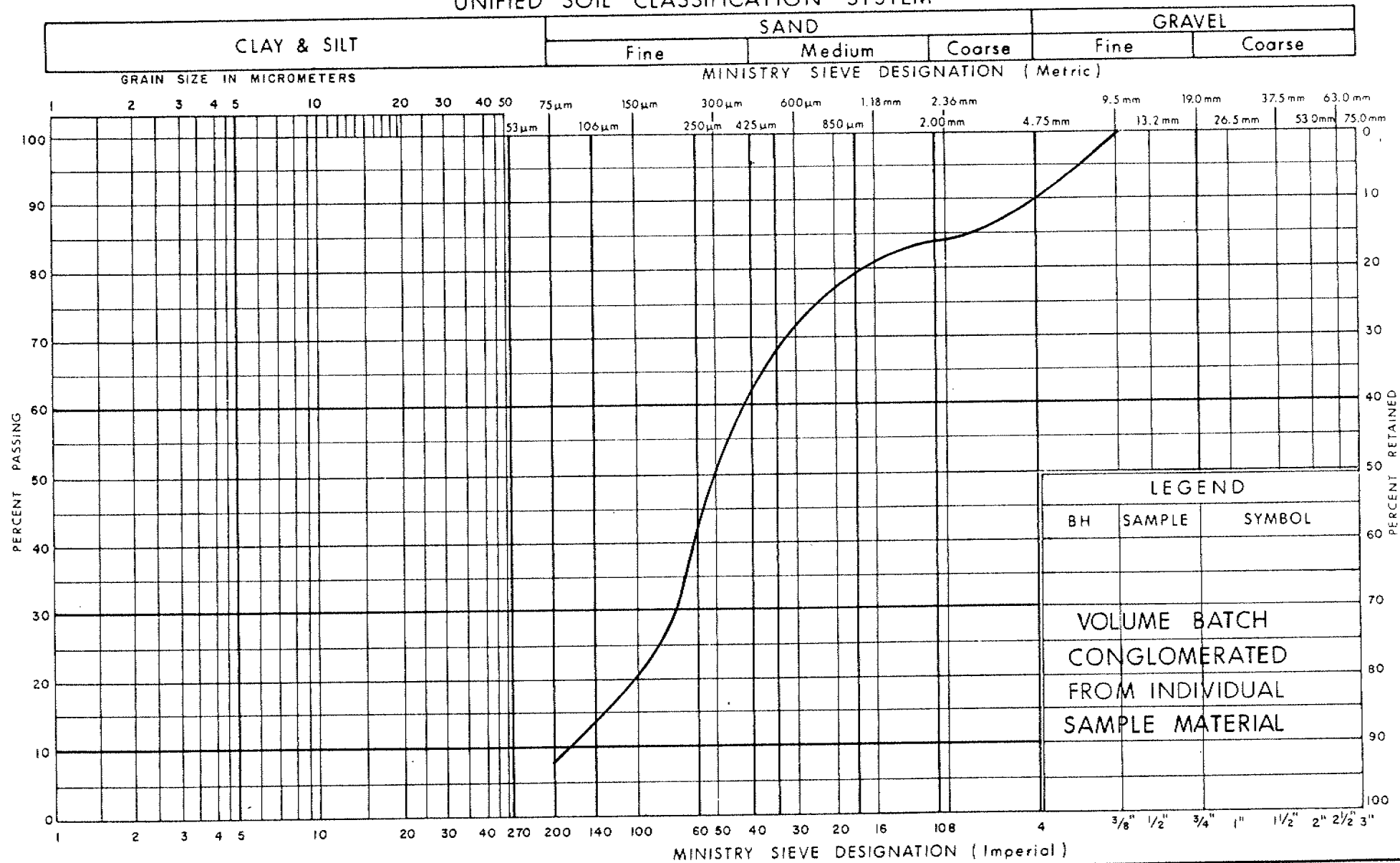
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, TRACE SILT, TRACE/SOME GRAVEL

FIG No 1

W P 141-87-00 (A)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, TRACE SILT, TRACE / SOME GRAVEL

FIG No 2

W P 141-87-00 (A)

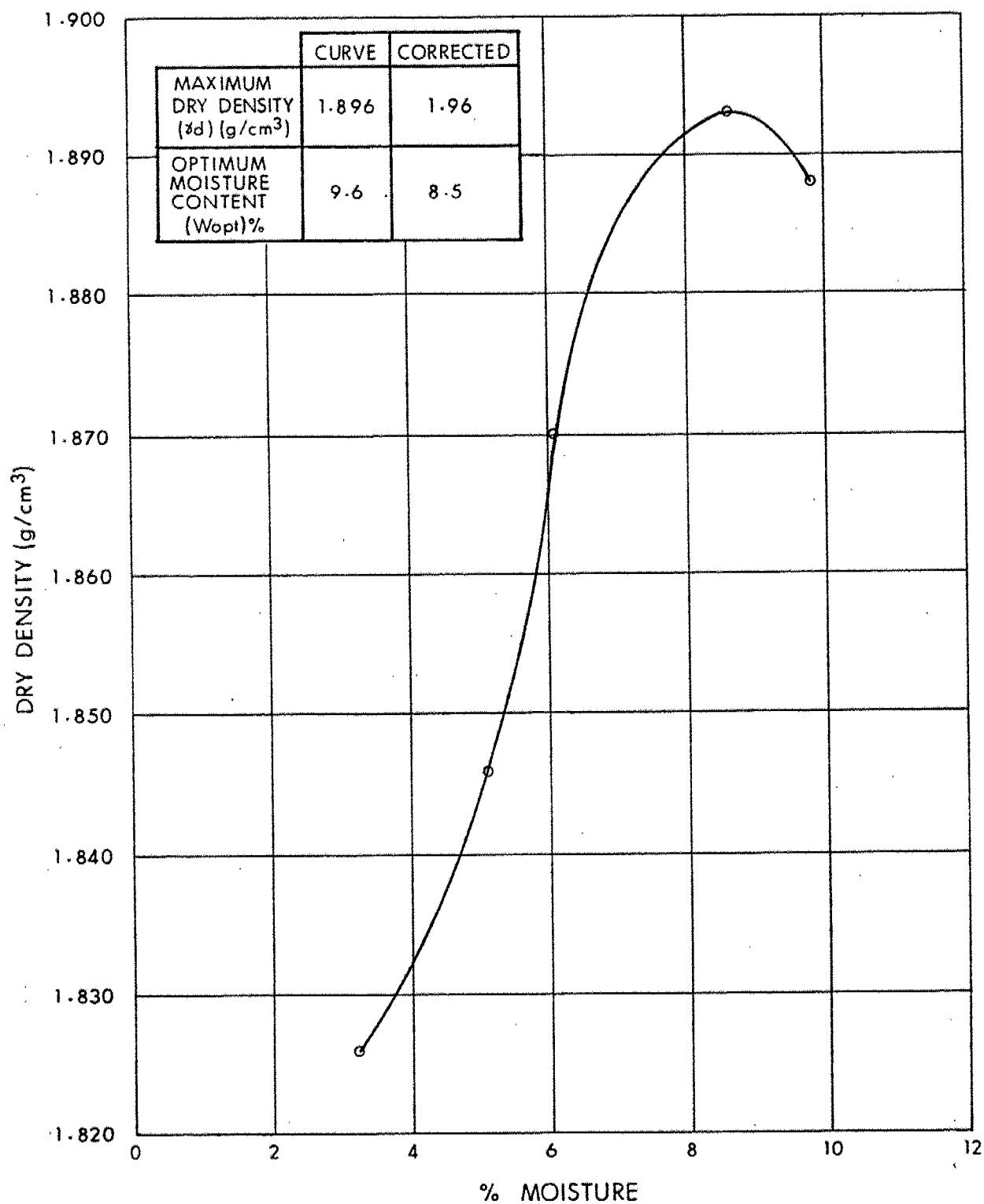
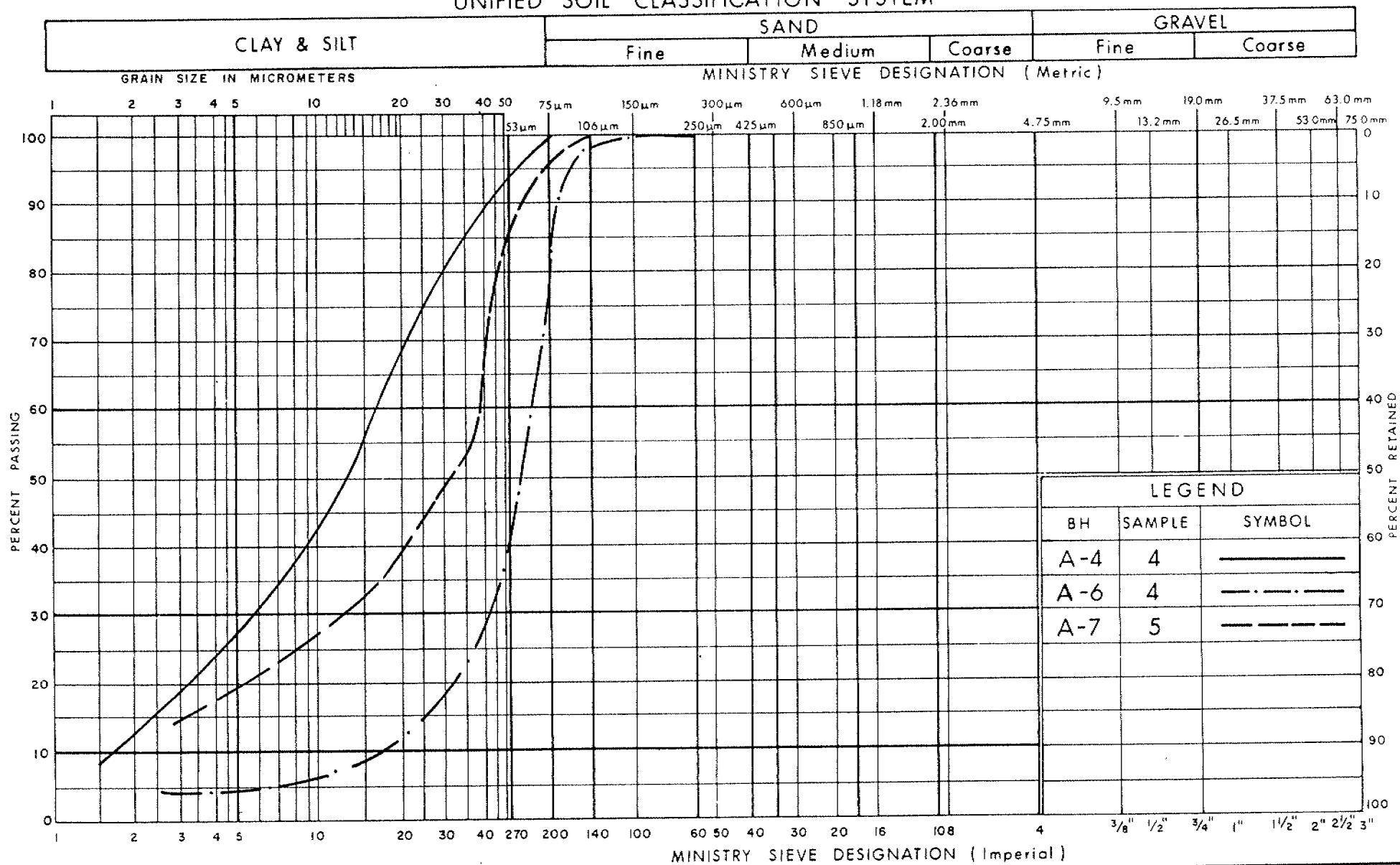


FIG - 3
WP 141-87-00(A)

UNIFIED SOIL CLASSIFICATION SYSTEM



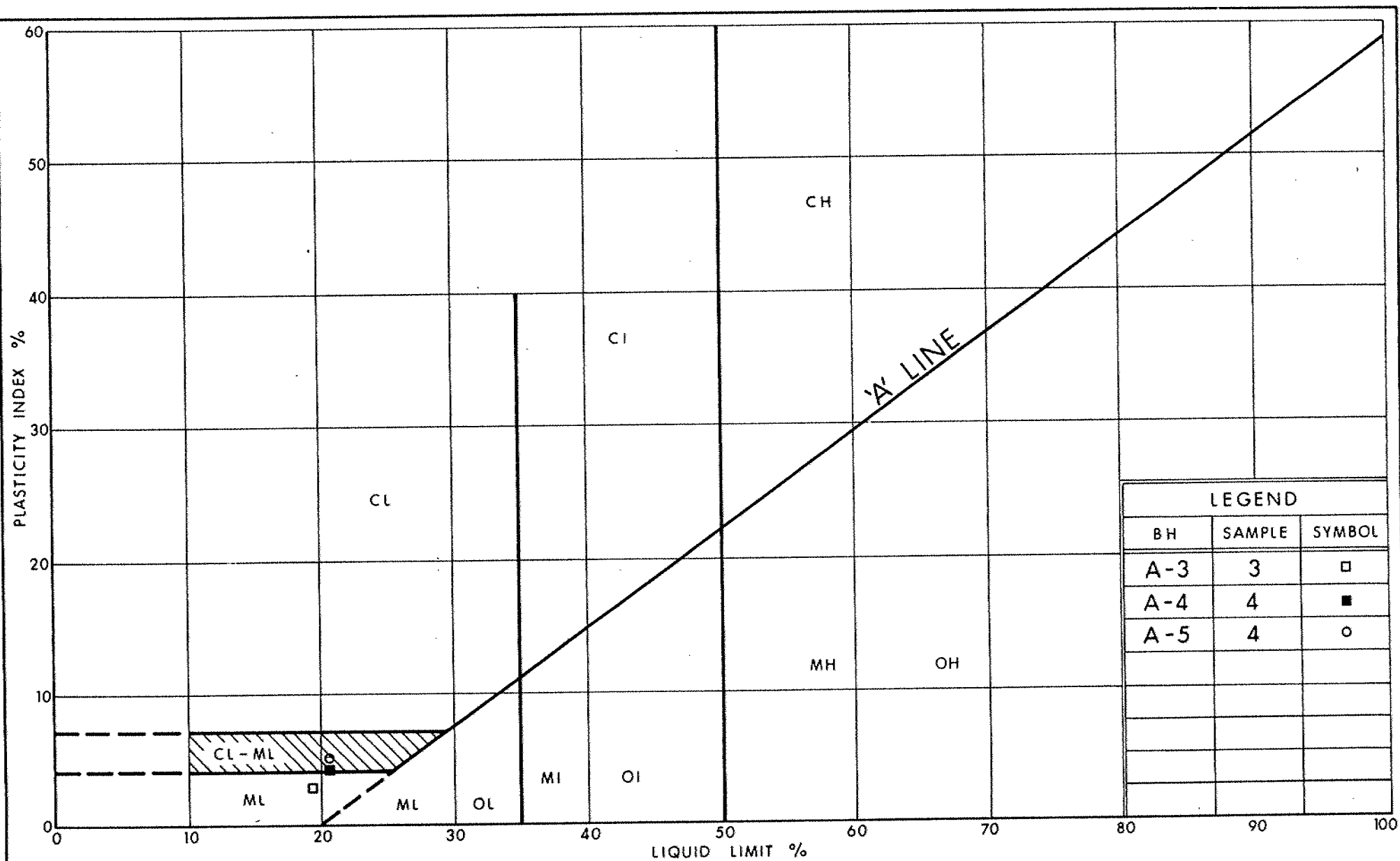
Ministry of
Transportation

Ontario

GRAIN SIZE DISTRIBUTION
SILT

FIG No 4

W P 141-87-00 (A)



Ontario

Ministry of
Transportation

PLASTICITY CHART SILT

FIG No 5

W P 141-87-00 (A)

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

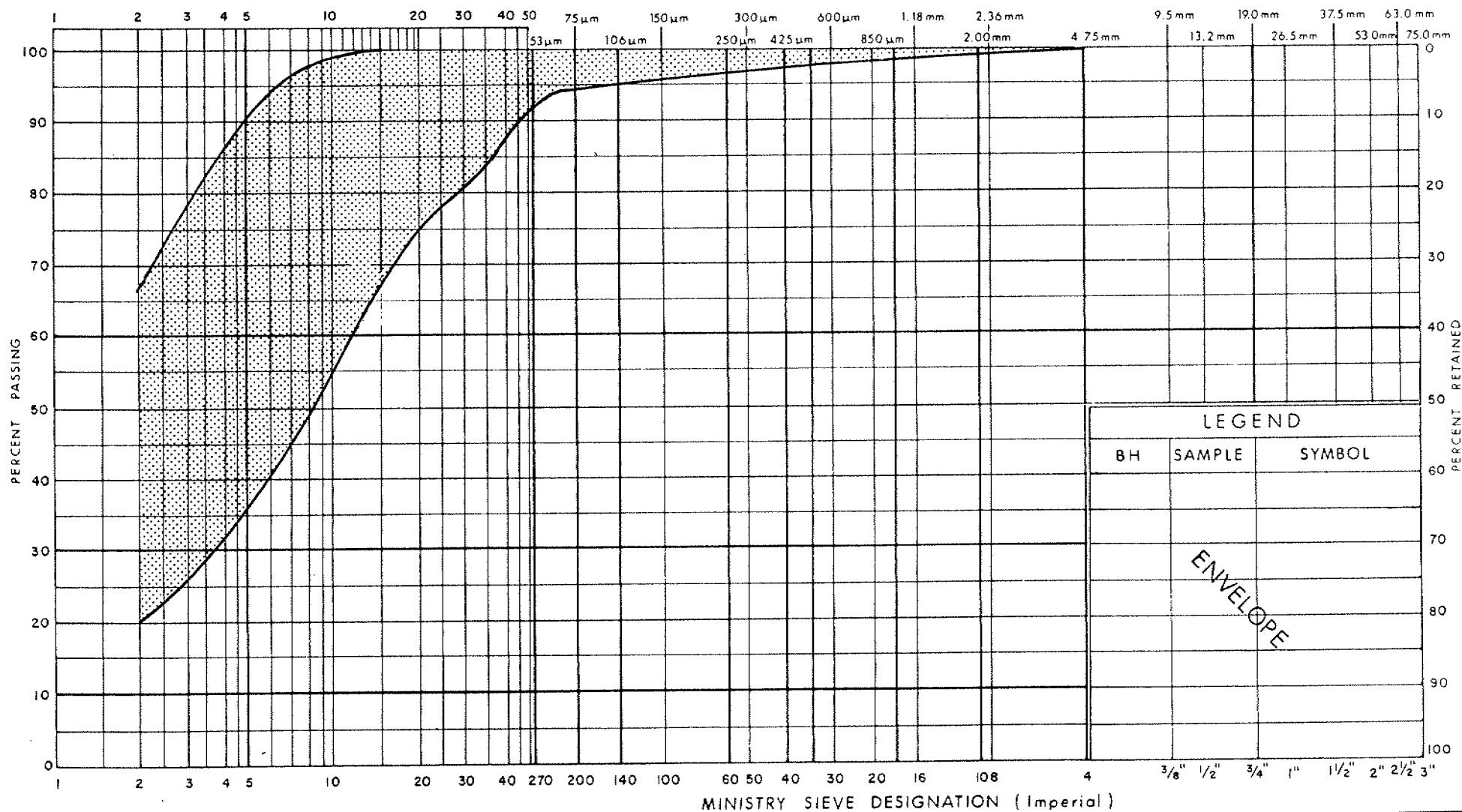
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH

SAMPLE

SYMBOL

ENVELOPE

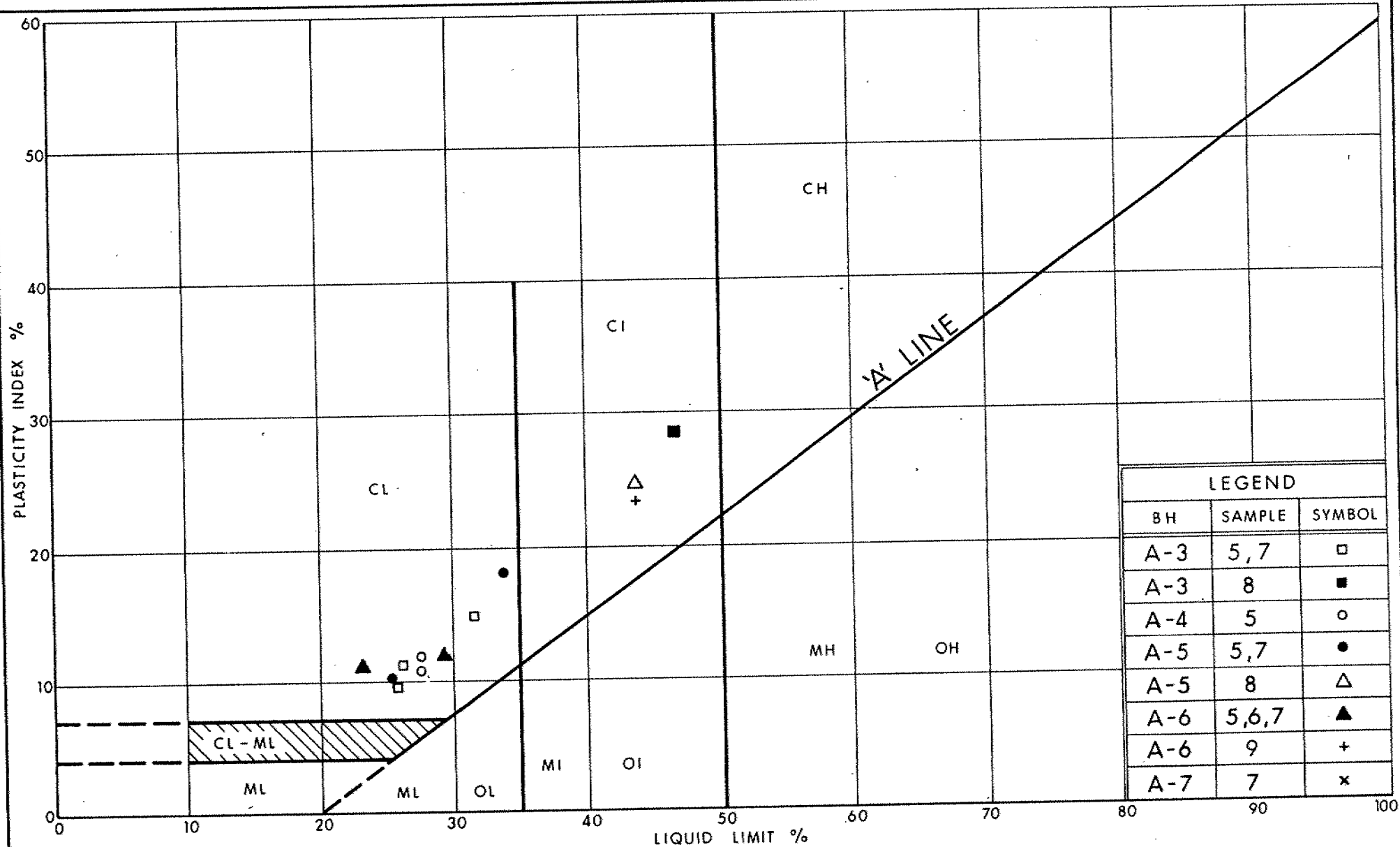
MINISTRY SIEVE DESIGNATION (Imperial)

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
WITH RANDOM NODULES/SEAMS OF SILT

FIG No 6

W P 141-87-00 (A)



Ministry of
Transportation

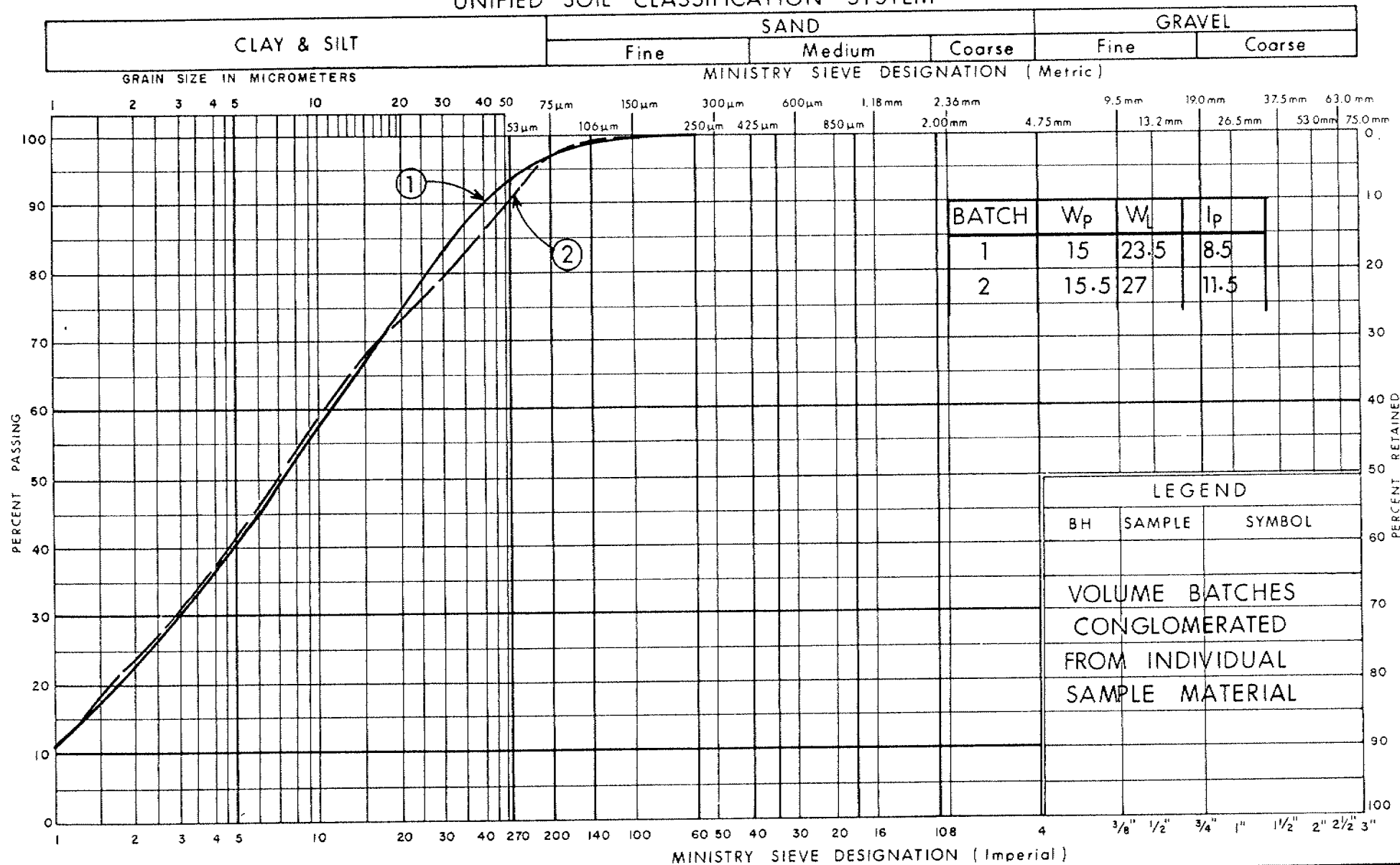
Ontario

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
WITH RANDOM NODULES/SEAMS OF SILT

FIG No 7

W P 141-87-00 (A)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
WITH RANDOM NODULES / SEAMS OF SILT

FIG No 8

W P 141-87-00 (A)

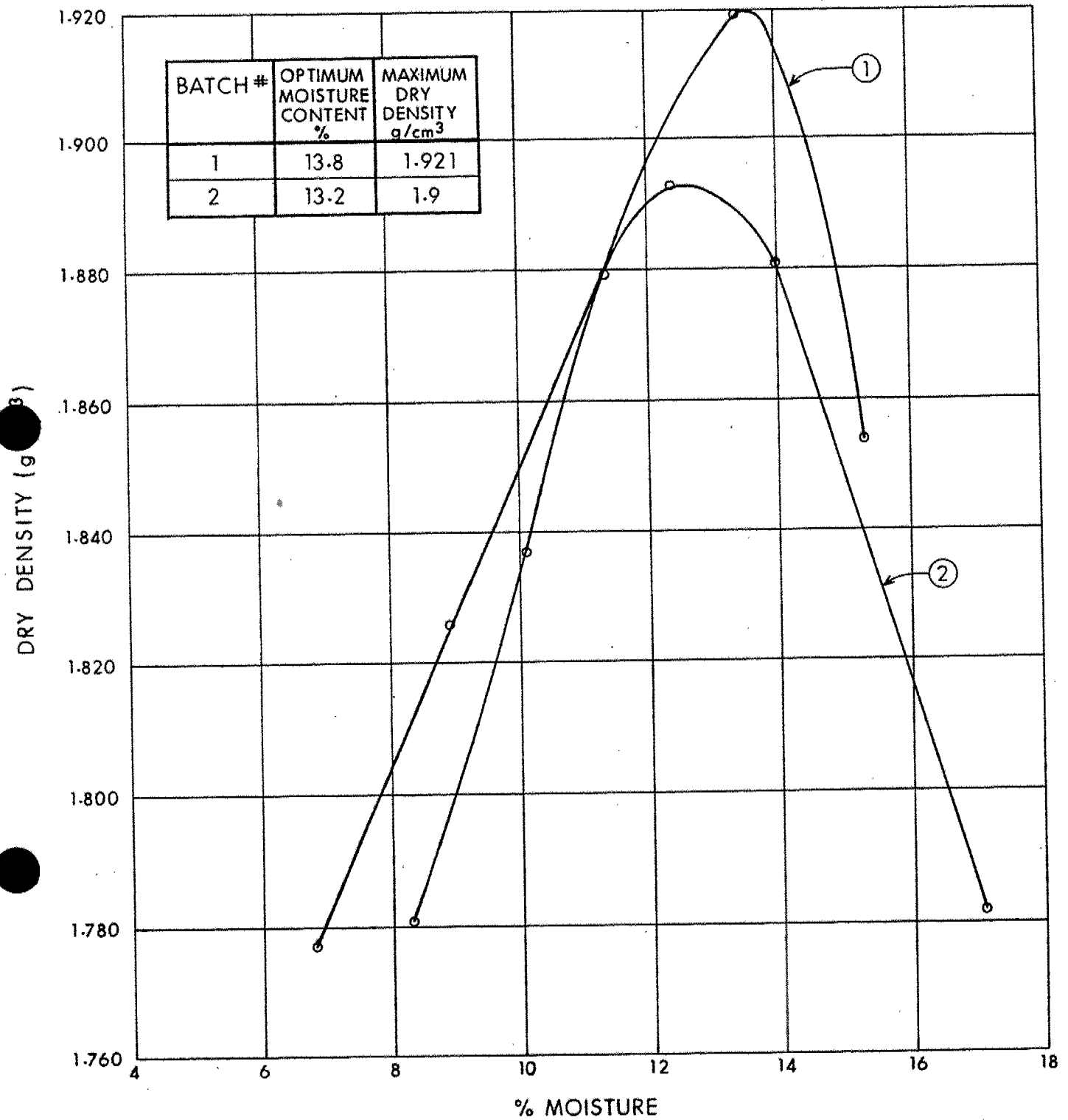
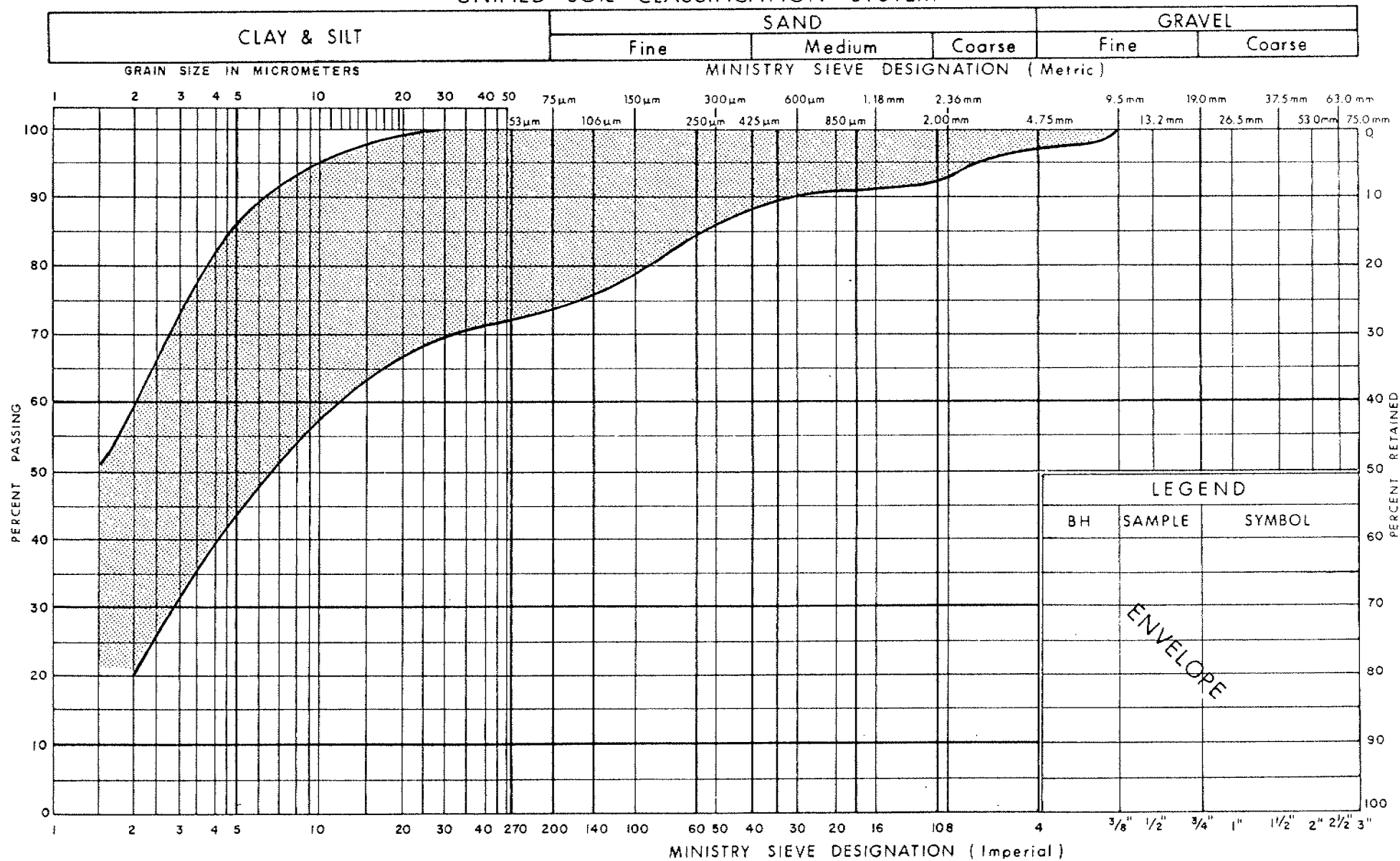


FIG-9
WP 141-87-00(A)

UNIFIED SOIL CLASSIFICATION SYSTEM



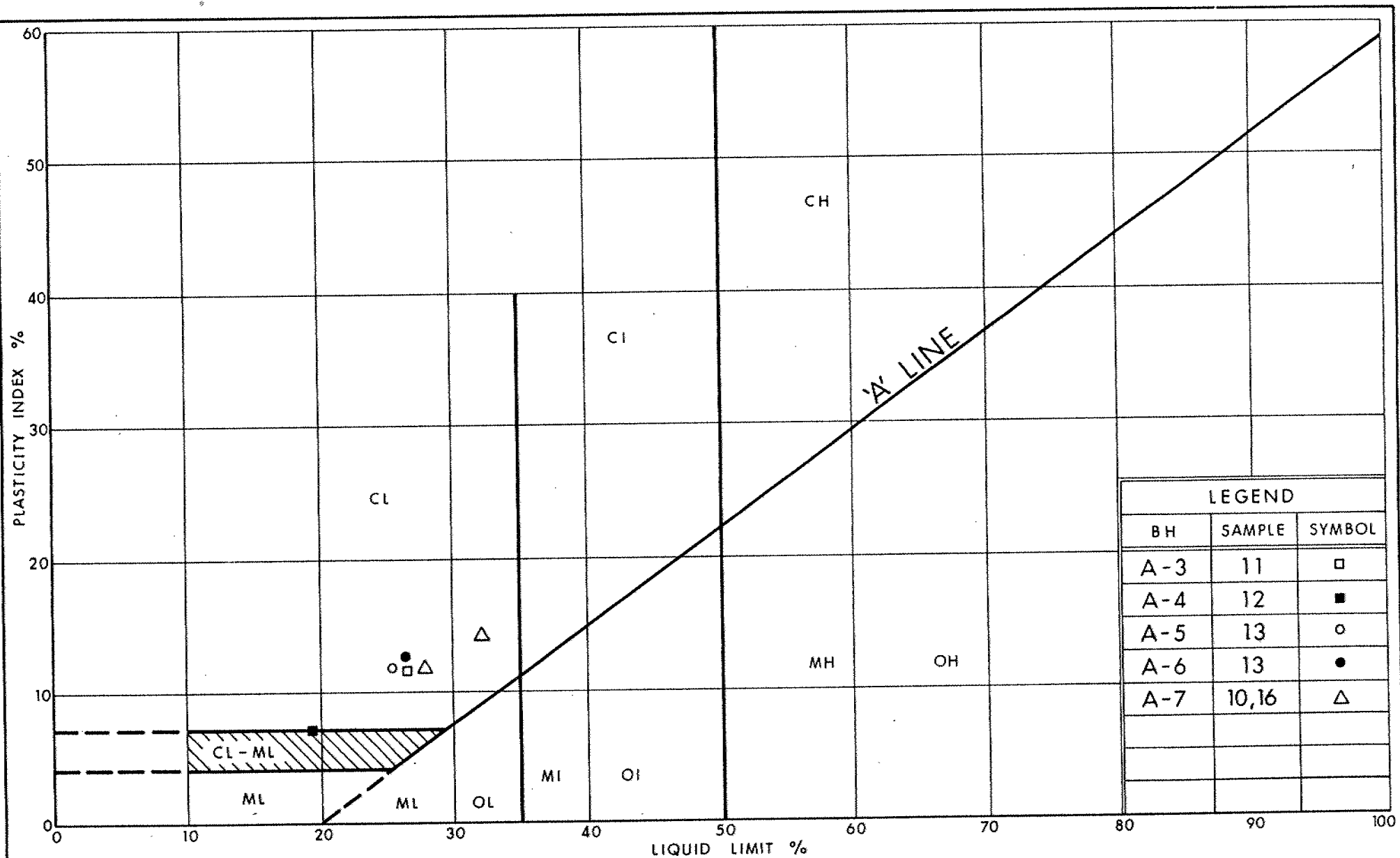
Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME / TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)

FIG No 10

W P 141-87-00 (A)

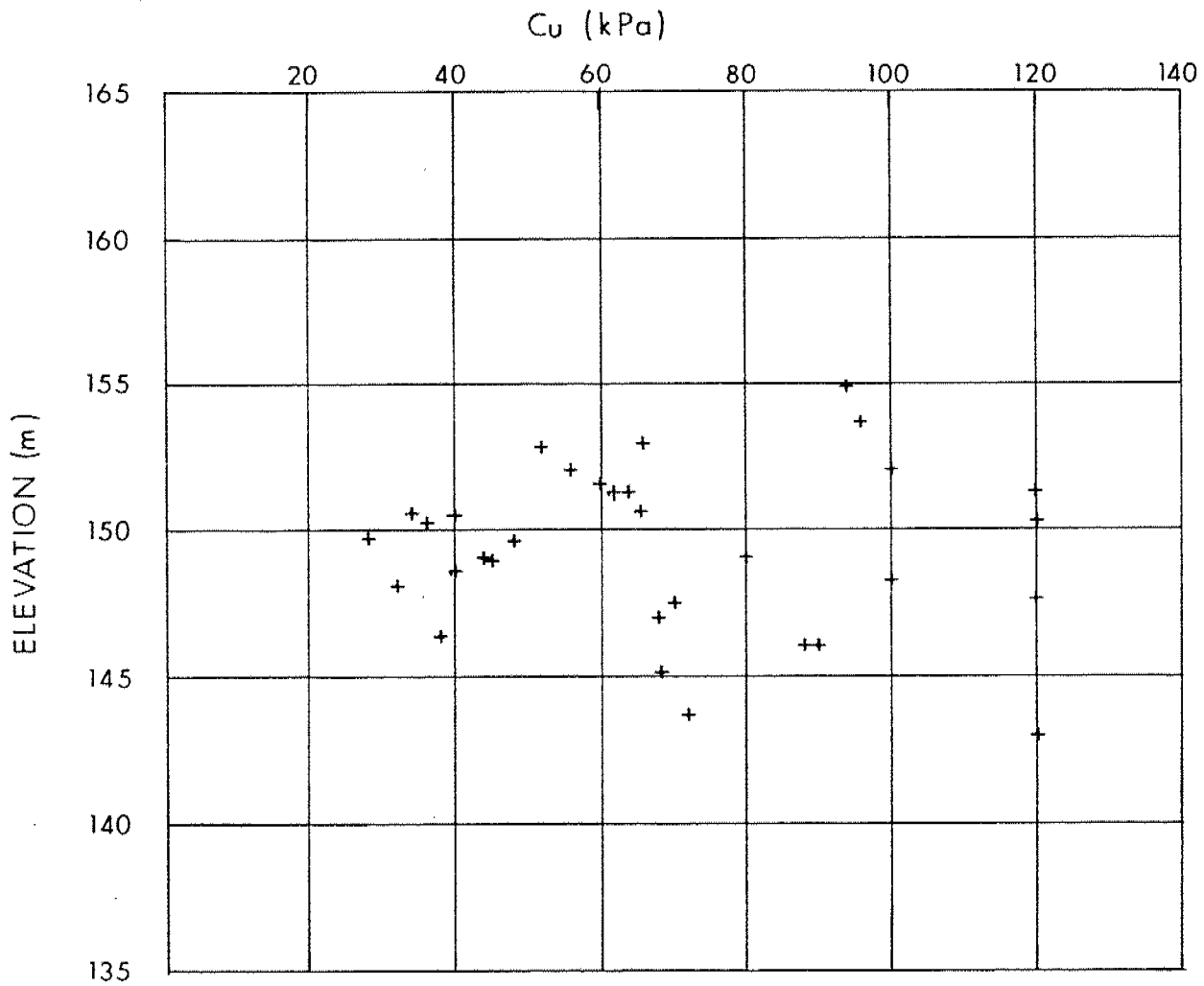


Ministry of
Transportation

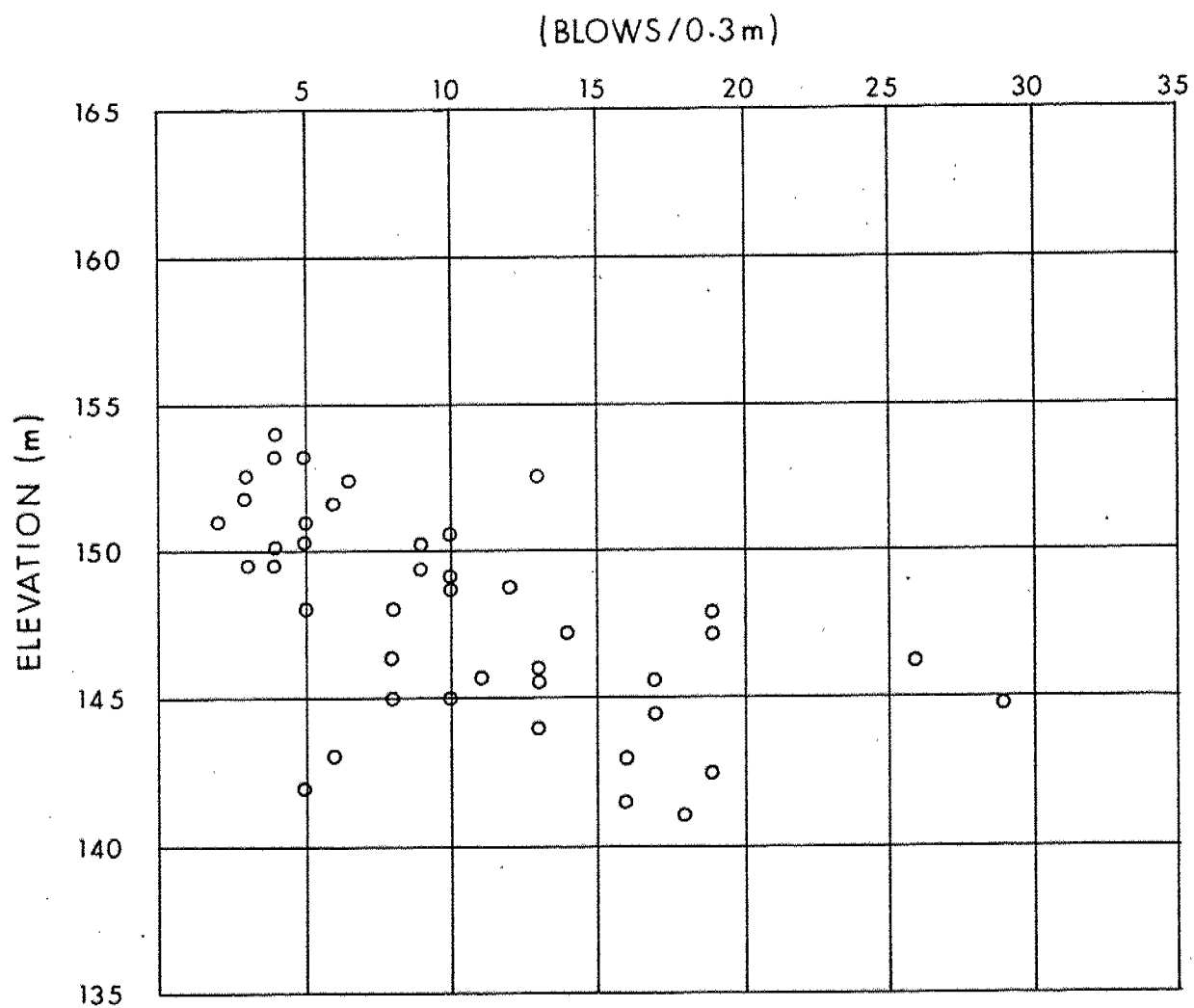
PLASTICITY CHART
CLAYEY SILT, SOME/TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)

FIG No 11

W P 141-87-00(A)



UNDRAINED SHEAR STRENGTH (C_u) KPa VS ELEVATION (m)
CLAYEY SILT, SOME / TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)



SPT 'N' VALUES (BLOWS /0.3m) VS ELEVATION (m)
CLAYEY SILT, SOME / TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)

RECORD OF BOREHOLE No A-1

1 OF 1

METRIC 172

W.P. 141-87-00A LOCATION Co-ords: N 4 847 751.6 ; E 298 751.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16-17 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80
160.2	Ground Surface															
159.4	Topsoil		1	AS	-											
0.8	Sand, Tr. Gravel		2	SS	14											
	Brown, Compact		3	SS	9											
157.2	Silt, Brown, Compact		4	SS	9											
156.7			5	SS	7											
3.5	Clayey Silt with Random Nodules/ Seams of Silt		6	SS	6											
	Grey, Stiff to Very Stiff		7	SS	5											
154.1			8	SS	4											
6.1			9	SS	3											
	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		10	SS	5											
	Grey, Firm to Very Stiff		11	SS	3											
			12	SS	8											
			13	SS	8											
144.5			14	SS	8											
15.7	End of Borehole															

* GROUND WATER CONDITIONS

PIEZO. NO.	GROUND WATER ELEVATION (Metres)
1	158.2

RECORD OF BOREHOLE No A-2

1 OF 1

METRIC 173

W.P. 141-87-00A LOCATION Co-ords: N 4 847 790.6 ; E 298 676.7 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 01 16-17 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _P	W	W _L		
160.1	Ground Surface																
159.3	Topsoil		1	SS	18												
0.8	Sand, Tr. Gravel		2	SS	21												
	Brown, Compact		3	SS	15												
156.4			4	SS	25												
155.8	Silt, Brown, Very Dense		5	SS	47												
4.3			6	SS	24												
	Clayey Silt with Random Nodules/ Seams of Silt		7	SS	19												
	Grey, Stiff to Very Stiff		8	SS	7												
152.5																	
7.6			9	SS	6												
			10	SS	5												
	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		11	SS	9												
	Grey, Firm to Very Stiff		12	SS	19												
			13	SS	26												
144.4			14	SS	29												
15.7	End of Borehole																

RECORD OF BOREHOLE No A-3

1 OF 1

METRIC 174

W.P. 141-87-00A LOCATION Co-ords: N 4 847 713 ; E 298 662.2 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%) 10 20 30			
160.9	Ground Surface													
160.2	Topsoil													
0.7	Sand, Tr. Gravel Brown, Loose		1	SS	7									
158.9			2	SS	6									
2.0	Silt		3	SS	13									
157.4	Compact		4	SS	12									
3.5	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt Grey, Stiff to Very Stiff		5	SS	12									
			6	SS	5									
			7	SS	12									
			8	TW	PH									
153.3														
7.6	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Stiff to Very Stiff		9	SS	5									
			10	SS	3									
			11	SS	9									
			12	SS	10									
			13	SS	19									
			14	SS	13									
145.2														
15.7	End of Borehole													

RECORD OF BOREHOLE No A-4

1 OF 1

METRIC 175

W.P. 141-87-00A LOCATION Co-ords: N 4 847 740.9 ; E 298 588.6 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 15 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
160.9	Ground Surface																	
160.1	Topsoil																	
0.8	Sand, Tr. Gravel, Tr. Silt		1	SS	24									3 86 (11)				
158.9	Brown, Compact		2	SS	28													
2.0	Silt		3	SS	27													
157.4	Compact		4	SS	17													
3.5	Brown Grey Clayey Silt with Random Nodules/ Seams of Silt Stiff to Very Stiff		5	SS	15								20.4					
			6	SS	13													
			7	SS	14													
			8	SS	11													
153.3			9	SS	4													
7.6	Clayey Silt, Some Sand, Tr. Gravel (Glacial Till) Grey, Firm to Stiff		10	TW	PH													
			11	SS	5													
			12	SS	12									7 32 (61)				
			13	SS	14													
145.2			14	SS	17													
15.7	End of Borehole																	
	Hole caved-in at 2.1m (GWL not established)																	

RECORD OF BOREHOLE No A-5

1 OF 1

METRIC 176

W.P. 141-87-00A LOCATION Co-ords: N 4 847 660.1 ; E 298 576.7 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 01 15 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								UNCONFINED • QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
160.2	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30					
159.4	Topsoil		1	SS	11								11 82 (7)		
0.8	Sand, Some Gravel		2	SS	10								25 68 (7)		
157.2	Brown, Compact		3	SS	17								0 0 (100)		
156.4	Silt, Brown, Compact		4	SS	14										
3.8	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt Grey, Stiff		5	SS	10								22.6		
			6	SS	11										
			7	SS	5										
			8	TW	PH									0 0 32 68 c'=0 φ'=29°	
152.6	Clayey Silt, Some Sand, Tr. Gravel (Glacial Till) Grey, Firm to Stiff		9	SS	13										
7.6			10	SS	2										
			11	SS	4										
			12	SS	5										
			13	SS	8									18.4 1 15 (64)	
			14	SS	10										
			15	SS	6										
			16	SS	5										
141.5	End of Borehole														
18.7															
137.3															
22.9	End of Cone Test														

RECORD OF BOREHOLE No A-6

1 OF 1

METRIC 177

W.P. 141-87-00A LOCATION Co-ords: N 4 847 691.2 ; E 298 501.7 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 12-15 CHECKED BY BC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					
159.8	Ground Surface												
159.0	Topsoil		1	AS	-								14 79 (7)
0.8	Sand, Tr. Silt, Some Gravel		2	SS	26								
157.5	Brown, Compact		3	SS	18								0 19 76 5
2.3	Silt		4	SS	21								0 0 60 40
156.8	Brown, Compact		5	SS	18								0 0 77 23
3.0	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt Firm to Stiff		6	SS	16							20.0	
			7	SS	12							22.2	
			8	SS	8							19.8	
			9	SS	5								
			10	TW	PH								
			11	SS	10								
			12	SS	10								
152.0	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Stiff to Very Stiff		13	TW	PH							20.3	1 11 62 26 * c' = 10 kPa φ' = 29°
7.8			14	SS	13								
			15	SS	17							20.8	1 20 49 30
			16	SS	16								
			17	SS	16								
141.1	End of Borehole												
137.5	End of Cone Test												
22.3													
* GROUND WATER CONDITIONS													
PIEZO. NO.		GROUND WATER ELEVATION (Metres)											
1		157.5											

RECORD OF BOREHOLE No A-7

1 OF 1

METRIC 178

W.P. 141-B7-00A LOCATION Co-ords: N 4 847 615.4 ; E 298 488.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 11-12 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPo							WATER CONTENT (%)
								20 40 60 80 100							
159.3	Ground Surface														
158.5	Topsoil		1	AS	-	*									
0.8	Sand, Tr. Silt, Tr. Gravel Brown, Compact		2	SS	16		158							5 89 (5)	
			3	SS	22										
			4	SS	16										
156.3			5	SS	26		156						0 3 86 11		
3.0	Silt Compact		6	SS	16										
154.7			7	TW	PH		154								
4.6	Clayey Silt with Random Nodules/ Seams of Silt Grey, Stiff		8	SS	8										
			9	SS	9										
			10	SS	6		152							17.7	
151.7			11	SS	4		150							17.0	
7.6	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Firm to Stiff		12	TW	PH		148							18.4	
			13	TW	PM		146								
			14	SS	11		144								
			15	SS	13										
			16	SS	19		142							20.8	
			17	SS	17										
140.6	End of Borehole														
18.7	Hole Cave-in at 1.5m (CWL not established)														

RECORD OF BOREHOLE No A-8

1 OF 1

METRIC 179

W.P. 141-87-00A LOCATION Co-ords: N 4 847 881 : E 298 813 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
160.2	Ground Surface																	
159.4	Topsoil																	
0.8	Sand, Tr. Gravel																	
158.7																		
1.5	Silt, Brown, Compact		1	SS	12													
1.8	Cloyey Silt with Random Nodules/ Seams of Silt		2	SS	10													
	Grey, Stiff		3	SS	7													
154.1			4	SS	3													
6.1			5	SS	3													
	Cloyey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		6	SS	7													
	Grey, Stiff to Very Stiff		7	SS	12													
147.6			8	SS	16													
12.6	End of Borehole																	

RECORD OF BOREHOLE No A-9

1 OF 1

METRIC 180

W.P. 141-87-00A LOCATION Co-ords: N 4 847 921 ; E 298 877 ORIGINATED BY TS

DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS

DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _P	W	W _L		
160.1	Ground Surface																
159.3	Topsoil																
0.8	Sand, Tr. Gravel																
158.6	Brown																
1.5	Silt		1	SS	16												
157.8	Brown, Compact																
2.3	Clayey Silt with Random Nodules/ Seams of Silt		2	SS	14												
	Grey, Stiff to Very Stiff		3	SS	7												
154.0																	
6.1	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		4	SS	3												
	Grey, Firm to Very Stiff		5	SS	3												
			6	SS	5												
148.7			7	SS	8												
11.4	Sand, Tr. Silt																
147.5	Loose		8	SS	6												
12.6	End of Borehole																

RECORD OF BOREHOLE No A-10 1 OF 1 METRIC 181

W.P. 141-87-00A LOCATION Co-ords: N 4 847 953 ; E 298 923 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					w _p w w _L				
								SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
160.0	Ground Surface																
159.4	Topsoil																
0.6	Sand, Tr. Gravel																
158.5	Brown, Compact																
1.5	Silt		1	SS	14												
157.7	Brown, Compact																
2.3	Clayey Silt with Random Nodules/ Seams of Silt		2	SS	6												
	Grey, Very Stiff		3	SS	11												
153.9																	
6.1	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		4	SS	6												
	Grey, Firm to Stiff		5	SS	5												
			6	TW	PH												
149.3																	
10.7	Silty Sand		7	SS	5												
	Grey, Loose																
147.4			8	SS	5												
12.6	End of Borehole																

FOUNDATION INVESTIGATION REPORT

For

Proposed Hwy. 407 Cut & Detention Pond

Islington Avenue to Pine Valley Drive

W.P. 141-87-00(A), Hwy. 407

District 6, TorontoINTRODUCTION

Subsequent to requests submitted by the Central Region Geotechnical Section, an investigation was carried out by this office to determine the subsurface conditions for the proposed Hwy. 407 cuts east of Islington Avenue and west of Pine Valley Drive and for a proposed detention pond and stockpile located within this region.

Excavation cuts of up to 10 m will be required to satisfy the proposed Hwy. 407 profile grade. The proposed Hwy. 407 profile grade sloped westward from 156 m to 151 m with the natural ground surface relatively flat on the east side of Islington Avenue with an elevation of 160 m.

The investigating procedure, including the fieldwork procedures and laboratory analysis and a detailed description of the subsurface conditions are also included in this report.

SITE DESCRIPTION AND GEOLOGY

The site is located $\frac{1}{2}$ km north of Steeles east of Islington Avenue in the City of Vaughan, Region of York. The area consists of farmland with hydro power towers to the east and north, CNR tracks south and an industrial building to the north. At the time of the investigation the farmers field contained short grassy vegetables. Boreholes were located along narrow farmer roads located between crops.

Physiographically, the site is located in the geological domain known as the "Peel Plain". The "Peel Plain" is the product of the advances and retreat of the wisconsinan ice sheet which covered the area during the pleistocene epoch. It consists of a bevelled till plain with a gently undulating rolling surface

and limited relief. At some locations, the till is overlain by the deposits of varved clay. Till sheets of varying composition comprise the "Peel Plain". Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristics of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay. The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 35 m below ground surface and consists of interbedded shale and limestone of the Dundas-Meaford formation ordovician period.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing. The procedures employed are discussed below.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 91 07 24 to 91 07 31 and consisted of five sampled boreholes located within the proposed stock pile and retention pond east of Islington.

3 boreholes were advanced 21 m below natural ground surface and 2 boreholes were advanced deeper, down to 48 m to collect data for a future possible retaining wall alternative if found necessary.

Vanes and undisturbed shelby tube samples were taken when plastic cohesive material was encountered. Cone penetration tests were taken down at the invert or each borehole and at two boreholes from the surface.

Track mounted CME 55 equipment employing hollow stem and wash boring techniques were used to advance all boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.75 m intervals for the surficial 4.5 m and 1.5 m thereafter. All samples were identified in the field and then returned to the laboratory for applicable testing. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586).

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation, two piezometers were utilized at opposite ends of the site. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by the Central Region Surveys and Plans Office.

LABORATORY ANALYSIS

The following laboratory tests were carried out on select soil samples:

- 1) Atterberg Limit Tests
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents

Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached appendix.

SUBSURFACE CONDITIONS

General

The stratigraphy encountered consisted mainly of 2.1 m to 4.4 m of a non-cohesive silty sand which contained surficial interbeds of organics. This stratum generally has a compact state of denseness. Underlying the above is a cohesive 1.2 m to 5.7 m thick deposit of clayey silt, trace sand which is in turn underlyed by a clayey silt (Glacial Till) trace sand, trace gravel which was found to extend down to 31.5 m to 30 m below the ground surface, within the two deeper boreholes (BH's 17 and 18). The two deposits have a very soft to stiff and very soft to hard consistency but generally the clayey silt layer has a stiff consistency. A non-cohesive heterogeneous mixture of clay, silt and sand, trace gravel was encountered in the two deep boreholes to extend from 31.5 m to

47.3 m. Bits of shale with probable bedrock was encountered at the terminated depths of these two deep boreholes. This deposit generally has a very dense state of denseness.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater level established at the time of the investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes are provided on Dwg. No. 1418700(A)-A.

A detailed description of the subsurface conditions encountered is given below.

Silty Sand

The native surficial deposit at the site consists of a non-cohesive silty sand that extends to a depth of 2.1 m to 4.4 m below the existing ground surface.

A grain size distribution envelope as determined by mechanical sieve and hydrometer analysis is provided in Figure 1 in the Appendix. The envelope illustrates that a large percentage of the deposit consists of sand and silt. This deposit comprised of 2-10% gravel, 68-83% sand, 9-20% sand and 1-13% clay.

Natural moisture contents for this stratum are in the 6.5-21% range. The deposit has been oxidized and hence is brown in colour.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 2 to 19 blows/0.3 m. Based on these 'N' values, the material can be described as having a denseness of very loose to compact.

Clayey Silt, trace Sand

The surficial non-cohesive deposit is underlain by a cohesive stratum consisting of clayey silt, trace sand. A Grain Size Distribution envelope is provided in Figure 2 in the Appendix. The thickness of the stratum ranges from 1.2 m to 5.7 m. The envelope illustrates that a large percentage of the deposit is finer than 75 micrometers and hence is in the clay and silt range. This deposit comprises of 0% gravel, 1-3% sand, 37-84% silt and 13-60% clay.

The deposit is unoxidized and hence is grey in colour. The oxidation delineation was found within the surficial layer.

The fine grained portion of the deposit dictates the behaviour of this cohesive deposit. Hence, Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 3 in the Appendix. A summary of the indices is provided in Table 1 below.

Table 1 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	22.5-34	6
Liquid Limit (w _L %)	19-37	6
Plastic Index (I _p %)	8-20	6
Unit Weights (kN/m ³)	19.3-23.3	6

The results reveal that the fine grained portion of the deposit is primarily of low plasticity and hence can be classified as a clayey silt.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 0 to 9 blows/0.3 m. Based on these 'N' values, the material can be described as having a consistency of very soft to firm.

Clayey Silt, trace Sand, trace Gravel, (Glacial Till)

Underlying the above layer is a deposit of clayey silt, trace sand, trace gravel (Glacial Till). A Grain Size Distribution envelope is provided in Figure 4 in the Appendix.

This layer extends down to 31.5 m to 30 m below the ground surface. The envelope illustrates a large percentage of clay and silt with a trace of gravel and sand. This deposit comprises of 0-8% gravel, 5-34% sand, 36-87% silt and 12-63% clay. The material within the till is unsorted and unstratified and has been completely oxidized and is grey in colour.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 5 in the Appendix. A summary of the indices is provided in Table 2 below.

Table 2 - Clayey Silt (Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	13-29	14
Liquid Limit (w _L %)	24-38	14
Plastic Index (I _p %)	10-19	14
Unit Weights (kN/m ³)	20.6-21.7	14

The results indicate that the fine grained portion of the deposit ranges in plasticity from low to intermediate and hence can be categorized as a clayey silt (till).

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 1 to 40 blows/0.3 m, however the 'N' values were generally between 1 to 20 blows/0.3 m. Therefore, the deposit can be considered to have a soft to very stiff consistency with random hard zones.

Heterogeneous mixture of Silt and Sand, trace Clay, trace Gravel

Underlying the above material is a heterogeneous mixture of silt and sand, trace gravel, trace clay which was found at a depth of 31.5 m to 47.3 m and extending down to unknown depths. This layer was only encountered in the two deep boreholes. Near the terminated depths of the two boreholes pieces of shale with a greater percentage of gravel. At depths of 49 m refusal with possible bedrock was encountered. A Grain Size Distribution envelope is provided in Figure 6 in the Appendix. The envelope illustrates a large percentage of silt, sand and gravel. This deposit comprised of 0-22% gravel, 10-15% sand, 15-83% silt and 6-46% clay.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained proportion of the soil and the results are plotted in Figure 7 in the Appendix. A summary of the indices is provided in Table 3 below.

Table 3 - Heterogeneous mixture of
Silt, Sand, Tr. Gravel, Tr. Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	6-22	6
Liquid Limit (w _L %)	16-25	5
Plastic Index (I _p %)	0-3	5
Unit Weights (kN/m ³)	20.3-22.9	3

The results indicate the material is an inorganic silt or sandy silt of slight plasticity.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 40 to >120 blows/0.3 m which gives it a very dense state of relative density.

GROUNDWATER CONDITIONS

Observations of the groundwater level was carried out by measuring the water level in the open boreholes and two piezometers placed at opposite ends of the site. Groundwater levels determined at the time of the investigation ranged from 2.7 m to 3.5 m below the ground surface or at an elevation of 156.6 m.

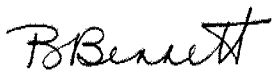
Soil cave-in witnessed in the heterogeneous mixture of silt and sand deposit confirms that the stratum is under some sub-artesian head. However, no excess head was observed.

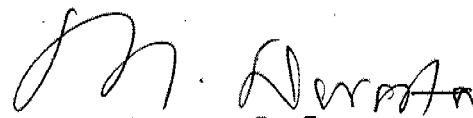
Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Michalek, Junior Foundation Engineer and P. Thase, Student Engineer. The equipment was owned and operated by Malones Soil Samples Ltd., Toronto.

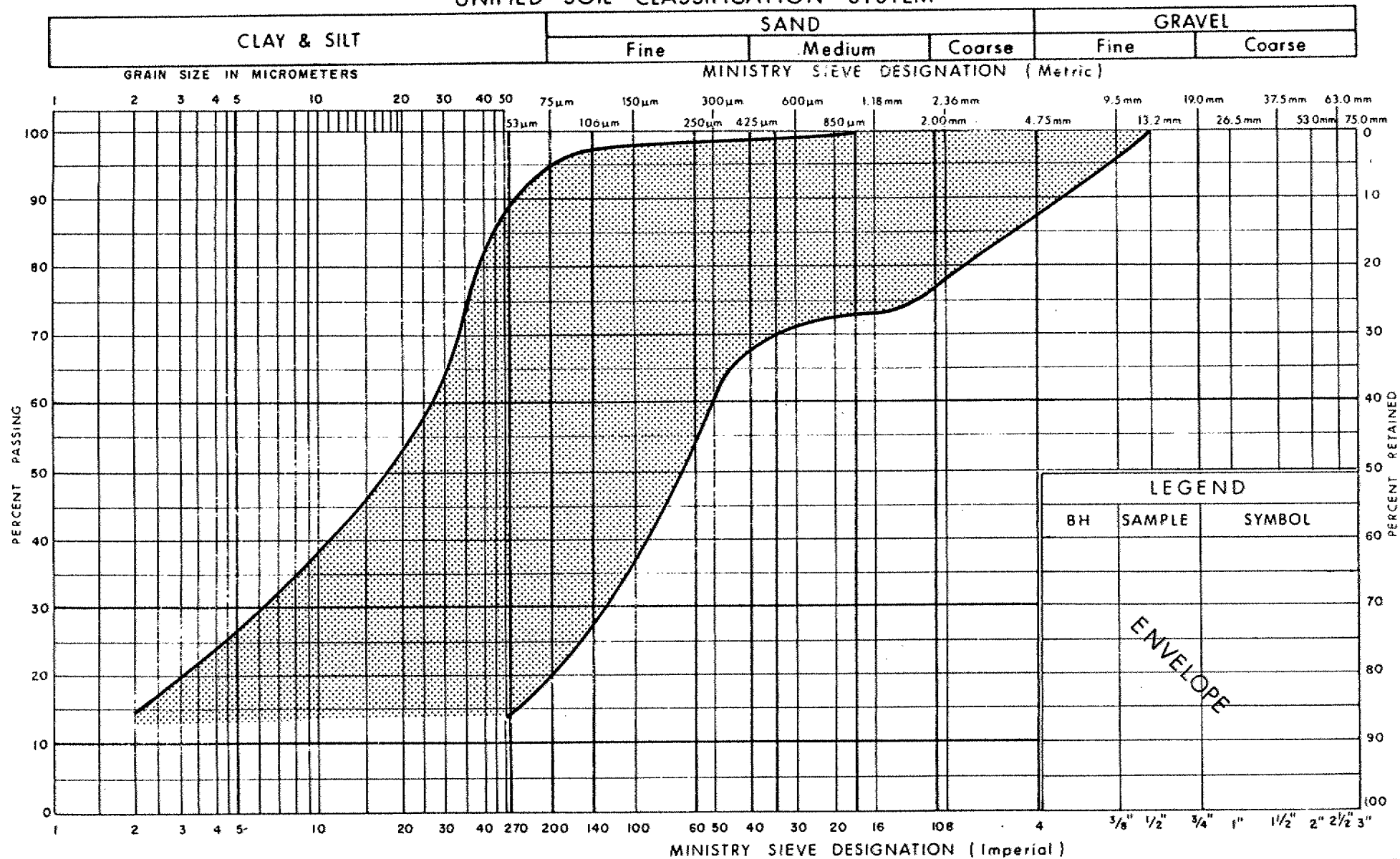
The report was written by M. Michalek under the general supervision of B. Iyer, Senior Foundation Engineer and reviewed by M. Devata, Chief Foundation Engineer.


for Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SILTY SAND

FIG No 1

W P 141-87-00A

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)

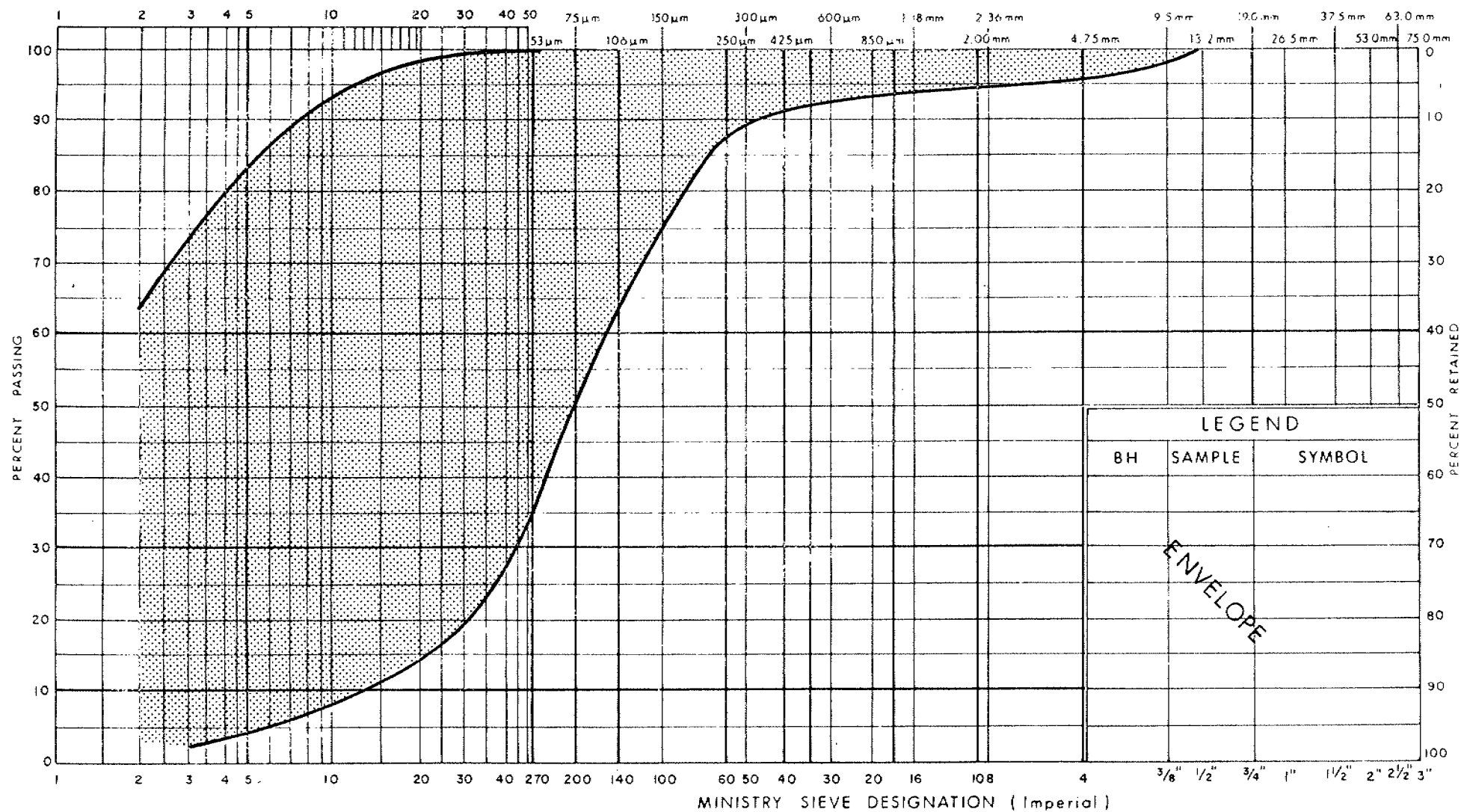
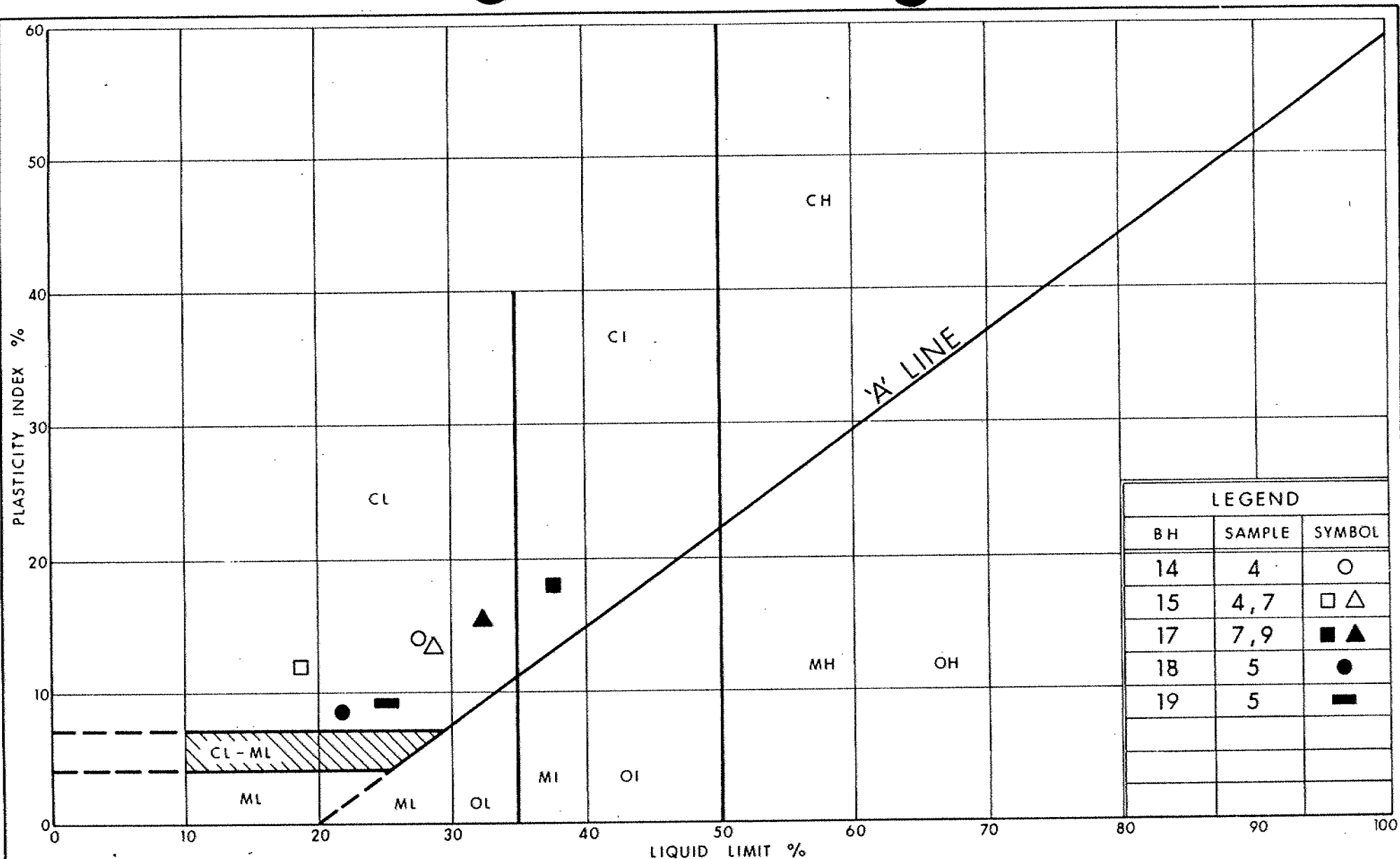
Ministry of
TransportationGRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIG No 2

W P 141-87-00A



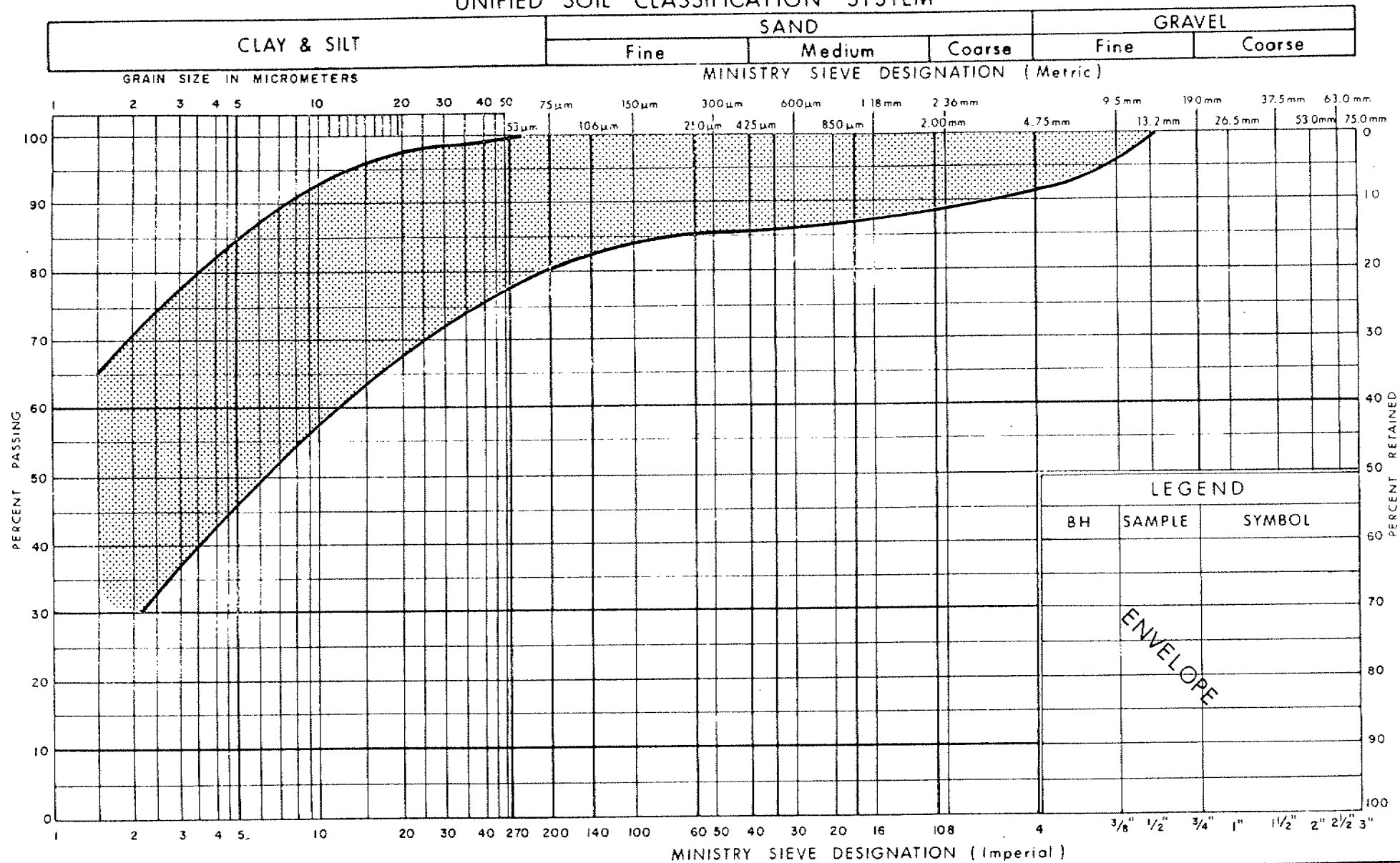
Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT

FIG No 3

W P 141-87-00A

UNIFIED SOIL CLASSIFICATION SYSTEM

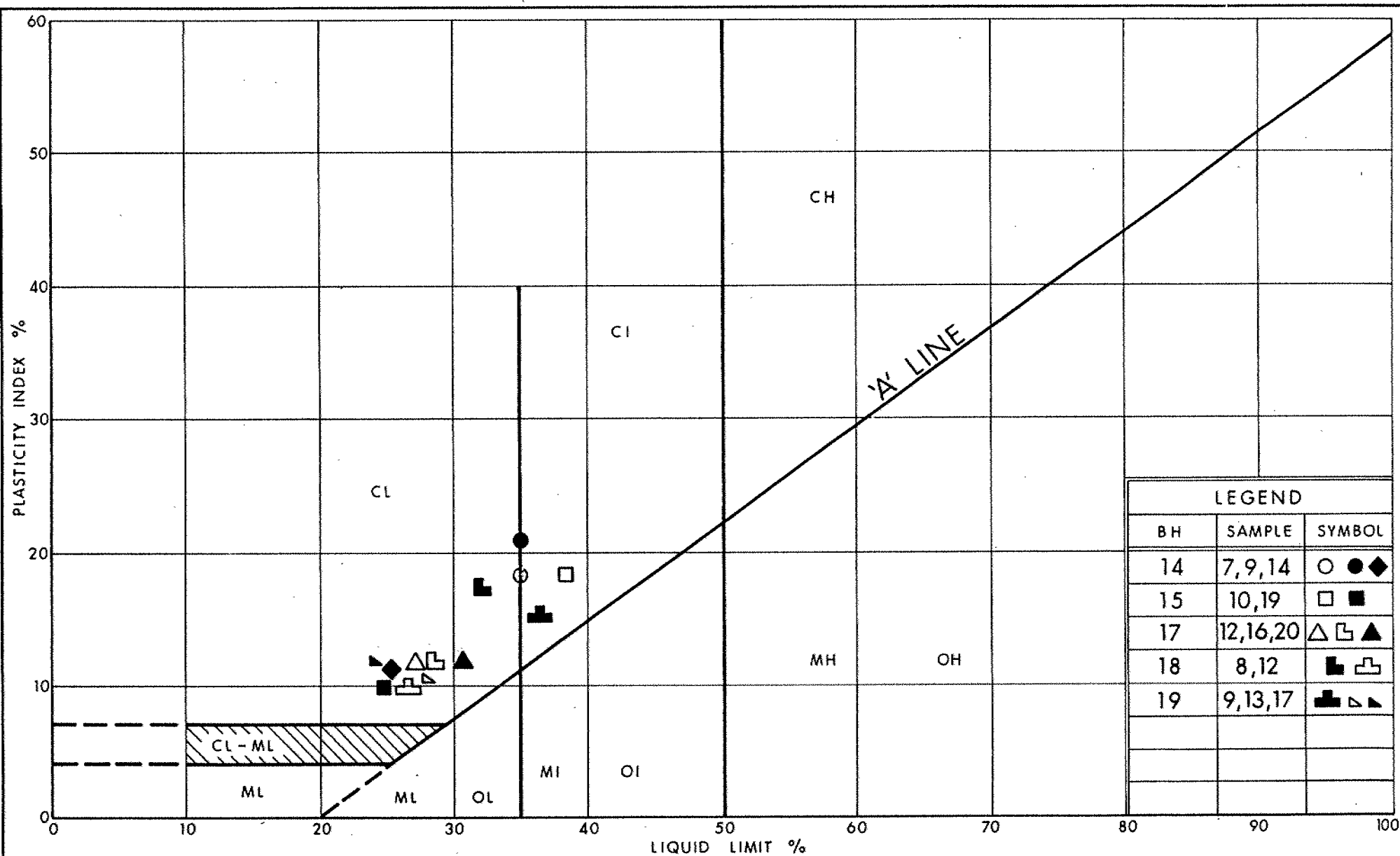


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
(GLACIAL TILL)

FIG No 4

W P 141-87-00A



Ministry of
Transportation

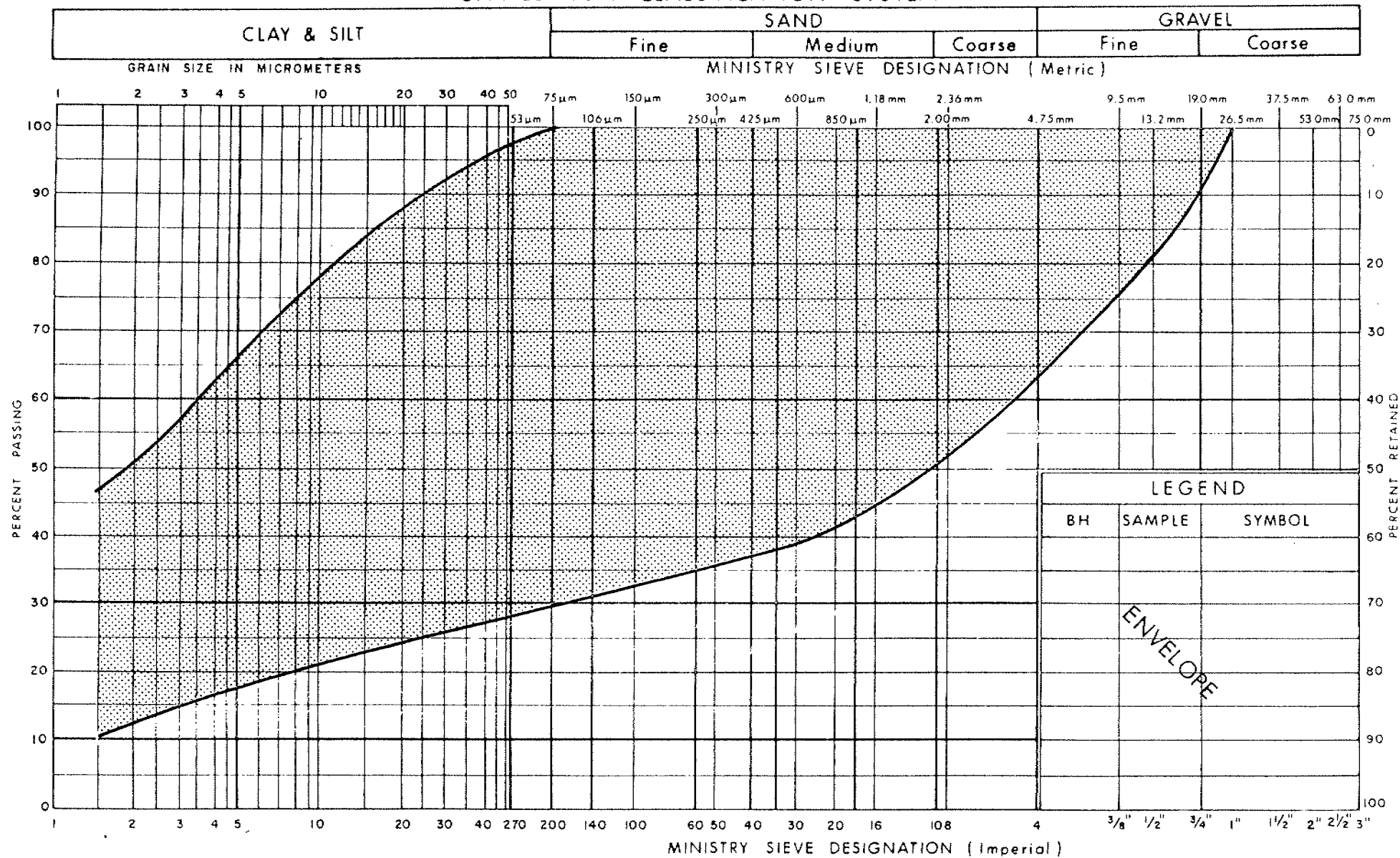
Ontario

PLASTICITY CHART CLAYEY SILT (GLACIAL TILL)

FIG No 5

W P 141-87-00 A

UNIFIED SOIL CLASSIFICATION SYSTEM

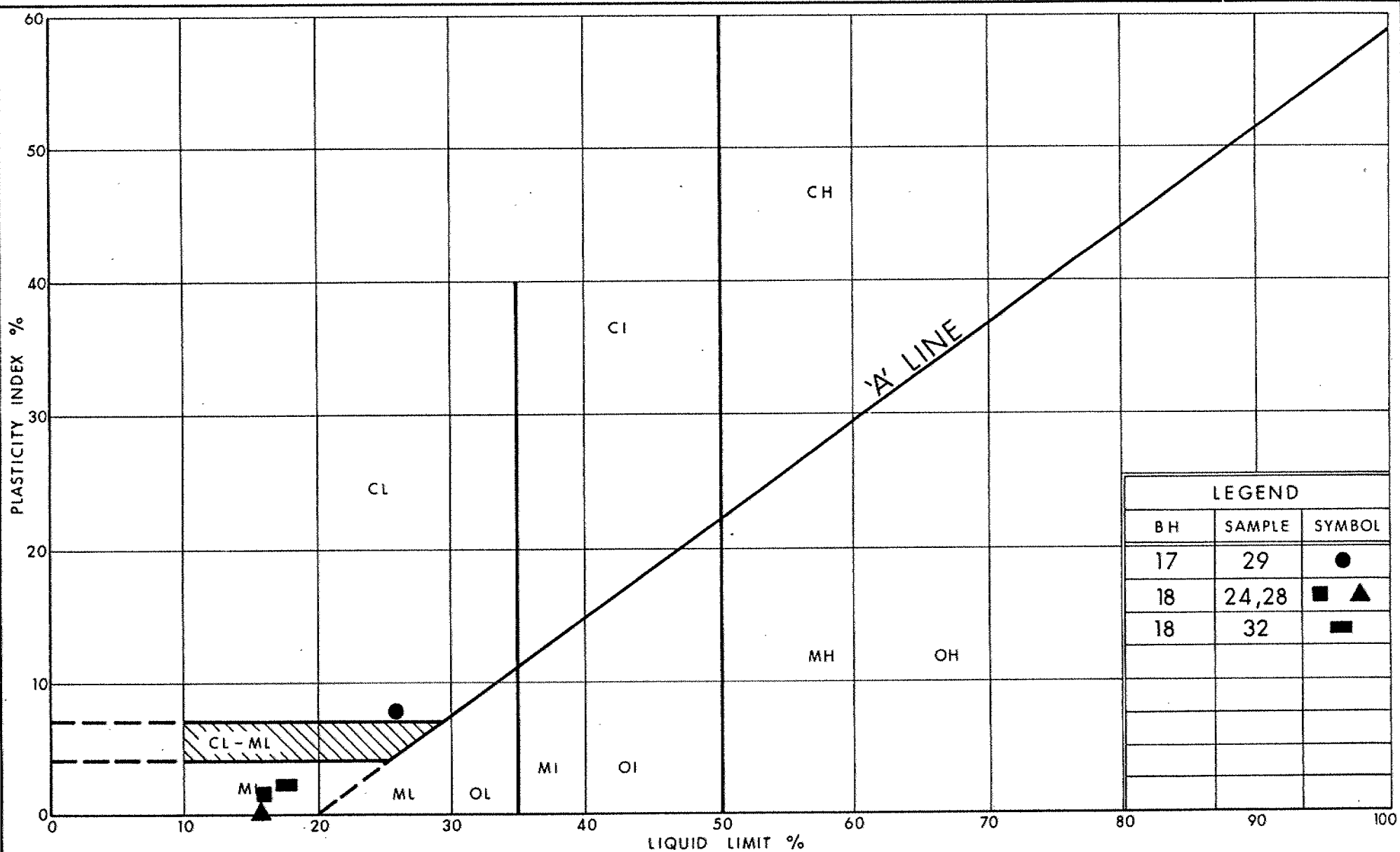


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILT & SAND
TRACE GRAVEL, TRACE CLAY

FIG No 6

W P 141-87-00A



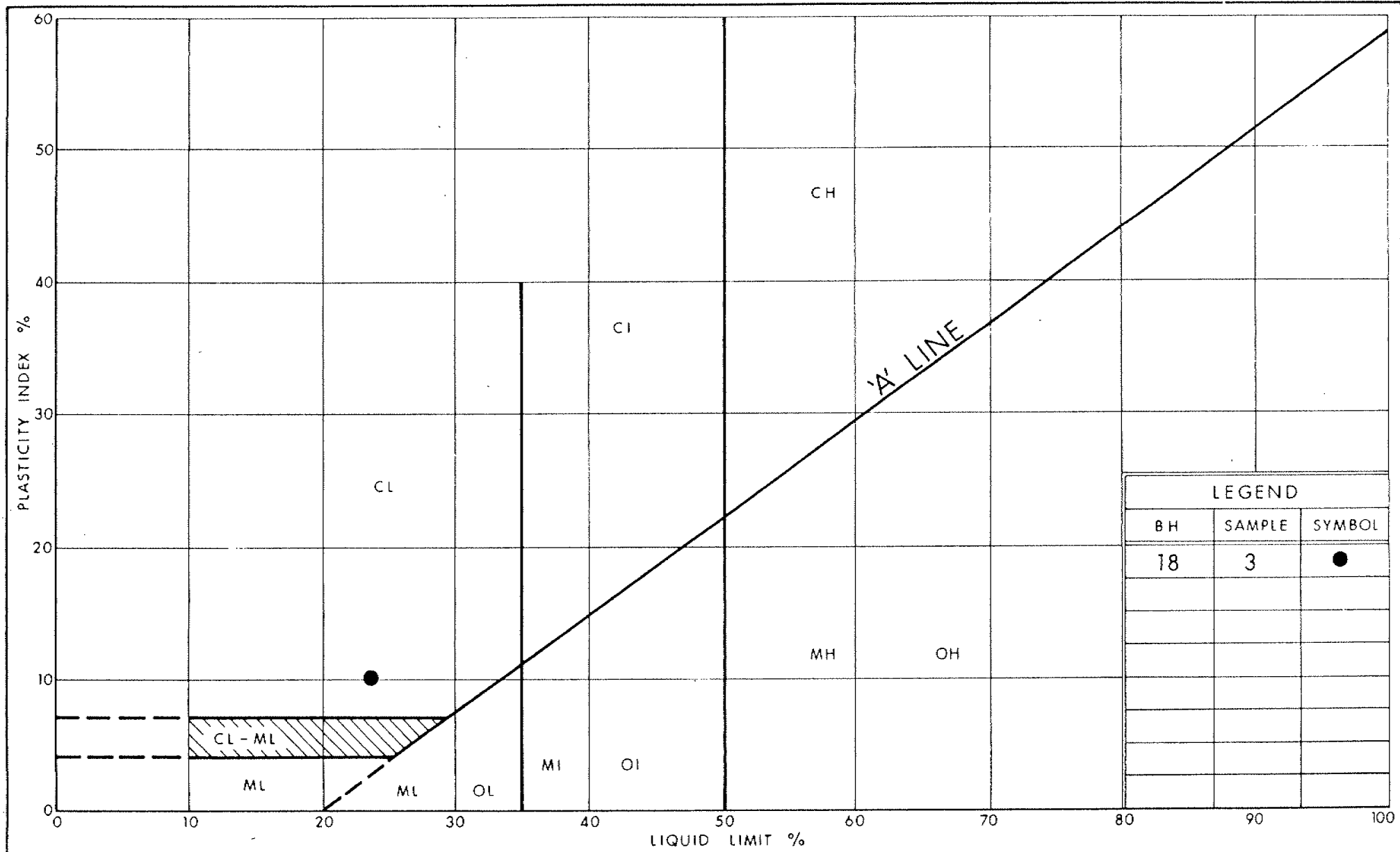
Ministry of
Transportation

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILT & SAND
TRACE GRAVEL, TRACE CLAY

FIG No 7

W P 141-87-00A

197



LEGEND		
BH	SAMPLE	SYMBOL
18	3	●



Ministry of
Transportation

PLASTICITY CHART SILTY SAND

FIG No 8
W P 141-87-00A

RECORD OF BOREHOLE No 14

1 OF 1

METRIC 199

W.P. 141-87-00 LOCATION Coords: N 4 847 628, E 298 878 ORIGINATED BY M.M.
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Ceodetic DATE 91/07/15 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%) 10 20 30							
158.2	GROUND SURFACE																	
0.0	TRACE ORGANICS		1	SS	0									2 75 18 5				
	SILTY SAND COMPACT		2	SS	16													
	BROWN		3	SS	7													
155.3	GREY		4	SS	5													
2.9	CLAYEY SILT TRACE SAND FIRM		5	SS	4									0 0 63 37				
			6	TW	PH													
152.6			7	SS	1									1 12 37 50				
5.6			8	SS	1													
			9	SS	1									3 15 36 46				
			10	SS	2													
			11	TW	PH													
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO VERY STIFF		12	SS	4									2 17 53 28				
			13	SS	5													
			14	SS	6									21.2 2 14 52 32				
			15	SS	7													
			16	SS	11									1 19 53 27				
136.4			17	SS	29													
21.8 135.6	End of Borehole																	
22.6	End of Cone Test																	
<p>91/07/12 * GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>138.2</td> </tr> </table>															PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	138.2
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																	
1	138.2																	

RECORD OF BOREHOLE No 15

1 OF 1

METRIC 200

W.P. 141-87-00 LOCATION Coords: N 4 847 528, E 298 538 ORIGINATED BY M.M.
DIST 5 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/07/17 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	10 20 30			
159.8	GROUND SURFACE													
0.0	TRACE ORGANICS SILTY SAND LOOSE TO COMPACT BROWN GREY		1	SS	4		159							10 68 9 13
156.9			2	SS	13		157							
2.9			3	SS	13									
	CLAYEY SILT TRACE SAND SOFT TO STIFF		4	SS	9									0 3 84 13
			5	SS	2									
			6	TW	PH									
152.9			7	SS	2		155							
6.9			8	SS	1		153							
			9	SS	1		151							
			10	SS	1		149							1 8 36 55
			11	SS	2		147							
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO FIRM		12	TW	PH		145							
			13	SS	6		143							
			14	SS	6		141							
			15	SS	4		139							
			16	SS	3									
138.0			17	SS	9									
21.8	End of Borehole													
135.7														
24.1	End of Cone Test													
91/07/29 * GROUND WATER CONDITIONS														
PIEZO. NO.		GROUND WATER ELEVATION (Metres)												
1		143.3												

RECORD OF BOREHOLE No 17

1 OF 2

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 549, E 298 618 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Wash-boring COMPILED BY M.M.
DATUM Geodetic DATE 91/07/18 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.1	GROUND SURFACE																
0.0	TRACE ORGANICS		1	SS	14		158										19 72 6 3
	SILTY SAND VERY LOOSE TO COMPACT		2	SS	19												
	BROWN		3	SS	13												0 1 91 8
	GREY		4	SS	4												
155.7			5	SS	2		156										
4.4			6	SS	0												
	CLAYEY SILT TRACE SAND VERY SOFT		7	SS	0		154										1 2 37 60
			8	TW	PH		152										
150.0			9	SS	1		150										
10.1			10	SS	1		148										10 24 38 28
			11	SS	3												
			12	SS	5		146										1 11 52 36
			13	TW	PH		144										
			14	SS	8		142										
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO HARD		15	SS	9												
			16	SS	9		140										1 12 53 34
			17	SS	14		138										
			18	SS	17		136										
			19	SS	27												
			20	SS	24		134									21.0	1 1 65 33
			21	SS	11		132										
			22	SS	30												2 34 51 13
							130										

Continued

+3, x5, Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 17

2 OF 2

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 549, E 298 618 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Wash-boring COMPILED BY M.M.
DATUM Geodetic DATE 91/07/18 CHECKED BY B.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					w _P			w	w _L
								SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE							
								● QUICK TRIAXIAL	×	LAB VANE							
								20 40 60 80 100									

RECORD OF BOREHOLE No 18

1 OF 2 METRIC

W.P. 141-87-00 LOCATION COORDS: N 4 847 606, E 298 587 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY A.H.
DATUM GEODETIC DATE 91/05/15 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
160.1													
0.0	SILTY SAND COMPACT	1	SS	15	*								8 83 8 1
		2	SS	12		158						20.0	
157.2	BROWN GREY	3	SS	11									
2.9	CLAYEY SILT TRACE SAND FIRM TO STIFF	4	SS	10								19.3	0 0 74 26
		5	SS	6		156							
		6	SS	5									
154.5		7	SS	5		154							0 1 58 41
		8	SS	3									
		9	TW	PH		152							
		10	SS	3									0 5 32 63
		11	SS	6		148							
		12	SS	8									
		13	SS	9		146							0 9 54 37
		14	SS	6									
		15	TW	PH		142							
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) SOFT TO HARD	16	SS	11		140							
		17	SS	13									20 42 29 9
		18	SS	33		138							
		19	SS	40		136							
		20	SS	25		134							1 7 45 47
		21	SS	15		132							0 2 86 12
		22	SS	3									
130.2						130							
29.9													

Continued

+3, x5; Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 18

2 OF 2

METRIC

W.P. 141-87-00 LOCATION COORDS: N 4 847 606, E 298 587 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY A.H.
DATUM GEODETIC DATE 91/05/15 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)			
								20	40	60	80						100	10	20	30

30.5	Continued		23	SS	19											
			24	SS	44	128									22.9	11 20 52 17
			25	SS	90	126										
			26	SS	63											1 19 70 10
			27	SS	51	124										
			28	SS	50	122										0 10 83 7
			29	SS	100	120										
			30	SS	78	118										
			31	SS	164											
			32	SS	127	116										22 56 15 7
			33	SS	144	114										
			34	SS	169	112										
110.9	CHUNKS OF SHALE															
49.2	End of Borehole • Water Level Not Established															

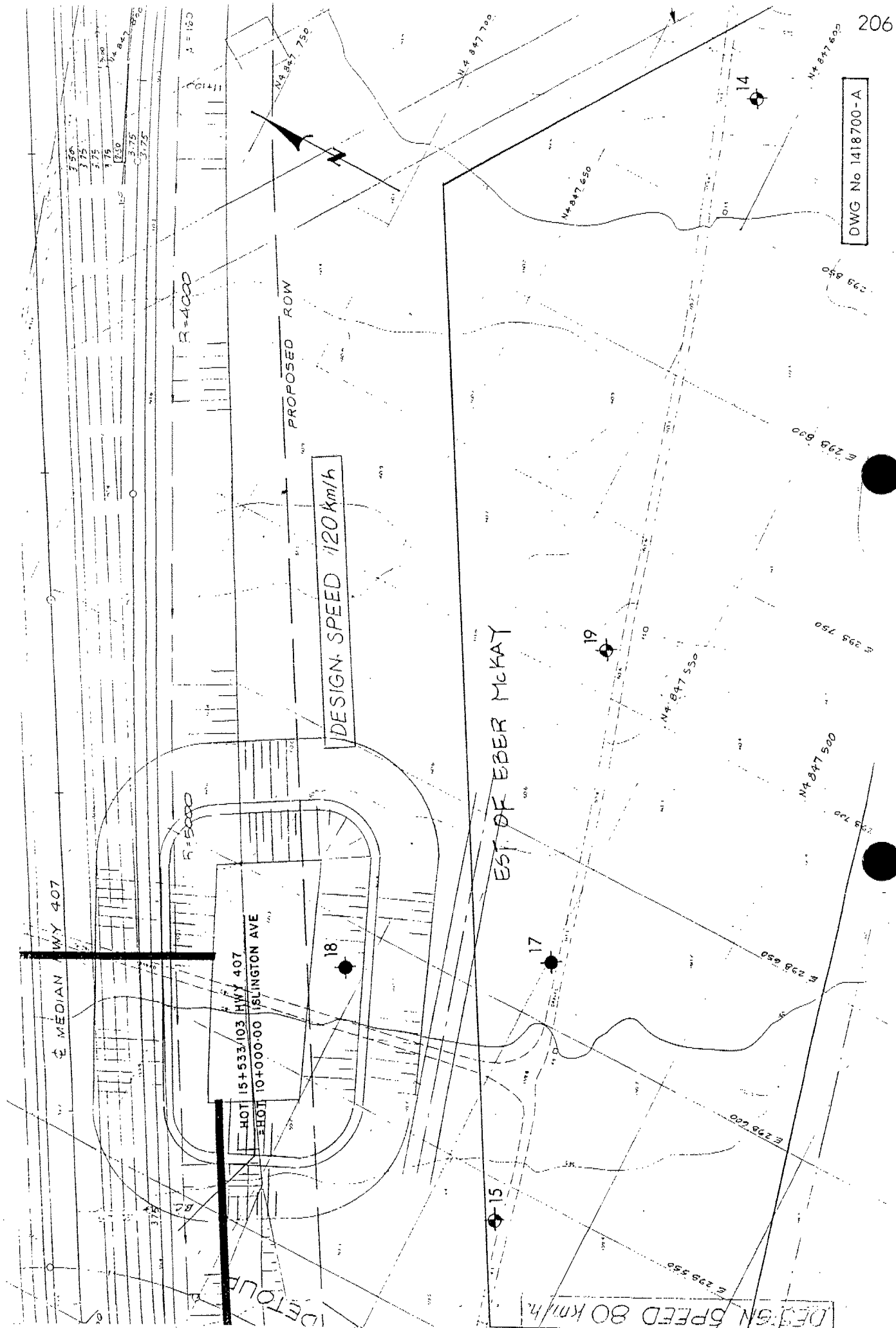
RECORD OF BOREHOLE No 19

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 578, E 298 713 ORIGINATED BY M.M.
DIST 6 HWY 416 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY A.H.
DATUM Geodetic DATE 91/06/16 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100	20 40 60 80 100						
160.3	GROUND SURFACE							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
0.0	SILTY SAND COMPACT		1	SS	11		160							10 80 10 0	
158.2			2	SS	19		158							0 8 75 17	
2.1	BROWN CLAYEY SILT TRACE SAND STIFF GREY		3	SS	19		156							0 0 82 18	
			4	SS	11		154								
			5	SS	10		152								
154.8			6	SS	9		150								
5.5			7	SS	3		148								
			8	TW	PH		146								
			9	SS	1	/30cm	144							0 5 40 55	
			10	SS	1	/30cm	142								
			11	TW	PH		140								
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO STIFF		12	SS	4		138							1 11 53 35	
			13	SS	8		136								
			14	SS	13		134								
			15	SS	14		132								
			16	SS	4		130								
138.5			17	SS	5		128						21.7	8 21 41 30	
21.8	End of Borehole														
134.4															
25.9	End of Cone Test														



DWG No 1418700-A

FOUNDATION INVESTIGATION REPORT

For

Proposed Hwy. 407 Cut

CPR Tracks to Islington Avenue

W.P. 141-87-00(B), Hwy. 407

District 6, TorontoINTRODUCTION

Subsequent to requests submitted by the Central Region Geotechnical Section, an investigation was carried out by this office to determine the subsurface conditions for the proposed Hwy. 407 cuts east of The CPR Tracks and West of Islington Avenue.

The proposed Hwy. 407 profile grade slopes westward from 149 m to 145 m which will require cuts up to 10 m as the natural ground surface varies considerably with a ravine to the west.

The investigating procedure, including the fieldwork procedures and laboratory analysis and a detailed description of the subsurface conditions are also included in this report.

SITE DESCRIPTION AND GEOLOGY

The site is located $\frac{1}{2}$ km north of Steeles east of Islington Avenue in the City of Vaughan, Region of York. The area consists of farmland with residential homes to the north and south. Hydro power towers to the east, CNR and CPR rail tracks west and south, and an industrial building to the northeast. Boreholes were located directly to the north and west of the farmers house.

Physiographically, the site is located in the geological domain known as the "Peel Plain". The "Peel Plain" is the product of the advances and retreat of the wisconsinan ice sheet which covered the area during the pleistocene epoch. It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. At some locations, the till is overlain by the deposits of varved clay. Till sheets of varying composition comprise the "Peel Plain".

Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristics of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay. The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 35 m below the ground surface and consists of interbedded shale and limestone of the Dundas-Meaford formation ordovician period.

INVESTIGATING PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing. The procedures employed are discussed below.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 91 07 12 to 91 07 24 and consisted of 9 sampled boreholes located along the proposed right-of-way of Hwy. 407 and at proposed sewer main locations

Two boreholes were advanced 12.6 m below natural ground surface with continuous sampling to obtain enough material to conduct proctor tests to find the suitability of the cut material to be utilized as fill. The seven other boreholes ranged in depth between 21.8 m to 27.9 m depending on the depth of cut at its particular location.

Vanes and undisturbed shelby tube samples were taken when plastic cohesive material was encountered. Cone Penetration Tests were taken down at the invert of each borehole and at three boreholes from the surface.

Track mounted CME 55 equipment employing hollow stem and wash boring techniques was used to advance all boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.75 m intervals for the surficial 4.5 m and 1.5 m thereafter. At certain boreholes to obtain enough material for the proctor tests sampling was retrieved at 0.75 m intervals down to 12.2 m. All

samples were identified in the field and then returned to the laboratory for applicable testing. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586).

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation. Two piezometers were utilized at opposite ends of the site. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by the Central Region Surveys and Plans Office.

LABORATORY ANALYSIS

The following laboratory tests were carried out on select soil samples.

- 1) Atterberg Limit Tests
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents

Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

To test the suitability of the excavation cuts to be useful as fill elsewhere proctor tests were conducted to find the optimum moisture content. Three tests were conducted utilizing samples from different layers in the subsoil, depths underlying one another of 5.3 m, 4.6 m and 4.6 m. All split spoon samples within these layers were mixed and tested. See Figures 9, 10 and 11 for resultant plots.

SUBSURFACE CONDITIONS

The stratigraphy encountered is similar to those found west of Islington Avenue and consists of 2.1 m to 4.5 m of a non-cohesive silty sand which contained

surficial interbeds of organics. This layer had a very loose to compact state of denseness underlying the surficial deposit is a 1.5 m to 4.2 m thick deposit of cohesive clayey silt, trace sand which is in turn underlain by a 7 m to 23 m thick layer of clayey silt, trace sand, trace gravel (Glacial Till). This thickness varied throughout the site. The two layers had soft to stiff consistencies. Underlying the above is a second layer of clayey silt, trace sand which extends down beyond the scope of this investigation, with a stiff to hard consistency. Throughout the site rising from a depth of 12 m west to 7 m east is a 1.5 m to 3 m thick interbedded layer of silt, trace clay which was found to cross through the glacial till. This material was not encountered in the most eastern borehole (BH 13).

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater level established at the time of the investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes are provided on Dwg. No. 1418700-B.

A detailed description of the subsurface conditions encountered is given below.

Silty Sand

The native surficial deposit at the site consists of a non-cohesive silty sand that extends to a depth of 2.1 m to 4.5 m below the existing ground surface.

A Grain Size Distribution envelope as determined by mechanical sieve and hydrostatic analysis is provided in Figure 1 in the Appendix. The envelope illustrates that a large percentage of the deposit consists of sand and silt. this deposit comprised of 0-13% gravel, 9-71% sand, 16-85% silt and 7-21% clay.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2 in the Appendix. A summary of the indices is provided in Table 1 below.

Table 1 - Silty Sand

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	7-26	7
Liquid Limit (w_L %)	18-22	7
Plastic Index (I_p %)	1-6	7
Unit Weights (kN/m^3)	19.2-20	7

The results reveal that the fine grained can be classified as inorganic silts and sandy silts of slight plasticity.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 17 blows/0.3 m. Based on these 'N' values, the material can be described as having a relative state of density of very loose to compact. The deposit has been oxidized and hence is brown in colour.

Clayey Silt, trace Sand (Upper)

The surficial non-cohesive deposit is underlain by a cohesive stratum consisting of clayey silt, trace sand. A Grain Size Distribution envelope is provided in Figure 3 in the Appendix. The thickness of the stratum ranges from 7 m to 23 m. The envelope illustrates that a large percentage of the deposit is finer than 75 micrometers and hence is in the clay and silt range. This deposit comprises of 0-3% gravel, 1-12% sand, 51-84% silt, and 5-47% clay.

The deposit is unoxidized and hence is grey in colour. The oxidation delineation was found within the surficial layer.

The fine grained portion of the deposit dictates the behaviour of this cohesive stratum. Hence, Atterberg Limit Tests were carried out to define the plasticity of the fine grained portion of the soil and the results are plotted in Figure 4 in the Appendix. A summary of the indices is provided in Table 2 below.

Table 2 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-31	18
Liquid Limit (w_L %)	18-36	18
Plastic Index (I_p %)	2-18	18
Unit Weights (kN/m^3)	18.6-20.7	18

The results reveal that the fine grained portion of the deposit is primarily of low plasticity and hence can be classified as a clayey silt.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 1 blow/0.3 m to 9 blows/0.3 m. Based on these 'N' values the material can be classified as a very soft to firm, but primarily soft consistency.

Clayey Silt, trace Sand, trace Gravel (Glacial Till)

Underlying the above layer is a deposit of clayey silt, trace sand, trace gravel (Glacial Till). A Grain Size Distribution envelope is provided in Figure 5 in the Appendix. This layer ranges from 7 m to 23 m thick which varies throughout the site. The envelope illustrates a large percentage of clay and silt with a trace of gravel and sand. This deposit comprises of 0-4% gravel, 3-23% sand, 26-74% silt and 11-65% clay. The material within the till is unsorted and unstratified and has been completely oxidized and is grey in colour.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 6 in the Appendix. A summary of the indices is provided in Table 3 below.

Table 3 - Clayey Silt (Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-39	28
Liquid Limit (w_L %)	19-43	28
Plastic Index (I_p %)	9-23	28
Unit Weights (kN/m^3)	22.8-18.4	28

The results indicate that the fine grained portion of the deposit ranges in plasticity from low to intermediate and hence can be categorized as a clayey silt (Till).

Standard Penetration Test carried out in this deposit revealed 'N' values ranging from 1 blow/0.3 m to 9 blows/0.3 m. Therefore the deposit can be considered to have a very soft to stiff consistency, generally firm.

Silt, trace Clay

Encountered throughout the site at various depths this non-cohesive interbedded silt, trace clay crosses the glacial till layer found at an elevation of 132 m rising eastward to a depth of 150 m and is 1.5 m to 3 m deep. It was not encountered at the most eastern borehole (BH 13). A Grain Size Distribution envelope is provided and illustrates a large percentage of silt. This deposit comprises of 0% gravel, 2-10% sand, 47-91% silt and 2-60% clay.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained proportion of the soil and the results are plotted in Figure 8 in the Appendix. A summary of the indices is provided in Table 4 below.

Table 4 - Silt, trace Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	14-29	3
Liquid Limit (w _L %)	25-33	3
Plastic Index (I _p %)	11-18	3
Unit Weights (kN/m ³)	19.9-22.3	3

The results indicate the material has low plasticity which shows the presence of clay within this material.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 3 blows/0.3 m to 44 blows/0.3 m which gives it soft to hard consistency.

Clayey Silt, trace Sand

Underlying the above deposits a second layer of the previous material clayey silt, trace silt which extends down beyond the scope of this investigation was encountered. The Grain Size Distribution envelope is included in Figure 3 in the Appendix. The envelope illustrates a large percentage of silt and clay. The deposit comprises of 0-2% gravel, 1-3% sand, 61-77% silt and 20-36% clay.

The fine grained portion of the deposit dictates the behaviour of this cohesive stratum. Hence, Atterberg Limit Tests were carried out to define the plasticity of the fine grained portion of the soil, shown included in Figure 4 in the Appendix. A summary of the indices is provided in Table 5 below.

Table 5 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-25	5
Liquid Limit (w _L %)	19-33	5
Plastic Index (I _p %)	2-9	5
Unit Weights (kN/m ³)	20.7-22.8	5

The results reveal that the fine grained proportion of the deposit is primarily of low plasticity and hence can be classified as a clayey silt.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 12 blows/0.3 m to 41 blows/0.3 m, thus it has a stiff to hard consistency.

GROUNDWATER CONDITIONS

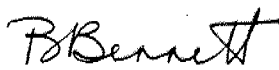
Observations of the groundwater level was carried out by measuring the water level in the open boreholes and two piezometers placed at opposite ends of the site. Groundwater levels determined at the time of the investigation ranged from elevation 133 m to elevation 155.7 m rising eastwards away from the sloping ravine to the west.

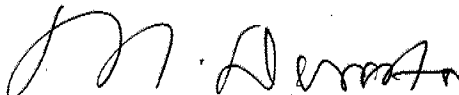
Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Michalek, Junior Foundation Engineer and P. Thase, Student Engineer. The equipment was owned and operated by Malones Soil Samples Ltd., Toronto.

The report was written by M. Michalek under the general supervision of B. Iyer, Senior Foundation Engineer and reviewed by M. Devata, Chief Foundation Engineer.

for 
Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

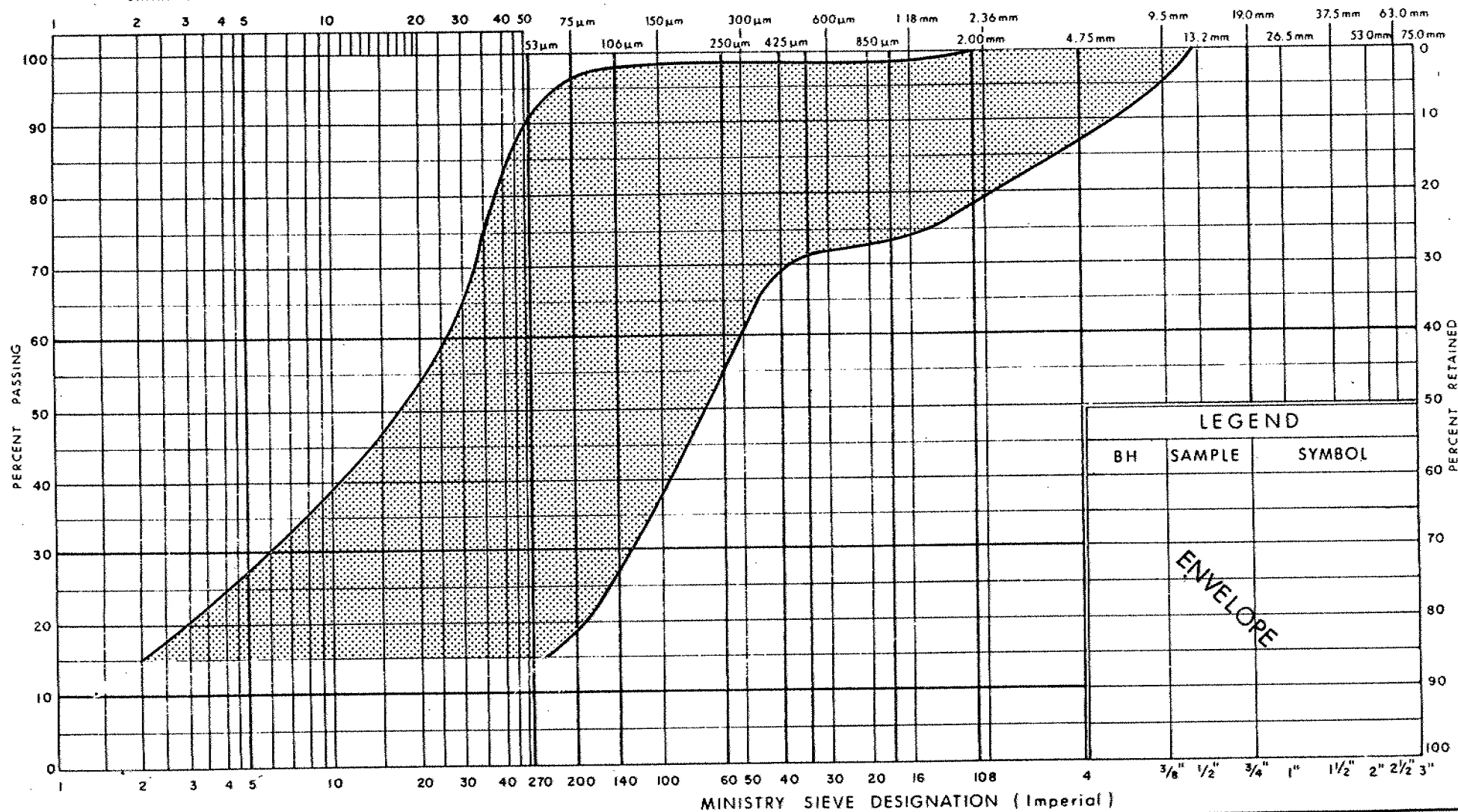
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

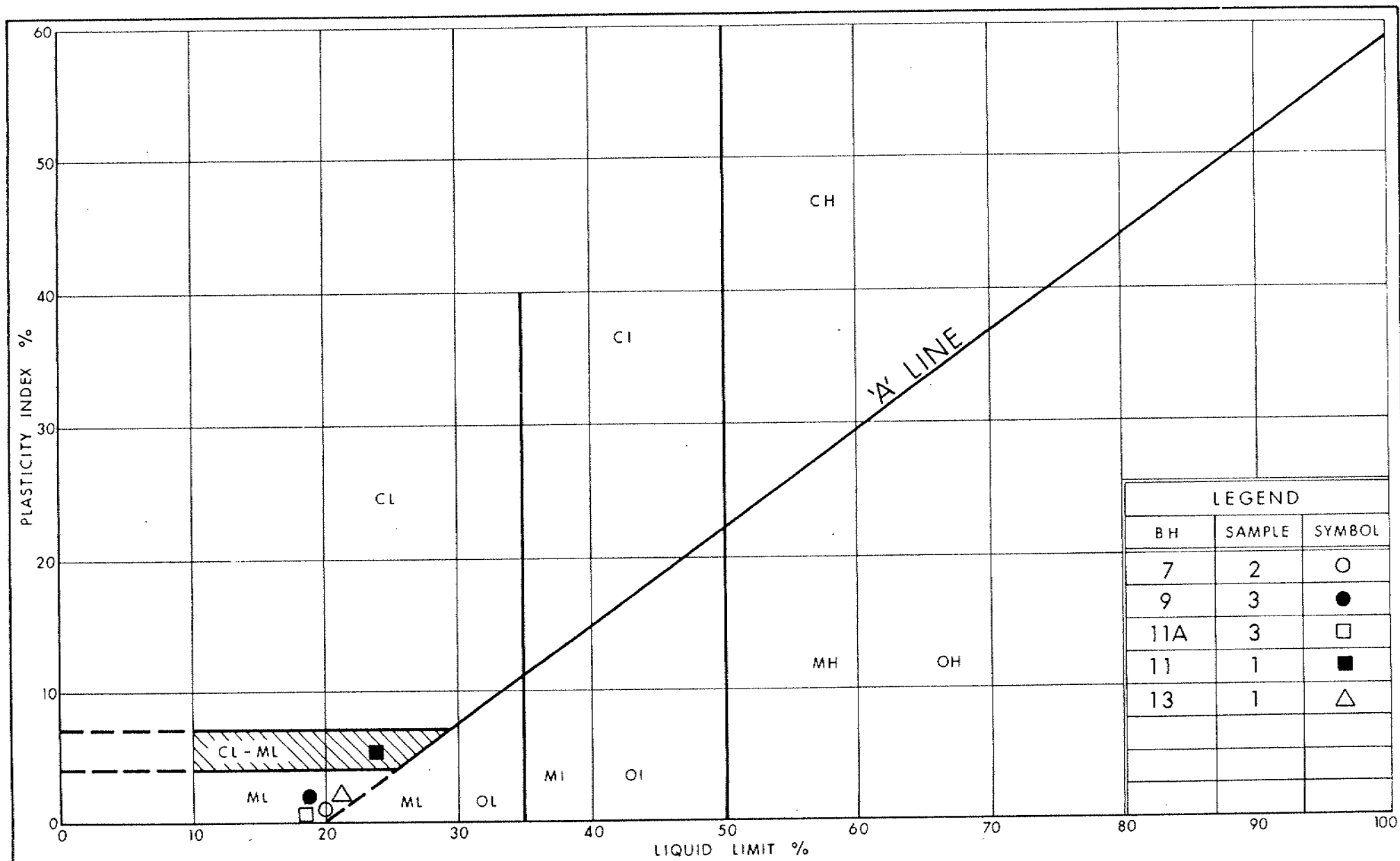
BH SAMPLE SYMBOL

ENVELOPE

Ministry of
TransportationGRAIN SIZE DISTRIBUTION
SILTY SAND

FIG No 1

W P 141-87-00 B



Ontario

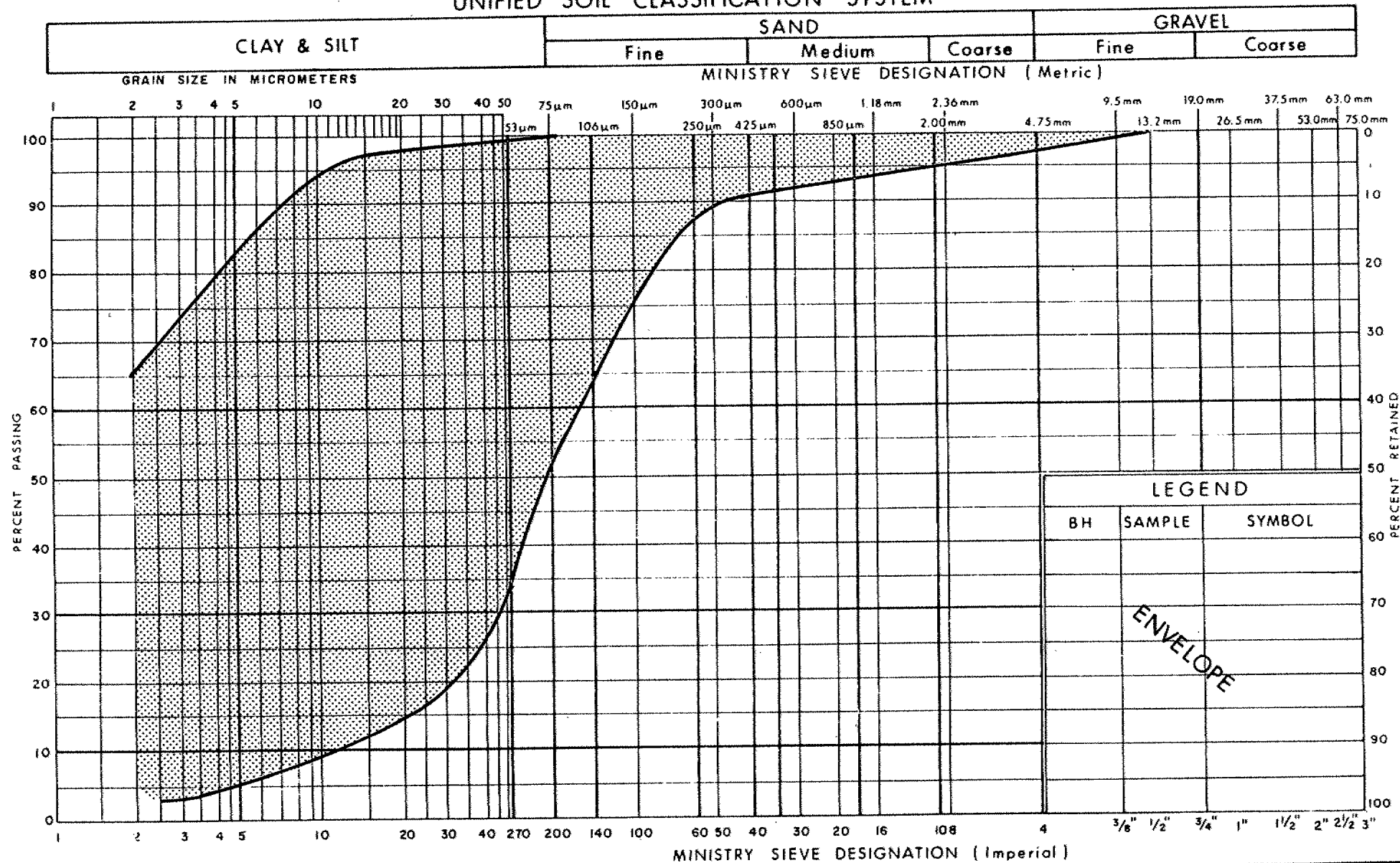
Ministry of
Transportation

PLASTICITY CHART SILTY SAND

FIG No 2

W P 141-87-00B

UNIFIED SOIL CLASSIFICATION SYSTEM

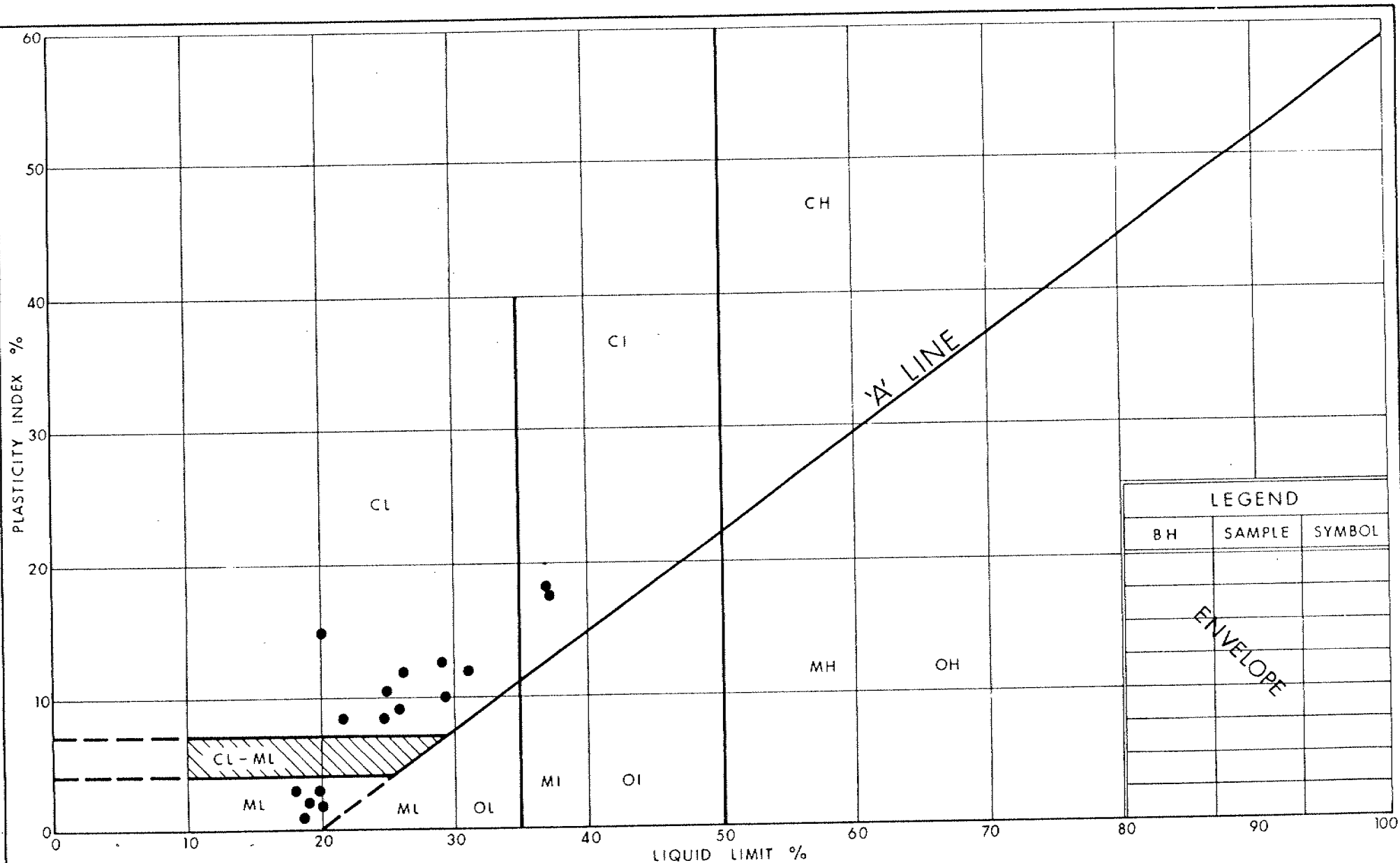


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TRACE SAND

FIG No 3

W P 141-87-00 B



Ministry of
Transportation

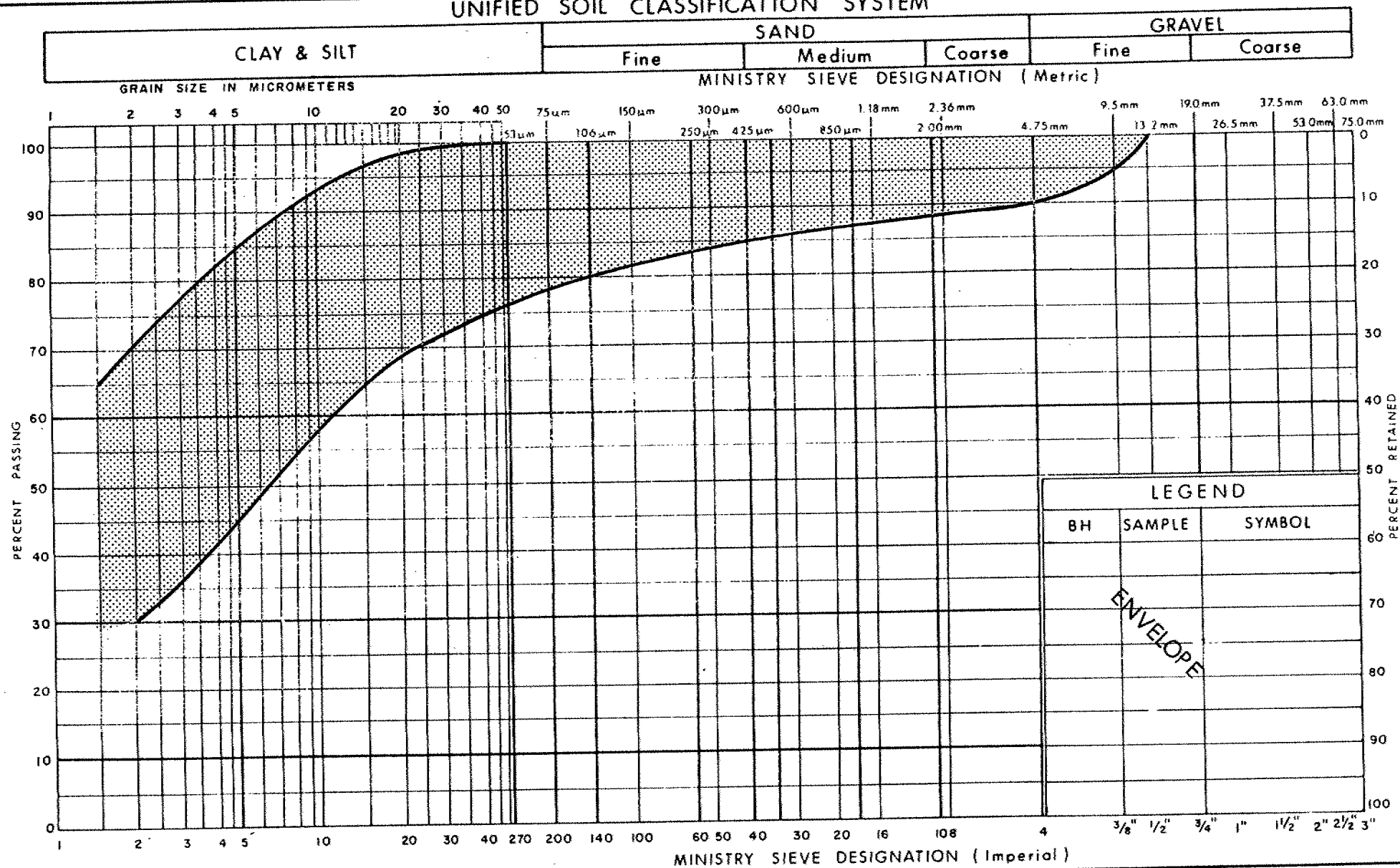
Ontario

PLASTICITY CHART CLAYEY SILT INTERBEDDED SAND

FIG No 4

W P 141-87-00 B

UNIFIED SOIL CLASSIFICATION SYSTEM

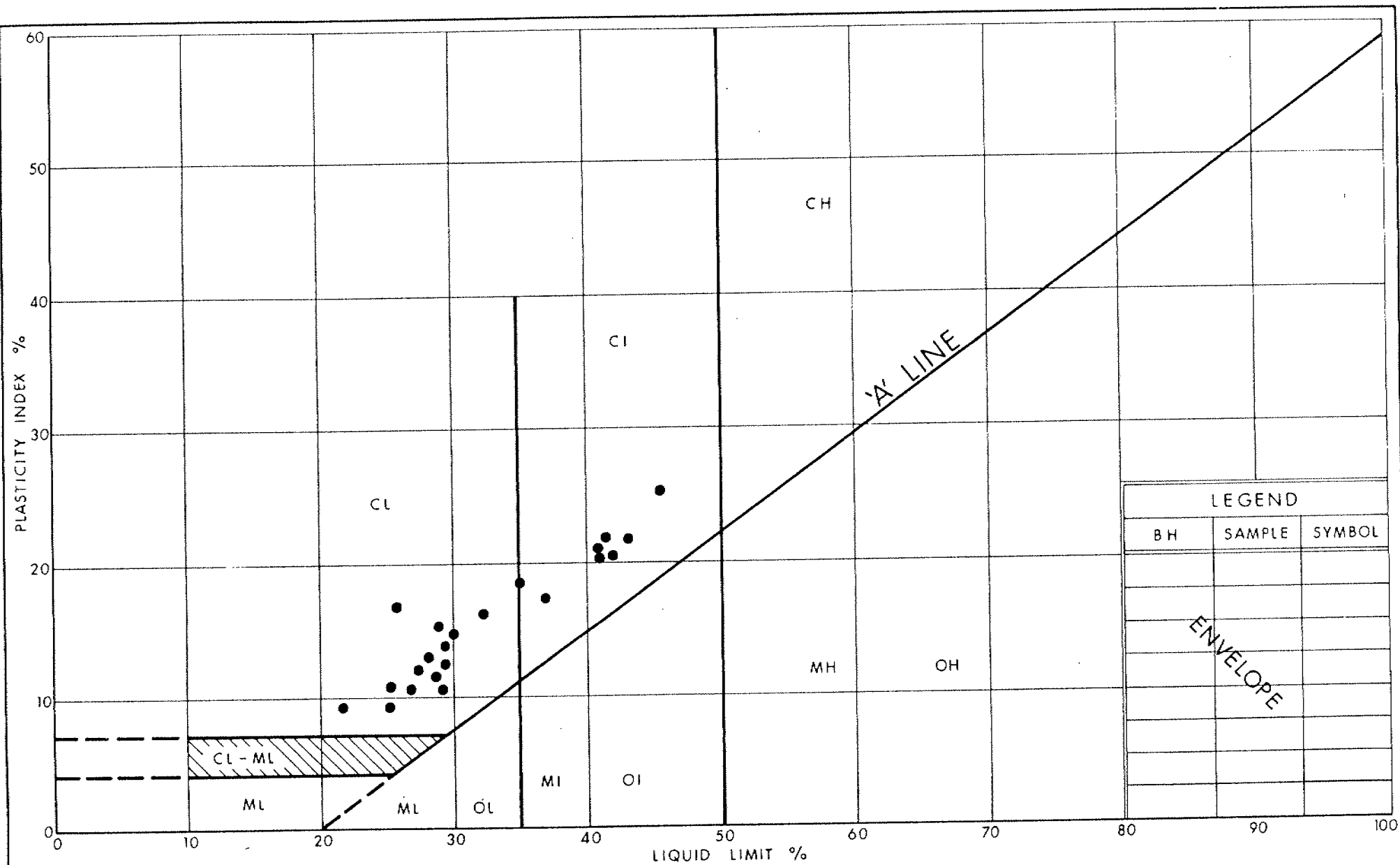


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
(GLACIAL TILL)

FIG No 5

W P 141-87-00B

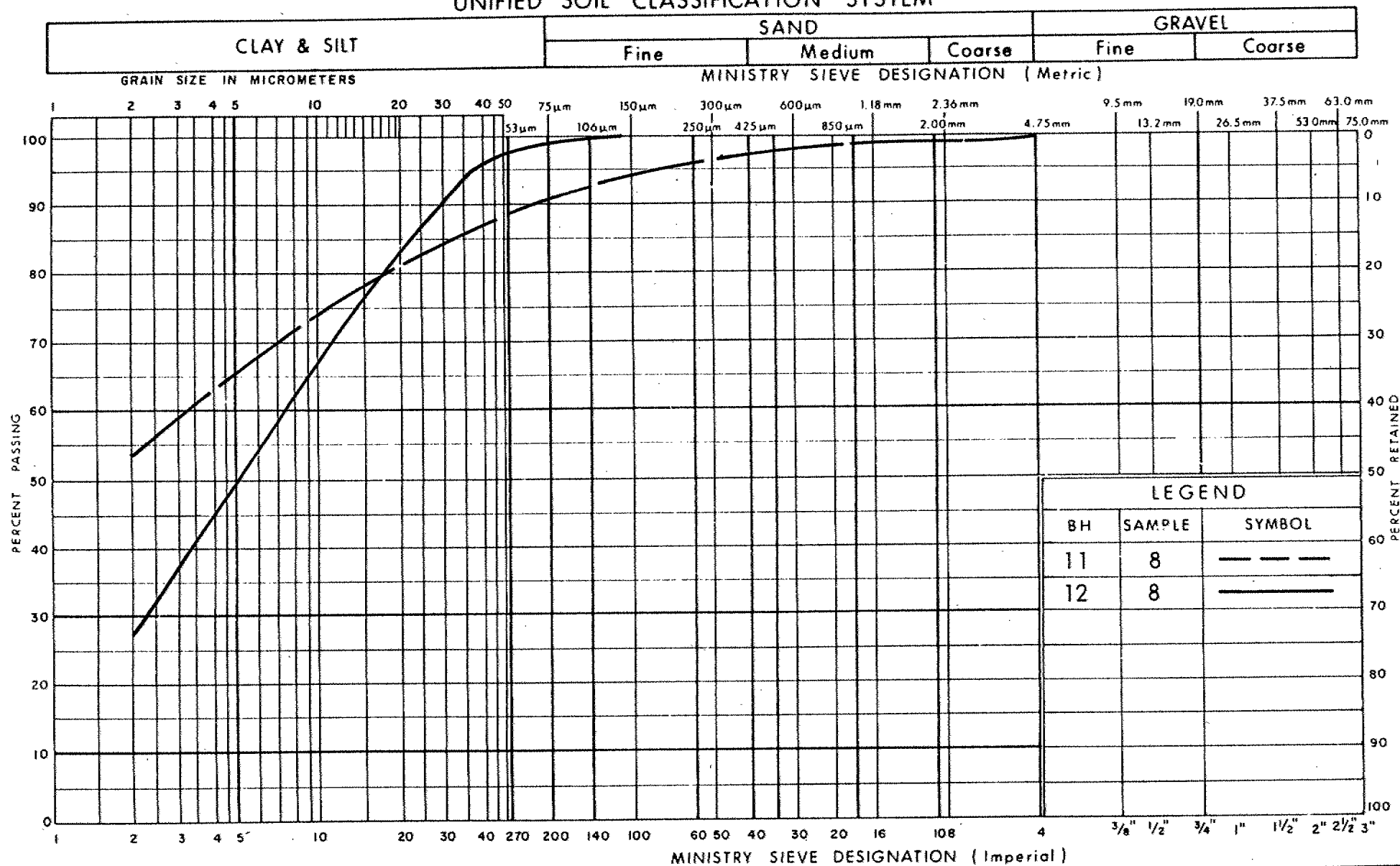
Ministry of
Transportation

PLASTICITY CHART
CLAYEY SILT
(GLACIAL TILL)

FIG No 6

W P 141-87-00B

UNIFIED SOIL CLASSIFICATION SYSTEM

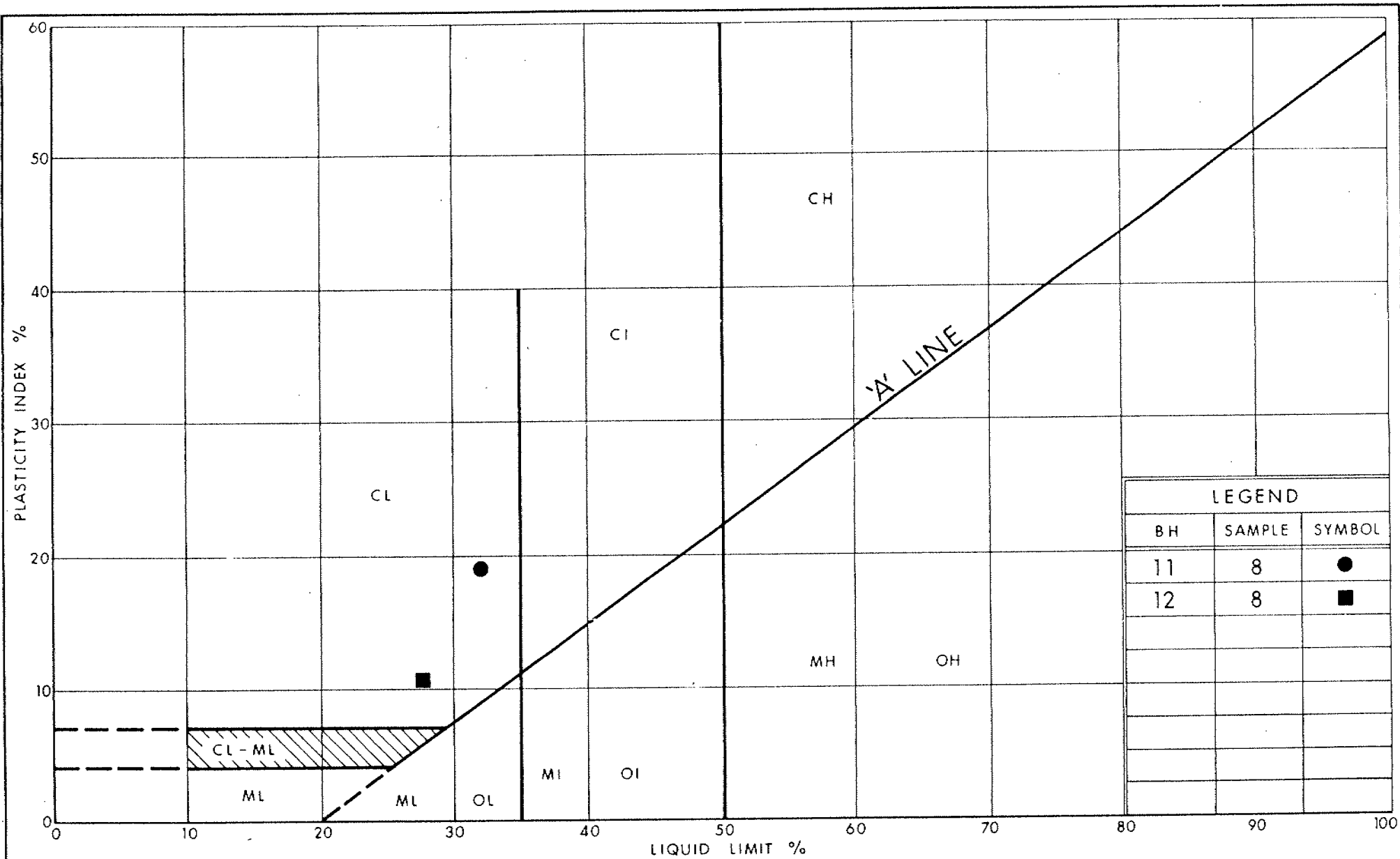


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, TRACE CLAY

FIG No 7

W P 141-87-00B



Ministry of
Transportation

Ontario

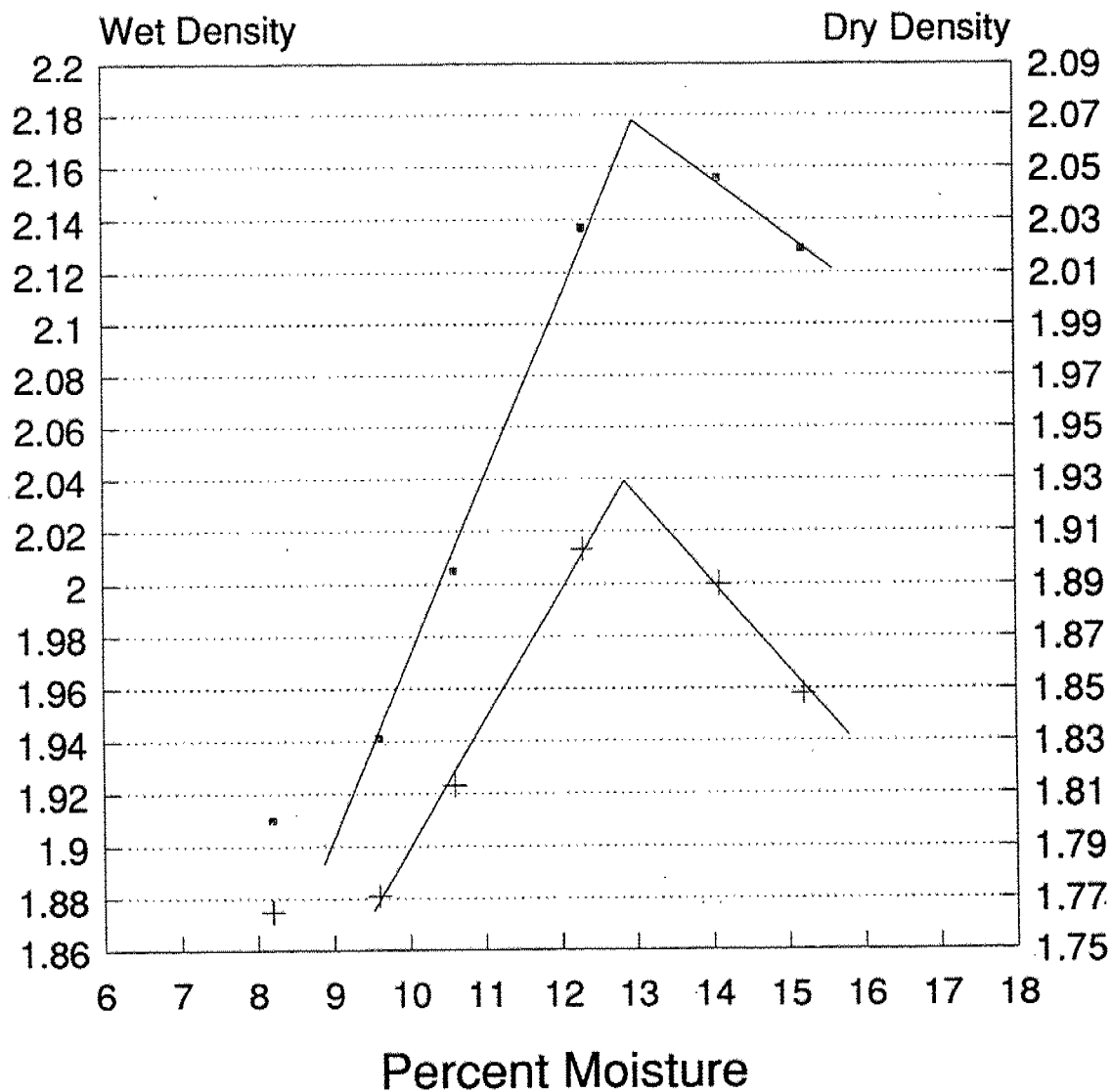
PLASTICITY CHART SILT TRACE CLAY

FIG No 8

W P 141-87-00B

PROCTOR TEST

Mix I



▪ Wet Density

+ Dry Density

Max. Wet Density = 2.180 g/cm³

Max. Dry Density = 1.931 g/cm³

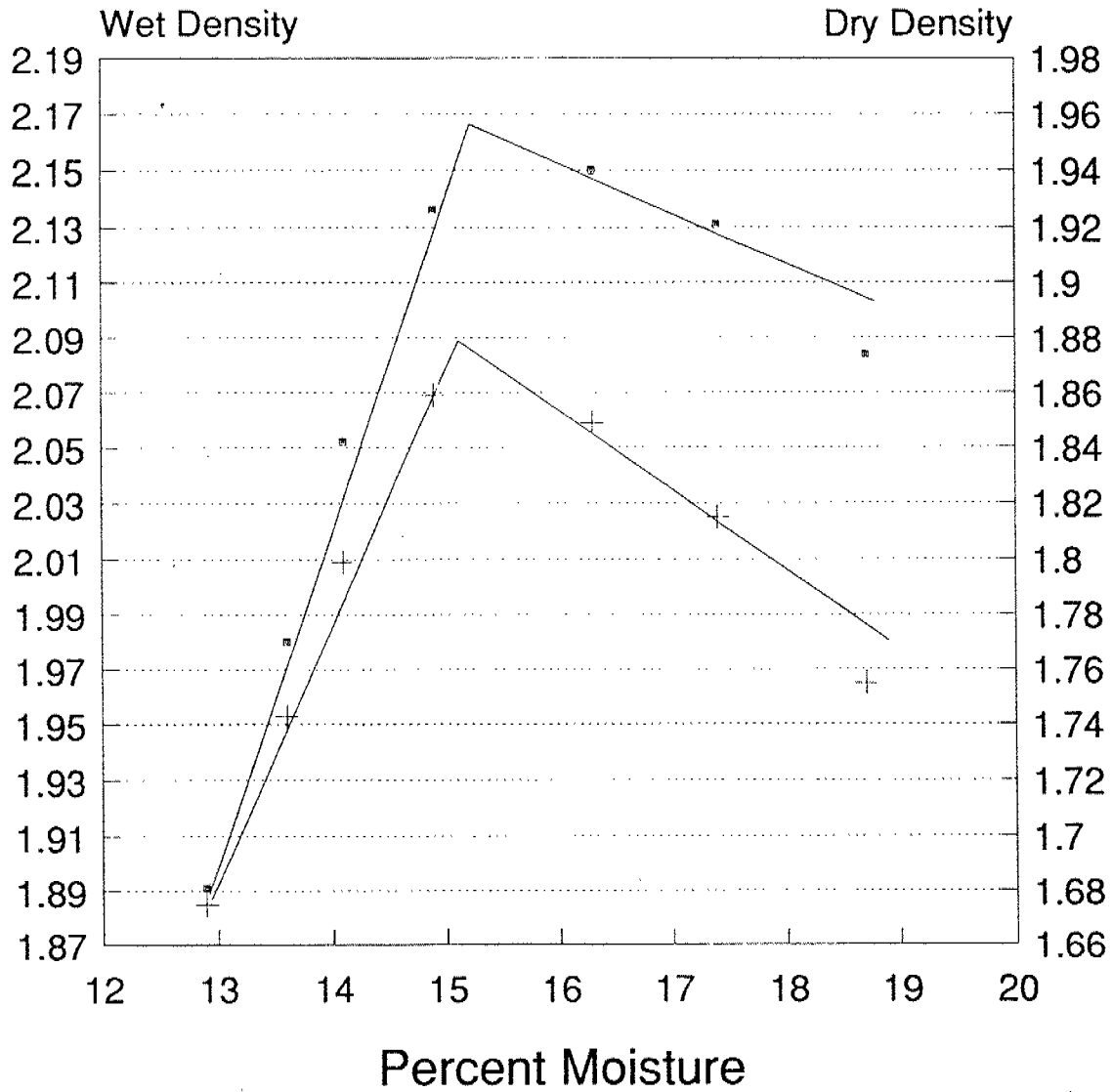
O.M.C. = 12.9%

WP 141-87-00

Fig No 9

PROCTOR TEST

Mix II



■ Wet Density + Dry Density

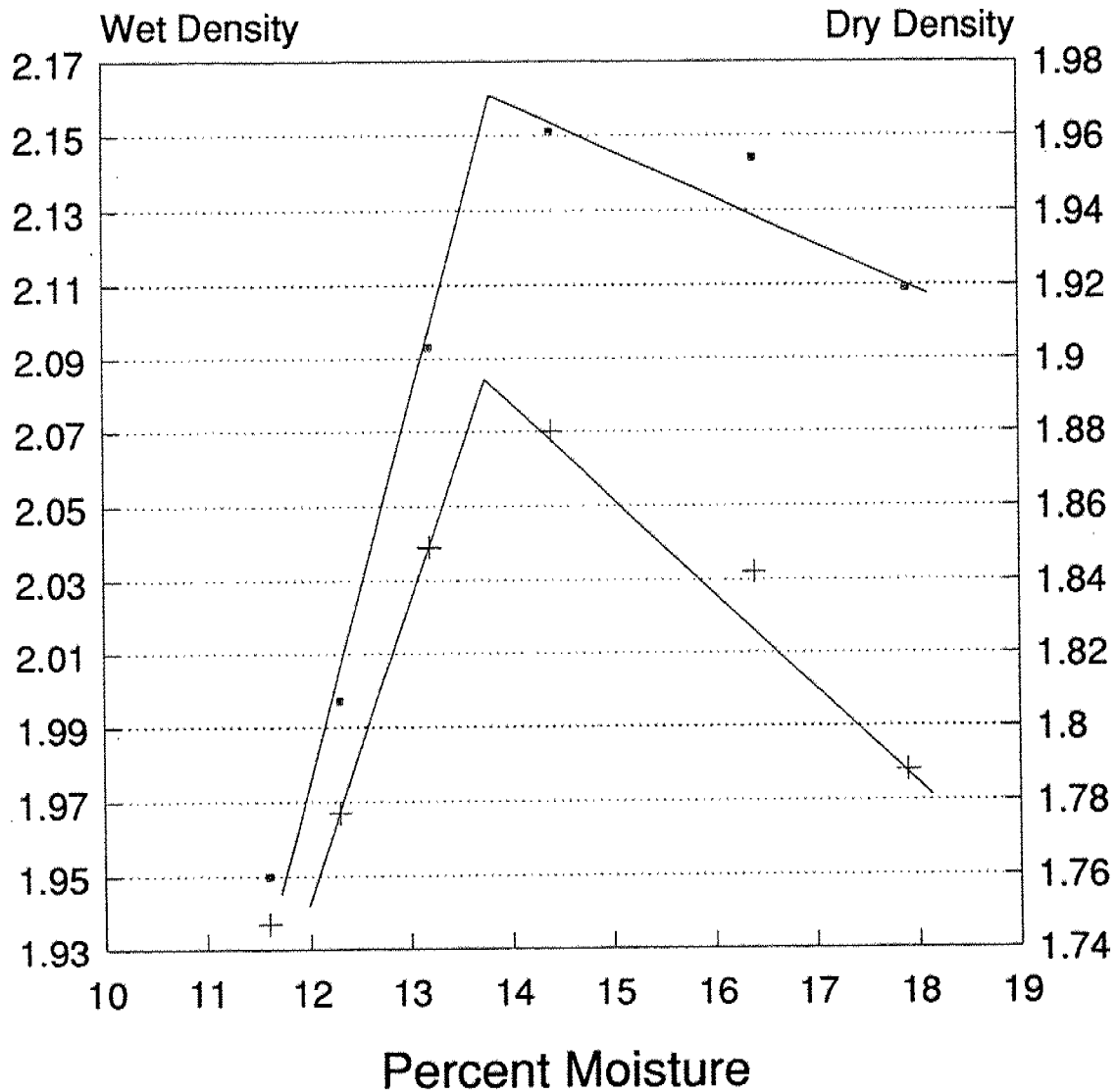
Max. Wet Density = 2.166 g/cm³
 Max. Dry Density = 1.880 g/cm³
 O.M.C. = 15.2%

WP 141-87-00

Fig No 10

PROCTOR TEST

Mix III



• Wet Density + Dry Density

Max. Wet Density = 2.156 g/cm³
Max. Dry Density = 1.894 g/cm³
O.M.C. = 13.8%

WP 141-87-00

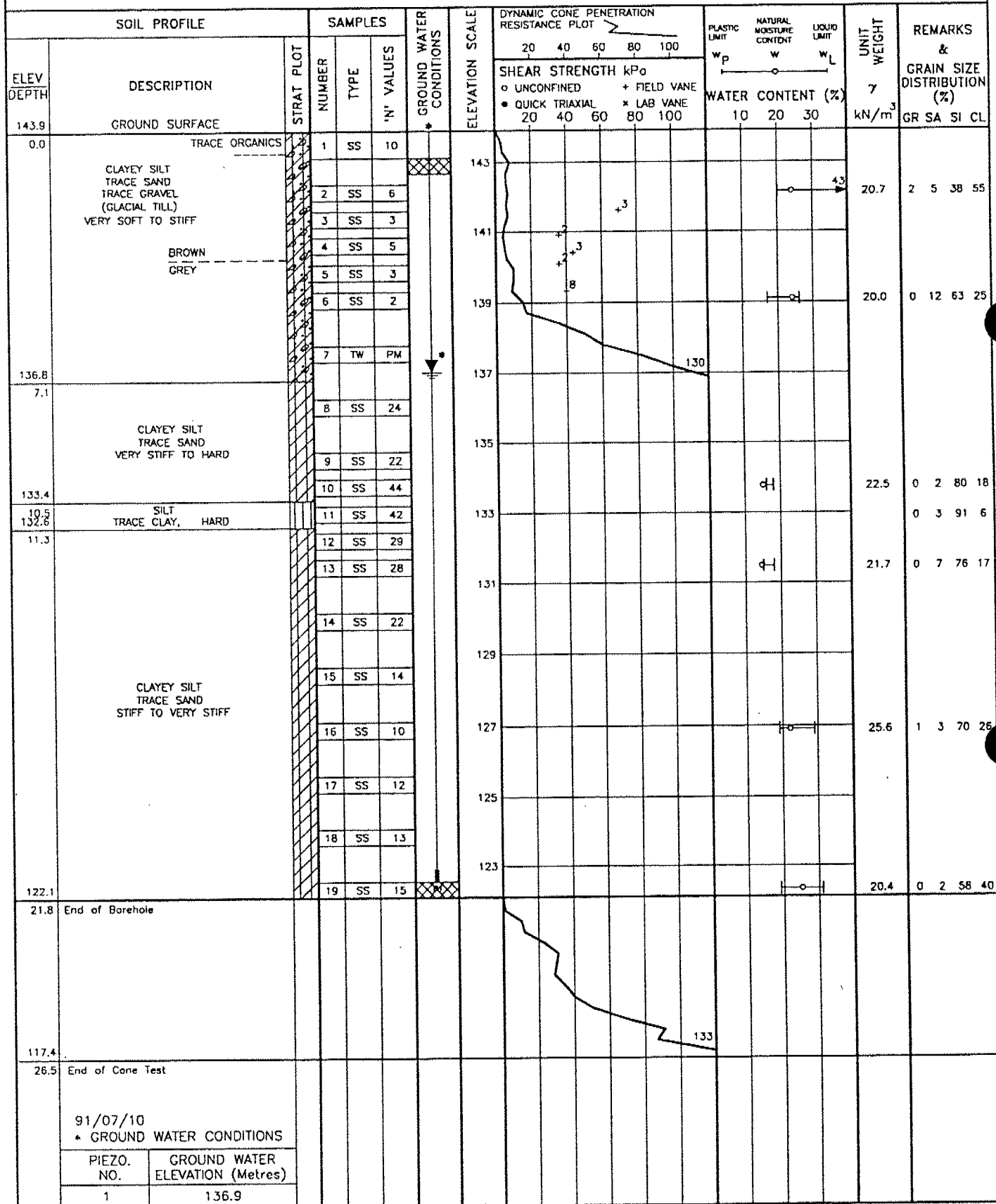
Fig No 11

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 567, E 298 268 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/07/09 CHECKED BY B.L.

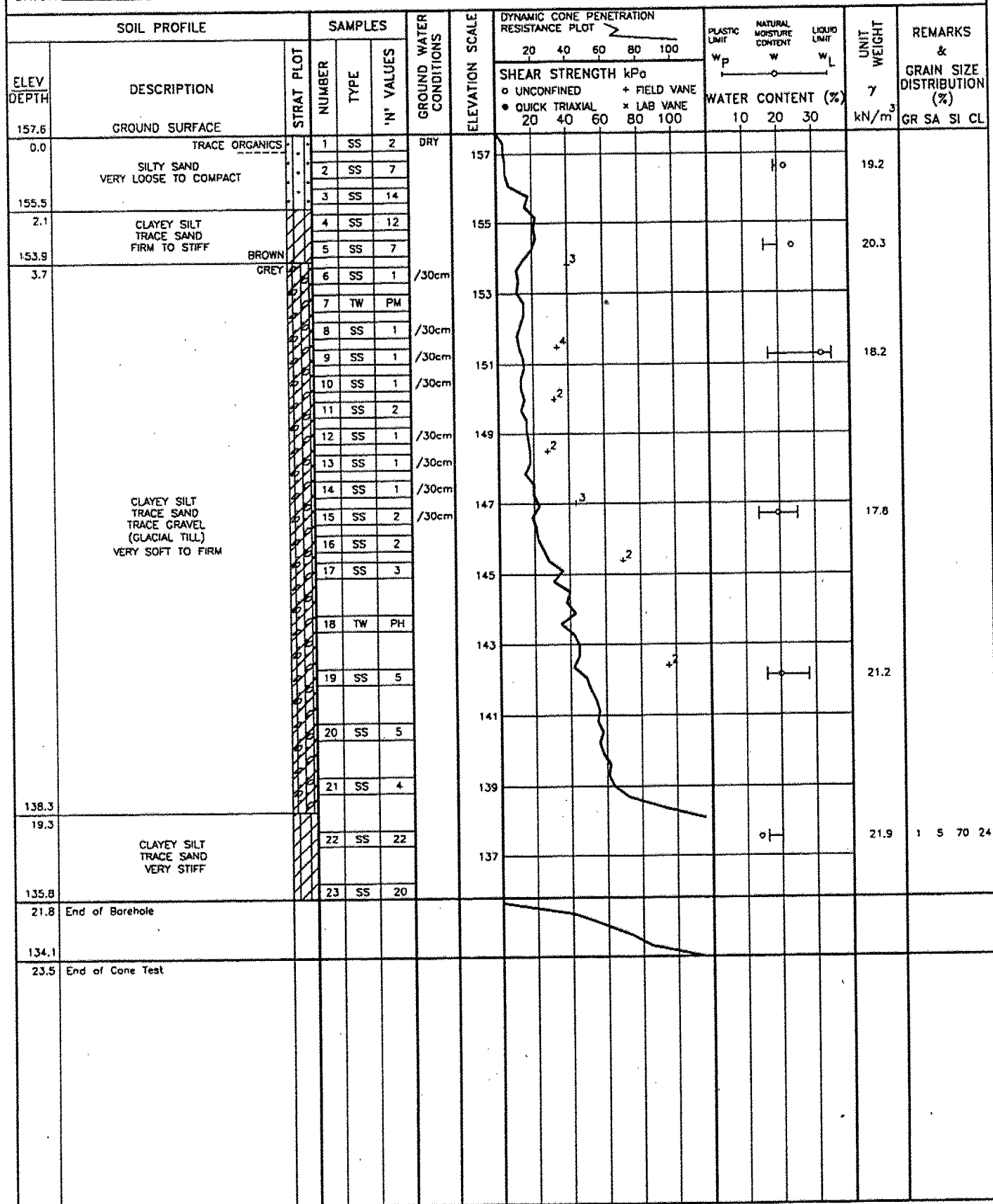


RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 495, E 298 331 ORIGINATED BY M.M.
DIST 6 HWY 416 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/08/06 CHECKED BY B.J.



RECORD OF BOREHOLE No 8

1 OF 1 METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 537, E 298 336 ORIGINATED BY M.M.
 DIST 5 HWY 417 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 91/07/09 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100								
158.0	GROUND SURFACE																			
0.0	TRACE ORGANICS SILTY SAND VERY LOOSE TO COMPACT		1	SS	3															
155.9	BROWN GREY		2	SS	5															
2.1	CLAYEY SILT TRACE SAND SOFT TO FIRM		3	SS	15															
153.6			4	SS	6															
4.4			5	SS	4															
			6	SS	2															
			7	TW	PH															
			8	SS	2	/30cm														
			9	SS	2	/30cm														
			10	SS	2	/30cm														
			11	SS	1	/30cm														
			12	SS	2	/30cm														
			13	SS	1	/30cm														
			14	SS	1	/30cm														
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO SOFT		15	SS	2															
			16	TW	PH															
			17	SS	5															
			18	SS	4															
			19	SS	4															
			20	SS	2															
			21	SS	1	/30cm														
138.7																				
19.3	SILT TRACE CLAY VERY STIFF		22	SS	22															
137.2																				
20.8	CLAYEY SILT TRACE SAND HARD		23	SS	41															
136.2																				
21.8	End of Borehole																			
135.1																				
22.9	End of Cone Test																			
<p>91/07/10 * GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>142.0</td> </tr> </table>																	PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	142.0
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																			
1	142.0																			

METRIC

[illegible]

+J, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 621, E 298 310 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/04/30 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
155.1	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	CLAYEY SILT TRACE SAND SOFT TO FIRM	1	SS	2								19.3	0 2 63 35
		2	SS	3									0 2 33 65
		3	SS	5									
152.2	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) SOFT TO FIRM	4	SS	2								19.6	3 11 39 47
2.9		5	SS	2									
		6	SS	2									
		7	SS	6								20.3	2 23 54 21
148.0	SILT TRACE CLAY VERY STIFF	8	SS	11									
7.1		9	SS	24									
145.3		10	SS	7									
9.8	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) SOFT TO FIRM	11	SS	4									0 3 64 33
		12	TW	PH								20.3	1 8 58 33
		13	SS	5									
		14	SS	3									11 8 54 27
		15	SS	3									
138.9		16	SS	5									
16.2		17	SS	23									
	CLAYEY SILT TRACE SAND FIRM TO VERY STIFF	18	SS	24									0 2 73 25
		19	SS	23									
		20	SS	30									
130.3		21	SS	23									0 3 61 36
24.8	End of Borehole												
128.6													
26.5	End of Cone Test												
	91/05/01												
	* GROUND WATER CONDITIONS												
	PIEZO. NO.												

RECORD OF BOREHOLE No 11

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 601, E 298 354 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/05/02 CHECKED BY B.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
158.0	GROUND SURFACE																
0.0	TRACE ORGANICS		1	SS	5										20.0		
	SILTY SAND LOOSE		2	SS	8												
155.1	BROWN GREY		3	SS	7												
2.9	CLAYEY SILT TRACE SAND SOFT TO FIRM		4	SS	5												
152.8			5	SS	2												
			6	SS	6												
5.2	SILT TRACE CLAY SOFT		7	SS	3												
151.3			8	SS	2										20.0	0 0 73 27	
6.7	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT		9	SS	2										18.4	1 10 38 51	
			10	SS	2										19.2	1 15 40 44	
			11	SS	1												
			12	SS	1												
			13	SS	1												
145.4			14	SS	1										20.0	1 17 68 14	
12.6	End of Borehole																
134.8																	
23.2	End of Cone Test																

RECORD OF BOREHOLE No 12

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 555, E 298 395 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/05/03 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
157.7	GROUND SURFACE													
0.0	SILTY SAND LOOSE TO COMPACT		1	SS	12		157							13 70 17 0
			2	SS	8									
154.8			3	SS	14		155							0 44 51 5
2.9	BROWN GREY		4	SS	20									
			5	SS	22									
	CLAYEY SILT TRACE SAND FIRM TO VERY STIFF		6	SS	12		153							0 5 88 9
150.8			7	SS	5		151	2						
6.9	SILT TRACE CLAY SOFT		8	SS	3								19.9	0 0 73 27
149.3			9	SS	6		149	+2						
8.4			10	SS	4			+3						
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) SOFT TO FIRM		11	SS	3		147	5						0 1 38 61
			12	SS	4			+2						
			13	TW	PH		145	+4					20.1	0 11 49 40
			14	SS	4			+2						
			15	TW	PH		143	+3						1 4 30 65
			16	SS	2			+3						
			17	SS	3		141						18.4	3 8 26 63
			18	SS	5			>100						
139.9			19	SS	8		139	>100					21.1	0 13 54 33
17.8	CLAYEY SILT TRACE SAND STIFF		20	SS	12		137							
			21	SS	11		135						20.7	1 9 54 36
			22	SS	11		133							
			23	SS	8									
129.8			24	SS	8									
27.9	End of Borehole													
129.0	91/05/10 * GROUND WATER CONDITIONS													
28.7	End of Core Test PIEZO. NO.													
	GROUND WATER ELEVATION (Metres)													
	1													154.7

RECORD OF BOREHOLE No 13

1 OF 1

METRIC

W.P. 141-87-00 LOCATION Coords: N 4 847 649, E 298 356 ORIGINATED BY M.M.
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 91/04/29 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT UNIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT UNIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20	40							60	80	100
158.0	GROUND SURFACE																	
0.0	SILTY SAND VERY LOOSE		1	SS	4								20.0					
156.6			2	SS	12													
1.4	BROWN GREY		3	SS	12													
	CLAYEY SILT TRACE SAND STIFF		4	SS	9													
			5	SS	7								20.0	0 1 77 22				
			6	SS	8													
152.4			7	SS	2													
5.6			8	TW	PH								20.6	4 15 41 40				
			9	SS	1													
			10	SS	1									1 9 30 60				
			11	SS	4													
	CLAYEY SILT TRACE SAND TRACE GRAVEL (GLACIAL TILL) VERY SOFT TO FIRM		12	SS	3													
			13	SS	4								6 16 52 26					
			14	SS	4													
			15	SS	6								20.9	1 11 53 35				
			16	TW	PH													
			17	SS	9													
			18	SS	9													
			19	SS	6								21.9	1 17 47 35				
			20	SS	5													
			21	SS	5													
135.7			22	SS	29								22.8	3 3 74 20				
22.3			23	SS	38													
	CLAYEY SILT TRACE SAND VERY STIFF TO HARD		24	SS	36													
130.1			25	SS	46									0 4 77 24				
27.9	End of Borehole																	
128.7																		
29.3	End of Cone Test																	

FOUNDATION INVESTIGATION REPORT

For

Jersey Creek Concrete Culvert

at

Hwy. 407/CPR Subway

W.P. 141-87-00C

District 6, TorontoINTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. The Jersey Creek, a tributary of the Humber River, flows through an existing concrete culvert located beneath the CPR embankment at the site. The creek and culvert are currently aligned at a skew to the proposed Hwy. 407. Hence, it is proposed to construct a new culvert that will intercept the creek along a realignment located approximately 35 metres north of the Hwy. 407 right-of-way.

This report describes the subsurface conditions present at the site of the proposed structure.

SITE DESCRIPTION AND GEOLOGY

The site is located along and adjacent to the existing CPR track approximately 0.3 km northwest of the CPR-Islington Avenue level crossing in the Town of Vaughan, Regional Municipality of York. The site is characterized by a meandering valley that supports side slopes of approximately 2.5H:1V and trends in a general southwesterly direction. The crest of the valley is approximately 200 m in width and the valley depth is approximately 20 m. The valley houses the Jersey Creek that runs its course at the valley floor and is approximately 2 m in width and normally flows at 1 m depths. The Jersey Creek flows into the Humber River located in a floodplain immediately west of the site.

The valley slopes are densely covered with trees, brush, tall grasses and shrubs. There is no evidence of slope creep or displacement indicating that the valley slopes appear to be stable at its present geometry.

The existing CPR track at the site is supported by an earth embankment spanning the valley crest width. The railroad embankment, supposedly constructed in the early 1900's supports side slopes approximately 1.5H:1V. Trees and low lying shrubs and grassland cover the existing constructed slopes. There appears to be no evidence of slope stability other than a localized area at the northeastern portion of the embankment. Rip-rap and armour stone was placed on the slope to retard surficial erosion at this location.

A concrete culvert is located at the base of the constructed embankment to facilitate the Jersey Creek outflow beneath the embankment. Again, no visible signs of distress in the culvert were apparent.

Land use surrounding the site consists of residential lots located east of the site, a hydro corridor consisting of transmission towers just north of the site and forestland elsewhere. A CPR two span structure is located approximately 0.3 km north of the site along the same track alignment. The structure spans of the Humber River at this location. In addition, a CNR rigid frame overhead exists approximately 0.2 km south of the site to facilitate CN Rail traffic in a east-west direction over the CPR track.

Physiographically, the site lies within the region known as the South Slope (Chapman and Putnam, 1984). The south Slope Formation at the site consists of a ground moraine, scoured at intervals by valleys tributary to the Humber River systems. The valleys accentuate the hilly moraine topography. The glacial landforms and deposits were formed by the advance and retreat of the Wisconsin ice sheet that covered the area during the Pleistocene epoch (over 5000 years ago).

The overburden is underlain by the grey shales of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION

The fieldwork for the investigation was coordinated with the field investigation for the proposed CPR Subway and the associated detour. The fieldwork was implemented between 89 10 21 and 89 11 30 and consisted of a total of 14 sampled boreholes. Four of these boreholes were advanced along the proposed concrete culvert alignment.

Five of the fourteen boreholes were advanced through the overburden using hollow stem augering techniques to the depths of the lower sand to silty deposit (approximately 39 metres). Beyond that depth, the boreholes were advanced using conventional diamond drilling techniques (casing and washboring) to overcome torquing restriction imposed on the hollow stem augers. The NW casing used was advanced by both driven and rotary methods. The drilling equipment used was a track mounted CME 55.

In consideration of the importance of establishing the composition of the CPR embankment fill, a total of four boreholes were advanced in the existing embankment fill. Two of the boreholes were advanced from the crest of the embankment using the track-mounted CME. The other two boreholes were advanced at mid-slope, on the west side of the embankment (BH's 4A, 6A). These boreholes were advanced using conventional diamond drilling techniques via a tripod apparatus.

In general, subsoil samples were retrieved at 0.7 m intervals within a significant depth of 5 to 6 m beneath the proposed culvert invert elevations and 1.5 m intervals elsewhere. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved in the surficial till deposit using a shelly tube sampler in accordance with standard practice (ASTM D1587). In situ vane tests were also conducted in the cohesive surficial deposit, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

Bedrock was cored at five of the fourteen boreholes advanced at the overall site including BH C-3 located along the proposed culvert alignment. Bedrock was cored using conventional rock coring methods in NQ size.

All subsoil samples and rock core were identified in the field and then returned to the laboratory for further examination and applicable testing.

Water levels were obtained in the open boreholes and also in a sealed piezometer installed at BH D-8. Groundwater levels were monitored throughout the duration of the investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Unconfined Compression Tests
- 6) Unconsolidated Undrained Tests
- 7) Multi-stage consolidated undrained tests with pore pressure measurements
- 8) Consolidation Test

In view of the general uniformity of soil types found in the general site area, including the proposed CPR Subway structure and the proposed detour, all laboratory results for similar soil strata have been integrated from the different structures. Laboratory test results have been summarized in the

subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The native subsoil of the original valley at the site consists of a surficial deposit composed of a clayey silt to silty clay with occasional sand seams and traces of gravel. The stratum is a till deposit of glacial origin and extends to a maximum thickness of 13.7 m at the crest of the valley. The thickness of this deposit decreases down the valley slope and does not exist at the valley floor and the floodplain located at the base of the existing CPR embankment (BH D-3) and at the culvert outlet (BH C-1). The consistency of this deposit ranges from firm to hard.

Underlying the upper till deposit and located as a surficial stratum in the floodplain exists a deposit of clayey silt that extends for a considerable thickness ranging from 18.3 m to 28 m below the upper till and from 10.7 m to 11.1 m in the floodplain area. This stratum also contains random interbeds of sand and gravel.

The clayey silt deposit is in turn underlain by a cohesionless deposit of sands and silts. The deposit varies randomly in silt and sand percentages, varying from sand with some silt to sandy silt. Random zones of silt also exist in the soil matrix. Gravel, boulders and cobbles are also components of the lower depths of the deposit. The thickness of this deposit ranges from 4.2 m to 15.8 m with an average thickness of approximately 10 m. The denseness of this deposit varies from compact to very dense. This cohesionless deposit overlies shale bedrock of the Georgian Bay shale formation.

Two types of fill material was used to construct the CPR embankment. Surficially and within a zone above and immediately adjacent to the existing concrete culvert, a cohesionless backfill material consisting of a sand with some silt to sandy silt was used. Beneath the surficial sand material and beyond the culvert backfill wedge zone, the embankment fill material consists of a clayey silt with interbedded layers of sand. The thickness of the surficial

cohesionless fill material which also exists on the embankment slopes, ranges from 2.0 to 4.6 m. The maximum depth of the embankment fill explored was 13.9 m at BH D-6, located at the proposed CPR Subway pier location. At BH's D-1, D-2, located in the area of the south abutment, only 1.5 to 2.4 m of granular fill was encountered, confirming the valley crest location. At BH D-4, the location of the proposed north abutment, 12.2 m of clayey silt fill material with interbedded layers of sand exists.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwgs. 1418700C-1* & 1418700C-2*.

A detailed description of the subsurface conditions encountered is given below.

Sand, some Silt (Fill)

As previously mentioned, the surficial embankment fill material and backfill material to the existing concrete culvert consists generally of a brown sand with some silt. Occasional layers of sandy silt and clayey silt are also present in the fill material and traces of fine gravel are also randomly intermixed. A grain size distribution envelope illustrating the gradation of the fill is provided in Figure 1 in the Appendix. The surficial thickness of the fill material varies from 1.5 to 2.4 metres and the maximum thickness explored was 16.2 metres at which depth the existing concrete culvert roof was encountered (see BH D-7).

Standard Penetration tests carried out in the cohesionless fill material revealed 'N' values ranging from 2 blows/0.3 m to 21 blows/0.3 m indicating a very loose to compact state of condition.

Clayey Silt (Fill)

Beneath the surficial cohesionless fill and beyond the culvert cohesionless backfill material, the CPR embankment fill consists of a brown, cohesive clayey

* SHEET NO'S 289 & 289-1 OF THE CONTRACT DWG'S

silt. The maximum thickness of the clayey silt fill encountered was 12.2 metres at the proposed north abutment location. Interbedded layers of fine sand ranging in thickness from 50 mm to 150 mm are also present randomly in the cohesive matrix. A grain size distribution envelope for this material as determined by mechanical sieve and hydrometer analysis is given in Figure 2.

Atterberg Limits were obtained to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 3. A summary of the indices is provided in Table 1 below. Unit weights are also included.

Table 1 - Clayey Silt (Fill)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-24	8
Liquid Limit (w _L %)	21-32	8
Plastic Limit (w _p %)	13-19	8
Unit Weight (kN/m ³)	19.2-20.2	4
Undrained Shear Strength (c _u) (kPa)	80->120	5

The test results reveal that the cohesive fill material is of low plasticity and hence can be categorized as clayey silt.

Undrained shear strength measurements (c_u) were obtained in situ by conducting field vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 1 above. However, in consideration of the interbedded layers of sand, consistencies ranging from stiff to very stiff which is representative of the determined shear strength values cannot be implicitly assumed.

Silty Clay to Clayey Silt (Glacial Till)

The native surficial deposit present at the site consists of a cohesive silty clay to clayey silt with traces of sand and gravel and occasional random interbedded sand seams. The thickness of the deposit explored in the

investigation ranges from 11.3 to 13.7 and the interbedded sand seams are generally 50 to 100 mm in thickness. At BH D-4, the approximate location of the proposed north abutment, this deposit does not exist indicating that the deposit decreases in thickness from the crest of the valley to the valley floor. The deposit is generally oxidized (brown) for the upper 1.5 to 3.5 metres and unoxidized (grey) for its lower thickness. The deposit is a till of glacial origin.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 25-61% and 35-61% respectively, confirming the range in behaviour of the fine grained portion of the deposit.

Although not encountered during this investigation, boulders and cobbles are characteristic components of till deposits and consequently may be encountered in this deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 5. A summary of the indices is provided in Table 2. Unit weights are also included.

Table 2 - Silty Clay to Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-29	14
Liquid Limit (w_L %)	22-47	14
Plastic Limit (w_p %)	12-20	14
Unit Weight (kN/m^3)	18.8-20.3	9
Undrained Shear Strength (cu) (kPa)		
- Field Vane	35->120	28
- Laboratory*	41-82	28
Sensitivity	2-3	28

*Unconfined Compression Tests

*Unconsolidated Undrained Tests

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay).

Undrained shear strength measurements (c_u) of the soil were obtained both by in situ vane tests and by laboratory tests, namely unconfined compression tests and unconsolidated undrained tests (quick triaxial). Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2 above. A Shear Strength vs Elevation profile is also provided in Figure 6. Based on shear strength values ranging from 35-120 kPa, it is considered that the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 3 indicating that the soil has a low sensitivity.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 3.

Table 3 - Effective Shear Strength Parameters

Sample	BH D-1, TW5
Elevation (m)	147.0
Liquid Limit	47
Plastic Limit	20
Natural Moisture Content (w%)	26
Effective Angle of Internal Friction (ϕ°)	29.5
Effective Shear Strength Intercept (c') (kPa)	10

For design purposes, a reduced angle of internal friction (ϕ°) of 26° and a shear strength intercept of 5 kPa was selected to account for the fact that the sample test was not saturated.

In conjunction with the proposed detour, (BH D-5, WP 141-87-00D) located immediately west of the proposed CPR Subway, a consolidation test was conducted to evaluate the compressibility characteristics of this same deposit. The results (e-log p curve) of the test are illustrated in Figure 7 in the Appendix. The results reveal that this cohesive stratum has been preconsolidated in the past to an effective pressure 200 kPa in excess of the existing overburden pressure.

The coefficient of consolidation (cv) used to determine the time rate of consolidation settlement was computed using Taylor's Method (1948). The results reveal values ranging from 0.004 m²/day to 0.005 m²/day for loadings ranging from 100 to 200 kPa.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 15 blows/0.3.

Clayey Silt

Underlying the surficial clayey silt to silty clay deposit at a depth ranging from 10.7 m to 13.7 m below the ground surface (Elevation 140.0 to 135.2) and extending for a maximum thickness of 18.3 m, and present at the the surface of the floodplain and extending to a maximum thickness of 11.1 m, a cohesive deposit of clayey silt exists. This stratum also contains traces of sand and random zones of silt. In the floodplain, a trace of organics was encountered in the surficial 2 m of the deposit and interbedded layers of sand and gravel approximately 100 mm in thickness also exist.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 8. The envelope illustrates that clay and silt percentages in the deposit range from 12-34% and 60-88% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 9. A summary of the indices is provided in Table 4. Unit weights are also included.

Table 4 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	14-35	17
Liquid Limit (w _L %)	26-29	17
Plastic Limit (w _p %)	14-18	17
Unit Weight (kN/m ³)	20-22	8

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 76 blows/0.3 m indicating that the deposit ranges in consistency from firm to hard. In general, in the upper 10 m or so, 'N' values ranged from 20 blows/0.3 m to 30 blows/0.3 m (although lower 'N' values were obtained in the floodplain area because of the presence of organics), indicating a very stiff consistency. In the lower depths of the deposit, 'N' values ranged from 10 blows/0.3 m to 20 blows/0.3 m and the soil can be categorized as having a stiff consistency.

Sand and Silt

Underlying the clayey silt deposit and extending to bedrock a cohesionless deposit of sand and silt exists. The deposit is predominantly composed of sand with some silt but random zones of sandy silt to silt are also present within this deposit. In addition, gravel, boulders and cobbles exist as a heterogeneous mixture in the deposit at the lower depths immediately above the bedrock. At BH's D-4 and C-3, approximately 2.5 m of the coarser grained gravel, boulders and cobbles was encountered. The thickness of the entire deposit ranges from 4.2 m to 15.8 m, but is generally in the order of 10 metres. A grain size distribution envelope for this deposit is provided in Figure 10 in the Appendix.

This cohesionless deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 10 blows/0.3 m to 120 blows/0.8 m indicating that the deposit ranges in denseness from compact to very dense. In the floodplain area of the site, 'N' values obtained below the upper 3 m thickness were generally representative of very dense material. The deposit is predominantly compact to dense at the other locations of the site.

Bedrock

The cohesionless sand with some silt deposit is directly underlain by shale bedrock of the Georgian Bay shale formation. The bedrock surface is generally flat with surface elevations ranging from 105.9 m to 107.7 m. The bedrock was cored by NQ size up to 2.8 metres in thickness.

The shale bedrock is grey in colour and is very fine grained and thinly laminated. The rock is generally slightly to moderately weathered and contains occasional clay seams, approximately 50 to 100 mm in thickness. Minor beds of argillaceous limestone are also present in the rock formation. Detailed descriptions of the bedrock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Rock recoveries varied between 60 and 100% while RQD's varied between 0 and 15%. The shale bedrock is weak to very weak rock.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring the level in a piezometer installed at BH D-8 (CPR Subway pier location). The piezometer was installed in the clayey silt deposit with bentonite seals above and below the piezometer tip.

The water levels measured at the time of investigation along the proposed culvert alignment varied which reflects the changing topography from the culvert inlet to the culvert outlet. At the culvert inlet (BH C-4) and at BH C-2, the

water level was encountered at elevations 135.2 m to 135.0 m respectively. At BH C-3, a location representing the crest of the valley along the proposed alignment, the water level was at a higher elevation of 148.2 m.

Artesian conditions were encountered in the lower gravels, boulders and cobbles present at the lower depths of the sands and silts deposit within the floodplain. Up to 3 m of piezometric head above the natural ground surface was observed.

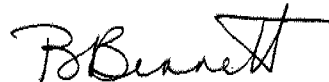
In all cases, boreholes advanced in the embankment fill were dry and groundwater was not observed.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

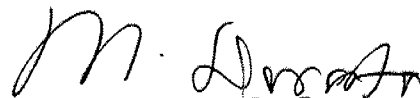
The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer and Bill Cung, Engineer Trainee, utilizing equipment owned and operated by Marathon Drilling. The description of bedrock core samples was carried out by S. Senior, Geological Engineer.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.



for

Dr. B. Iyer, P. Eng.
Senior Foundation Engineer



M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

ROCK CORE DESCRIPTION

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
D-1	34	46.10-47.22	73	0	46.10-48.90	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (5%).
	35	47.22-48.90	100	0		
D-2	22	47.55-49.07	92	7	47.55-49.07	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered, intensely weathered sections at 47.60m and 48.18m; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (8%).
D-4	22	44.81-46.33	60	8	44.81-44.98	OVERBURDEN , cobbles, weathered, bedrock.
					44.98-46.33	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; moderately weathered to highly weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (20%).
D-8	25	42.98-44.65	100	15	42.98-44.65	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (11%).

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

ROCK CORE DESCRIPTION
WP 141-87-00

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C-3	27	45.67-47.19	60	10	45.67-46.28	OVERBURDEN , gravel, cobbles, weathered bedrock.
					46.28-47.19	SHALE , medium grey to medium dark grey; very fine grained, very thinly laminated; weak to medium strong rock; slightly to medium weathered; extremely close spaced fractures.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.



GRAIN SIZE DISTRIBUTION (FILL MATERIAL)

W P 141-87-00C

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

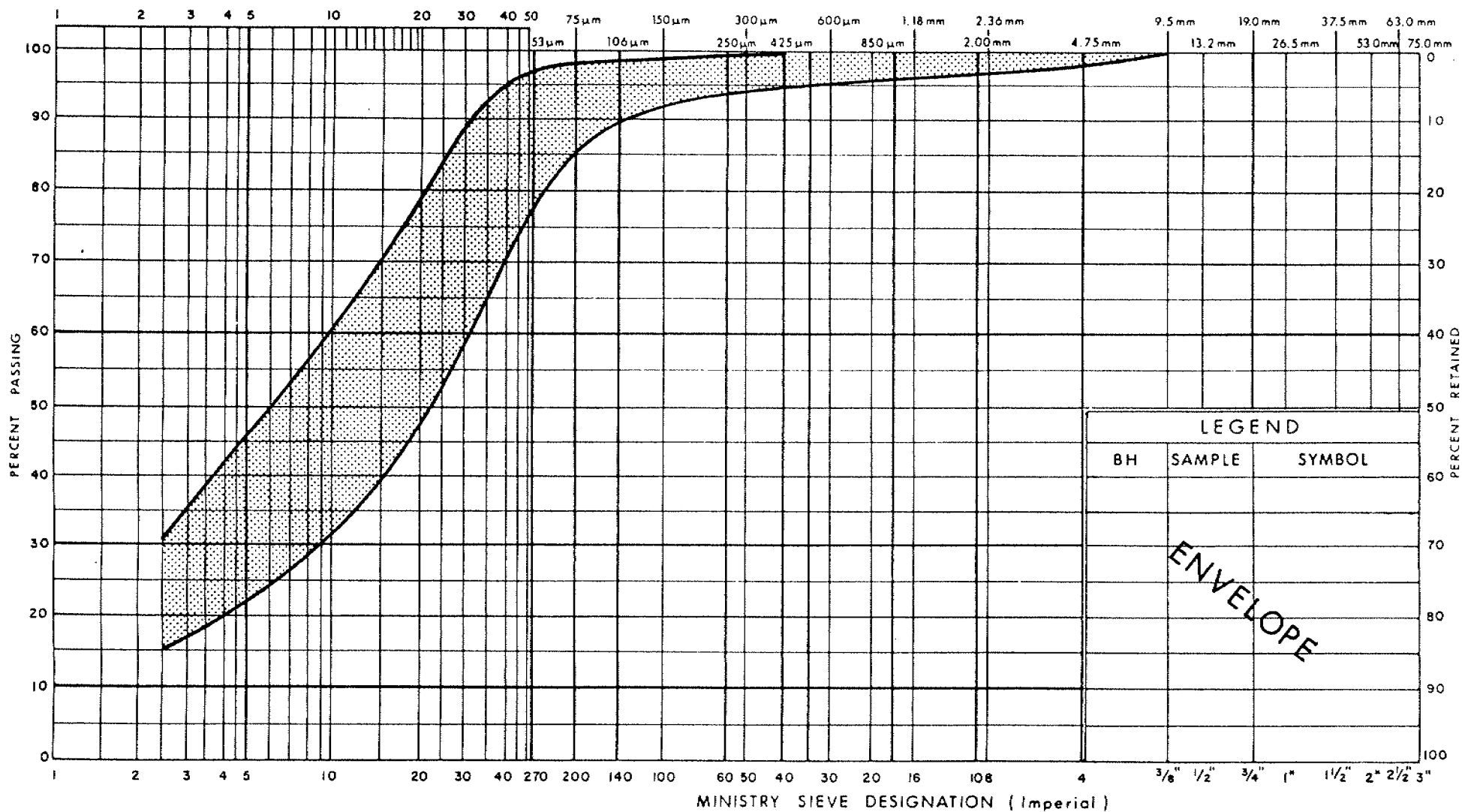
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH

SAMPLE

SYMBOL

ENVELOPE

MINISTRY SIEVE DESIGNATION (Imperial)

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (FILL)

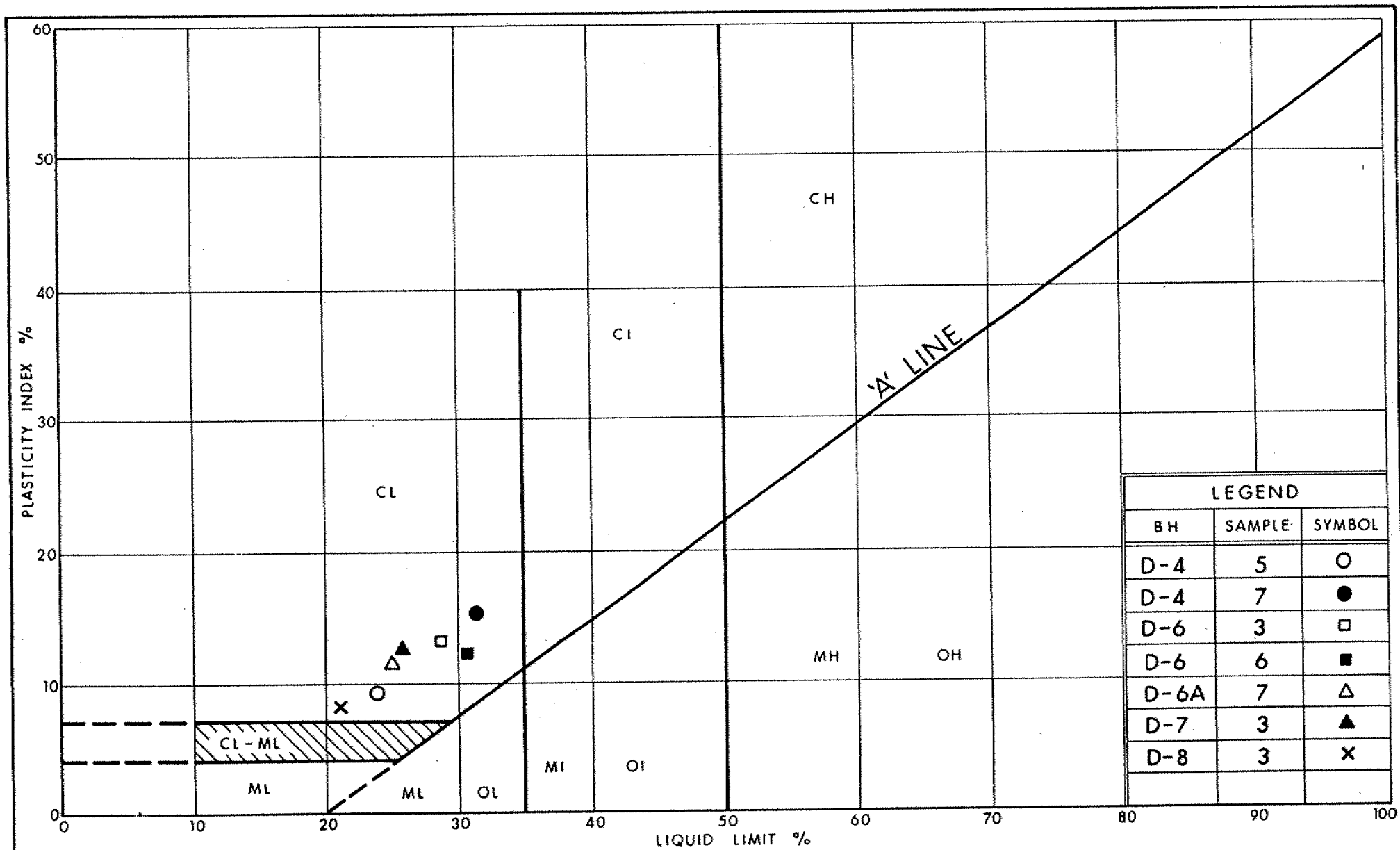
FIG No 2

W P 141-87-00C



Ministry of
Transportation

Ontario



Ministry of
Transportation

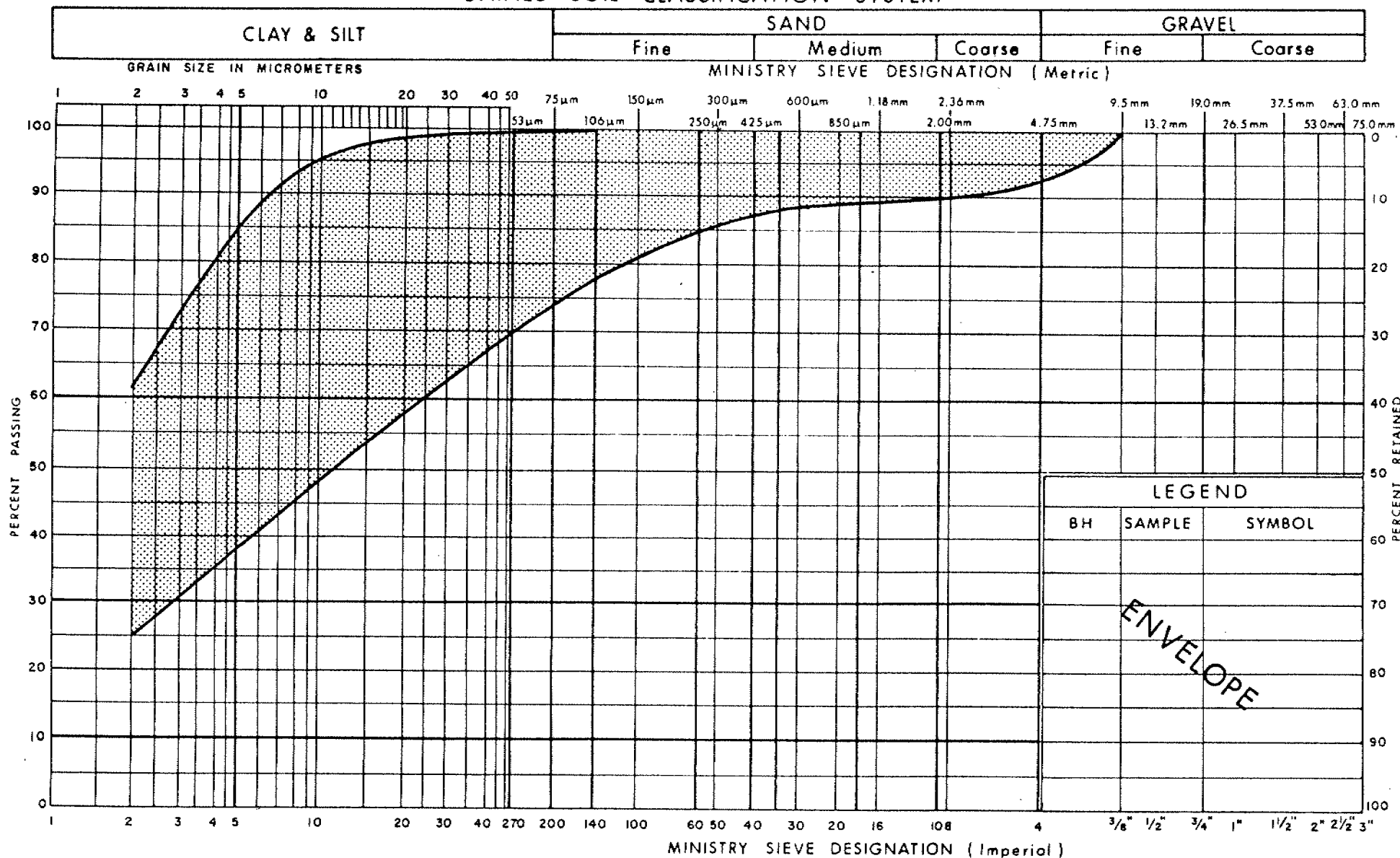
Ontario

PLASTICITY CHART
CLAYEY SILT (FILL)

FIG No 3

W P 141-87-00C

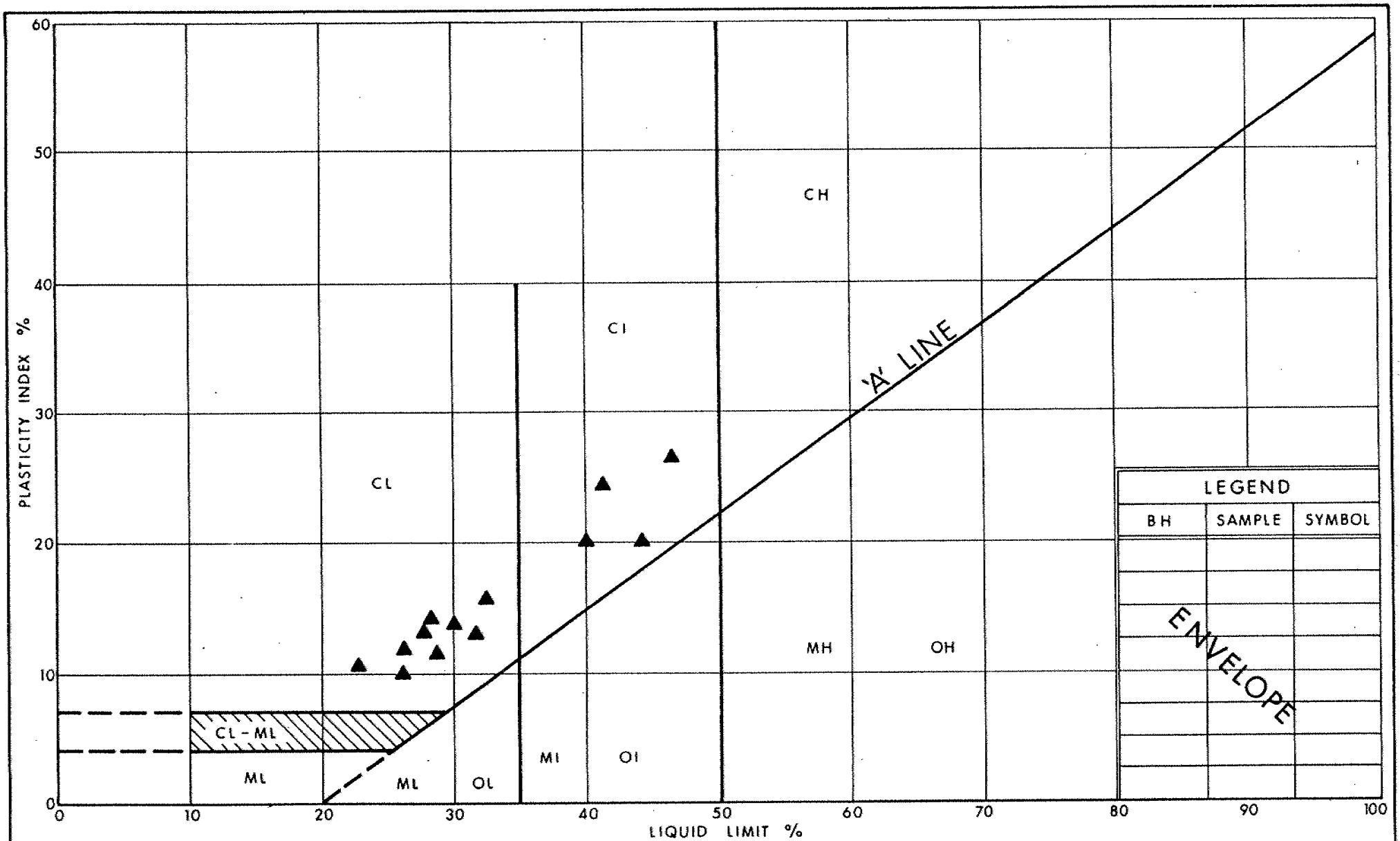
UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

FIG No 4

W P 141-87-00C

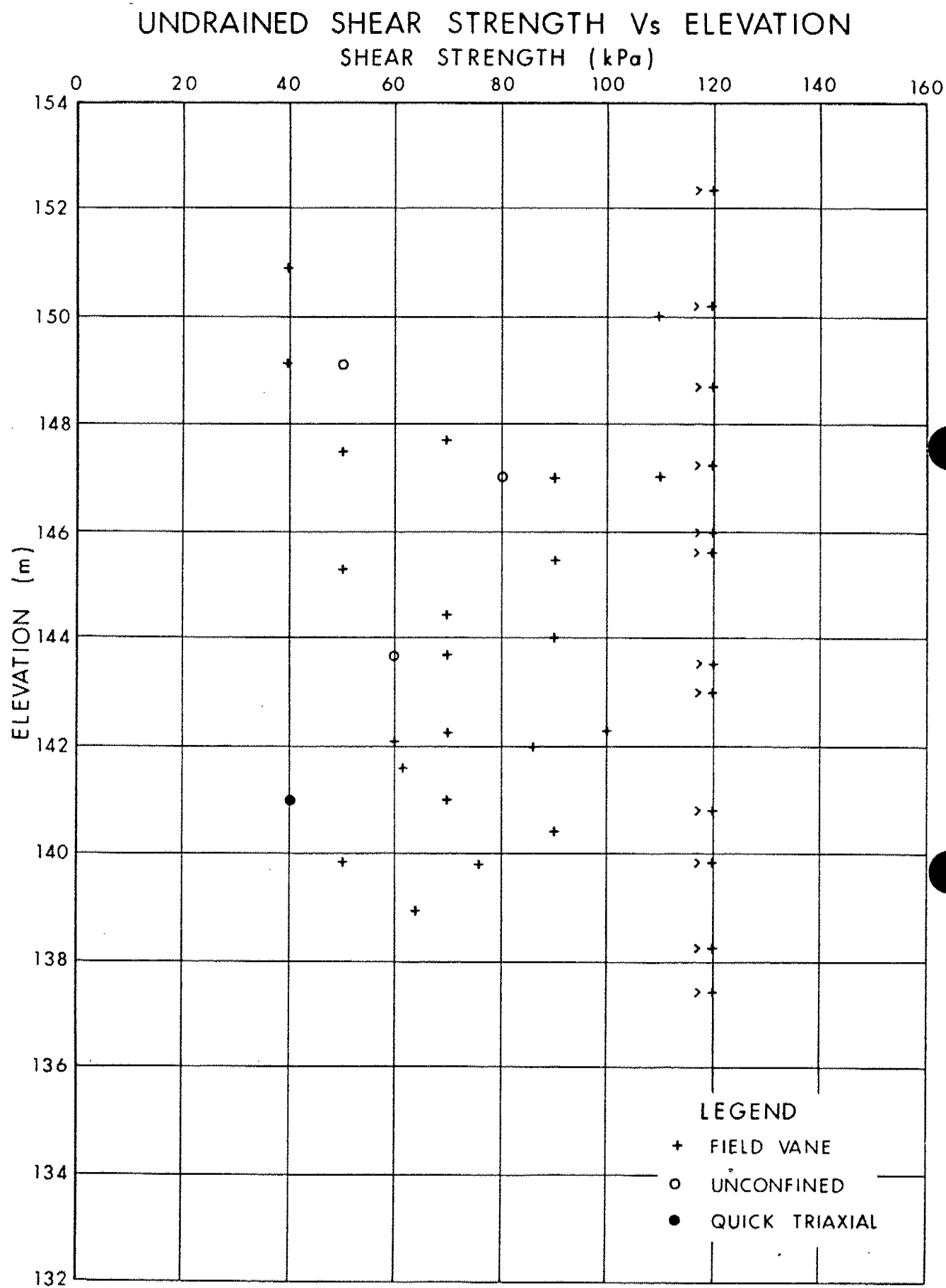


Ministry of
Transportation

PLASTICITY CHART
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

FIG No 5

W P 141-87-00C



W P 141-87-00 C

Fig 6

VOID RATIO - PRESSURE CURVES

259

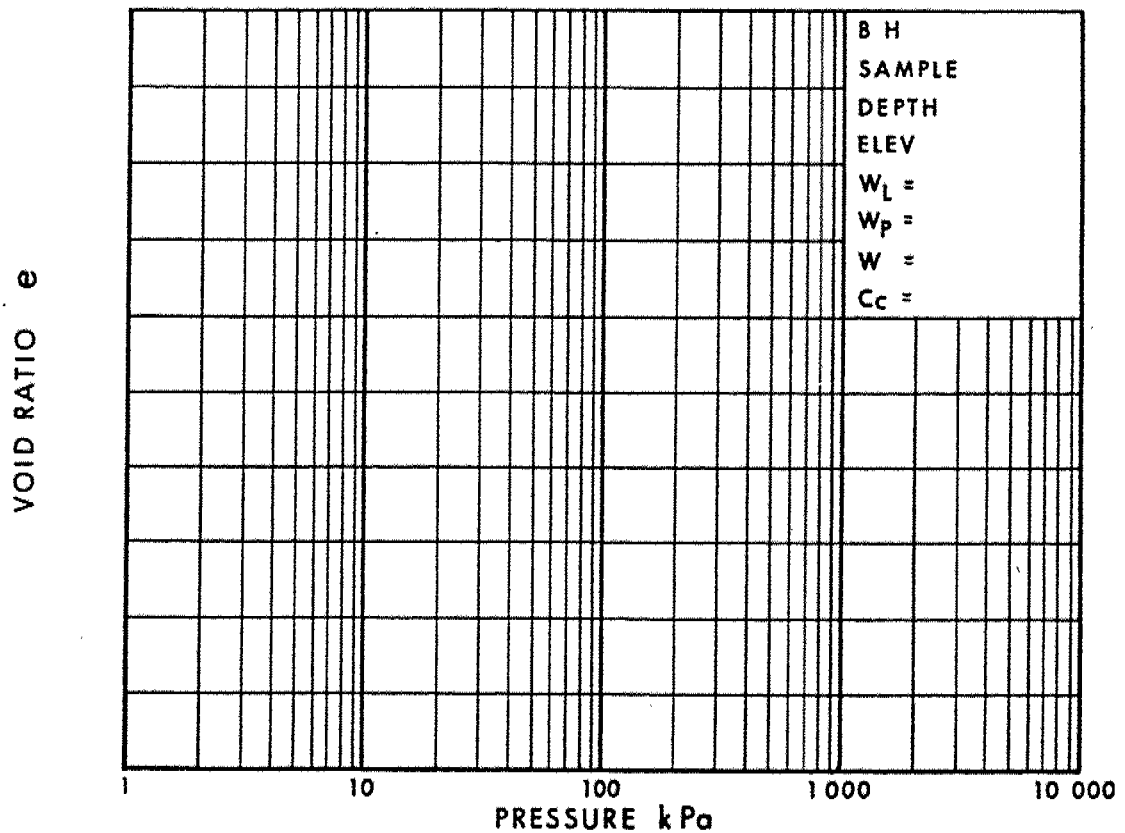
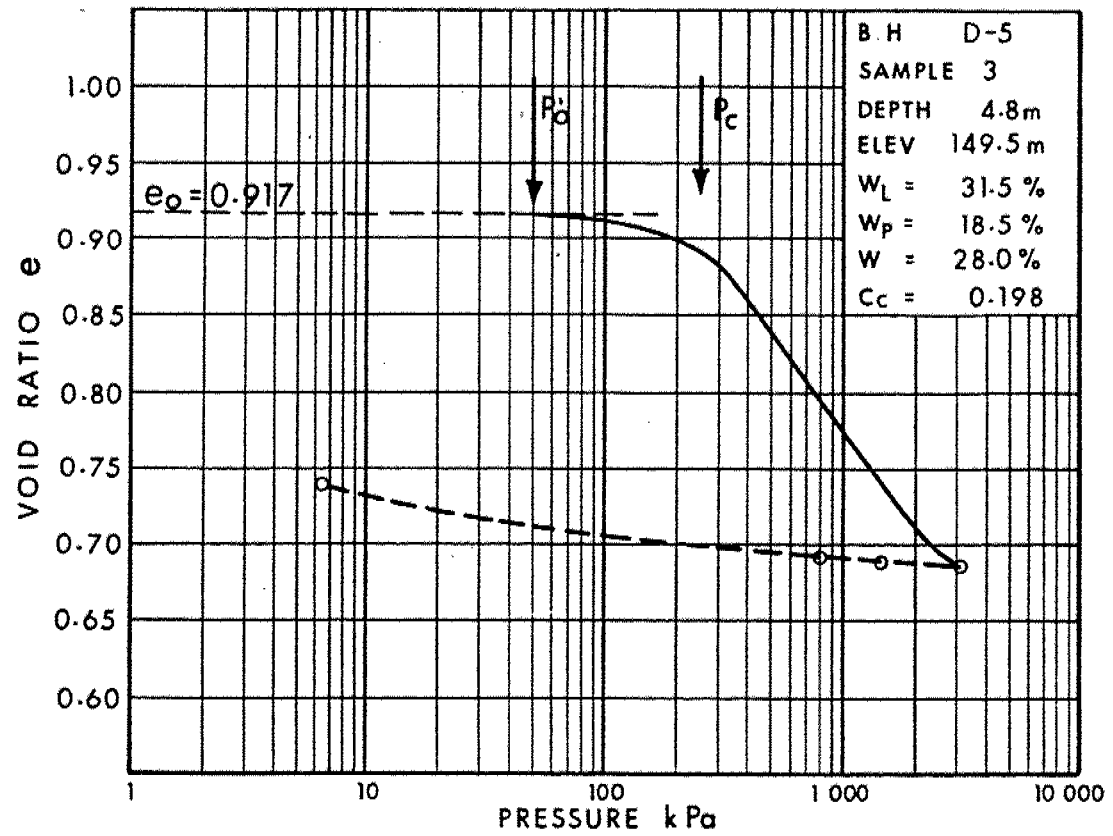
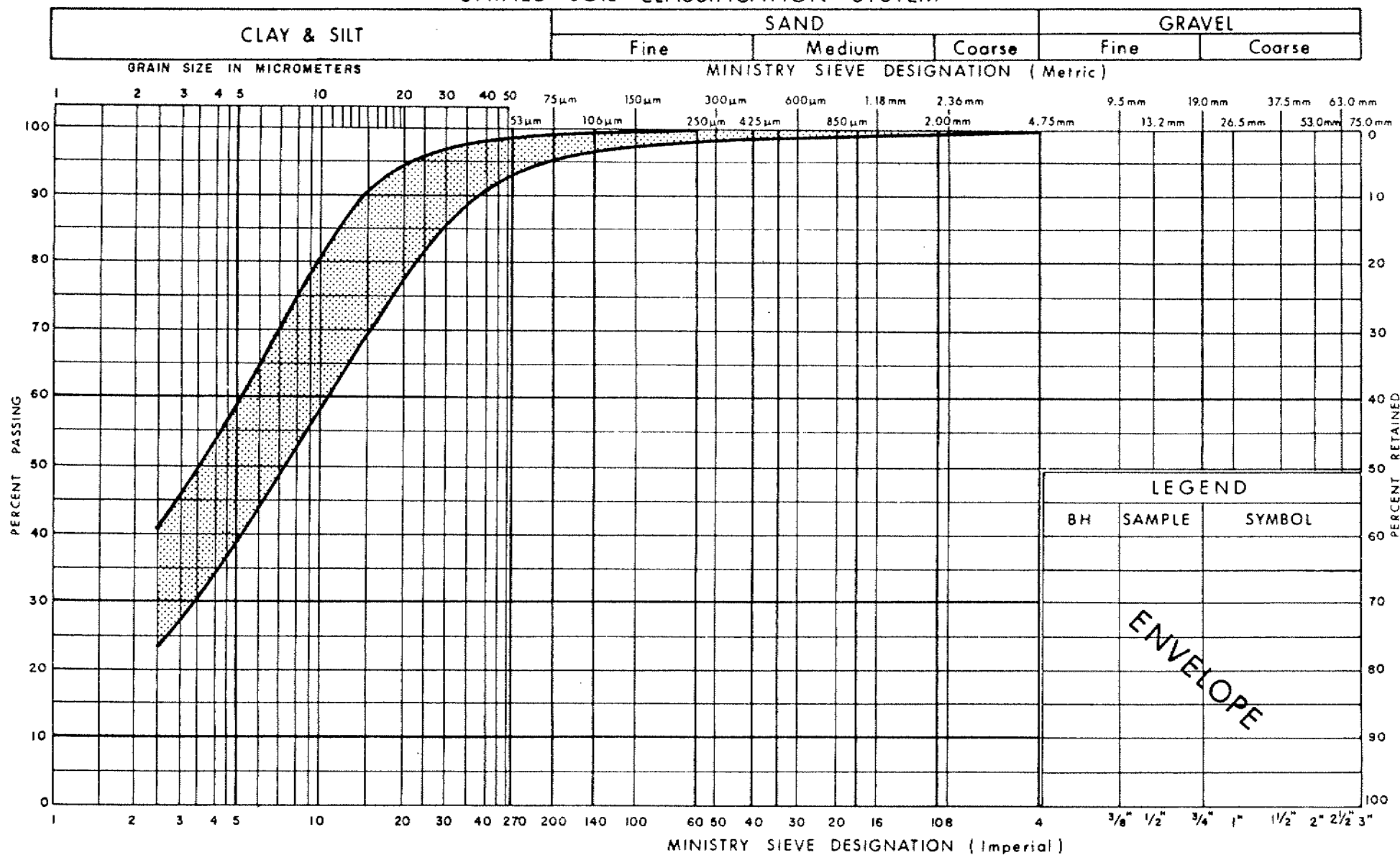


Fig 7

W P 141-87-00 C

UNIFIED SOIL CLASSIFICATION SYSTEM

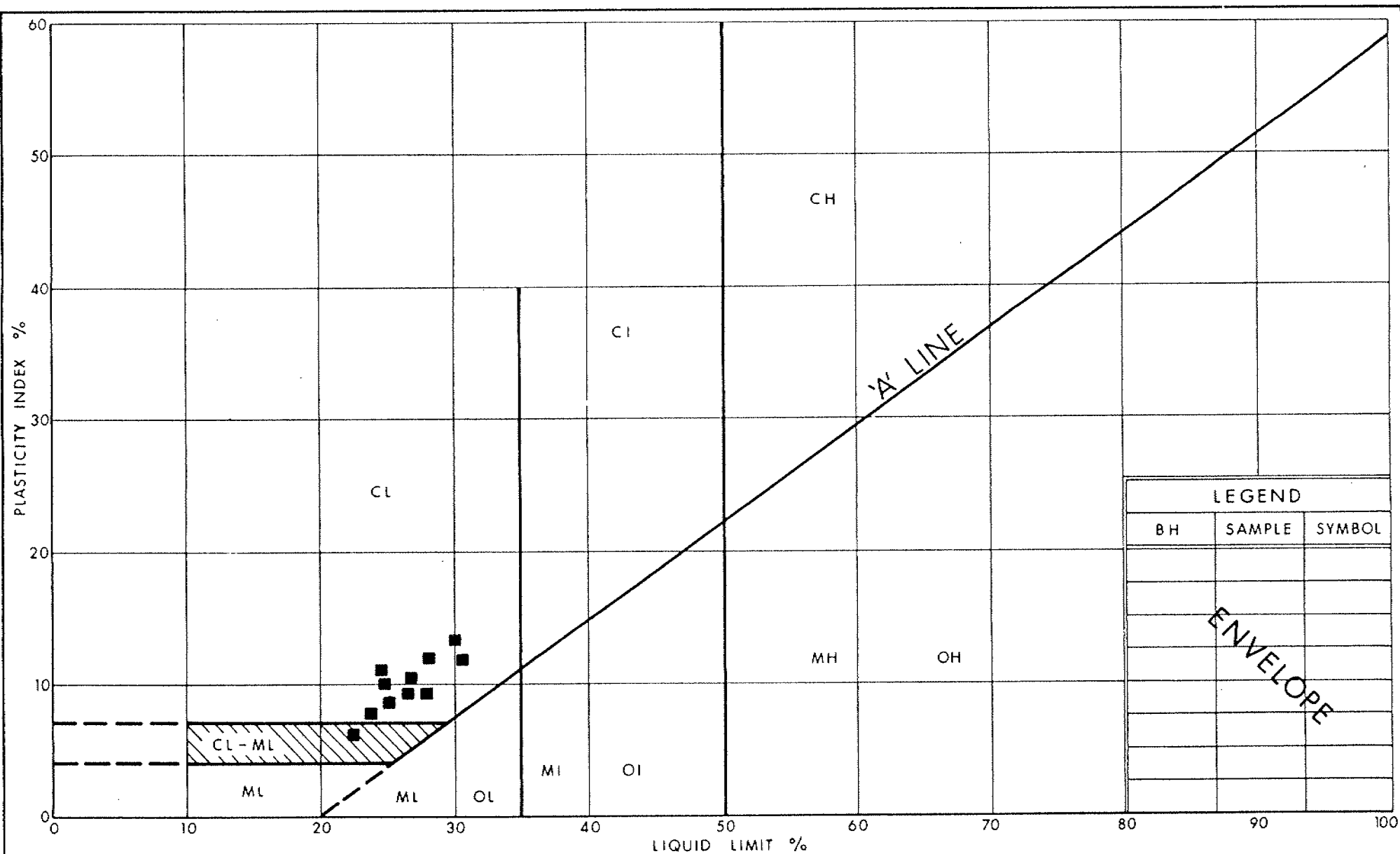
Ministry of
Transportation

Ontario

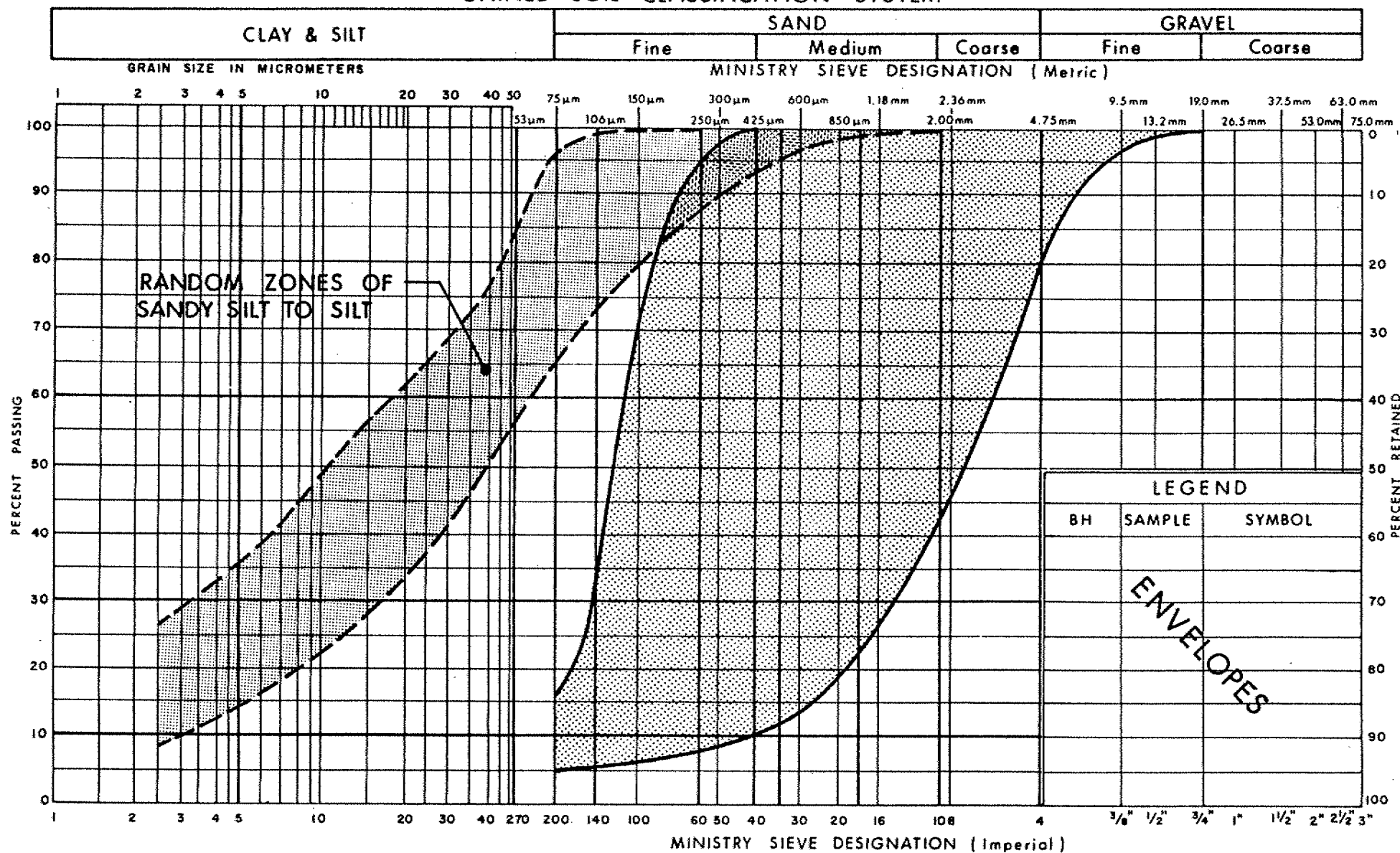
GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIG No 8

W P 141-87-00 C



UNIFIED SOIL CLASSIFICATION SYSTEM



RECORD OF BOREHOLE No C-1

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 519.6; E 298 137.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 24 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					
136.5	Ground Surface																GR SA SI CL
0.0	Trace Organics		1	SS	7		136										
			2	SS	9												
	Firm to Stiff		3	SS	11		134										0 2 73 25
	Stiff to Hard	Brown Grey	4	SS	22												
			5	SS	30		132									21.6	
	Clayey Silt		6	SS	32												
	Trace of Sand		7	SS	28		130										
			8	SS	30												
			9	SS	12		128									21.3	0 5 65 30
125.8																	
10.7	Sandy Silt		10	SS	12		126										0 1 84 15
			11	SS	18		124										0 36 60 4
	Compact V. Dense		12	SS	120		122										28 32 34 6
	Occ. Gravel Seams		13	SS	120/	15cm	120										
			14	SS	90		118										
			15	SS	94		116										
							114										
111.8	Gravel, Boulders and Cobbles		16	AS	-		112										
24.7	End of Borehole																
	*Artesian Head 3.0m Above Ground Surface																

OFFICE REPORT ON SOIL EXPLORATION

*3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-2

METRIC

W P 141-87-000 LOCATION Co-ords: N 4 847 540.1; E 298 173.9 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
DATUM Geodetic DATE 1989 11 28 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					
147.4	Ground Surface																
0.0																	
	Sand, Trace Silt																
	Trace Gravel		1	SS	5		146										
	(Fill)																
	Brown, V. Loose		2	SS	4		144										10 81 (9)
	to Loose																
142.4			3	SS	7												
5.0							142										
	Silty Clay		4	SS	5												
	to																
	Clayey Silt		5	SS	10		140										
	Trace Gravel																
	Occ. Sand Seams		6	TW	PH		138										
	Firm to V. Stiff		7	TW	PH												
	(Glacial Till)						136										
135.2			8	SS	9												
12.2			9	SS	15		134										0 4 66 30
	Clayey Silt		10	SS	14												
	Trace Sand		11	SS	15		132										
	Grey		12	SS	13												
			13	SS	11		130										
			14	SS	12												
			15	SS	13		128										
			16	SS	10		126										
	Stiff		17	SS	7												
	Firm																
124.5			18	SS	5		124										
22.9																	
	Sand																
	Some Silt																
	Grey, Loose		19	SS	8												
122.6																	
24.8	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-3										METRIC			
W P 141-87-00C		LOCATION Co-ords: N 4 847 561.0; E 298 190.8				ORIGINATED BY TS							
DIST 6 HWY 407		BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core				COMPILED BY TS							
DATUM Geodetic		DATE 89 11 22 - 25				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					
152.2	Ground Surface												
0.0													
	Clayey Silt, Trace Sand, Trace Gravel		1	SS	8								
			2	SS	9								
	Brown Grey		3	SS	2								
	Firm to V. Stiff		4	TW	PH								
	Occ. Sand Seams (Glacial Till)		5	SS	12								0 4 61 35
			6	SS	5							20.2	
	Silt, Tr. Sand		7	SS	12								0 10 85 5
140.0			8	SS	16								
12.2			9	SS	23								
	Clayey Silt		10	SS	24								
	Trace Sand		11	SS	26								
	Grey, Stiff to		12	SS	26								
	V. Stiff		13	SS	27								0 8 69 23
			14	SS	29								
			15	SS	24								
			16	SS	21								
			17	SS	15								
			18	SS	36								
			19	SS	14								
			20	SS	14								
			21	SS	11								
			22	SS	14								
122.0													
30.2													

OFFICE REPORT ON SOIL EXPLORATION

Continued

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No C-3 Cont'd

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 22 - 25 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					
122.0	Continued														
121.7	Clayey Silt		23	SS	10										
30.5	Sand Some Silt Grey, Compact to Dense														
			24	SS	39										
			25	SS	28										
			26	SS	46										
	Occ. Cobbles Boulders and Gravel														
105.9															
46.3	Bedrock		27	RC	REC 60%										
105.0	Shale														
47.2	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-4

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 580.0; E 298 204.5 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 11 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
147.0	Ground Surface							○ UNCONFINED	+ FIELD VANE									
0.0								● QUICK TRIAXIAL	x LAB VANE									
								20 40 60 80 100		10 20 30								
				</														

OFFICE REPORT ON SOIL EXPLORATION

METRIC

OFFICE REPORT ON SOIL EXPLORATION

[illegible]

Continued

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-1 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 89 10 21-30 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
121.8 30.2	Continued															
	Clayey Silt Very Stiff to Hard		23	SS	16		120									
			24	SS	16											
			25	SS	76		118									
			26	SS	45		116									
115.4 36.6	Sand Tr. Silt Compact to V. Dense		27	SS	15		114									0 86 (14)
			28	SS	59											
			29	SS	58		112									
			30	SS	65		110									1 89 (10)
			31	SS	33											
			32	SS	44		108									8 85 (7)
105.9 46.1	Bedrock Shale Weak to Very Weak		33	SS	129	23cm	106									RQD = 34%
			34	BXL RC	732											RQD = 0%
103.1 48.9	End of Borehole		35	BXL RC	1002		104									

RECORD OF BOREHOLE No D-2

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 1989 11 08-11 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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				
153.0	Ground Surface															
0.0	Irregular Mixture of Silt, Sand, Slag Ballast (Fill)		1	SS	11		152									
150.6	Brown-Black, Compact		2	SS	7		150					2				
2.4			3	SS	7		148					2				
	Brown Grey		4	SS	8		146		2							
	Silty Clay to Clayey Silt		5	TW	PH		144								21.0	1 13 58 28
	Some Sand, Trace Gravel Firm to V. Stiff		6	TW	PH		142									
	Occ. Sand Seams		7	SS	4		140									
	(Glacial Till)		8	SS	4		138									
139.3			9	SS	22		136									
13.7	Clayey Silt Firm to V. Stiff		10	SS	20		134									
			11	SS	23		132									
			12	SS	12		130									
			13	SS	20		128									
			14	SS	18		126									
			15	SS	13		124									
122.8																
30.2																

Continued

+3, x5: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No D-2 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NO Core COMPILED BY TS
DATUM Geodetic DATE 1989 11 08-11 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						SHEAR STRENGTH kPa	WATER CONTENT (%) 10 20 30
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
122.8 30.2	Continued		16	SS	9		122								
	Clayey Silt Firm to Very Stiff		17	SS	5		120								
			18	SS	50		118								
116.1 36.9			19	SS	20		116								
	Sand Tr. Silt Compact to V. Dense Occ. Gravelly Seams		20	SS	56		114						17 78 (5)		
			21	SS	50		112								
			22	RC	REC 92%		110								
105.5 47.5	Bedrock Shale Weak to Very Weak						108						RQD = 20%		
103.9 49.1	End of Borehole						106								
							104								

+3, x5: Numbers refer to Sensitivity

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





RECORD OF BOREHOLE No D-3

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 504.0; E 298 204.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 27 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								20 40 60 80 100									10 20 30		

136.0	Ground Surface															GR SA SI CL											
0.0	Interbedded Layers of Sand and Gravel Tr. Organics Brown Grey Clayey Silt Tr. Sand, Tr. Gravel Stiff to Hard		1	SS	4		134									0 5 61 34											
2			SS	2																							
3			SS	14																							
4			SS	12																							
5			SS	22																							
6			SS	19																							
7			SS	27																							
8			SS	20																							
9			SS	20																							
10			SS	15																							
124.9	Silt Tr. Clay, Tr. Sand Loose V. Dense		11	SS	7												15cm	124									0 0 77 23
11.1			12	SS	85																						
12			SS	100/																							
13			SS	120/																							
119.1	End of Borehole		14	SS	120/	10cm	120									0 5 85 10											
16.9																											

+3, x5: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No D-4

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 13-21 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100					
152.1	Ground Surface					152							
0.0	Clayey Silt With Interbedded Layers of Sand (Fill) Brown to Grey V. Soft to Stiff		1	SS	2	150							
			2	SS	3	148							0 32 64 4
			3	SS	3	146							
			4	SS	6	144							
			5	SS	6	142							
			6	SS	8	140							
			7	SS	15	138							
139.9			8	SS	20	136							
12.2	Clayey Silt Grey, Stiff to Hard		9	SS	25	134							
			10	SS	30	132							
	Sandy Silt		11	SS	53	130							
			12	SS	32	128							
			13	SS	17	126							
			14	SS	11	124							
			15	SS	13	122							
121.9													
30.2													

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-4 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
121.9 30.2	Continued		16	SS	10		120										
	Clayey Silt Grey Stiff to Hard																
118.6 33.5			17	SS	45		118										
	Sand Some Silt Grey, Compact to V. Dense		18	SS	20		116										
			19	SS	72		114										
			20	SS	120/8 cm		112										0 85 14 1
	Occ. Cobbles Boulders and Gravel		21	SS	65		110										
107.1 45.0	Bedrock Shale		22	NQ RC	REC 60%		108										RQD = 8%
105.8 46.3	End of Borehole						106										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4A										METRIC							
W P 88-78-16		LOCATION Co-ords: N 4 847 520.0; E 298 212.0				ORIGINATED BY TS											
DIST 6 HWY 407		BOREHOLE TYPE B-Casing, Washbore				COMPILED BY TS											
DATUM Geodetic		DATE 1989 11 30				CHECKED BY											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)					
143.5	Ground Surface																
0.0	Sand, Tr. Gravel (Fill)		1	SS	6	*	142										
	Brown, Loose to Compact		2	SS	21		140										
138.9	Clayey Silt With Interbedded Layers of Sand		3	SS	37		138										
4.6	(Fill)																
136.9	Brown, Stiff to Hard		4	SS	22												
6.6	End of Borehole *Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-5

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 605.0; E 298 115.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 16-17 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					
154.3	Ground Surface																
0.0	Silty Clay to Clayey Silt Trace Gravel Grey, Firm to V. Stiff Occ. Sand Seams (Glacial Till)		1	SS	7	*	154									19.5	0 4 61 35
			2	SS	3		152										
			3	TW	PH		150										
			4	TW	PH		148										
			5	SS	11		146										
			6	SS	8		144										
			7	SS	10		142										
			8	SS	5		140										
			9	SS	10		138										
139.1			10	SS	12		136										
15.2	Clayey Silt Grey, Stiff to V. Stiff		11	SS	22												
			12	SS	32												
134.0			13	SS	22												
20.3	End of Borehole *Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 511.1; E 298 240.4 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 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										WATER CONTENT (%)		
								SHEAR STRENGTH kPa										10 20 30		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
152.9	Ground Surface					*	152									GR SA SI CL				
0.0	Sand, Tr. Silt (Fill)																			
150.5	Brown, V. Loose		1	SS	4															
2.0			2	SS	6		150													
	Clayey Silt With Interbedded Layers of Sand (Fill)		3	SS	6		148									0 5 73 22				
	Brown, Firm		4	SS	5		146													
			5	SS	7		144								19.4	0 2 84 14				
			6	SS	6										19.2	0 14 64 22				
141.8							142									1 79 15 5				
10.7	Sand, Some Silt (Fill)		7	SS	4															
	Brown, Very Loose to Loose		8	SS	6		140													
138.6			9	SS	7											6 72 18 4				
13.9	Clayey Silt, Tr. Gravel Tr. Organics						138													
136.8	Grey, Firm to Stiff		10	SS	14															
15.7	End of Borehole *Borehole Dry																			

OFFICE REPORT ON SOIL EXPLORATION

*3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10


RECORD OF BOREHOLE No D-6A										METRIC							
W P 88-78-16		LOCATION Co-ords: N 4 847 504.0; E 298 229.0				ORIGINATED BY TS											
DIST 6 HWY 407		BOREHOLE TYPE B-Casing, Washbore				COMPILED BY TS											
DATUM Geodetic		DATE 1989 11 29				CHECKED BY											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W			W _L
143.5	Ground Surface																
0.0	Sand, Some Gravel, Trace Silt (Fill) Brown, V. Loose to Compact		1	SS	2	*	142									20 77 (3)	
			2	SS	6												
			3	SS	8												
			4	SS	9												
			5	SS	12												
138.9	Clayey Silt (Fill) Brown, V. Stiff		6	SS	19	140										26 59 (15)	
4.6																	
137.3	Clayey Silt Grey, Tr. Organics					138											
136.5																	
6.6	End of Borehole															4 6 65 25	
	* Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-7

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 530.8; E 298 232.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION [%]
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
								SHEAR STRENGTH kPa						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
152.5	Ground Surface									10 20 30			GR SA SI CL	
0.0	Clayey Silt Brown, Firm Silty Sand to Sandy Silt (Fill) V. Loose to Loose					*	152						11 62 23 4 0 12 66 22 2 41 54 3 0 30 66 4 1 63 31 5 4 73 19 4	
			1	SS	2		150							
			2	SS	3		148							
			3	SS	8		146							
			4	SS	4		144							
			5	SS	5		142							
			6	SS	5		140							
			7	SS	8		138							
			8	SS	9									
			9	SS	9									
	10	SS	8											
136.3	End of Borehole Auger Refusal Probable Culvert Roof *Borehole Dry													
16.2														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-8

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 02-08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPo							WATER CONTENT (%)			
								20 40 60 80 100										
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
150.6	Ground Surface																	
0.0	Sand, Some Silt With Interbedded Layers of Clayey Silt Brown, Loose (Fill)		1	SS	9		150		2					14 56 29 1				
			2	SS	6		148		3									
			3	SS	4		146							0 13 75 12				
144.5	Clayey Silt Grey, Firm to Stiff Occ. Sand Seams (Glacial Till)		4	SS	4		144		3					0 7 52 41				
6.1			5	SS	8		142		2				20.2					
			6	SS	12													
			7	SS	4		140		3									
139.9		Clayey Silt Grey, Firm to Hard		8	SS	17												
10.7				9	SS	22												
			10	SS	19		138						20.3	2 1 72 25				
			11	SS	22													
			12	SS	28		136						21.6					
			13	SS	25													
			14	SS	23		134											
			15	SS	19		132											
			16	SS	16		130							0 5 60 35				
			17	SS	14													
							128											
			18	SS	18		126											
							124											
			19	SS	10													
							122											
120.4																		

OFFICE REPORT ON SOIL EXPLORATION

120.4
30.2 Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No D-8 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 02-08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
120.4	Continued													
30.2			20	SS	9		120							
				21	SS	107		118						
	Silt, Tr Sand V. Dense						116							
	Clayey Silt													
	Grey		22	SS	36		114							
	Firm to Hard													
111.9							112							
38.7														
	Sand With Silt Grey, Compact		23	SS	12		110							
107.7	Some Gravel		24	SS	120	15 cm	108							17 38 31 14
42.9	Bedrock Shale Weak to Very Weak		25	NQ RC	REC 100%		106							RQD = 15%
105.9														
44.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
For
CPR Detour
at
Hwy. 407/CPR Subway
(Between Islington Avenue and Humber River)
W.P. 141-87-00D
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. In order to maintain train traffic throughout the construction of the Hwy. 407/CPR Subway which is proposed along the existing alignment, it is proposed to construct a detour for the CPR at a location west of the existing track. The proposed alignment is illustrated on Drawing 1418700D-1* in the Appendix and reflects radii of curvature required by the CPR to facilitate train traffic at speeds requested by the railroad. The realignment will stretch from Sta. 9+621.5 to Sta. 10+127 through a range of surface topographies that will dictate excavation cuts in some locations and traversal of low lying areas (by earth fills or trestle structure) at other locations.

This report describes the subsurface conditions within the proposed realignment

SITE DESCRIPTION AND GEOLOGY

The site is located immediately west of the existing CPR track approximately 0.3 km northwest of the CPR-Islington Avenue level crossing in the Town of Vaughan, Regional Municipality of York. The site is characterized by a pronounced valley that supports side slopes of approximately 2.5H:1V and trends in a general southwesterly direction. The crest of the valley is approximately 200 m in

* SHEET NO'S 79-1 & 79-2 OF THE CONTRACT DWG'S

200 m in width and the valley depth is approximately 20 m. The valley houses the Jersey Creek that runs its course at the valley floor and is approximately 2 m in width and normally flows at 1 m depths. The Jersey Creek flows into the Humber River located in a flood plain immediately west of the site.

The valley slopes are densely covered with trees, brush, tall grasses and shrubs. There is no evidence of slope creep or displacement indicating that the valley slopes appear to be stable at its present geometry.

The existing CPR track at the site is advanced partly in a excavation cut in the native subsoil and partly on embankment fills. An earth embankment spans the valley at the proposed Hwy. 407 right-of-way. This railroad embankment, supposedly constructed in the early 1900's supports side slopes approximately 1.5H:1V. Trees and low lying shrubs and grassland cover the existing constructed slopes. There appears to be no evidence of slope stability other than a localized area at the northeastern portion of the embankment. Rip-rap and armour stone was placed on the slope to retard surficial erosion at this location.

A concrete culvert is located at the base of the constructed embankment to facilitate the Jersey Creek outflow beneath the embankment. Again, no visible signs of distress in the culvert were apparent.

Land use surrounding the site consists of residential lots located east of the site, a hydro corridor consisting of transmission towers just north of the site and forestland elsewhere. A CPR two span structure is located approximately 0.3 km north of the site along the same track alignment. The structure spans the Humber River at this location. In addition, a CNR rigid frame overhead exists approximately 0.2 km south of the site to facilitate CN Rail traffic in a east-west direction over the CPR track.

Physiographically, the site lies within the region known as the South Slope (Chapman and Putnam, 1984). The South Slope Formation at the site consists of a ground moraine, scoured at intervals by valleys tributary to the Humber River systems. The valleys accentuate the hilly moraine topography. The glacial

landforms and deposits were formed by the advance and retreat of the Wisconsin ice sheet that covered the area during the Pleistocene epoch (over 5000 years ago).

The overburden is underlain by the grey shales of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION

The fieldwork for the investigation was coordinated with the field investigation for the proposed CPR Subway and the proposed Jersey Creek concrete culvert. The fieldwork was conducted between 89 10 21 and 89 11 30 and consisted of a total of 14 sampled boreholes, including the 8 sampled boreholes advanced in conjunction with the CPR Subway and 3 sampled boreholes advanced in conjunction with the concrete culvert.

Five of the twelve boreholes were advanced through the overburden using hollow stem augering techniques to the depths of the lower sand to silty deposit (approximately 39 metres). Beyond that depth, the boreholes were advanced using conventional diamond drilling techniques (casing and washboring) to overcome torquing restriction imposed on the hollow stem augers. The NW casing used was advanced by both driven and rotary methods. The drilling equipment used was a track mounted CME 55.

In consideration of the importance of establishing the composition of the CPR embankment fill, a total of four boreholes were advanced in the existing embankment fill. Two of the boreholes were advanced from the crest of the embankment using the track-mounted CME. The other two boreholes were advanced at mid-slope, on the west side of the embankment (BH's 4A, 6A). These boreholes were advanced using conventional diamond drilling techniques via a tripod apparatus.

Three of the boreholes were advanced along the proposed realignment until a "competent" subsoil was encountered and ascertained where "competent subsoil" is defined as a compact to dense cohesionless deposit, a hard cohesive deposit or

bedrock. Hollow stem auger equipment was used to advance the boreholes in the overburden. At the site, a very dense cohesionless deposit was encountered in the floodplain area of the proposed detour alignment and a hard cohesive deposit was located at the crest of the valley and hence the boreholes were terminated in these deposits.

Two additional boreholes were advanced in conjunction with the concrete culvert using hollow stem augering techniques.

In general, subsoil samples were retrieved at 1.5 m intervals for the upper 27-30 m and at 3.0 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved in the surficial silty clay to clayey silt till deposit using a Shelby tube samples in accordance with standard practice (ASTM D1587). In situ vane tests were also conducted in the cohesive silty clay to clayey silt till deposit, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the Standard MT0 'N' values in accordance with ASTM 2573.

Bedrock was cored at five boreholes using conventional rock coring methods in NQ size.

All subsoil samples and rock core were identified in the field and returned to the laboratory for further examination and applicable testing.

Water levels were obtained in the open boreholes and also in a sealed piezometer installed at BH D-8. Groundwater levels were monitored throughout the duration of the investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Unconfined Compression Tests
- 6) Unconsolidated Undrained Tests
- 7) Multi-stage consolidated undrained tests with pore pressure measurements
- 8) Consolidation Test

In view of the general uniformity of soil types found in the general site area, all laboratory results for similar soil strata have been integrated from the different structures (CPR Subway structure, Jersey Creek concrete culvert). Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The native subsoil of the original valley at the site consists of a surficial deposit composed of a clayey silt to silty clay with occasional sand seams and traces of gravel. The stratum is a till deposit of glacial origin and extends to a maximum thickness of 13.7 m at the crest of the valley. The thickness of this deposit decreases down the valley slope and does not exist at the valley floor and the floodplain located at the base of the existing CPR embankment (BH D-3) and at the culvert outlet (BH C-1). The consistency of this deposit ranges from firm to hard.

Underlying the upper till deposit and located as a surficial stratum in the floodplain exists a deposit of clayey silt that extends for a considerable thickness ranging from 18.3 m to 28 m below the upper till and from 10.7 m to 11.1 m in the floodplain area. This stratum also contains random interbeds of sand and gravel.

The clayey silt deposit is in turn underlain by a cohesionless deposit of sands and silts. The deposit varies randomly in silt and sand percentages, varying

from sand with some silt to sandy silt. Random zones of silt also exist in the soil matrix. Gravel, boulders and cobbles are also components of the lower depths of the deposit. The thickness of this deposit ranges from 4.2 m to 15.8 m with an average thickness of approximately 10 m. The denseness of this deposit varies from compact to very dense. This cohesionless deposit overlies shale bedrock of the Georgian Bay shale formation.

Two types of fill material was used to construct the CPR embankment. Surficially and within a zone above and immediately adjacent to the existing concrete culvert, a cohesionless backfill material consisting of a sand with some silt to sandy silt was used. Beneath the surficial sand material and beyond the culvert backfill wedge zone, the embankment fill material consists of a clayey silt with interbedded layers of sand. The thickness of the surficial cohesionless fill material which also exists on the embankment slopes, ranges from 2.0 to 4.6 m. The maximum depth of the embankment fill explored was 13.9 m at BH D-6, located at the proposed CPR Subway pier location. At BH's D-1, D-2, located in the area of the south abutment, only 1.5 to 2.4 m of granular fill was encountered, confirming the valley crest location. At BH D-4, the location of the proposed north abutment, 12.2 m of clayey silt fill material with interbedded layers of sand exists.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwgs. 1418700D-1* & 1418700D-2*.

A detailed description of the subsurface conditions encountered is given below.

Sand, some Silt (Fill)

As previously mentioned, the surficial embankment fill material and backfill material to the existing concrete culvert consists generally of a brown sand with some silt. Occasional layers of sandy silt and clayey silt are also

* SHEET NO'S 79-1 & 79-2 OF THE CONTRACT DWG'S

present in the fill material and traces of fine gravel are also randomly intermixed. A grain size distribution envelope illustrating the gradation of the fill is provided in Figure 1 in the Appendix. The surficial thickness of the fill material varies from 1.5 to 2.4 metres and the maximum thickness explored was 16.2 metres at which depth the existing concrete culvert roof was encountered (see BH D-7).

Standard Penetration tests carried out in the cohesionless fill material revealed 'N' values ranging from 2 blows/0.3 m to 21 blows/0.3 m indicating a very loose to compact state of condition.

Clayey Silt (Fill)

Beneath the surficial cohesionless fill and beyond the culvert cohesionless backfill material, the CPR embankment fill consists of a brown, cohesive clayey silt. The maximum thickness of the clayey silt fill encountered was 12.2 metres at the proposed north abutment location. Interbedded layers of fine sand ranging in thickness from 50 mm to 150 mm are also present randomly in the cohesive matrix. A grain size distribution envelope for this material as determined by mechanical sieve and hydrometer analysis is given in Figure 2.

Atterberg Limits were obtained to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 3. A summary of the indices is provided in Table 1 below. Unit weights are also included.

Table 1 - Clayey Silt (Fill)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-24	8
Liquid Limit (w _L %)	21-32	8
Plastic Limit (w _p %)	13-19	8
Unit Weight (kN/m ³)	19.2-20.2	4
Undrained Shear Strength (c _u) (kPa)	80->120	5

The test results reveal that the cohesive fill material is of low plasticity and hence can be categorized as clayey silt.

Undrained shear strength measurements (cu) were obtained in situ by conducting field vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 1 above. However, in consideration of the interbedded layers of sand, consistencies ranging from stiff to very stiff which is representative of the determined shear strength values cannot be implicitly assumed.

Silty Clay to Clayey Silt (Glacial Till)

The native surficial deposit present at the site consists of a cohesive silty clay to clayey silt with traces of sand and gravel and occasional random interbedded sand seams. The thickness of the deposit explored in the investigation ranges from 11.3 to 13.7 and the interbedded sand seams are generally 50 to 100 mm in thickness. At BH D-4, the approximate location of the proposed north abutment, this deposit does not exist indicating that the deposit decreases in thickness from the crest of the valley to the valley floor. The deposit is generally oxidized (brown) for the upper 1.5 to 3.5 metres and unoxidized (grey) for its lower thickness. The deposit is a till of glacial origin.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 25-61% and 35-61% respectively, confirming the range in behaviour of the fine grained portion of the deposit.

Although not encountered during this investigation, boulders and cobbles are characteristic components of till deposits and consequently may be encountered in this deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 5. A summary of the indices is provided in Table 2. Unit weights are also included.

Table 2 - Silty Clay to Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-29	14
Liquid Limit (w _L %)	22-47	14
Plastic Limit (w _p %)	12-20	14
Unit Weight (kN/m ³)	18.8-20.3	9
Undrained Shear Strength (cu) (kPa)		
- Field Vane	35->120	28
- Laboratory*	41-82	4
Sensitivity	2-3	28

*Unconfined Compression Tests

*Unconsolidated Undrained Tests

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay).

Undrained shear strength measurements (cu) of the soil were obtained both by in situ vane tests and by laboratory tests, namely unconfined compression tests and unconsolidated undrained tests (quick triaxial). Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2 above. A Shear Strength vs Elevation profile is also provided in Figure 6. Based on shear strength values ranging from 35->120 kPa, it is considered that the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 3 indicating that the soil has a low sensitivity.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 3.

Table 3 - Effective Shear Strength Parameters

Sample	BH D-1, TW5
Elevation (m)	147.0
Liquid Limit	47
Plastic Limit	20
Natural Moisture Content (w%)	26
Effective Angle of Internal Friction (ϕ°)	29.5
Effective Shear Strength Intercept (C')	10

For design purposes, a reduced angle of internal friction (ϕ°) of 26° and a shear strength intercept of 5 kPa was selected to account for the fact that the sample test was not saturated.

A consolidation test was conducted to evaluate the compressibility characteristics of this deposit. The results (e-log p curve) of the test are illustrated in Figure 7 in the Appendix. The results reveal that this cohesive stratum has been preconsolidated in the past to an effective pressure 200 kPa in excess of the existing overburden pressure.

The coefficient of consolidation (c_v) used to determine the time rate of consolidation settlement was computed using Taylor's Method (1948). The results reveal values ranging from 0.004 m²/day to 0.005 m²/day for loadings ranging from 100 to 200 kPa.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 15 blows/0.3 m.

Clayey Silt

Underlying the surficial clayey silt to silty clay deposit at a depth ranging from 10.7 m to 13.7 m below the ground surface (Elevation 140.0 to 135.2) and

extending for a maximum thickness of 18.3 m, and present at the the surface of the floodplain and extending to a maximum thickness of 11.1 m, a cohesive deposit of clayey silt exists. This stratum also contains traces of sand and random zones of silt. In the floodplain, a trace of organics was encountered in the surficial 2 m of the deposit and interbedded layers of sand and gravel approximately 100 mm in thickness also exist.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 8. The envelope illustrates that clay and silt percentages in the deposit range from 12-34% and 60-88% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 9. A summary of the indices is provided in Table 4. Unit weights are also included.

Table 4 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	14-35	17
Liquid Limit (w_L %)	26-29	17
Plastic Limit (w_p %)	14-18	17
Unit Weight (kN/m^3)	20-22	8

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 76 blows/0.3 m indicating that the deposit ranges in consistency from firm to hard. In general, in the upper 10 m or so, 'N' values ranged from 20 blows/0.3 m to 30 blows/0.3 m (although lower 'N' values were obtained in the floodplain area because of the presence of organics), indicating a very stiff consistency. In the lower depths of the deposit, 'N' values ranged from 10 blows/0.3 m to 20 blows/0.3 m and the soil can be categorized as having a stiff consistency.

Sand and Silt

Underlying the clayey silt deposit and extending to bedrock a cohesionless deposit of sand and silt exists. The deposit is predominantly composed of sand with some silt but random zones of sandy silt to silt are also present within this deposit. In addition, gravel, boulders and cobbles exist as a heterogeneous mixture in the deposit at the lower depths immediately above the bedrock. At BH's D-4 and C-3, approximately 2.5 m of the coarser grained gravel, boulders and cobbles was encountered. The thickness of the entire deposit ranges from 4.2 m to 15.8 m, but is generally in the order of 10 metres. A grain size distribution envelope for this deposit is provided in Figure 10 in the Appendix.

This cohesionless deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 10 blows/0.3 m to 120 blows/0.8 m indicating that the deposit ranges in denseness from compact to very dense. In the floodplain area of the site, 'N' values obtained below the upper 3 m thickness were generally representative of very dense material. The deposit is predominantly compact to dense at the other locations of the site.

Bedrock

The cohesionless sand with some silt deposit is directly underlain by shale bedrock of the Georgian Bay shale formation. The bedrock surface is generally flat with surface elevations ranging from 105.9 m to 107.7 m. The bedrock was cored by NQ size up to 2.8 metres in thickness.

The shale bedrock is grey in colour and is very fine grained and thinly laminated. The rock is generally slightly to moderately weathered and contains occasional clay seams, approximately 50 to 100 mm in thickness. Minor beds of argillaceous limestone are also present in the rock formation. Detailed descriptions of the bedrock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Rock recoveries varied between 60 and 100% while RQD's varied between 0 and 15%. The shale bedrock is weak to very weak rock.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring the level in a piezometer installed at BH D-8 (CPR Subway pier location). The piezometer was installed in the clayey silt deposit with bentonite seals above and below the piezometer tip. Measurements obtained at the time of the investigation revealed levels as tabulated in Table 5 below.

Table 5 - Groundwater Levels

Depths (m)	Elevations (m)	BH's	Location
2.0-4.0 m	148.2-150.6	D-1 D-2 D-3	Valley Crest (South Abutment, 40 m north of North Abutment)
6.2	144.4	D-8	Pier
16	136.1	D-4	North Abutment (12.2 m of embankment fill).

Artesian conditions were encountered in the gravels, boulders and cobbles present at the lower depths of the sands and silts deposit within the floodplain. Up to 3 m of piezometric head above the natural ground surface was observed.


In all cases, the groundwater level was not found in the boreholes advanced in the embankment fill.

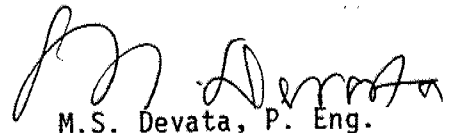
Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Marathon Drilling. The description of bedrock core samples was carried out by S. Senior, Geological Engineer.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M. Devata, Chief Foundation Engineer.


for Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

ROCK CORE DESCRIPTION

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
D-1	34	46.10-47.22	73	0	46.10-48.90	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (5%).
	35	47.22-48.90	100	0		
D-2	22	47.55-49.07	92	7	47.55-49.07	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered, intensely weathered sections at 47.60m and 48.18m; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (8%).
D-4	22	44.81-46.33	60	8	44.81-44.98	OVERBURDEN , cobbles, weathered, bedrock.
					44.98-46.33	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; moderately weathered to highly weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (20%).
D-8	25	42.98-44.65	100	15	42.98-44.65	SHALE , medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (11%).

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

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ROCK CORE DESCRIPTION
WP 141-87-00

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C-3	27	45.67-47.19	60	10	45.67-46.28	OVERBURDEN , gravel, cobbles, weathered bedrock.
					46.28-47.19	SHALE , medium grey to medium dark grey; very fine grained, very thinly laminated; weak to medium strong rock; slightly to medium weathered; extremely close spaced fractures.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

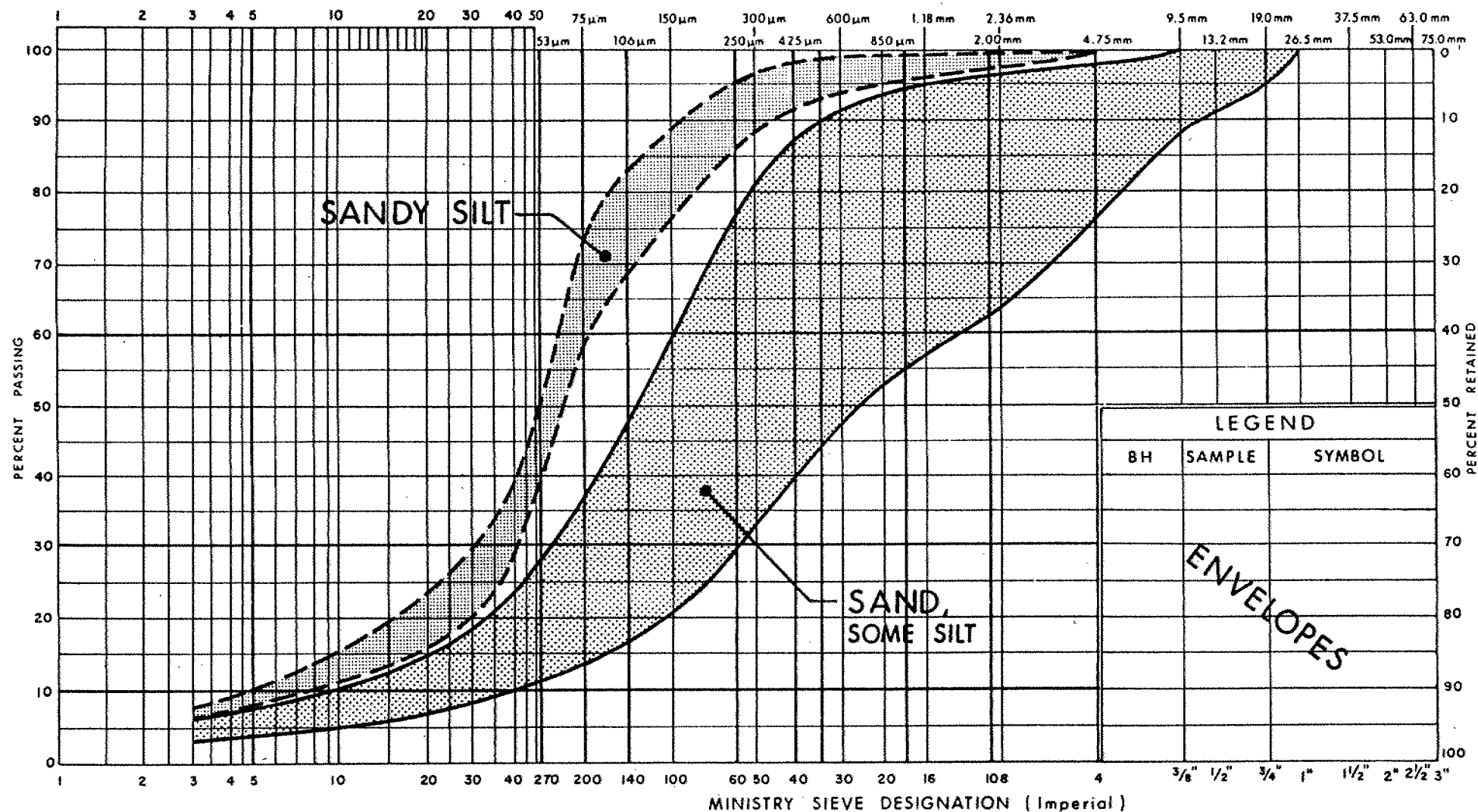
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH SAMPLE SYMBOL

ENVELOPES

Ministry of
TransportationGRAIN SIZE DISTRIBUTION
(FILL MATERIAL)

FIG No 1

W P 141-87-00 D

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

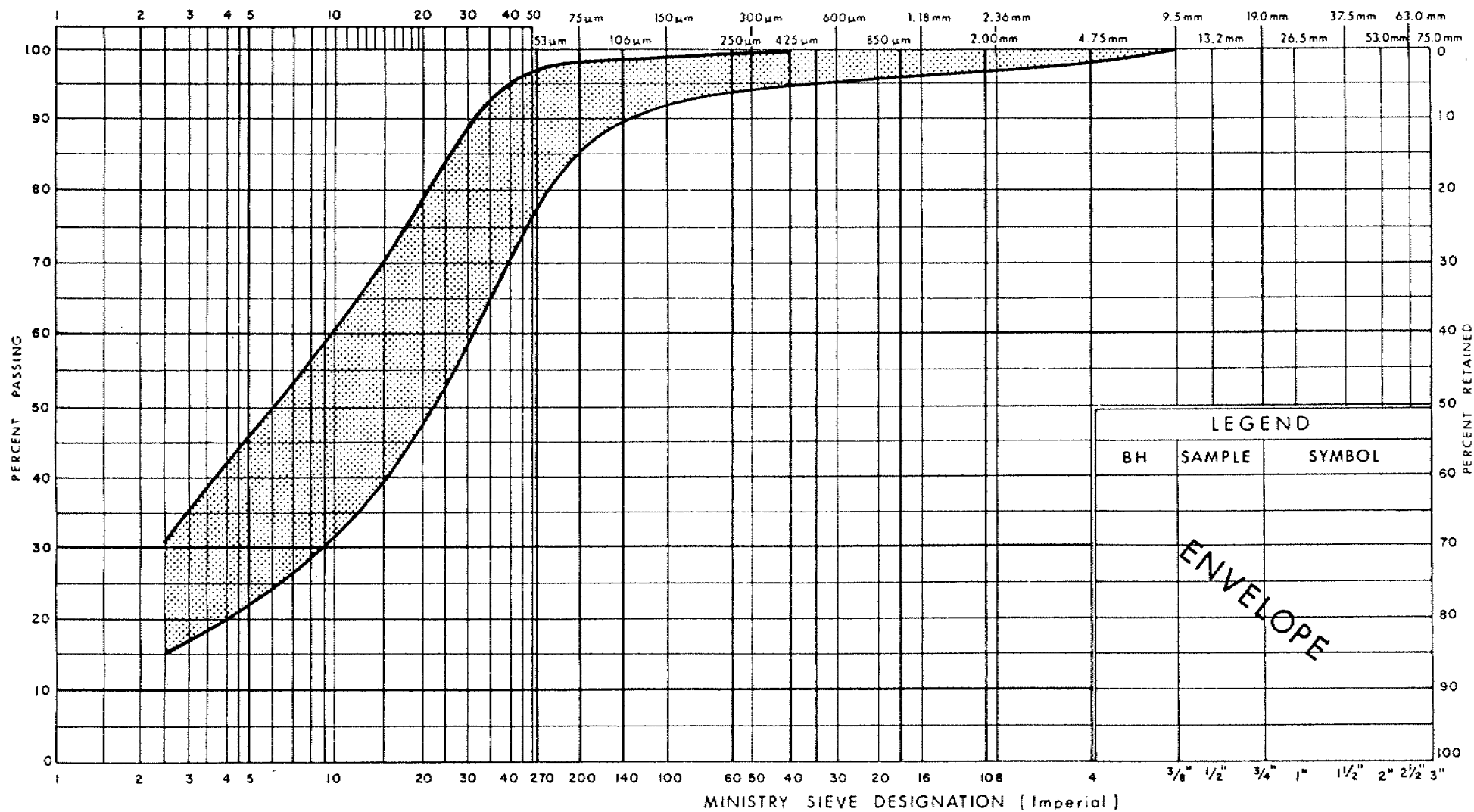
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH SAMPLE SYMBOL

ENVELOPE

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (FILL)

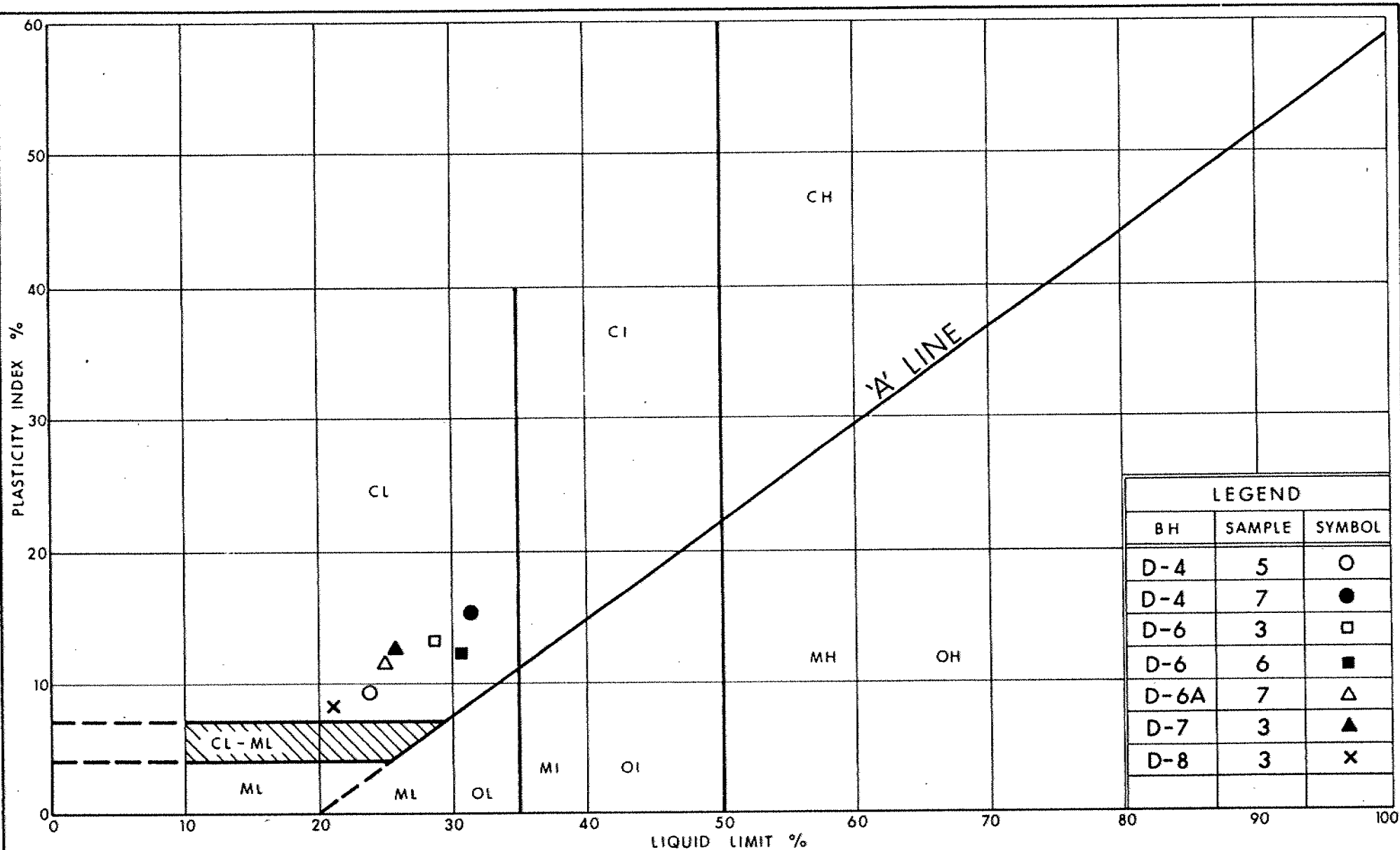
FIG No 2

W P 141-87-00 D

300



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Transportation



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Transportation

Ontario

PLASTICITY CHART CLAYEY SILT (FILL)

FIG No 3

W P 141-87-00 D

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

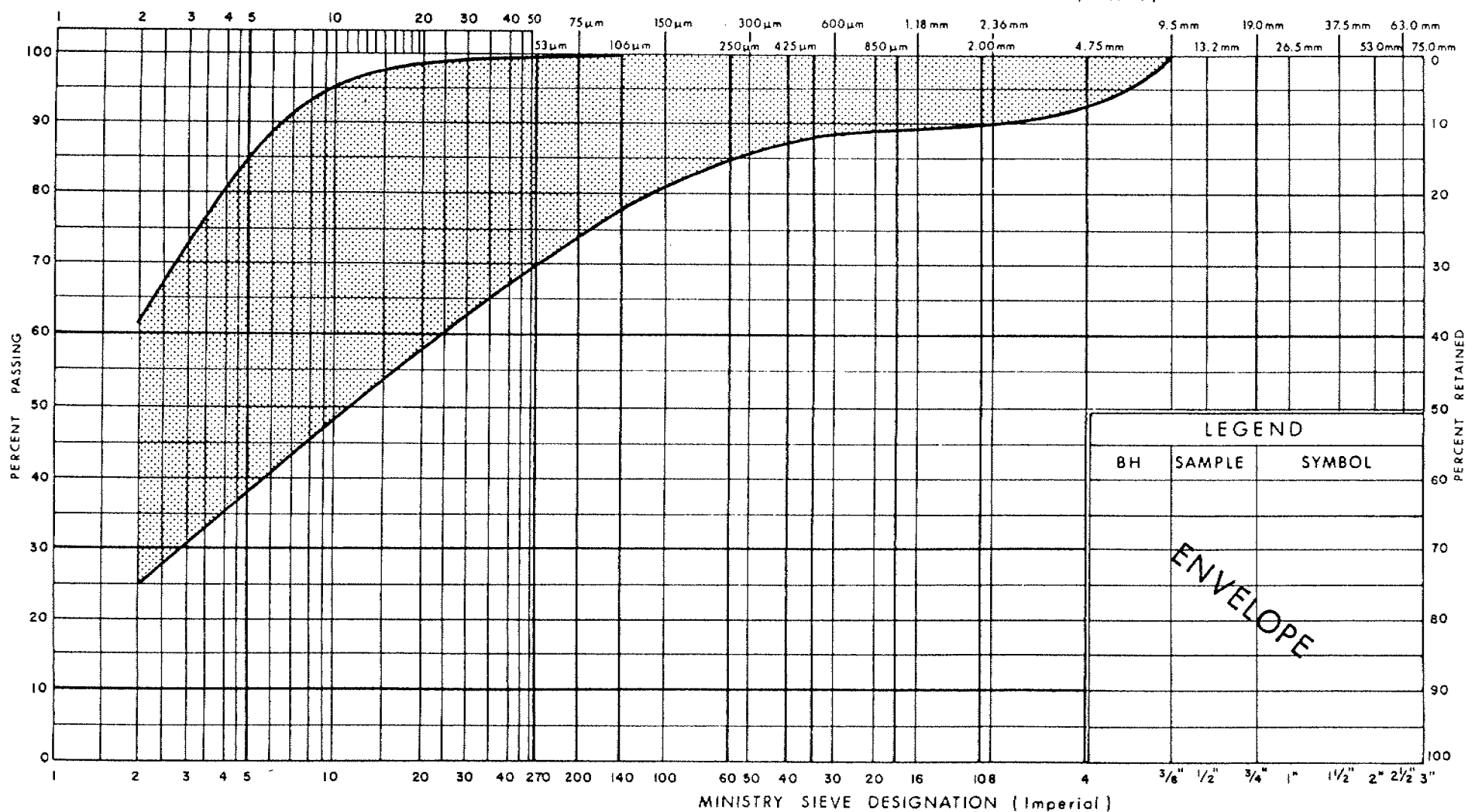
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH

SAMPLE

SYMBOL

ENVELOPE

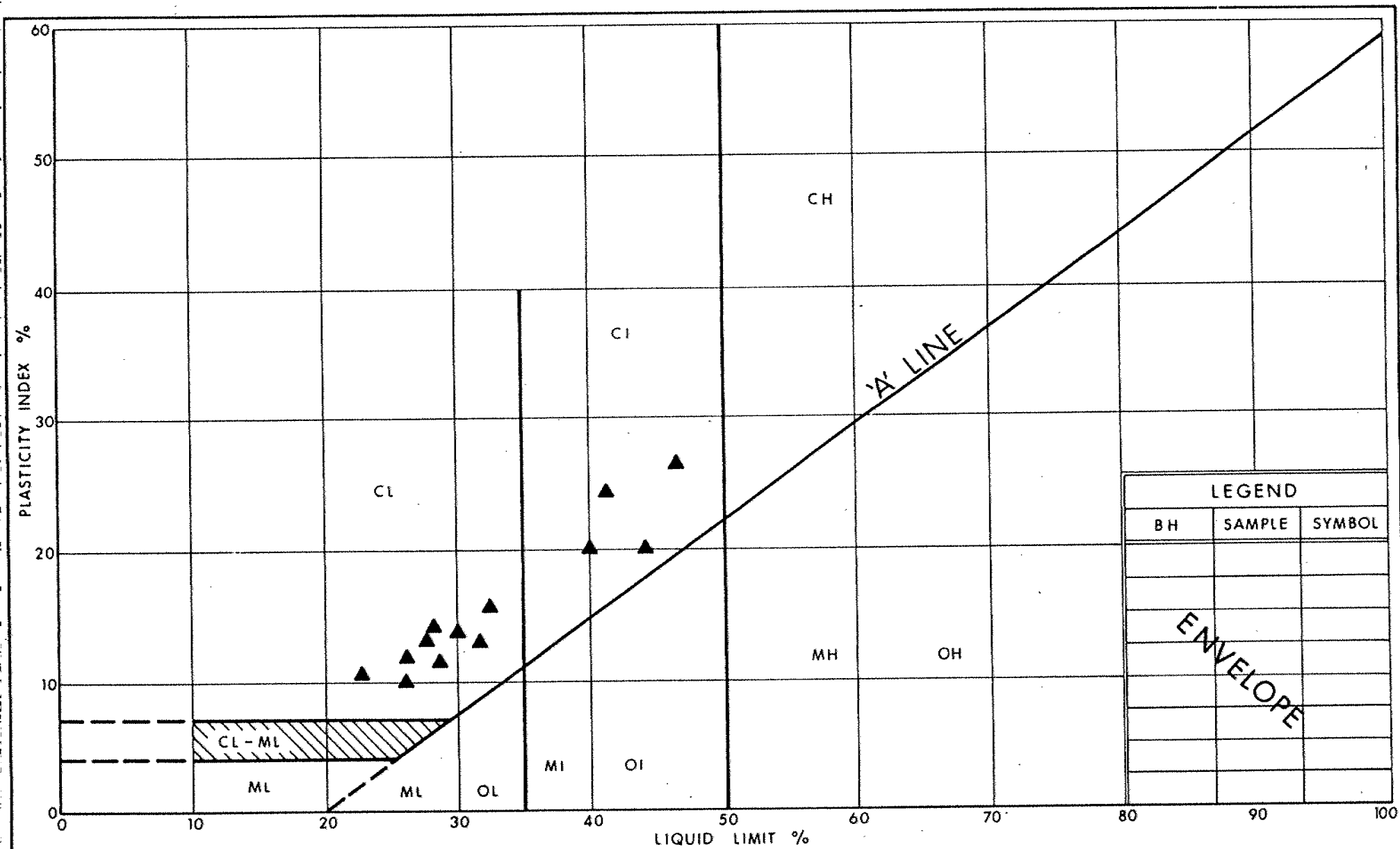
GRAIN SIZE DISTRIBUTION
 SILTY CLAY TO CLAYEY SILT
 (Glacial Till)

FIG No 4

W P 141-87-00D



Ministry of
 Transportation



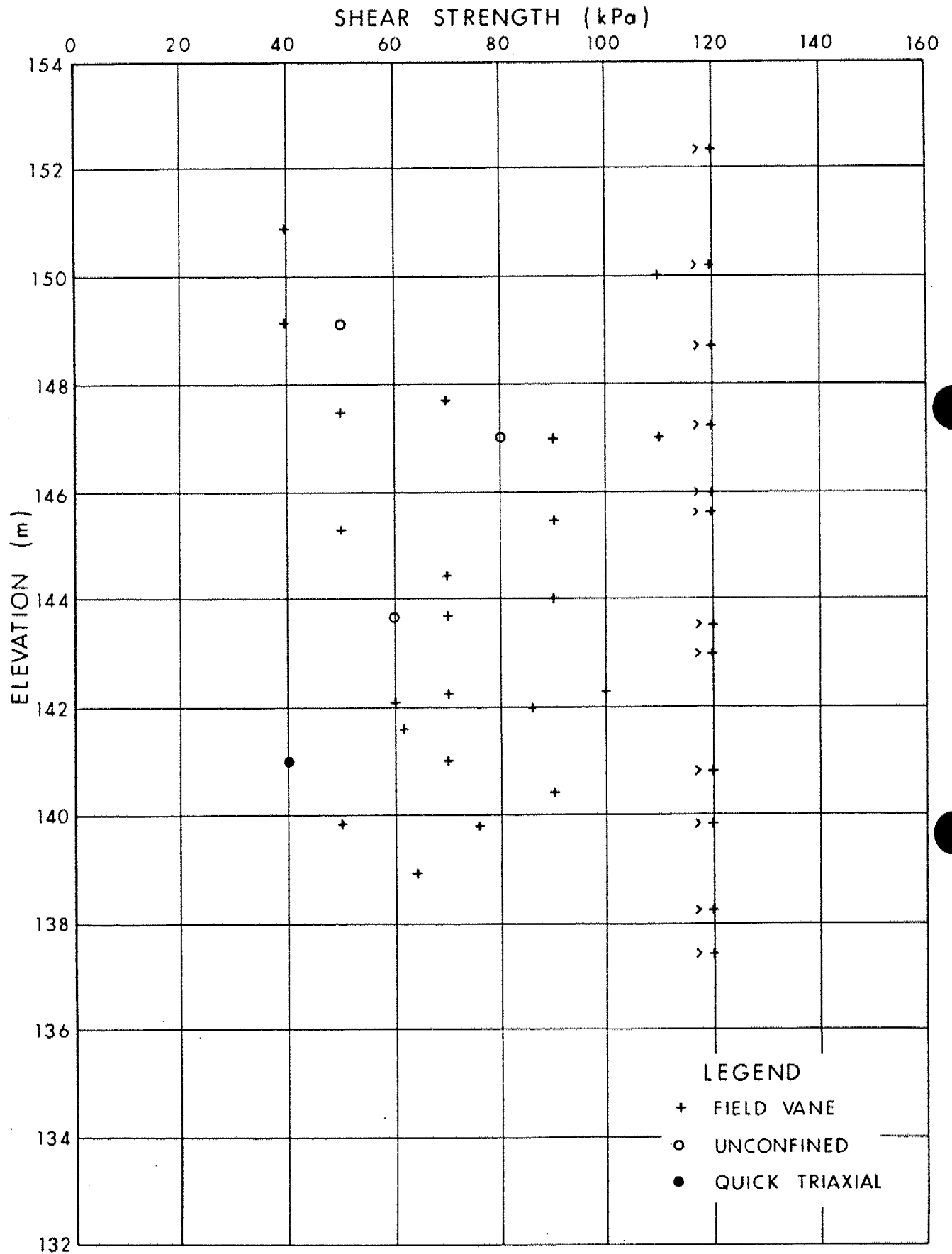
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Ontario

PLASTICITY CHART SILTY CLAY TO CLAYEY SILT (Glacial Till)

FIG No 5

W P 141-87-00 D

UNDRAINED SHEAR STRENGTH V_s ELEVATION

W P 141-87-00D

Fig 6

VOID RATIO - PRESSURE CURVES

305

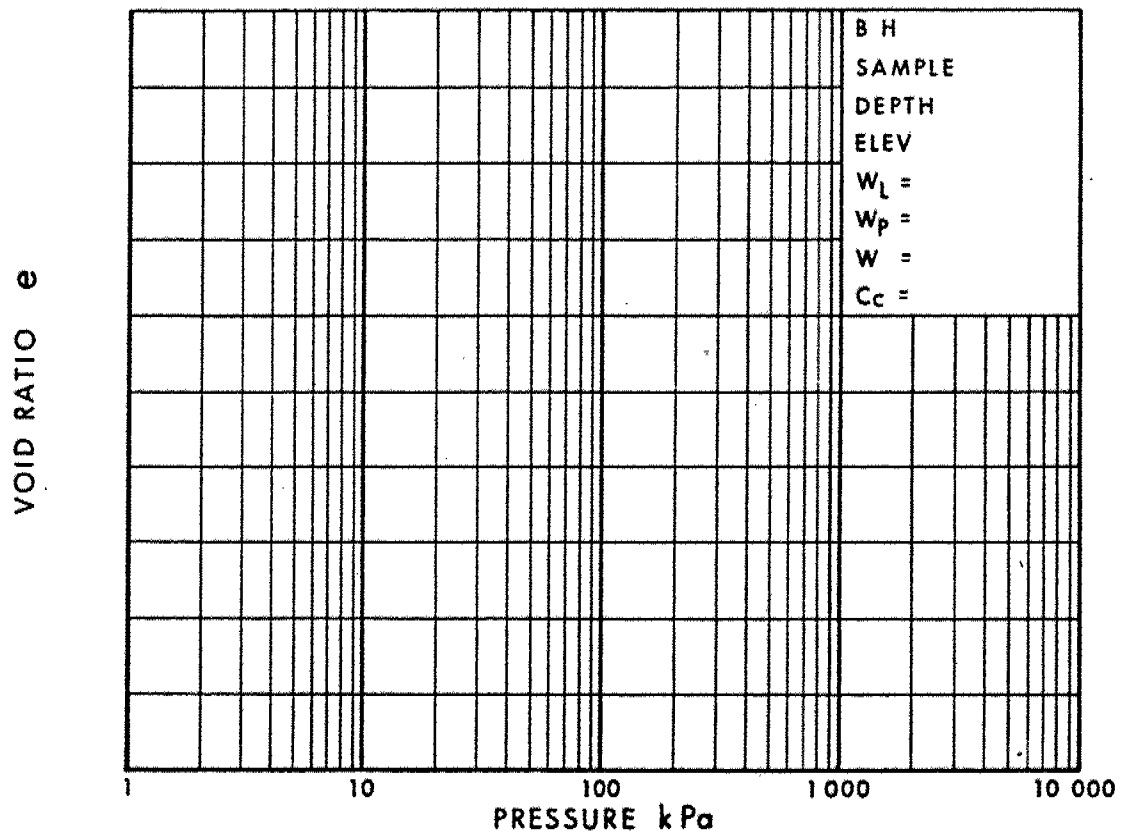
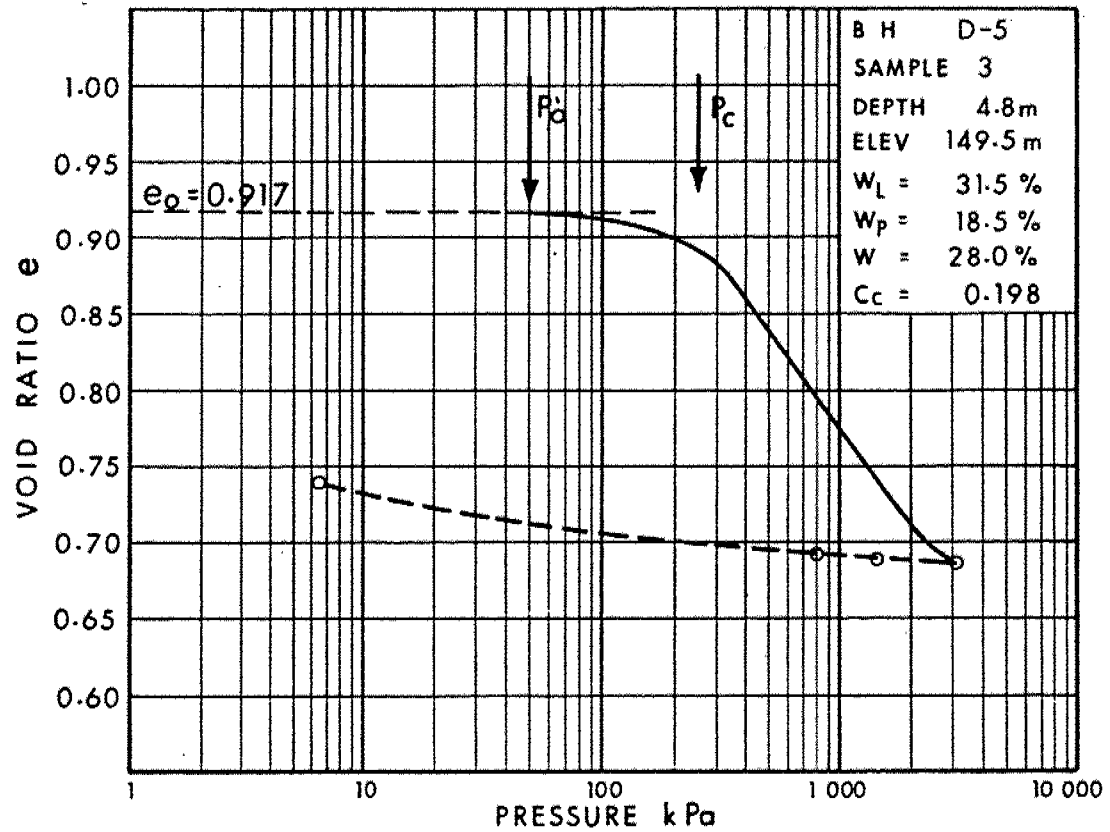
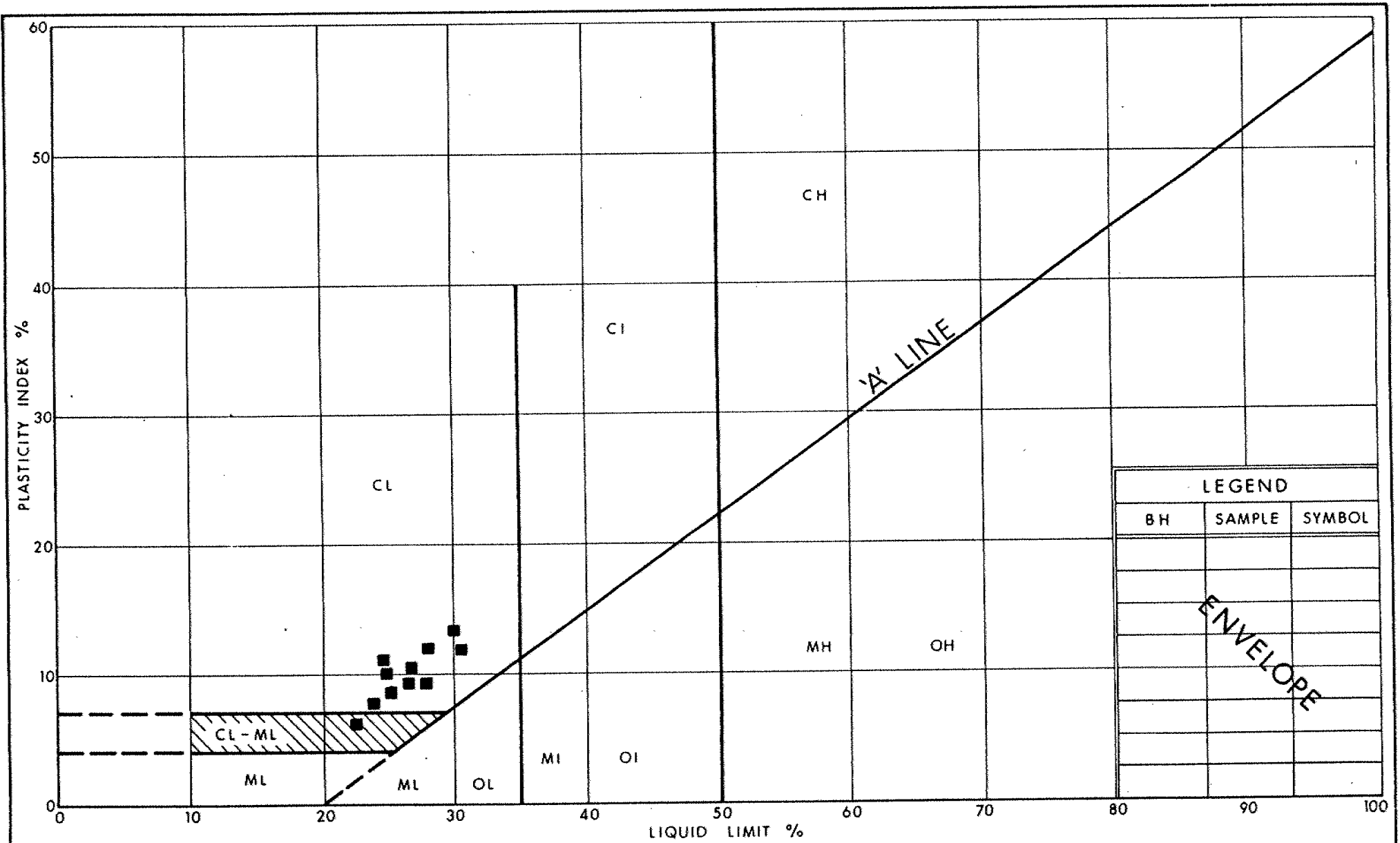


Fig 7

W P 141-87-00D



W P 141-87-00 D



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PLASTICITY CHART CLAYEY SILT

FIG No 9

W P 141-87-00 D

307

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

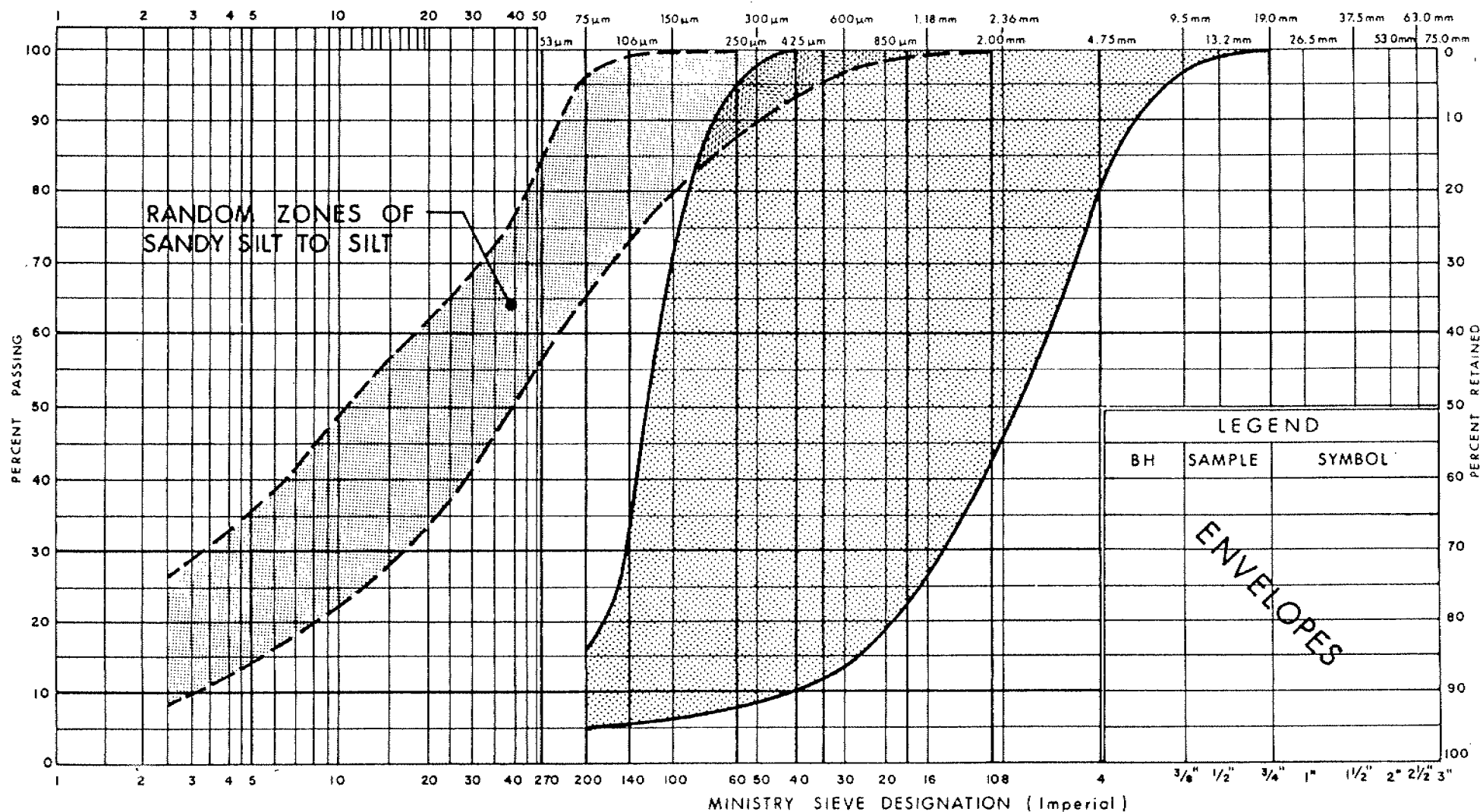
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



GRAIN SIZE DISTRIBUTION
SAND, SOME SILT

FIG No 10

W P 141-87-00 D

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Ministry of
Transportation

RECORD OF BOREHOLE No C-1

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 519.6; E 298 137.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 24 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	* ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
136.5	Ground Surface													
0.0														
	Trace Organics		1	SS	7									
			2	SS	9									
	Firm to Stiff		3	SS	11									
	Stiff to Hard	Brown Grey	4	SS	22									
			5	SS	30									
			6	SS	32									
	Clayey Silt													
	Trace of Sand		7	SS	28									
			8	SS	30									
			9	SS	12									
125.8														
10.7	Sandy Silt		10	SS	12									
			11	SS	18									
	Compact V. Dense		12	SS	120									
			13	SS	120/15cm									
	Occ. Gravel Seams													
			14	SS	90									
			15	SS	94									
	Gravel, Boulders and Cobbles													
111.8														
24.7	End of Borehole		16	AS	-									
	*Artesian Head 3.0m Above Ground Surface													

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C-2

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 540.1; E 298 173.9 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
DATUM Geodetic DATE 1989 11 28 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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					
147.4	Ground Surface															
0.0	Sand, Trace Silt															
	Trace Gravel		1	SS	5											
	(Fill)															
	Brown, V. Loose		2	SS	4											10 EI (9)
	to Loose															
142.4			3	SS	7											
5.0																
	Silty Clay		4	SS	5											
	to															
	Clayey Silt		5	SS	10											
	Trace Gravel															
	Occ. Sand Seams		6	TW	PH											
	Firm to V. Stiff															
	(Glacial Till)		7	TW	PH											
135.2																
12.2			8	SS	9											
			9	SS	15											
	Clayey Silt		10	SS	14											0 4 66 30
	Trace Sand		11	SS	15											
	Grey		12	SS	13											
			13	SS	11											
			14	SS	12											
			15	SS	13											
			16	SS	10											
	Stiff															
	Firm		17	SS	7											
124.5																
22.9	Sand		18	SS	5											
	Some Silt															
122.6	Grey, Loose		19	SS	8											
24.8	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-3

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
152.2	Ground Surface						152										
0.0																	
	Clayey Silt, Trace Sand, Trace Gravel		1	SS	8		150										
			2	SS	9		148										
	Brown Grey		3	SS	2		146										
	Firm to V. Stiff		4	TW	PH		144										
	Occ. Sand Seams (Glacial Till)		5	SS	12		142										0 4 61 35
			6	SS	5		140									20.2	
	Silt, Tr. Sand		7	SS	12		138										0 10 85 5
140.0			8	SS	16		136										
12.2			9	SS	23		134										
	Clayey Silt		10	SS	24		132										
	Trace Sand		11	SS	26		130										
	Grey, Stiff to		12	SS	26		128										
	V. Stiff		13	SS	27		126										
			14	SS	29		124										
			15	SS	24												
			16	SS	21												
			17	SS	15												
			18	SS	36												
			19	SS	14												
			20	SS	14												
			21	SS	11												
			22	SS	14												
122.0																	
30.2																	

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No C-3 Cont'd

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 89 11 22 - 25 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					
122.0	Continued												
121.7	Clayey Silt		23	SS	10								
30.5	Sand												
	Some Silt												
	Grey, Compact		24	SS	39								
	to Dense												
			25	SS	28								
			26	SS	46								
	Occ. Cobbles												
	Boulders and												
	Gravel												
105.9													
46.3	Bedrock		27	RC	REC								
105.0	Shale				60%								RQD = 10%
47.2	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C-4

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 580.0; E 298 204.5 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 11 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
147.0	Ground Surface																
0.0																	
	Brown Grey		1	SS	12		146										
	Clayey Silt		2	SS	6		144										
	Some Sand, Tr. Gravel						142			2							
	Stiff to V. Stiff		3	SS	7		140			2							8 17 47 28
	Occ. Sand Seams (Glacial Till)		4	SS	5		138			2							
			5	SS	5		136										
136.3			6	SS	13		134										
10.7			7	SS	22		132										
	Clayey Silt		8	SS	13		130										
	Grey, Stiff to Hard		9	SS	34		128										
	Random Zones of Silt		10	SS	39		126										0 1 73 26
			11	SS	25		124										
			12	SS	23												
			13	SS	19												0 3 67 30
			14	SS	18												
			15	SS	15												
			16	SS	14												
			17	SS	10												
122.2			18	SS	11												
24.8	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

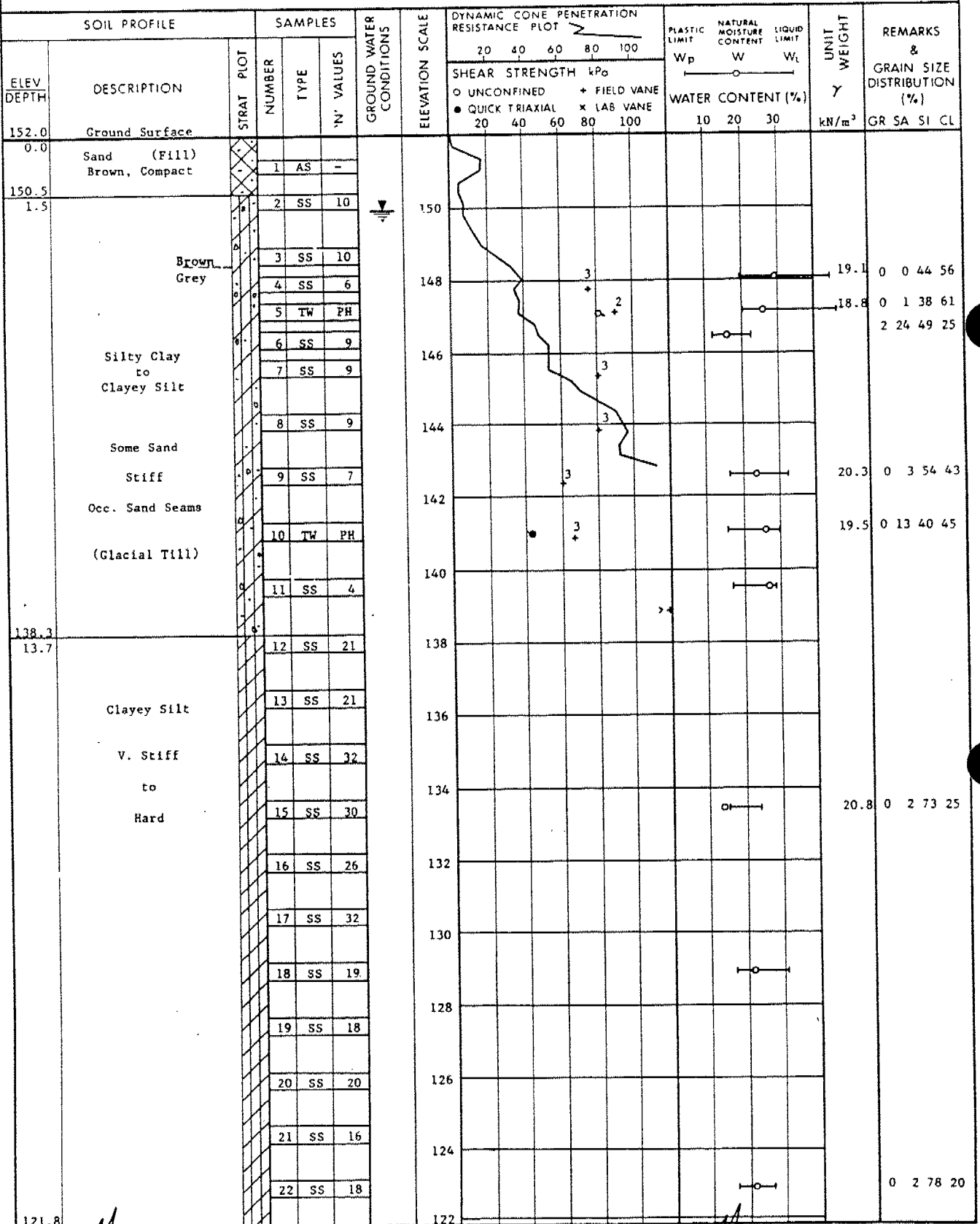
20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-1

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & Cone Test COMPILED BY TS
DATUM Geodetic DATE 89 10 21-30 CHECKED BY



OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-1 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE R.S. Auger, BW Casing, Washbore, BXL Rock Core & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 89 10 21-30 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
121.8 30.2	Continued		23	SS	16									
	Clayey Silt Very Stiff to Hard		24	SS	16		120							
			25	SS	76		118							
			26	SS	45		116							
115.4 36.6			27	SS	15									0 86 (14)
	Sand Tr. Silt Compact to V. Dense		28	SS	59		114							
			29	SS	58		112							
			30	SS	65		110							1 89 (10)
			31	SS	33		108							
	Tr. Gravel		32	SS	44		106							8 85 (7)
105.9 46.1			33	SS	129	23cm	104							
	Bedrock Shale Weak to Very Weak		34	BXL RC	REC 73%									RQD = 34%
			35	BXL RC	REC 100%									RQD = 0%
103.1 48.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-2

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 1989 11 08-11 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100					
153.0	Ground Surface												
0.0	Irregular Mixture of Silt, Sand, Slag Ballast (Fill)		1	SS	11								
150.6	Brown-Black, Compact												
2.4			2	SS	7				2				
			3	SS	7				2				
	Brown Grey		4	SS	8								
	Silty Clay to Clayey Silt		5	TW	PH							21.0	1 13 58 28
	Some Sand, Trace Gravel Firm to V. Stiff		6	TW	PH								
	Occ. Sand Seams		7	SS	4								4 13 35 48
	(Glacial Till)		8	SS	4								
139.3			9	SS	22								0 4 79 17
13.7	Clayey Silt Firm to V. Stiff		10	SS	20								
			11	SS	23								
			12	SS	12								
			13	SS	20								
			14	SS	18								
			15	SS	13								
122.8													
30.2													

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-2 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NO Core COMPILED BY TS
 DATUM Geodetic DATE 1989 11 08-11 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
122.8 30.2	Continued															
	Clayey Silt Firm to Very Stiff		16	SS	9											
			17	SS	5											
116.1 36.9	Sand Tr. Silt Compact to V. Dense Occ. Gravelly Seams		18	SS	50											
			19	SS	20											
			20	SS	56											
			21	SS	50											
105.5 47.5	Bedrock Shale Weak to Very Weak		22	RC	REC 92%											
103.9 49.1	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-3

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 504.0; E 298 204.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 27 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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	20 40 60 80 100					
136.0	Ground Surface													
0.0														
	Interbedded Layers of Sand and Gravel		1	SS	4									
			2	SS	2									
	Brown Grey		3	SS	14									
	Tr. Organics		4	SS	12									
			5	SS	22									
			6	SS	19									
	Clayey Silt		7	SS	27									
	Tr. Sand, Tr. Gravel		8	SS	20									
			9	SS	20									
	Stiff to Hard		10	SS	15									
124.9														
11.1	Silt		11	SS	7									
	Tr. Clay, Tr. Sand		12	SS	85									
	Loose V. Dense		13	SS	100/	15cm								
			14	SS	120/	10cm								
119.1														
16.9	End of Borehole													

RECORD OF BOREHOLE No D-4

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 13-21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	IN' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
152.1	Ground Surface						152									GR SA SI CL
0.0																
	Clayey Silt With Interbedded Layers of Sand (Fill) Brown to Grey V. Soft to Stiff		1	SS	2		150									
			2	SS	3		148									0 32 64 4
			3	SS	3		146									
			4	SS	6		144								20.0	0 2 78 20
			5	SS	6		142								20.2	4 22 49 25
			6	SS	8		140									
			7	SS	15		138									0 1 79 20
139.9			8	SS	20		136								22.0	
12.2	Clayey Silt Grey, Stiff to Hard		9	SS	25		134									
			10	SS	30		132									
	Sandy Silt		11	SS	53		130								21.2	
			12	SS	32		128									
			13	SS	17		126									
			14	SS	11		124									0 0 88 12
			15	SS	13		122									
121.9																
30.2																

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-4 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
121.9 30.2	Continued		16	SS	10												
	Clayey Silt Grey Stiff to Hard						120										
118.6 33.5			17	SS	45		118										
	Sand Some Silt Grey, Compact to V. Dense		18	SS	20		116										
			19	SS	72		114										
			20	SS	120/8 cm		112										0 85 14 1
107.1 45.0			21	SS	65		110										
105.8 46.3	Bedrock Shale		22	NQ RC	REC 60%		108										RQD = 8%
	End of Borehole						106										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 520.0; E 298 212.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 30 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					
143.5	Ground Surface																
0.0	Sand, Tr. Gravel (Fill)		1	SS	6	*	142										
	Brown, Loose to Compact		2	SS	21		140										
138.9	Clayey Silt With Interbedded Layers of Sand (Fill)		3	SS	37		138										
136.9	Brown, Stiff to Hard		4	SS	22												
6.6	End of Borehole *Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-5

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 605.0; E 298 115.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 16-17 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	100	W _p	W		
154.3	Ground Surface											
0.0					*	154						
	Silty Clay		1	SS	7							
	to											
	Clayey Silt		2	SS	3							
	Trace Gravel											
	Grey, Firm		3	TW	PH							
	to V. Stiff											
	Occ. Sand Seams		4	TW	PH							
	(Glacial Till)											
			5	SS	11							
			6	SS	8							
			7	SS	10							
			8	SS	5							
			9	SS	10							
139.1			10	SS	12							
15.2	Clayey Silt											
	Grey, Stiff to		11	SS	22							
	V. Stiff											
			12	SS	32							
			13	SS	22							
134.0												
20.3	End of Borehole											
	*Borehole Dry											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 511.1; E 298 240.4 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 20 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		SHEAR STRENGTH kPa				W _p	W	W _L		
152.5	Ground Surface						20 40 60 80 100				10 20 30				
0.0	Sand, Tr. Silt (Fill) Brown, V. Loose		1	SS	4	*	+ FIELD VANE				+ 10 20 30				
150.5	Clayey Silt With Interbedded Layers of Sand (Fill) Brown, Firm		2	SS	6		+ 10 20 30				+ 10 20 30			19.4	0 2 84 14
2.0			3	SS	6		+ 10 20 30				+ 10 20 30			19.2	0 14 64 22
			4	SS	5		+ 10 20 30				+ 10 20 30				
			5	SS	7		+ 10 20 30				+ 10 20 30				
			6	SS	6		+ 10 20 30				+ 10 20 30				
			7	SS	4		+ 10 20 30				+ 10 20 30				
141.8	Sand, Some Silt (Fill) Brown, Very Loose to Loose		8	SS	6		+ 10 20 30				+ 10 20 30				
10.7			9	SS	7		+ 10 20 30				+ 10 20 30				
138.6	Clayey Silt, Tr. Gravel Tr. Organics Grey, Firm to Stiff		10	SS	14		+ 10 20 30				+ 10 20 30				
13.9							+ 10 20 30				+ 10 20 30				
136.8	End of Borehole *Borehole Dry						+ 10 20 30				+ 10 20 30				
15.7							+ 10 20 30				+ 10 20 30				

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 504.0; E 298 229.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 29 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				
143.5	Ground Surface														
0.0	Sand, Some Gravel, Trace Silt (Fill)		1	SS	2	*									20 77 (3)
			2	SS	6										
			3	SS	8										
			4	SS	9										
	Brown, V. Loose to Compact		5	SS	12										26 59 (15)
138.9															
4.6	Clayey Silt (Fill) Brown, V. Stiff		6	SS	19										
137.3	Clayey Silt														
136.8	Grey, Tr. Organics		7	SS	29										4 6 65 25
6.6	End of Borehole * Borehole Dry														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No D-7

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 530.8; E 298 232.1 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
152.5	Ground Surface													
0.0						*	152							
			1	SS	2									11 62 23 4
			2	SS	3		150							
	Clayey Silt Brown, Firm		3	SS	8		148							0 12 66 22
			4	SS	4		146							
	Silty Sand to Sandy Silt (Fill) V. Loose to Loose		5	SS	5		144							2 41 54 3
			6	SS	5		142							
			7	SS	8		140							0 30 66 4
			8	SS	9		138							1 63 31 5
			9	SS	9									4 73 19 4
			10	SS	8									
136.3														
16.2	End of Borehole Auger Refusal Probable Culvert Roof *Borehole Dry													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-8

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 02-08 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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	20 40 60 80 100					
150.6	Ground Surface													
0.0														
	Sand, Some Silt With Interbedded Layers of Clayey Silt Brown, Loose (Fill)		1	SS	9		150							14 56 29 1
			2	SS	6		148							
			3	SS	4		146							0 13 75 12
144.5			4	SS	4		144							0 7 52 41
6.1	Clayey Silt Grey, Firm to Stiff Occ. Sand Seams (Glacial Till)		5	SS	8		142						20.2	
			6	SS	12									
			7	SS	4		140							
139.9			8	SS	17									
10.7	Clayey Silt Grey, Firm to Hard		9	SS	22									
			10	SS	19		138						20.3	2 1 72 25
			11	SS	22									
			12	SS	28		136						21.6	
			13	SS	25									
			14	SS	23		134							
			15	SS	19		132							
			16	SS	16									0 5 60 35
			17	SS	14		130							
			18	SS	18		128							
			19	SS	10		126							
							124							
							122							
120.4														
30.2														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No D-8 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NO Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							W _p	W	W _L
								SHEAR STRENGTH kPa							WATER CONTENT (%)		
120.4	Continued		20	SS	9		120										
30.2																	
			21	SS	107		118								0 7 79 14		
	Silt, Tr Sand V. Dense																
	Clayey Silt																
	Grey		22	SS	36		114										
	Firm to Hard																
111.9																	
38.7																	
	Sand With Silt Grey, Compact		23	SS	12		110										
107.7	Some Gravel		24	SS	120	15 cm	108								17 38 31 14		
42.9	Bedrock Shale Weak to Very Weak		25	NQ RC	REC 100%		106								RQD = 15%		
105.9																	
44.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
For
High Mast Lighting Footings
Highway 407, Humber River to Pine Valley Drive
W.P. 141-87-00P
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A total of six (6) high mast lighting pole footings are proposed within the boundary limits. Four (4) footings are proposed in excavation cut sections whilst two (2) footings are proposed in fill sections.

SITE DESCRIPTION AND GEOLOGY

The site spans the area bounded by the Humber River to the west and the existing Pine Valley Drive to the east along the proposed Hwy. 407 alignment. Two railroads are located within the general site area. The CPR railroad tracks intersect the proposed highway between the Humber River and Islington Avenue and the existing CNR railroad tracks parallel the proposed highway approximately 0.5 km south of the highway right-of-way. A residential subdivision bounds the site location at Islington Avenue and eastwardly to Pine Valley Drive. In addition, hydro transmission towers intersect the site approximately at mid-distance between Islington Avenue and Pine Valley Drive. The existing hydro corridor continues parallel to the proposed Hwy. 407 right-of-way beyond the line of intersection, located north and south of the proposed highway, west and east of the line of intersection respectively.

Land use at the site is primarily agricultural and residential. Agricultural farmland comprises the sector of land between Islington Avenue and Pine Valley Drive. The land west of Islington Avenue is composed of a river valley approximately 20 m in depth with a crest width of approximately 200 m. The valley houses the Jersey Creek, a meandering creek that is approximately 2 m wide and a tributary of the Humber River. Aside from the embankment supported CPR railroad, this area is not developed and consists of trees, brush, tall grasses and shrubs.

Physiographically, the site is located in the geological domain known as the Bolton Area. At the site, deltaic and glaciolacustrine sands and silts, the products of Lake Peel (Karrow 1963), a body of water confined between a lobe of glacial ice projecting up the Humber Valley and the surrounding higher elevation grounds, overly a glaciolacustrine Wildfield Till complex consisting of stratified silty clays, clayey silts and silt nodules which are also depositions of Lake Peel. These deposits levelled out the former gently undulating surface of ground moraine, known as the "Peel Plain" (Putnam and Chapman, 1936).

The Bolton area features overburden deposited during the Wisconsin glacialiation of the Pleistocene era. The overburden is underlain by shale bedrock of the Dundas-Meaford formation. Water well records indicate that the bedrock is found at depths ranging from 40 to 60 m.

INVESTIGATION PROCEDURE

Soil data and inherent properties were obtained by in situ and laboratory testing derived from investigations executed for the Hwy. 407-Humber River crossing (W.P. 88-78-15), the Hwy. 407/CPR subway (W.P. 88-78-16), the Hwy. 407-Islington Avenue Underpass (W.P. 88-78-18) and the Hwy. 407 excavation cuts between Islington Avenue and Pine Valley Drive (W.P. 141-87-00A). Details of the investigation methods and procedures can be obtained by referring to these reports. Due to property procurement difficulty in the area bounded by Islington Avenue and the CPR railroad embankment, subsurface investigation has not been conducted within this location at the time of this report. Consequently, high mast foundation soil parameters for poles in this section (P6) were obtained by extrapolation of existing information from adjacent sites, namely W.P. 88-78-16.

SUBSURFACE CONDITIONS

Due to the variable nature of the soil stratigraphy and surface topography across the site of the proposed high mast lighting poles, the description of the subsurface conditions, including the groundwater conditions, have been hereby divided into three subsections.

- 1) Pine Valley Drive to Islington Avenue
- 2) CPR/Hwy. 407 Subway
- 3) Floodplain Area West of CPR

A plan of the overall site illustrating the locations of the boreholes advanced within each subsection and the locations of the proposed high mast poles is attached on Dwg. 1418700P.*

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation have been summarized on the individual Record of Borehole sheets also attached in the Appendix.

A detailed description of the subsurface conditions for each subsection is given below.

AREA 1 - Pine Valley Drive to Islington Avenue

The soil stratigraphy within this area consists of a surficial veneer of topsoil, brown in colour and of thickness equivalent to approximately 0.7 m. The topsoil is underlain by a cohesionless brown sand that contains traces/some silt and traces/some gravel. This deposit has a thickness ranging from 0.7 m to 2.9 m and generally has a compact denseness. A cohesionless deposit of non plastic, brown silt underlies the sand deposit and extends for a relatively shallow thickness ranging from 0.3 m to 1.6 m. Thicknesses of the sands and silts generally decline in an easterly direction across the site. The non-plastic silt is underlain by a glacio-lacustrine deposit consisting of a cohesive, grey clayey silt to silty clay containing interbedded layers and random nodules of silt within the soil matrix. The stratum can be categorized as having a stiff consistency and ranges in thickness from 2.6 m to 4.8 m.

The glaciolacustrine stratum is underlain by a cohesive unstratified glacial till deposit consisting of a clayey silt host material with traces/some sand and traces of gravel. The extent of this deposit was not fully explored across the entire site. For the area bounded by BH's 8 and BH's 7 (Sta. 15+975 to 15+500), the deposit was penetrated up to a maximum thickness of 11.1 m. At BH's 9 and BH 10, the thickness of the deposit is in the order of 5 to 6 m and is underlain

* SEE DWG NO'S 1418700P-A, B, C, & D OF THE CONTRACT DWG'S
(SHEET NO'S 193-1, 193-2, 193-3 & 193-4)

by a cohesionless deposit of sand to silty sand. The extent of the underlying cohesionless deposit was not determined during the investigation.

Topsoil

A thin veneer of topsoil that is brown in colour, moist, and contains a rich, earthy odour is spread across the site. The thickness of this veneer is approximately 0.8 m.

Sand, trace Silt, trace/some Gravel

The surficial topsoil is underlain by a brown, cohesionless sand that contains traces of silt and traces/some gravel. A grain size distribution envelope for this deposit as determined by mechanical sieve analysis is provided in Figure 1 in the Appendix. The thickness of this native deposit varies from 0.7 m to 2.9 m extending to elevations ranging from El. 159.4 m to 156.4 m. The thickness decreases in an easterly direction and is typically in the 0.7 to 0.9 m range east of BH 8.

This cohesionless deposit was partially submerged below the groundwater table at the time of investigation and soil cave was witnessed in the open borehole. Natural moisture contents determined in the laboratory range from 6.5 to 15.5%.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 6 blows/0.3 m to 28 blows/0.3 m indicating that the deposit ranges in denseness from loose to compact. In general, the deposit can be categorized as compact.

Silt

The cohesionless sand deposit is underlain by a thin stratum of plastic silt ranging in thickness from 0.3 m to 1.6 m and found to extend to elevations ranging from 154.7 m to 158.4 m. The stratum is generally brown in colour although the stratum has been oxidized to grey at some locations.

The plasticity of the silt was confirmed by performing Atterberg Limit tests and the results are tabulated in Table 1 below and illustrated in Figure 2 in the Appendix. Natural moisture contents determined in the laboratory are also summarized in Table 1 and reveal values ranging from 21 to 22%.

Table 1 - Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content(w%)	21-22	5
Liquid Limit (w_L %)	19-21	3
Plasticity Index (IP)	3-4.5	3

The silt stratum was submerged beneath the groundwater table at the time of the investigation and soil sloughing in the open borehole is expected to have developed concurrent with the overlying sand deposit.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 9 blows/0.3 m to 47 blows/0.3 m indicating a range of denseness of loose to dense. In general, 'N' values were in the 15 blows/0.3 m to 25 blows/0.3 m which is equivalent to a compact denseness.

Clayey Silt to Silty Clay with random nodules/seams of Silt

Underlying the cohesionless silt deposit, a layer of clayey silt to silty clay with random nodules or zones and interbedded seams of silt exists. The surface of this stratum is at an elevation ranging from 158.4 m to 154.7 m and extends to an elevation ranging from 154.1 to 151.7 m. The thickness of the stratum varies from 2.6 m to 4.8 m. The stratum is grey in colour with the silt nodules and seams present at a lighter grey hue.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 3. A summary of the indices is provided in Table 2. Unit Weights are also included.

Table 2 - Clayey Silt to Silty Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content(w%)	20-34	14
Liquid Limit (w _L %)	23-46.5	12
Plasticity Index (I _p)	9.5-28.5	12
Unit Weight (kN/m ³)	17.5-22.6	7
Undrained Shear Strength (cu) (kPa)		
- Field Vane	30->120	10
Sensitivity	2-4	10
SPT 'N' values (blows/0.3 m)	5-24	24

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay). Natural moisture contents range from 20-34% but are generally in the 20-25% range.

Undrained shear strength measurements (cu) of the soil were obtained by conducting in situ vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2 above. The results reveal undrained shear strength values ranging from 30->120 and hence the soil can be classified as having a consistency ranging from firm to very stiff. In general, the soil can be categorized as stiff.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane tests and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 4 indicating that the soil has a low sensitivity.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 24 blows/0.3 m as tabulated in Table 2. The range of values confirms the firm to very stiff categorization determined from the in situ vane test.

Clayey Silt, trace/some Sand, trace Gravel (Glacial Till)

The clayey silt to silty clay stratum is underlain by a glacial till deposit consisting of a clayey silt host material combined with varying percentages (trace to some) of sand and traces of gravel. The extent of the deposit was not determined throughout the site area. For the area bounded by BH's 8 and 7, the deposit was explored to a maximum thickness of 11.1 m. At BH's 9 and 10, the thickness of the deposit is in the order of 5 to 6 m.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 26-41% and 58-65% respectively. The envelope also depicts percentages of sand up to 32% also comprise the deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 5 in the Appendix. A summary of the indices is provided in Table 3 below. Unit weights are also included.

Table 3 - Clayey Silt Till

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content(w%)	15-25	8
Liquid Limit (w_L %)	19-34	8
Plasticity Index (IP)	7-15	8
Unit Weight (kN/m^3)	18.3-20.8	6
Undrained Shear Strength (cu) (kPa)		
- Field Vane	30->120	32
Sensitivity	2-4	32
SPT 'N' values (blows/0.3 m)	3-29	(see BH logs)

The test results reveal that the fine grained portion of the deposit is predominantly of low plasticity and hence can be classified as clayey silt.

Undrained shear strength measurements (c_u) of the soil were obtained by conducting in situ vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 3 above. A shear strength (c_u) vs. Elevation (m) profile is also provided in Figure 6 in the Appendix. Based on shear strength values ranging from 30-120 kPa, the consistency of the soil ranges from firm to very stiff. In consideration that the higher shear strength values determined may not be representative because of the presence of the sand and gravel components of the till, the deposit can be generally categorized as having a stiff consistency. As Figure 6 illustrates, however, the consistency does become stiffer with depth.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 3 and identified in the Record of Borehole sheets. Sensitivity values range from 2 to 4 indicating that the soil has a low sensitivity.

Standard Penetration tests carried out in the stratum revealed 'N' values ranging from 3 blows/0.3 m to 29 blows/0.3 m. 'N' values generally increase with depth in the deposit indicating that the consistency of the soil becomes stiffer with depth.

Sand to Silty Sand

At BH's A-9 and A-10, the till deposit is underlain by a cohesionless sand to silty sand deposit. The deposit exists at an elevation ranging from 149.5 m to 148.7 m or depths of 10.7 to 11.4 m below the natural ground surface. The extent of this deposit was not determined during the investigation.

The fact that sloughing of the borehole occurred upon penetration into this deposit indicates that the deposit is under subartesian head. "Blow back" in the order of 2 to 3 m was observed when sampling through this material. A head of water was required to balance the unbalanced hydrostatic head so that penetration through this soil could be achieved.

Standard Penetration tests carried out in this deposit revealed 'N' values in the order of 5-6 blows/0.3 m indicating a loose material denseness.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring water levels in piezometers installed in the surficial sand and silt deposits. The piezometers were installed with the tips at an approximate elevation of 156 m with a bentonite seal of 0.3 m thickness below the piezometer tip and a bentonite seal at the surface of equal thickness. Pea gravel (10 mm) was used to fill the annular space between the piezometer and the borehole.

Measurements obtained from the aforementioned sources at the time of the investigation revealed water levels ranging from 2 to 2.5 m below the natural ground surface (Elevation 157.8 m to 158.8 m). At BH's A-7 and A-4, water levels could not be obtained because of the sloughing of the boreholes at depths of 1.5 m to 2.1 m respectively.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

AREA 2 - CPR/Hwy. 407 Subway

At the location of the proposed high mast lighting pole (P6), the stratigraphy consists of a surficial native deposit composed of a clayey silt to silty clay with occasional sand seams and traces of gravel. This stratum is a till deposit of glacial origin and extends to a thickness in the order of 12.5 m. The thickness of this deposit decreases down the existing natural valley slope and is not present at the valley floor.

Underlying the surficial deposit, exists a deposit of clayey silt that extends for a thickness in the order of 23 m.

The clayey silt deposit is in turn underlain by a cohesionless deposit of sand with a trace to some silt. Random zones of silt also exist in this deposit. Gravel, boulders and cobbles are also components of the lower depths of the deposit. The thickness of this deposit is in the order of 10 m. This cohesionless deposit overlies shale bedrock of the Georgian Bay shale formation.

Silty Clay to Clayey Silt (Glacial Till)

The native surficial deposit present at the site consists of a cohesive silty clay to clayey silt with traces of sand and gravel and occasional random interbedded sand seams. The thickness of the deposit explored in the investigation is in the order of 12.5 m and the interbedded sand seams are generally 50 to 100 mm in thickness. The deposit is generally oxidized (brown) for the upper 1.5 to 3.5 m and unoxidized (grey) for its lower thickness. The deposit is a till of glacial origin.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 7. A summary of the indices is provided in Table 4.

Table 4 - Silty Clay to Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content(w%)	15-29	14
Liquid Limit (w_L %)	22-47	14
Plasticity Index (I_p)	12-20	14
Unit Weight (kN/m^3)	18.8-20.3	9
Undrained Shear Strength (c_u) (kPa)		
- Field Vane	35->120	28
- Laboratory*	41-82	4
Sensitivity	2-3	28
SPT 'N' values (blows/0.3 m)	2-15	(see BH logs)

*Unconfined Compression Tests

*Unconsolidated Undrained Tests

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay).

Undrained shear strength measurements (c_u) of the soil were obtained both by in situ vane tests and by laboratory tests, namely unconfined compression tests and unconsolidated undrained tests (quick triaxial). Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 4. A Shear Strength vs. Elevation profile is also provided in Figure 8. Based on shear strength values ranging from 35-120 kPa, it is considered that the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 3 indicating that the soil has a low sensitivity.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 15 blows/0.3 m.

Clayey Silt

Underlying the surficial native clayey silt to silty clay deposit at a depth approximately 13.5 m below the ground surface (Elevation 138 to 139 m) and extending for a thickness in the order of 12.5 m, exists a cohesive, grey deposit of clayey silt. This stratum also contains traces of sand and random zones of silt.

Atterberg Limit tests were carried out to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 9 and summarized in Table 5 below. Unit weights are also included.

Table 5

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content(w%)	14-35	13
Liquid Limit (w_L %)	22-30	13
Plasticity Index (I_p)	14-18	13
Unit Weight (kN/m^3)	20-22	6

The test results reveal that the deposit is predominantly of low plasticity.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 76 blows/0.3 m indicating that the deposit ranges in consistency from firm to hard. In general, in the upper 10 m or so, 'N' values ranged from 20 blows/0.3 m to 25 blows/0.3 m, indicating a very stiff consistency, but in the lower depths of the deposit, 'N' values ranged from 10 blows/0.3 m to 20 blows/0.3 m and the soil can be categorized as having a stiff consistency.

Sand, some Silt

Underlying the clayey silt deposit and extending to bedrock a cohesionless deposit of sand with some silt exists. The thickness of the deposit is approximately 10 m. Random zones of silt are also present within this deposit. In addition, gravel, boulders and cobbles exist as a heterogeneous mixture in the main deposit at the lower depths immediately above the bedrock. A grain size distribution envelope for this deposit is provided in Figure 10 in the Appendix.

This cohesionless deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 15 blows/0.3 m to 120 blows/0.2 m indicating that the deposit ranging in denseness from compact to very dense. In view of the fact that the lower 'N' values may be attributable to sampling disturbance induced by unbalanced hydrostatic head as mentioned above and the higher 'N' values not necessarily representing the state of denseness because of the large boulders and cobbles, the deposit can be generally categorized as dense.

Bedrock

The cohesionless sand with some silt deposit is directly underlain by shale bedrock of the Georgian Bay shale formation. The bedrock surface is generally flat with surface elevations ranging from 105.9 m to 107.7 m. The bedrock was cored by NQ size up to 2.8 m in thickness.

The shale bedrock is grey in colour and is very fine grained and thinly laminated. The rock is generally slightly to moderately weathered and contains occasional clay seams, approximately 50 to 100 mm in thickness. Minor beds of argillaceous limestone are also present in the rock formation.

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Rock recoveries varied between 60 and 100% while RQD's varied between 0 and 15%. The shale bedrock is weak to very weak rock.

Groundwater Conditions

Observation of the groundwater level in the boreholes in the area of the proposed high mast lighting pole P6 was carried out by measuring the water level in the open boreholes. Measurements obtained at the time of the investigation revealed levels approximately 17 m below the existing ground surface. Hence, the groundwater table was at an elevation of 135 m. Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

AREA 3 - Floodplain West of CPR

The subsoils encountered in the floodplain area consist of a surficial layer of topsoil and sandy silt to silty sand underlain at depths ranging from 1.2 m to 2.9 m by about 0.8 to 2 m of a waterbearing sand and gravel deposit.

The granular materials are underlain by about 3.3 to 10 m of a deposit consisting of interlayered to stratified clayey silt and silt. The frequency of the silt interlayers is extremely variable across the site. The undrained shear strength of the cohesive clayey silt was determined by conducting in situ vane tests and results ranged from about 42 kPa to greater than 90 kPa.

The layered clayey silt and silts are underlain at depths of about 8.5 m to 12 m by a cohesionless deposit varying in composition from silt to sand and silt. The thickness of this deposit ranges from 4.5 m to 6.5 m. Blow back of these fine granular materials occurred in the open borehole during the drilling and sampling process.

The sand and silt deposit is underlain at depths of about 11.4 m to 14.6 m by a hard/very dense till deposit which ranges in composition from clayey silt to sandy silt and contains a variable proportion of gravel. The silt content of this stratum increases with depth and the deposit grades to a silt containing trace sand and clay. 'N' values measured in this deposit were generally greater than 100 blows per 0.3 m of penetration.

The till deposit is underlain by a sand and gravel deposit present approximately 19.5 m to 20.5 m below ground surface (Elevation 115 m to 116 m). This deposit exists under an artesian water pressure equivalent to approximately 4.5 m above the ground surface.

Surficial Sandy Silt to Silty Sand

Underlying approximately 0.3 m to 1.6 m of topsoil, a surficial deposit of sandy silt to silty sand exists. The deposit extends for a thickness ranging from 0.7 m to 1.8 m and based on 'N' values derived from the Standard Penetration Test ranging from 2 to 11 blows per 0.3 m of penetration, the deposit can be categorized as having a very loose to loose state of denseness.

Upper Sand to Sand and Gravel

The surficial silts and sands are underlain by about 0.8 m to 2 m of a deposit which varies in composition from sand containing some gravel to sand and gravel. The deposit is generally in a very loose to compact state of denseness with 'N' values ranging from 3 to 22 blows per 0.3 m of penetration.

Interlayered Clayey Silt and Silt

The granular deposits are underlain by about 3.3 m to 9.7 m of a deposit which consists primarily of a clayey silt. The upper 3.3 m to 6.5 m of the deposit exhibits little stratification and contains a variable proportion of coarse sand sizes with occasional fine gravel, giving this portion of the deposit a till-like texture. The lower 1.6 m to 5.6 m of the deposit contains silty clay and silt interlayers.

Laboratory testing was carried out to evaluate the behaviour of the fine-grained portion of the material and the results are tabulated in Table 6 below and illustrated in Figure 11 in the Appendix.

Table 6

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	16-31	46
Liquid Limit (w _L %)	24-37	8
Plasticity Index (I _p %)	5-14	8

The results reveal that the deposit ranges from a low plasticity clayey silt to an intermediate plasticity silt clay with interbeds of plastic silt.

The measured consistency of the layered deposit is also variable across the site. Undrained shear strength values, determined by in situ vane tests range from 42 kPa to 103 kPa. 'N' values range from 4 to 24 blows per 0.3 m of penetration. Generally, the deposit can be categorized as stiff to very stiff.

Sensitivity values, also determined by the in situ vane test, range from 2 to 4 indicating that the soil is of low sensitivity.

Silt to Sand and Silt

The clayey silt stratum is underlain by 4.5 m to 6.5 m of a cohesionless deposit consisting of silt to sand and silt. Grain size distribution curves representative of this deposit is illustrated in Figure 12 in the Appendix. "Blow-Back" of this material occurred in the open borehole during the sampling process as a result of unbalanced hydrostatic head.

Measured 'N' values ranged from 1 to 20 blows per 0.3 m of penetration indicating that the deposit is in a very loose to compact state of denseness.

Clayey Silt/Silt, some Sand, trace of Gravel (Glacial Till)

The clayey silt and silt deposits are underlain at depths of about 11.4 m to 14.6 m by a complex sequence of hard clayey silt to very dense silt containing a variable proportion of sand and gravel. These till deposits are also interlayered with silt and clayey silt strata.

The surface of the hard/very dense deposit was generally encountered at about El. 120.6 m to 124.7 m. 'N' values measured in this deposit were generally greater than 100 blows per 0.3 m of penetration.

Lower Sand and Gravel

The till deposit was penetrated in the area east of the Humber River and was found to be underlain by a sand and gravel deposit. The extent of this deposit was not determined during the investigation because of artesian conditions present within this deposit. The sand and gravel deposit is in a very dense state of condition with 'N' values greater than 79 blows/0.3 m.

Artesian pressure conditions were encountered once the till deposit was penetrated to the underlying sand and gravel. The head of water measured within the hollow stem augers was estimated to be about 4.6 m above ground surface. Mechanical packers and cement grout had to be pumped into the hole to retard the artesian water flow because of the associated high water pressure.

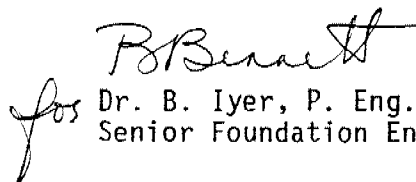
Artesian conditions were also noted within the till deposit at which the water level rose to ground surface within a few hours of the borehole completion. Grout plugs were successfully installed to arrest the artesian flow within this deposit without the requirement of mechanical packers.

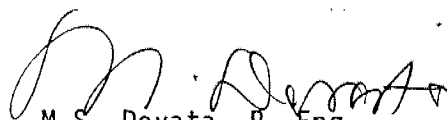
Piezometers were installed in the various boreholes across the site. The water level observed varied depending on the depth at which the piezometer was installed. The water level in the upper sand and gravel layer was about 1.2 m below ground surface, coincident with the adjacent river water level. Within the till deposit, a piezometer level equivalent to El. 136.4 m to El. 140.7 m (about 1.4 m to 5.2 m above ground surface) was recorded. Piezometers sealed into the overlying loose silts and stiff clayey silts indicate the piezometric level to be about El. 135.8 m to 138.6 m (about 0.5 m to 2.5 m above ground surface). These results reflect an overall upward gradient through the strata present between the lower sand and gravel deposit and the surficial sands.

MISCELLANEOUS

The factual information pertaining to the subsurface conditions for this project was derived from investigations carried out previously within the site area in conjunction with various other Hwy. 407 projects.

The report for this project was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.


for Dr. B. Iyer, P. Eng.
Senior Foundation Engineer


M.S. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

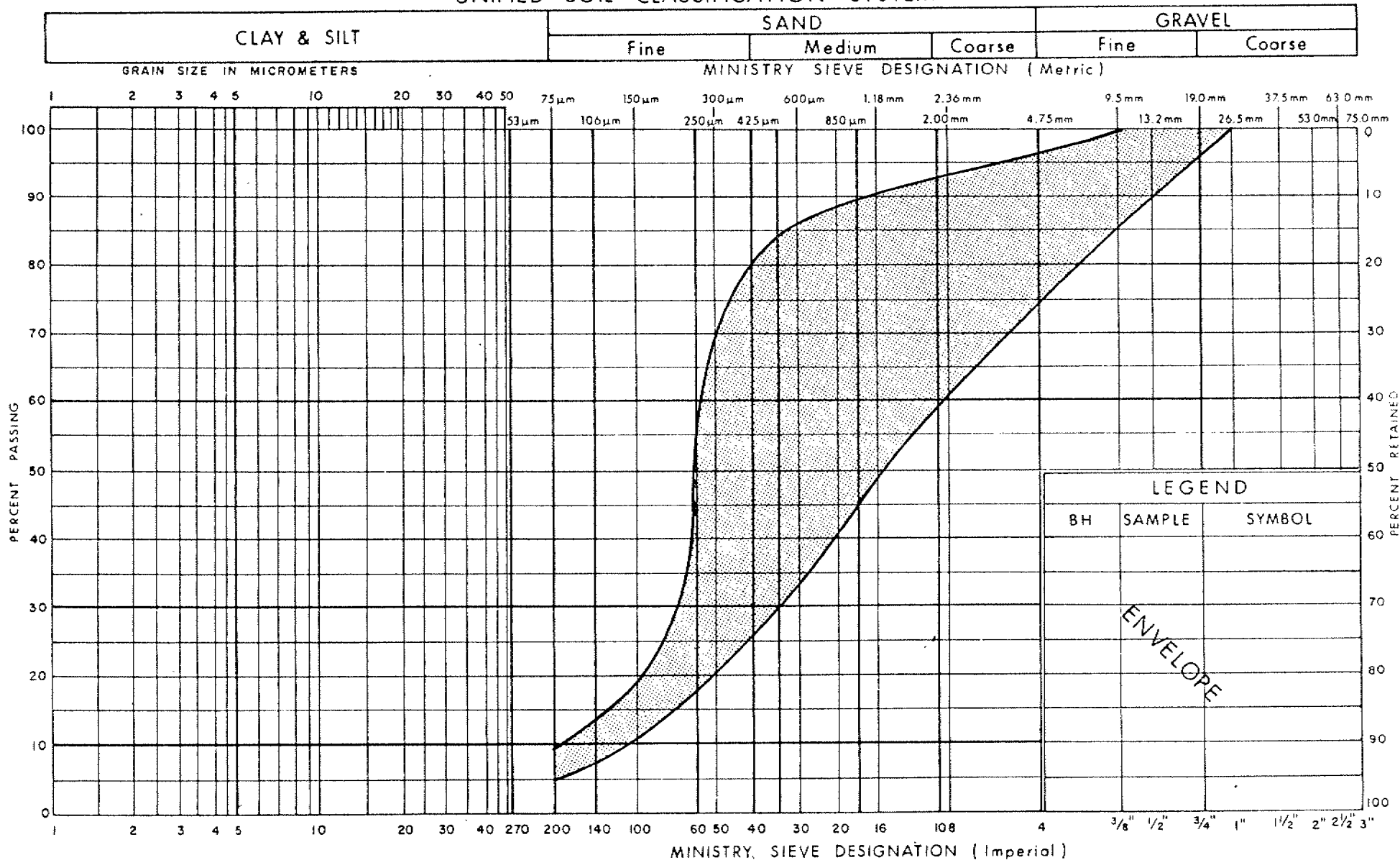
Table 1 - HML Foundation Design Parameters

<u>HML</u>	<u>Nearest Borehole</u>	<u>Geodetic El. (m)</u>	<u>GWL EL. (m)</u>	<u>Description</u>	<u>Consistency/ Denseness</u>	<u>Shear Strength Parameters</u> (ϕ) (C_u)	<u>Saturated Unit Weight (kN/m^3)</u>	<u>Cut/Fill</u>	<u>Remarks</u>
P4	5	Grade-135	Artesian	Fill	Compact	30° -	20	Fill (Granular)	- located at embankment median - Artesian condition construc- tion
		135-133.5		Sandy Silt	Loose	28° -	20		
		133.5-133		Sand & Gravel	Compact	30° -	20		
		133-124		Clayey Silt/Silt	Stiff/Compact	- 80	20		
		124-115		Clayey Silt/ Silt Till	Hard/V.Dense	35° -	20		
P4 (Alt.)	6	Grade-135	Artesian	Fill	Compact	30° -	20	Fill (Granular)	- located at embankment crest - Artesian condition construc- tion
		135-133.5		Sandy Silt	Loose	28° -	20		
		133.5-133		Sand & Gravel	Compact	30° -	20		
		133-124		Clayey Silt/Silt	Stiff/Compact	- 80	20		
		124-115		Clayey Silt/ Silt Till	Hard/V.Dense	35° -	20		
P5	11	Grade-135	Artesian	Fill	Compact	30° -	20	Fill (Granular)	- located at embankment median - Artesian condition construc- tion
		135-133		Sandy Silt	Loose	28° -	20		
		133-132		Sand & Gravel	Compact	30° -	20		
		132-127		Clayey Silt/Silt	Stiff	- 80	20		
		127-125		Clayey Silt Till	Stiff	- 80	20		
		125-122		Silt and Sand	Loose	28° -	20		
		122-117		Clayey Silt	Hard	- 250	20		
		<117		Sand & Gravel	V.Dense	35° -	20		
P5 (Alt.)	12	Grade-135	Artesian	Fill	Compact	30° -	20	Fill (Granular)	- located at embankment crest - Artesian condition construc- tion
		135-134		Sandy Silt	Loose	28° -	20		
		134-132.5		Sand & Gravel	Compact	30° -	20		
		132.5-124		Clayey Silt/Silt	V.Stiff	- 100	20		
		124-122		Silt & Sand	Loose	28° -	20		
		122-117		Clayey Silt Till		- 250	20		
		<117		Sand & Gravel	V.Dense	35° -	20		

Table 1 - HML Foundation Design Parameters .../cont'd

HML	Nearest Borehole	Geodetic El. (m)	GWL EL. (m)	Description	Consistency/ Denseness	Shear Strength Parameters (0) (Cu)		Saturated Unit Weight (kN/m ³)	Cut/Fill	Remarks
P6	C4, D1	150.5-136.3	136	Clayey Silt Till	Firm to V.Stiff	-	60	20	Cut	Soil cave-in encountered in sand deposit q=25MPa
		136.3-125.0		Clayey Silt	Stiff	-	100	21		
		125.0-115		Clayey Silt	Stiff	-	80	21		
		115-105.9		Sand	Dense	32	-	20		
		below 105.9		Bedrock	-	-	-	25		
P7	A7,4	158.5-156.3	157	Sand	Compact	30	-	20	Cut	Soil cave-in encountered in surficial sands/silts
		156.3-154.7		Silt	Compact	30	-	20		
		154.7-151.7		Clayey Silt	Firm to V.Stiff	-	50	20		
		151.7-146.0		Clayey Silt Till	Firm to Stiff	-	50	19		
		146.0-133.5		Clayey Silt Till	Firm to Stiff	-	80	20		
		133.5-125.9		Clayey Silt	Hard	-	100	20		
P8	A4	160.1-158.9	158	Sand	Compact	30	-	20	Cut	clayey silt till extent Inferred from cone test at BH A5
		158.9-157.4		Silt	Compact	30	-	20		
		157.4-153.3		Clayey Silt	Stiff	-	80	20		
		153.3-137.3		Clayey Silt Till	Stiff	-	60	19		
P9	A1	159.4-157.2	158	Sand	Compact	30	-	20	Cut	clayey silt till extent inferred from cone test at BH A5
		157.2-156.7		Silt	Compact	30	-	20		
		156.7-154.1		Clayey Silt	Firm	-	40	20		
		154.1-149		Clayey Silt Till	Stiff	-	60	19		
		149-137		Clayey Silt Till	Stiff	-	80	19		
P10	A9	159.3-158.6	158	Sand	Compact	30	-	20		Soil Cave-in encountered in surficial and lower sands
		158.6-157.8		Silt	Compact	30	-	20		
		157.8-154.0		Clayey Silt	Stiff	-	50	20		
		154-150		Clayey Silt Till	Firm	-	40	19		
		150-148.5		Clayey Silt Till	Stiff	-	75	19		
		>148		Sand		30	-	20		

UNIFIED SOIL CLASSIFICATION SYSTEM



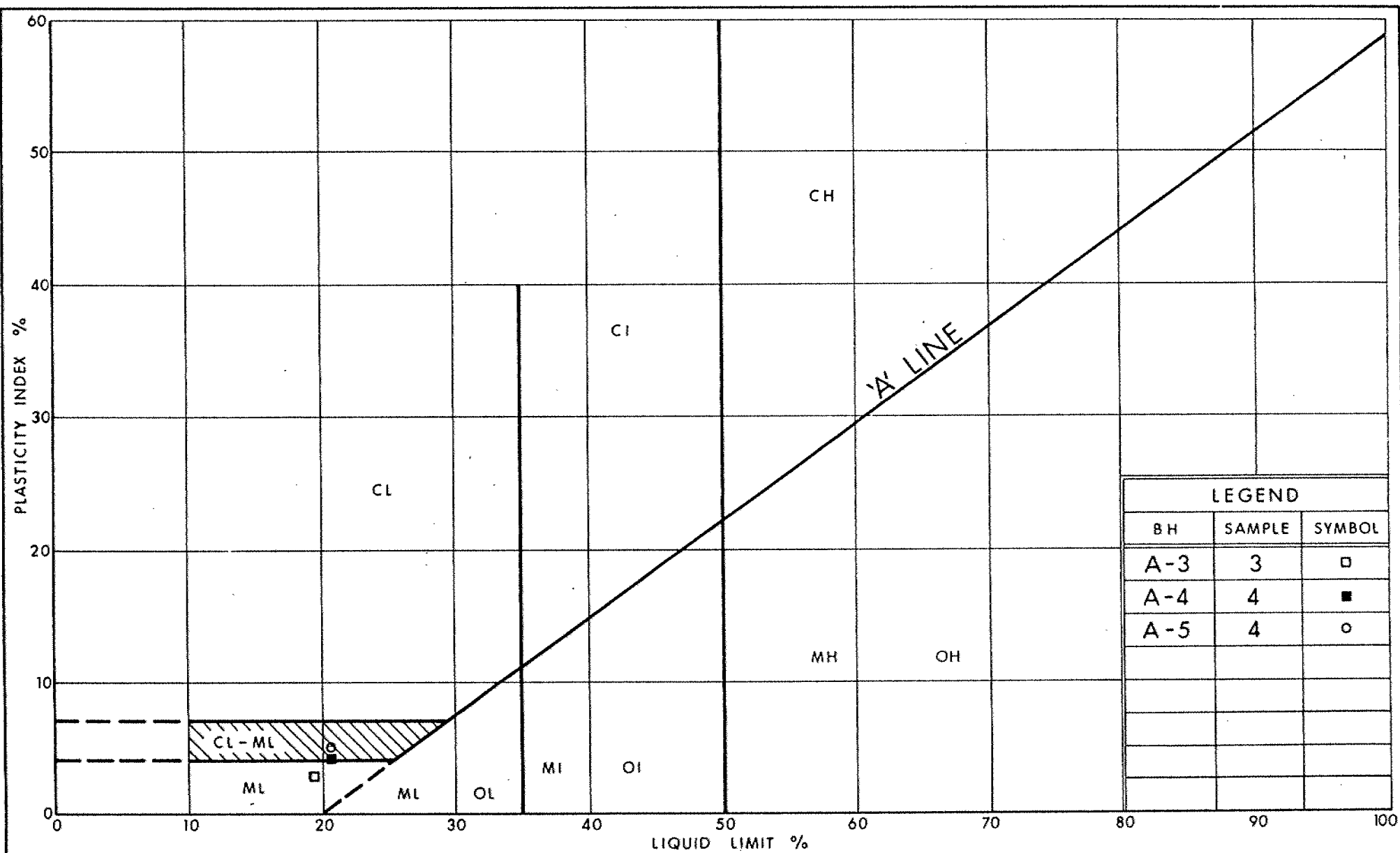
Ministry of
Transportation

Ontario

GRAIN SIZE DISTRIBUTION
SAND, TRACE SILT, TRACE /SOME GRAVEL

FIG No 1

W P 141-87-00 (P)

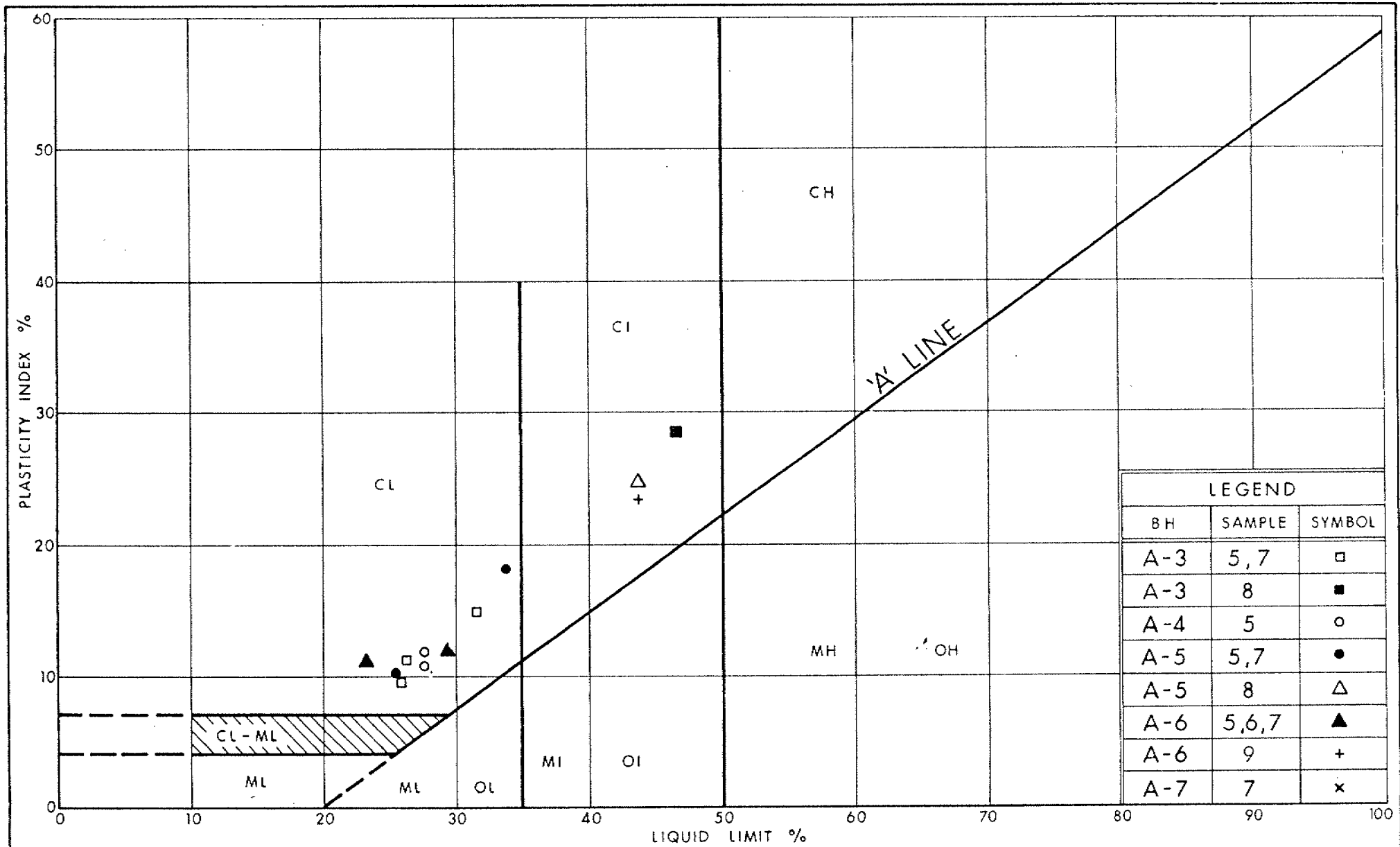


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Ontario

PLASTICITY CHART SILT

FIG No 2

W P 141-87-00 (P)



Ministry of
Transportation

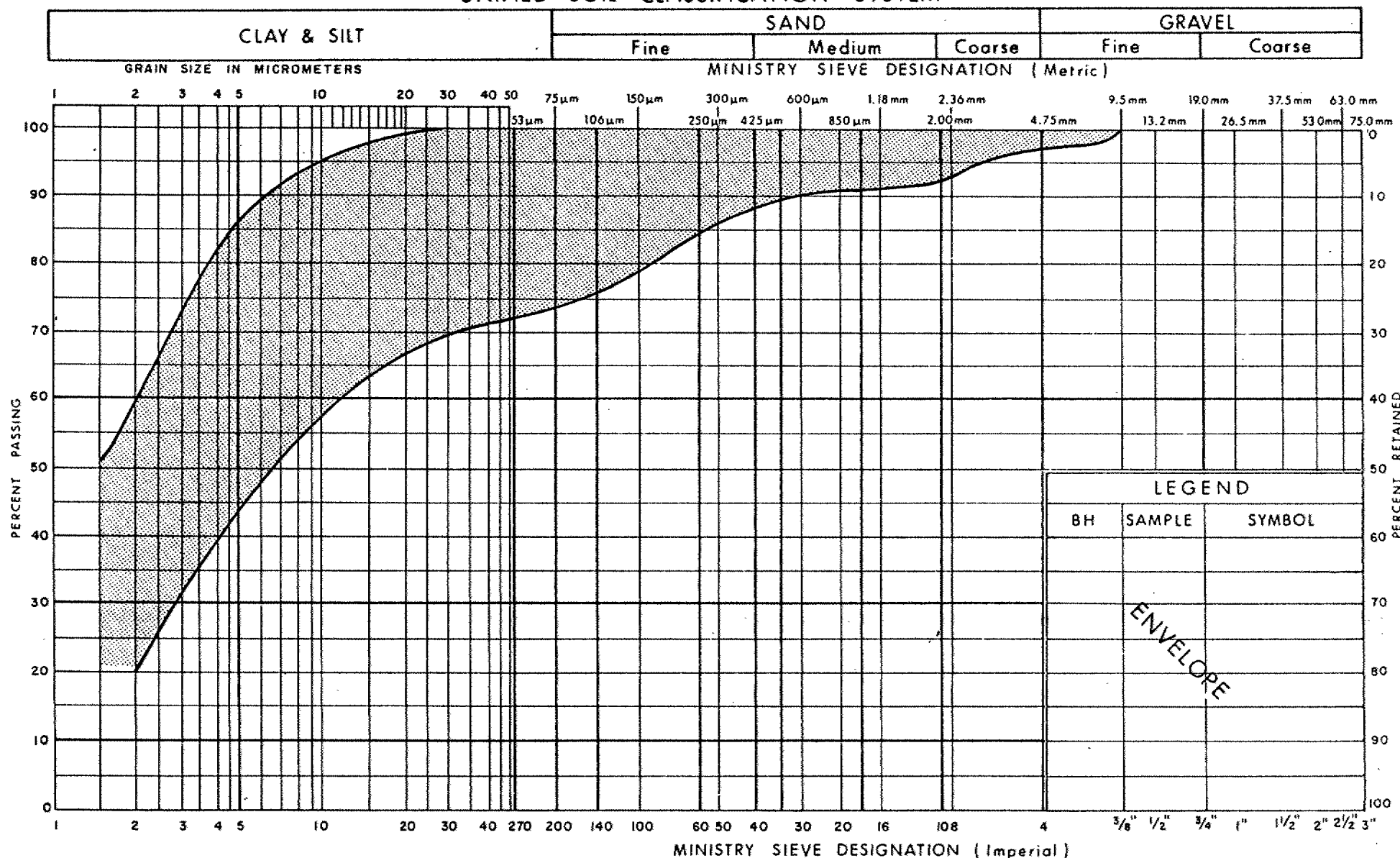
PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
W P 141-87-00 (P)

FIG No 3

W P 141-87-00 (P)

350

UNIFIED SOIL CLASSIFICATION SYSTEM

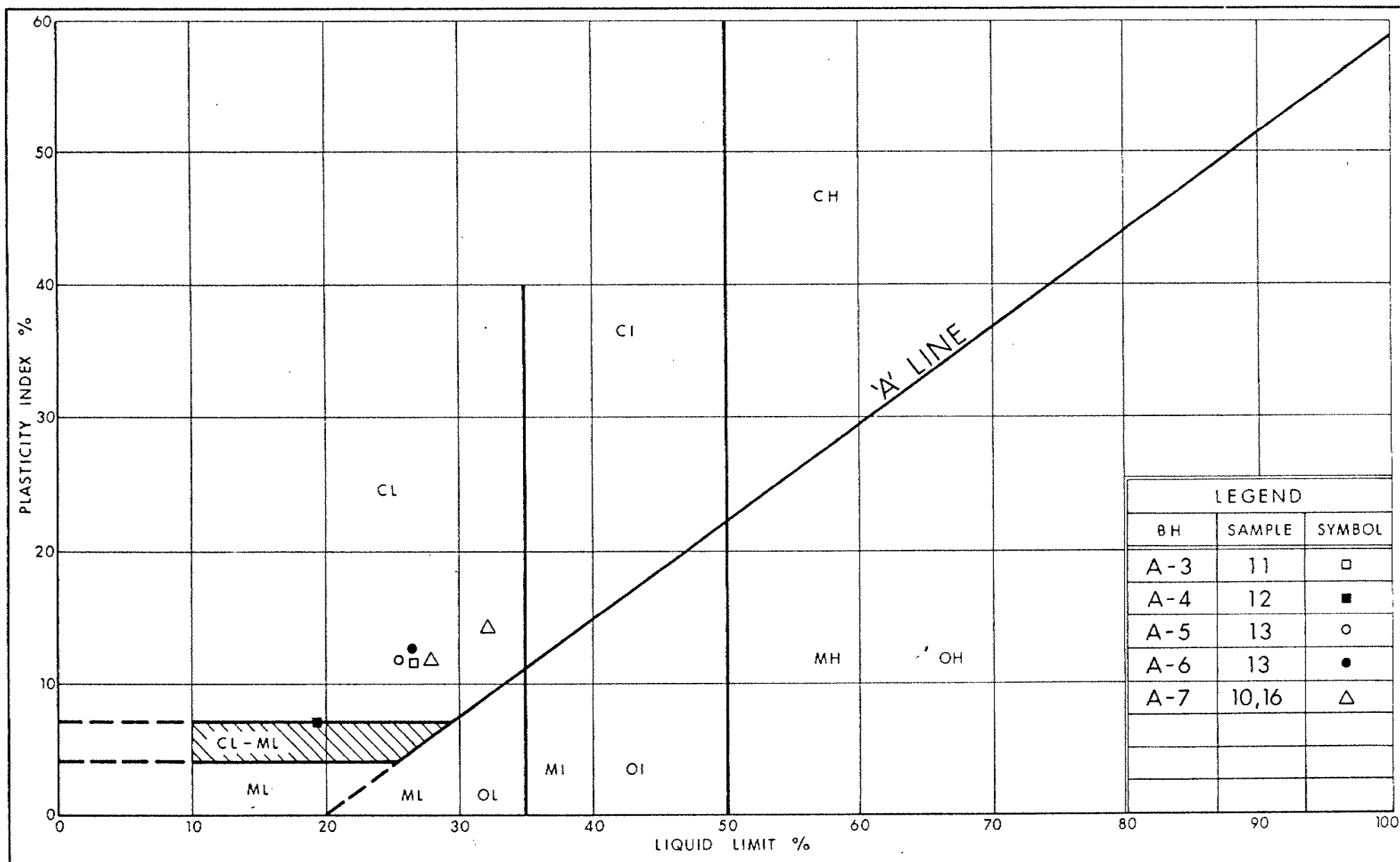


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME / TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)

FIG No 4

W P 141-87-00 (P)

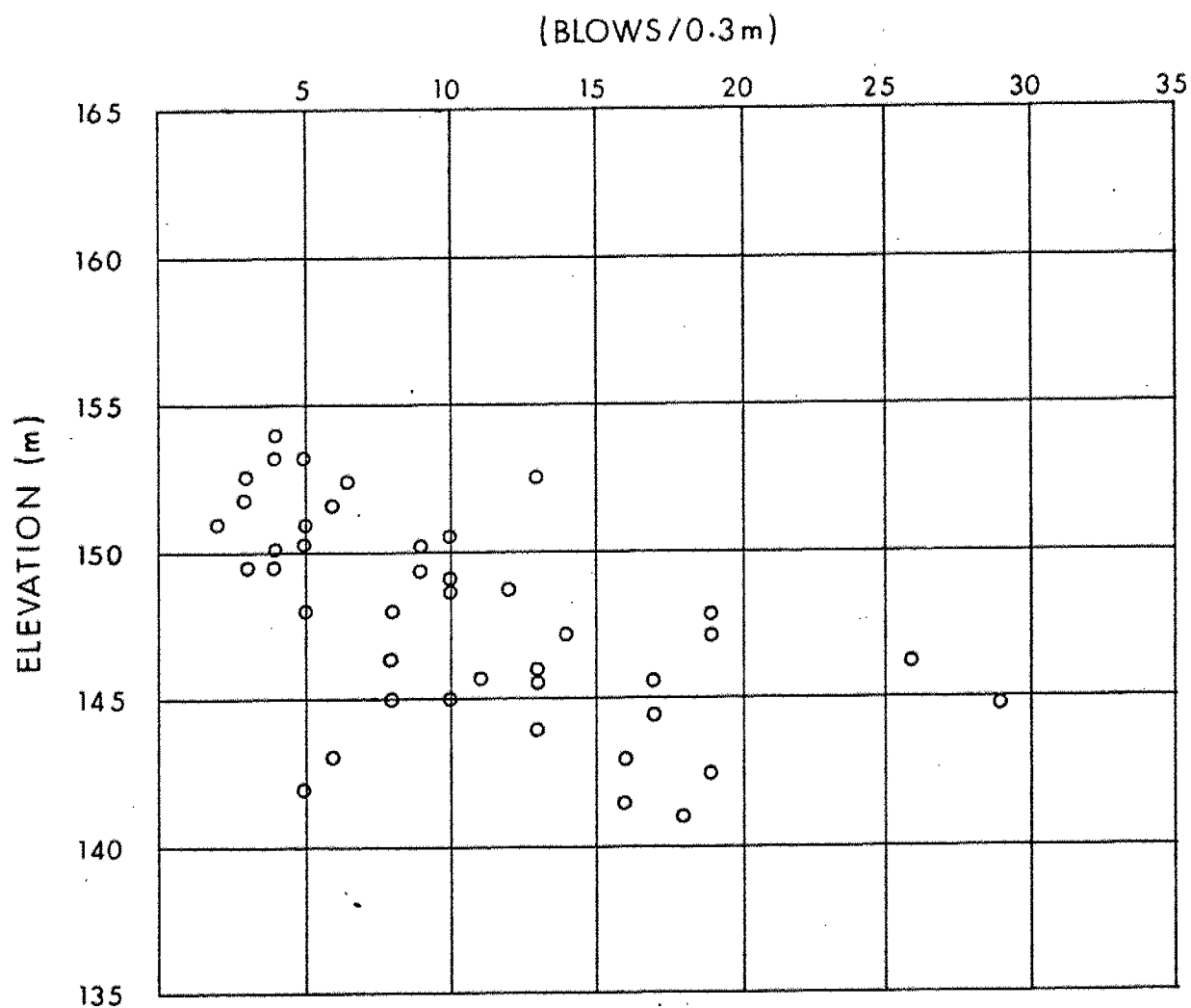


Ministry of
Transportation

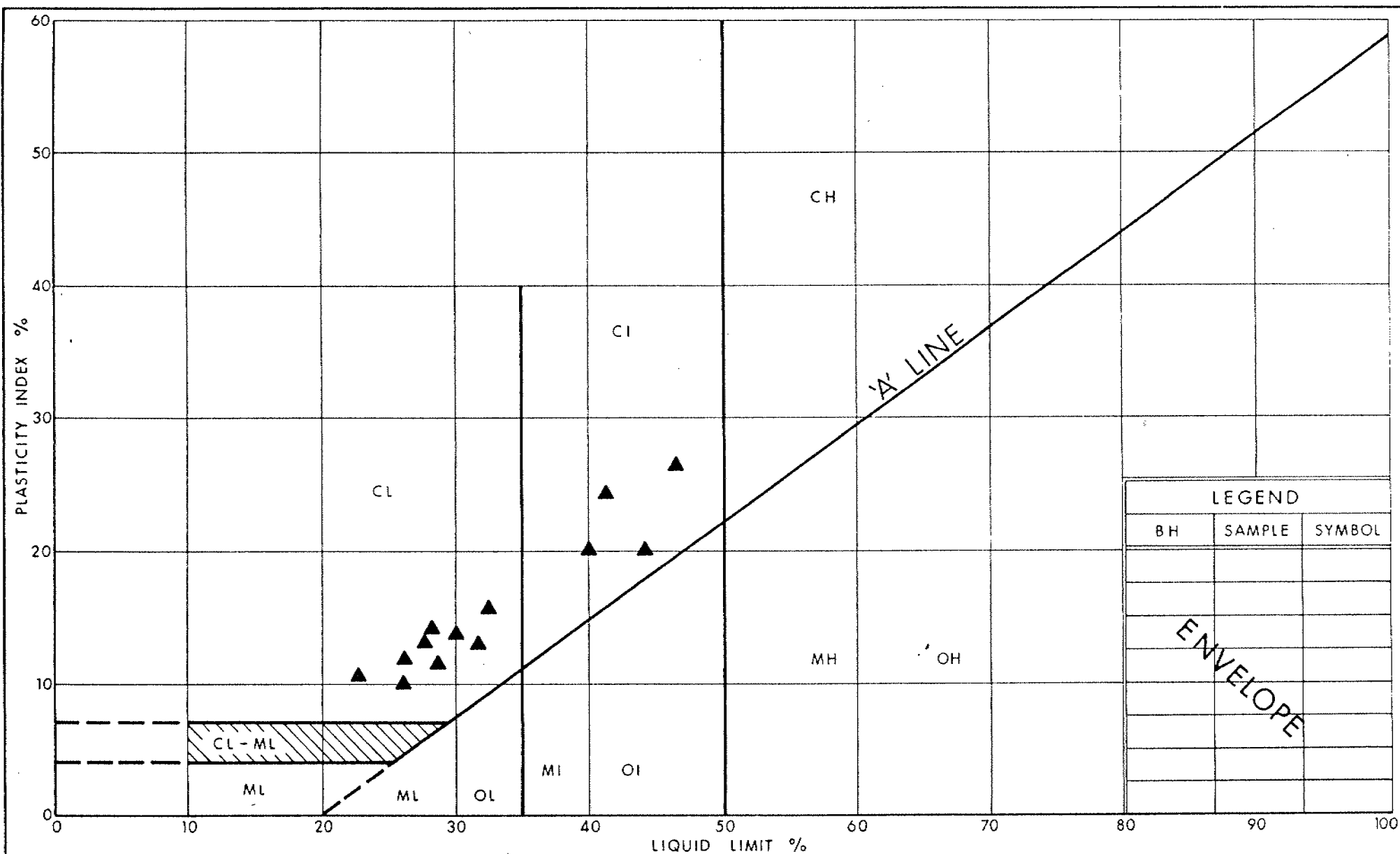
PLASTICITY CHART CLAYEY SILT, SOME/TRACE SAND, TRACE GRAVEL (GLACIAL TILL)

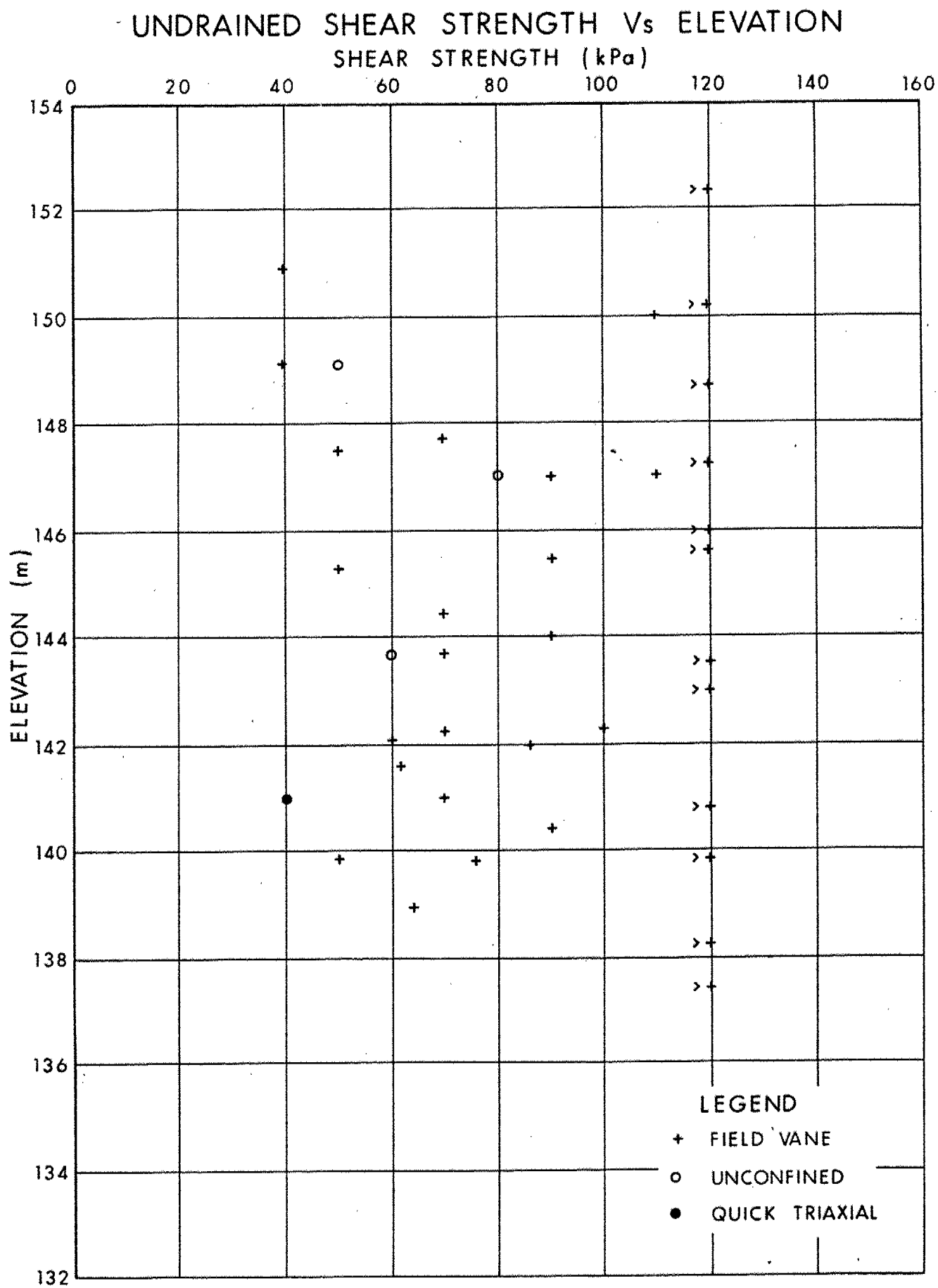
FIG No 5

W P 141-87-00(P)



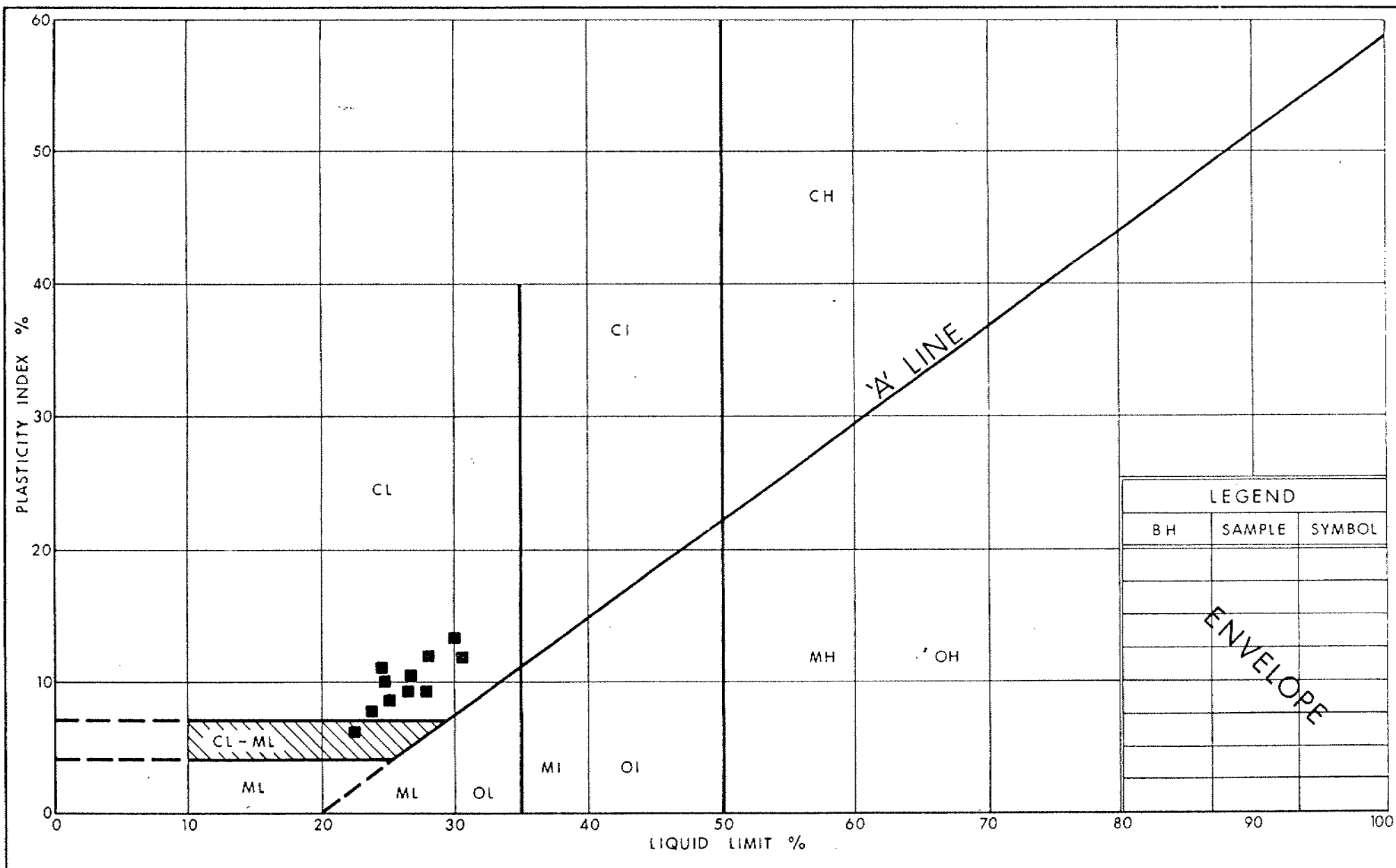
SPT 'N' VALUES (BLOWS /0.3m) VS ELEVATION (m)
CLAYEY SILT, SOME / TRACE SAND, TRACE GRAVEL
(GLACIAL TILL)





W P 141-87-00(P)

Fig 8



Ontario

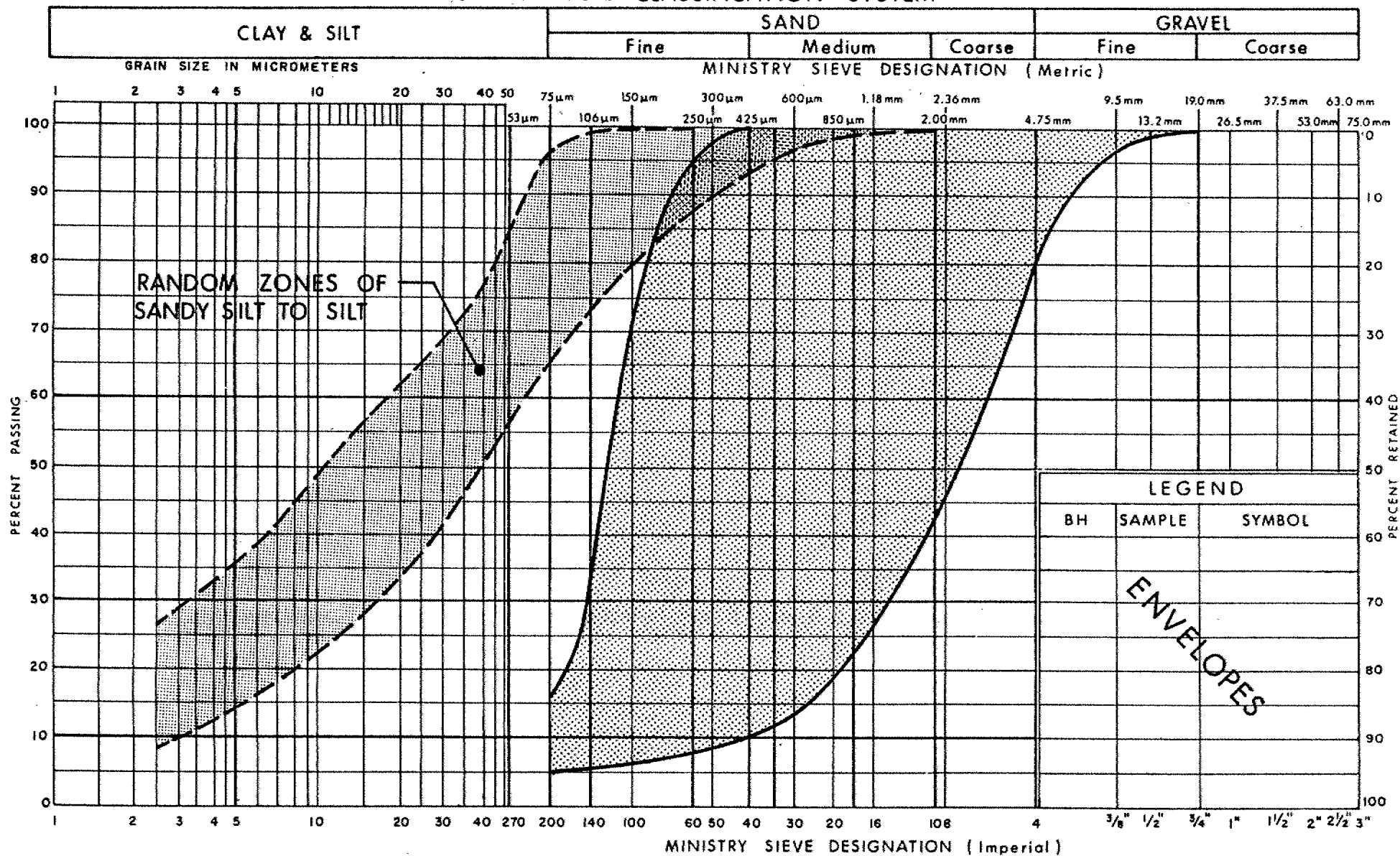
Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT

FIG No 9

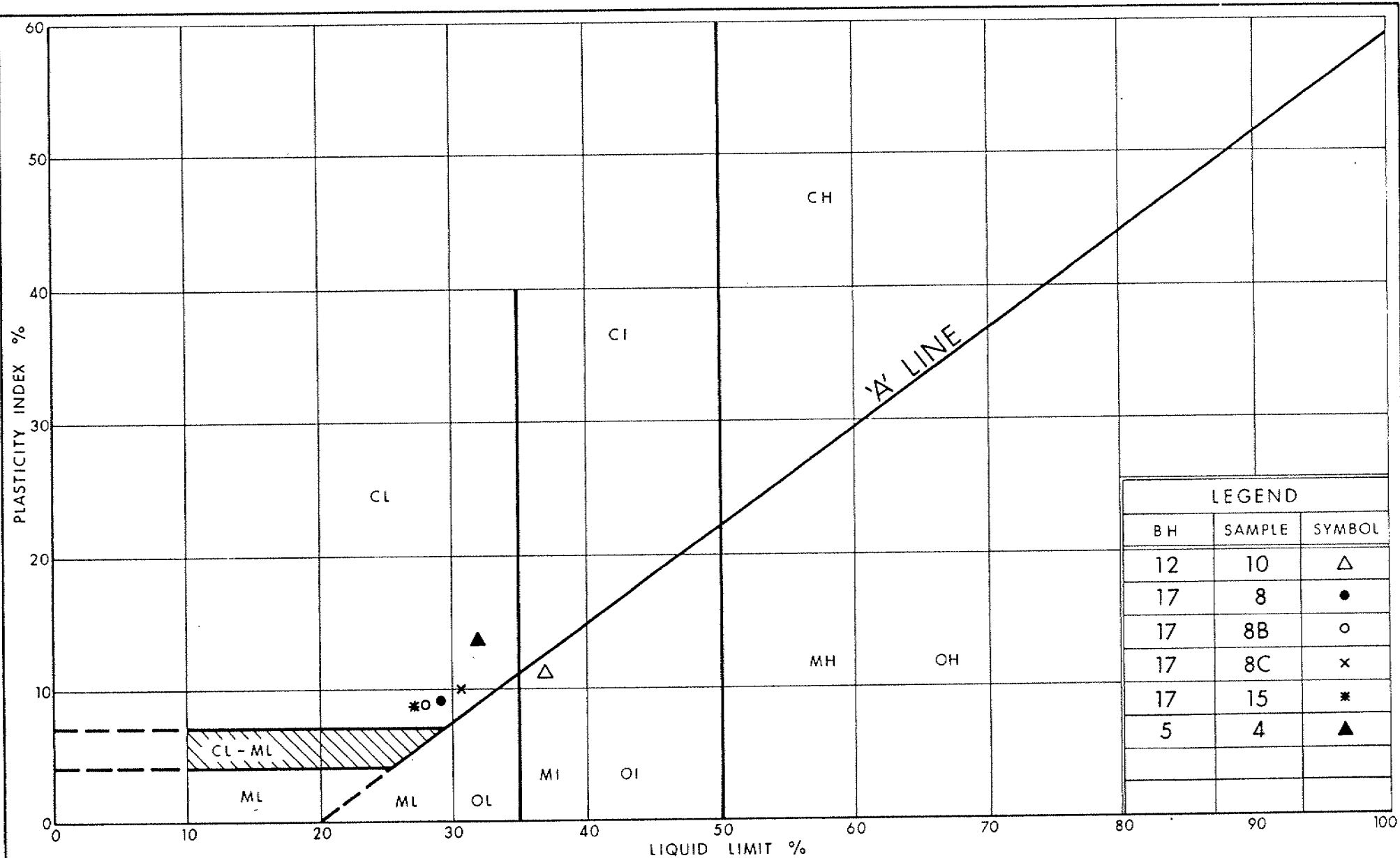
W P 141-87-00(P)

UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of
Transportation

 GRAIN SIZE DISTRIBUTION
SAND, SOME SILT

 FIG No 10
W P 141-87-00(P)



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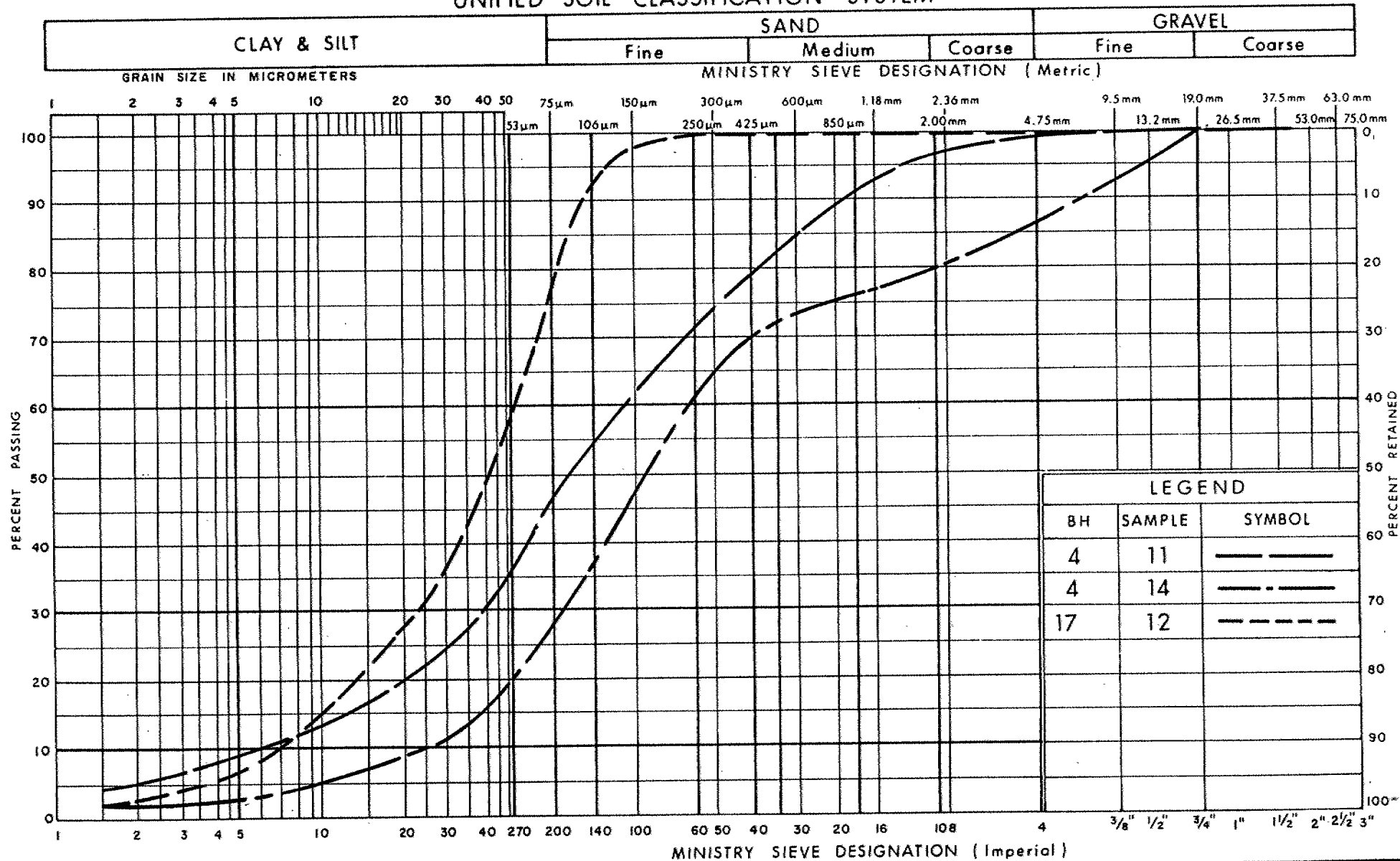
Ontario

PLASTICITY CHART INTERLAYERED CLAYEY SILT & SILT

FIG No 11

W P 141-87-01 (P)

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SILT TO SILT & SAND

FIG No 12

W P 141-87-00(P)



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Transportation

RECORD OF BOREHOLE No A-1

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 751.6 ; E 298 751.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16-17 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
160.2	Ground Surface																
159.4	Topsoil		1	AS	-												
0.8	Sand, Tr. Gravel Brown, Compact		2	SS	14												
157.2			3	SS	9												
156.7	Silt, Brown, Compact		4	SS	9												
3.5			5	SS	7												
	Clayey Silt with Random Nodules/ Seams of Silt		6	SS	6												
	Grey, Stiff to Very Stiff		7	SS	5												
154.1			8	SS	4												
6.1			9	SS	3												
	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		10	SS	5												
	Grey, Firm to Very Stiff		11	SS	3												
			12	SS	8												
			13	SS	8												
144.5			14	SS	8												
15.7	End of Borehole																

▲ GROUND WATER CONDITIONS	
PIEZO. NO.	GROUND WATER ELEVATION (Metres)
1	158.2

RECORD OF BOREHOLE No A-2

1 OF 1 METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 790.6 ; E 298 676.7 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16-17 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
160.1	Ground Surface							20 40 60 80 100	10 20 30					
159.3	Topsoil		1	SS	18		158							
0.8	Sand, Tr. Gravel Brown, Compact		2	SS	21									
			3	SS	15									
156.4			4	SS	25									
155.8	Silt, Brown, Very Dense		5	SS	47		156							
4.3	Clayey Silt with Random Nodules/ Seams of Silt		6	SS	24									
	Grey, Stiff to Very Stiff		7	SS	19		154							
			8	SS	7									
152.5			9	SS	6		152							
7.6			10	SS	5									
	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		11	SS	9		150							
	Grey, Firm to Very Stiff		12	SS	19		148							
			13	SS	26		146							
144.4			14	SS	29									
15.7	End of Borehole													

RECORD OF BOREHOLE No A-3

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 713 ; E 298 662.2 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
160.9	Ground Surface							20 40 60 80 100						
160.2	Topsoil													
0.7	Sand, Tr. Gravel		1	SS	7									
158.9	Brown, Loose		2	SS	6									
2.0	Silt		3	SS	13									
157.4	Compact		4	SS	12									
3.5	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt Grey, Stiff to Very Stiff		5	SS	12									
			6	SS	5									
			7	SS	12									
			8	TW	PH									
153.3	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Stiff to Very Stiff		9	SS	5									
7.6			10	SS	3									
			11	SS	9									
			12	SS	10									
			13	SS	19									
			14	SS	13									
145.2														
15.7	End of Borehole													

RECORD OF BOREHOLE No A-4

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 740.9 ; E 298 588.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 16 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.9	Ground Surface																
160.1	Topsoil																
0.8	Sand, Tr. Gravel, Tr. Silt		1	SS	24												
158.9	Brown, Compact		2	SS	28												3 86 (11)
2.0	Silt		3	SS	27												
157.4	Compact		4	SS	17		158										
3.5	Clayey Silt with Random Nodules/ Seams of Silt		5	SS	15											20.4	
	Stiff to Very Stiff		6	SS	13		156										
			7	SS	14												
			8	SS	11		154										
153.3			9	SS	4												
7.6	Clayey Silt, Some Sand, Tr. Gravel (Glacial Till)		10	TW	PH		152										
	Grey, Firm to Stiff		11	SS	5		150										
			12	SS	12		148										7 32 (61)
			13	SS	14												
145.2			14	SS	17		146										
15.7	End of Borehole																
	* Hole caved-in at 2.1m																

RECORD OF BOREHOLE No A-5

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 660.1 ; E 298 576.7 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 15 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
160.2	Ground Surface													
159.4	Topsoil		1	SS	11								11 82 (7)	
0.8	Sand, Some Gravel		2	SS	10									
	Brown, Compact		3	SS	17								25 68 (7)	
157.2			4	SS	14								18.8	0 0 (100)
156.4	Silt, Brown, Compact		5	SS	10									
3.8			6	SS	11								22.6	
	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt		7	SS	5									
	Grey, Stiff		8	TW	PH									0 0 32 68 • c'=0 φ'=29°
152.6			9	SS	13									
7.6			10	SS	2									
	Clayey Silt, Some Sand, Tr. Gravel (Glacial Till)		11	SS	4									
	Grey, Firm to Stiff		12	SS	5									
			13	SS	8								18.4	1 15 (84)
			14	SS	10									
			15	SS	6									
141.5			16	SS	5									
18.7	End of Borehole													
137.3														
22.9	End of Cone Test													

RECORD OF BOREHOLE No A-6

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 691.2 ; E 298 501.7 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 01 12-15 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC UNIT NATURAL MOISTURE CONTENT LIQUID UNIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	WATER CONTENT (%) 10 20 30			
159.8	Ground Surface													
159.0	Topsoil		1	AS	-									
0.8	Sand, Tr. Silt, Some Gravel		2	SS	26									14 79 (7)
157.5	Brown, Compact		3	SS	18									
2.3	Silt		4	SS	21									0 19 76 5
156.8	Brown, Compact		5	SS	18									0 0 60 40
3.0	Clayey Silt to Silty Clay with Random Nodules/Interbeds of Silt Firm to Stiff		6	SS	16								20.0	0 0 77 23
			7	SS	12								22.2	
			8	SS	8								19.8	
			9	SS	5									
			10	TW	PH									
152.0	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Stiff to Very Stiff		11	SS	10									
7.8			12	SS	10									
			13	TW	PH								20.3	1 11 62 26 * c' = 10 kPa φ' = 29°
			14	SS	13									
			15	SS	17								20.8	1 20 49 30
			16	SS	16									
			17	SS	16									
141.1														
18.7	End of Borehole													
137.5														
22.3	End of Cone Test													
* GROUND WATER CONDITIONS														
PIEZO. NO.			GROUND WATER ELEVATION (Metres)											
1			157.5											

RECORD OF BOREHOLE No A-7

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 615.4 ; E 298 488.6 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90.01.11-12 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
159.3	Ground Surface													
158.5	Topsoil		1	AS	-									
0.8	Sand, Tr. Silt, Tr. Gravel Brown, Compact		2	SS	16									5 89 (5)
			3	SS	22									
156.3			4	SS	16									
3.0	Silt Compact		5	SS	26									0 3 86 11
154.7			6	SS	16									
4.6	Clayey Silt with Random Nodules/ Seams of Silt Grey, Stiff		7	TW	PH									0 0 75
			8	SS	8									
			9	SS	9									17.7
151.7			10	SS	6									0 0 65 35
7.6	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Firm to Stiff		11	SS	4									17.0
			12	TW	PH									18.4
			13	TW	PM									
			14	SS	11									
			15	SS	13									
			16	SS	19									20.8
140.6			17	SS	17									0 10 56 34
18.7	End of Borehole													
	Hole Cove-in at 1.5m													

RECORD OF BOREHOLE No A-8

1 OF 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 881 ; E 298 813 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100								10 20 30		
160.2	Ground Surface																	
159.4	Topsoil																	
0.8 158.7	Sand, Tr. Gravel																	
1.5	Silt, Brown, Compact		1	SS	12													
1.8	Clayey Silt with Random Nodules/ Seams of Silt Grey, Stiff		2	SS	10													
			3	SS	7													
154.1			4	SS	3													
6.1	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Stiff to Very Stiff		5	SS	3													
			6	SS	7													
			7	SS	12													
			8	SS	16													
147.6																		
12.6	End of Borehole																	

RECORD OF BOREHOLE No A-9

1 of 1

METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 921 ; E 298 877 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100							10 20 30		
160.1	Ground Surface																
159.3	Topsoil																
0.8	Sand, Tr. Gravel																
158.6	Brown																
1.5	Silt		1	SS	16												
157.8	Brown, Compact																
2.3	Clayey Silt with Random Nodules/ Seams of Silt Grey, Stiff to Very Stiff		2	SS	14												
			3	SS	7												
154.0			4	SS	3												
6.1	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till) Grey, Firm to Very Stiff		5	SS	3												
			6	SS	5												
			7	SS	8												
			8	SS	6												
148.7																	
11.4	Sand, Tr. Silt																
147.5	Loose																
12.6	End of Borehole																

RECORD OF BOREHOLE No A-10 1 OF 1 METRIC

W.P. 141-87-00A LOCATION Co-ords: N 4 847 953 ; E 298 923 ORIGINATED BY TS
 DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 02 23 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.0	Ground Surface																
159.4	Topsoil																
0.6 158.5	Sand, Tr. Gravel Brown, Compact																
1.5 157.7	Silt Brown, Compact		1	SS	14		158										
2.3	Clayey Silt with Random Nodules/ Seams of Silt		2	SS	6		156										
	Grey, Very Stiff		3	SS	11												
153.9							154										
6.1	Clayey Silt, Tr. Sand, Tr. Gravel (Glacial Till)		4	SS	6		152										
	Grey, Firm to Stiff		5	SS	5												
			6	TW	PH		150										
149.3																	
10.7	Silty Sand		7	SS	5		148										
	Grey, Loose																
147.4			8	SS	5												
12.6	End of Borehole																

RECORD OF BOREHOLE No 1

1 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 645 E 298 404 ORIGINATED BY HCO
DIST 6 HWY 407 BOREHOLE TYPE Wash Boring, Hollow Stem Augers, Solid Stem Augers COMPILED BY RWR
DATUM Geodetic DATE June 20 to 23, 1983 CHECKED BY HCO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
159.5	Topsoil - Brown, Sandy													
0.4			1	SS	15									
			2	SS	18									
	Brown		3	SS	18									
	Grey		4	SS	15									
	Sandy Silt, Trace Clay		5	SS	11									
	Compact, Interbedded layers of Clayey Silt		6	SS	14									
	(Firm to Stiff)													0 22 73 5
152.2			7	SS	15									
7.3			8	SS	4									
			9	SS	WR									
	Clayey Silt, Trace Sand and Gravel, Random Silt Zones, Occasional Sand and Gravel Pockets		10	SS	PH									
	Firm to Stiff		11	TW	PM									18.5
	Grey		12	SS	1									
143.2			13	SS	WR									
16.3			14	TW	PH									
			15	SS	13									21.2
	Clayey Silt, Some Sand, Trace Gravel		16	SS	21									
	(Glacial Till)		17	SS	14									1 12 57 30
	Stiff		18	TW	PH									
	Grey		19	SS	10									21.4
133.9			20	SS	22									
25.6			21	SS	27									
	Clayey Silt		22	SS	11									
	Stiff to Very Stiff													
	Grey													
129.3														
30.3														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 1

2 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 645 E 298 404 ORIGINATED BY HCO
DIST 5 HWY 407 BOREHOLE TYPE Wash Boring, Hollow Stem Augers, Solid Stem Augers COMPILED BY RWR
DATUM Geodetic DATE June 20 to 23, 1983 CHECKED BY HCO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
30.5	Continued		23	SS	23											
			24	SS	16											
	Compact --- Very Dense		25	SS	131											
	Sandy Silt to Silty Sand, Trace Clay, Trace Gravel Occasional Sand Seams		26	SS	94	/23cm										
			27	SS	127	/23cm										
			28	SS	109											
119.4			29	SS	162	/27cm										
40.1	End of Borehole															
	** Water Level Elev. 157.5 m July 7 /83 Piezometer dry Aug. 24 /83 *** Water Level Elev. 141.4 m Aug. 4 /83															
	* GROUND WATER CONDITIONS															
	PIEZO. NO.															
	GROUND WATER ELEVATION (Metres)															
	1															
	2															

RECORD OF BOREHOLE No 2

1 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 575 E 298 428 ORIGINATED BY HCO
DIST 5 HWY 407 BOREHOLE TYPE Wash Boring COMPILED BY EFO
DATUM Geodetic DATE July 7-11, 1983 CHECKED BY HCO

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					
158.5	Ground Surface																
0.0	Sand, Some Gravel Compact		1	SS	15												
			2	SS	20												
	Silt - Sandy Silt Compact		3	SS	12		156										
			4	SS	21												
			5	SS	10												
			6	SS	15		154										
153.0																	
5.5	Clayey Silt, [CL-ML], with interbedded zones of Silt.		7	SS	13		152										
	Stiff, Grey		8	SS	13												
150.0							150										
8.5			9	SS	PH												
	Silty Clay [CI] with random zones, Traces of Gravel, layered		10	TW	PH		148										
	Firm to Stiff		11	SS	6		146										
	Grey		12	TW	PH		144										
143.3																	
15.2			13	SS	11		142										
			14	SS	17												
			15	SS	26		140										
	Clayey Silt with / some Sand and Trace Gravel		16	SS	20		138										
	(Glacial Till)		17	SS	18												
	Stiff to Hard, Grey		18	SS	20		136										
			19	SS	16		134										
			20	SS	54		132										
131.0																	
27.5	Clayey Silt, Trace / Some Fine Sand		21	SS	10		130										
	Very Stiff to Hard		22	SS	31												
	Grey																
128.0																	

30.5 Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2

2 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 575 E 298 428 ORIGINATED BY HCO
DIST 6 HWY 407 BOREHOLE TYPE Wash Boring COMPILED BY EFO
DATUM Geodetic DATE July 7-11, 1983 CHECKED BY HCO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40
30.5	Continued Limestone Cobbles with Silty Sand Dense, Grey		23	SS	33									
			24	SS	100									
			25	SS										
125.3														
33.2	Silt Some Sand and Gravel, Trace Clay, Occasional Sand layers Very Dense, Grey		26	SS	48									
			27	SS	97									
			28	SS	63									
			29	SS	60									
118.7														
39.8	Clayey Silt layered Hard, Grey Some Sand		30	SS	33									
			31	SS	117									
			32	SS	91									
114.1			33	SS	100									
44.4	End of Borehole													
	** Water Level Elev. 140.7 m Aug 24 /83.													
* GROUND WATER CONDITIONS		PIEZO. NO.		GROUND WATER ELEVATION (Metres)										
		1		140.7										

RECORD OF BOREHOLE No 3

1 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 617 E 298 429 ORIGINATED BY HCO
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Wash Boring COMPILED BY EFO
DATUM Geodetic DATE July 12-13, 1983 CHECKED BY HCO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
159.6																		
0.0 158.8	Fill - Sand and Gravel																	
0.8	Sandy Silt Very Loose to Compact Brown ----- Grey		1	SS	5									0 2 86 12				
			2	SS	7													
			3	SS	15													
			4	SS	5													
			5	SS	4													
			6	SS	3													
154.7	Clayey Silt [CL], Trace Sand Random Silt Zones Stiff, Grey		7	SS	6									0 0 67 33				
4.9																		
151.7	Clayey Silt [CL], Some Sand, Trace Gravel (Glacial Till) Firm to Stiff Grey		8	TW	PH									18.8				
7.9			9	TW	PH													
			10	SS	6													
			11	SS	6													
			12	SS	9													
			13	SS	16													
			14	SS	12													
			15	SS	10													
			16	SS	12													
			17	SS	11													
137.1			18	SS	34													
22.5			19	SS	58													
			20	SS	36													
			21	SS	30													
129.8	22	SS	19															
28.8 129.1	As below																	

30.5 Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 3

2 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 617 E 298 429 ORIGINATED BY HCO
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Wash Boring COMPILED BY EFO
 DATUM Geodetic DATE July 12-13, 1983 CHECKED BY HCO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
30.5	Continued Sandy Silt to Silty Sand Compact to Dense		23	SS	19												
			24	SS	48												
			25	SS	20												
			26	SS	69												
123.0																	
36.6	Clayey Silt Hard		27	SS	67												
121.0			28	SS	49												
38.6	Sandy Silt, Some Gravel Very Dense																
119.5			29	SS	76												
40.1	End of Borehole																
	Water Level Elev. 154.9 m Aug. 24 / 83																
* GROUND WATER CONDITIONS																	
	PIEZO. NO.		GROUND WATER ELEVATION (Metres)														
	1		154.9														

RECORD OF BOREHOLE No 4

1 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 569.3 E 298 444.7 ORIGINATED BY IR
DIST 6 HWY 407 BOREHOLE TYPE HS Auger and Washboring COMPILED BY HS
DATUM Geodetic DATE 84 07 23 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
159.4	Ground Surface																	
0.0	Clayey Silt with random zones of silt firm to stiff compact Sand trace silt		1	SS	5													
			2	SS	16									23 66 9 2				
			3	SS	16													
			4	SS	8									0 0 82 18				
			5	SS	9													
149.6			6	SS	5													
9.8	Silty Clay trace gravel firm		7	SS	5													
143.2			8	SS	8													
16.2	Clayey Silt some sand, trace gravel (Glacial Till) stiff very stiff		9	SS	13													
			10	SS	15													
133.5			11	SS	78													
25.9	Clayey Silt trace sand, occasional cobbles very stiff to hard																	
128.9																		

30.5

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 4

2 OF 2

METRIC

W.P. 88-78-18 LOCATION Co-ords: N 4 847 569.3 E 298 444.7 ORIGINATED BY JR
DIST 6 HWY 407 BOREHOLE TYPE HS Auger and Washboring COMPILED BY HS
DATUM Ceadetie DATE 84 07 23 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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
						○ UNCONFINED	+ FIELD VANE					WATER CONTENT (%)					
						● QUICK TRIAXIAL	x LAB VANE					10 20 30					
						20 40 60 80 100											
30.5	Continued		12	SS	67		128										
			13	SS	17		126										
	Sand(cemented) some silt, occasional cobbles very dense						124										
	hard		14	SS	100	/28cm	122									1 74 19 6	
			15	SS	163	/25cm	120										
117.3			16	SS	54		118										
42.1			17	SS	32		116										
	Sandy Gravel some silt		18	SS	150	/5cm	114									53 36 9 2	
	to		19	SS	61												
	Silty Sand		20	SS	150	/23cm	112										
	very dense		21	SS	200	/23cm											
110.9			22	SS	150	/5cm											
48.5	End of Borehole																

RECORD OF BOREHOLE No C-1

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 519.6; E 298 137.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 24 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITION	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				
136.5	Ground Surface															GR SA SI CL
0.0	Trace Organics		1	SS	7		136									
			2	SS	9											
	Firm to Stiff		3	SS	11		134									0 2 73 25
	Stiff to Hard	Brown Grey	4	SS	22											
			5	SS	30											
			6	SS	32		132									
	Clayey Silt		7	SS	28											
	Trace of Sand		8	SS	30		130									
			9	SS	12		128									0 5 65 30
125.8																
10.7	Sandy Silt		10	SS	12		126									0 1 84 15
			11	SS	18		124									0 36 60 4
	Compact V. Dense		12	SS	120		122									28 32 34 6
	Occ. Gravel Seams		13	SS	120	15cm	120									
			14	SS	90		118									
			15	SS	94		116									
							114									
111.8	Gravel, Boulders and Cobbles		16	AS	-		112									
24.7	End of Borehole															
	*Artesian Head 3.0m Above Ground Surface															

*3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No C-2										METRIC					
W P 141-87-00C		LOCATION Co-ords: N 4 847 540.1; E 298 173.9				ORIGINATED BY BC									
DIST 6 HWY 407		BOREHOLE TYPE H.S. Auger				COMPILED BY BC									
DATUM Geodetic		DATE 1989 11 28				CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100	20 40 60 80 100						
147.4	Ground Surface														
0.0															
	Sand, Trace Silt														
	Trace Gravel		1	SS	5										
	(Fill)														
	Brown, V. Loose		2	SS	4										
	to Loose														
142.4			3	SS	7										
5.0															
	Silty Clay to Clayey Silt		4	SS	5										
	Trace Gravel		5	SS	10										
	Occ. Sand Seams		6	TW	PH										
	Firm to V. Stiff		7	TW	PH										
	(Glacial Till)														
135.2			8	SS	9										
12.2			9	SS	15										
	Clayey Silt		10	SS	14										
	Trace Sand		11	SS	15										
	Grey		12	SS	13										
			13	SS	11										
			14	SS	12										
			15	SS	13										
			16	SS	10										
	Stiff Firm		17	SS	7										
124.5			18	SS	5										
22.9															
	Sand Some Silt														
	Grey, Loose		19	SS	8										
122.6															
24.8	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-3

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, HQ Core COMPILED BY TS
DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY _____

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5; Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No C-3 Cont'd

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
122.0	Continued												
121.7	Clayey Silt												
30.5			23	SS	10								
	Sand					120							
	Some Silt					118							
	Grey, Compact to Dense		24	SS	39	116							
						114							
			25	SS	28	112							
						110							
			26	SS	46	108							
	Occ. Cobbles Boulders and Gravel					106							
105.9													
46.3	Bedrock Shale		27	RC	REC 60%								RQD = 10%
105.0													
47.2	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C-4

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 580.0; E 298 204.5 ORIGINATED BY BC
 DIST 5 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 11 27 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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					
147.0	Ground Surface																
0.0																	
	Brown Grey		1	SS	12		146										
	Clayey Silt		2	SS	6		144										
	Some Sand, Tr. Gravel		3	SS	7		142										
	Stiff to V. Stiff		4	SS	5		140										
	Occ. Sand Seams (Glacial Till)		5	SS	5		138										
136.3			6	SS	13		136										
10.7			7	SS	22		134										
	Clayey Silt		8	SS	13		132										
	Grey, Stiff to Hard		9	SS	34		130										
	Random Zones of Silt		10	SS	39		128										
			11	SS	25		126										
			12	SS	23		124										
			13	SS	19												
			14	SS	18												
			15	SS	15												
			16	SS	14												
			17	SS	10												
122.2			18	SS	11												
24.8	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-1

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 89 10 21-30 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20	40							60	80	100
152.0	Ground Surface																	
0.0	Sand (Fill) Brown, Compact		1	AS	-													
150.5			2	SS	10													
1.5			3	SS	10													
	Brown Grey		4	SS	6													
			5	TW	PH													
	Silty Clay to Clayey Silt		6	SS	9													
			7	SS	9													
	Some Sand		8	SS	9													
	Stiff		9	SS	7													
	Occ. Sand Seams																	
	(Glacial Till)		10	TW	PH													
			11	SS	4													
138.3			12	SS	21													
13.7			13	SS	21													
	Clayey Silt		14	SS	32													
	V. Stiff		15	SS	30													
	to		16	SS	26													
	Hard		17	SS	32													
			18	SS	19													
			19	SS	18													
			20	SS	20													
			21	SS	16													
			22	SS	18													
121.8																		
30.2																		

Continued

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

0 2 78 20

RECORD OF BOREHOLE No D-1 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & COMPILED BY TS
Cone Test
DATUM Geodetic DATE 89 10 21-30 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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				
121.8 30.2	Continued															
	Clayey Silt		23	SS	16		120									
	Very Stiff to Hard		24	SS	16											
			25	SS	76		118									
			26	SS	45		116									
115.4 36.6	Sand		27	SS	15		114									0 86 (14)
	Tr. Silt		28	SS	59											
	Compact to		29	SS	58		112									
	V. Dense		30	SS	65		110									1 89 (10)
			31	SS	33											
	Tr. Gravel		32	SS	44		108									8 85 (7)
105.9 46.1	Bedrock Shale		33	SS	129/23cm		106									RQD = 34%
	Weak to Very Weak		34	BXL RC	REC 73%											RQD = 0%
			35	BXL RC	REC 100%		104									
103.1 48.9	End of Borehole															

*³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No D-2

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NO Core COMPILED BY TS
 DATUM Geodetic DATE 1989 11 08-11 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
153.0	Ground Surface																
0.0	Irregular Mixture of Silt, Sand, Slag Ballast (Fill)		1	SS	11		152										
150.6	Brown-Black, Compact		2	SS	7		150										
2.4			3	SS	7		148										
	Brown Grey		4	SS	8		146										
	Silty Clay to Clayey Silt		5	TW	PH		144									21.0	1 13 58 28
	Some Sand, Trace Gravel Firm to V. Stiff		6	TW	PH		142										4 13 35 48
	Occ. Sand Seams		7	SS	4		140										0 4 79 17
	(Glacial Till)		8	SS	4		138										
139.3			9	SS	22		136										
13.7	Clayey Silt		10	SS	20		134										
	Firm to V. Stiff		11	SS	23		132										
			12	SS	12		130										
			13	SS	20		128										
			14	SS	18		126										
			15	SS	13		124										

OFFICE REPORT ON SOIL EXPLORATION

122.8
30.2 Continued

*3, *5: Numbers refer to
Sensitivity

Continued
20
15 *5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-2 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 1989 11 08-11 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
122.8 30.2	Continued		16	SS	9		122										
	Clayey Silt						120										
	Firm to Very Stiff		17	SS	5		118										
116.1 36.9			18	SS	50		116										
	Sand		19	SS	20		114										
	Tr. Silt						112										
	Compact to						110										
	V. Dense		20	SS	56		108										
	Occ. Gravelly						106										
	Seams		21	SS	50		104										
105.5 47.5	Bedrock		22	RC	REC												
103.9	Shale				92%												
	Weak to Very Weak																RQD = 20%
49.1	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No D-3										METRIC				
W P 141-87-00D		LOCATION Co-ords: N 4 847 504.0; E 298 204.0				ORIGINATED BY TS								
DIST 6 HWY 407		BOREHOLE TYPE H.S. Auger				COMPILED BY TS								
DATUM Geodetic		DATE 1989 11 27				CHECKED BY								
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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
			NUMBER	TYPE	'N' VALUES			20	40					
136.0	Ground Surface													
0.0														
	Interbedded Layers of Sand and Gravel Brown Grey Tr. Organics		1	SS	4		134	2						0 5 61 34
			2	SS	2									
			3	SS	14									
			4	SS	12									
			5	SS	27		132							
			6	SS	19									
	Clayey Silt		7	SS	27		130							
	Tr. Sand, Tr. Gravel		8	SS	20		128							0 0 77 23
	Stiff to Hard		9	SS	20		126							
124.9			10	SS	15									
11.1	Silt Tr. Clay, Tr. Sand		11	SS	7		124							
	Loose V. Dense		12	SS	85		122							
			13	SS	100/	15cm								0 5 85 10
119.1			14	SS	120/	10cm	120							
16.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4

METRIC

W P RR-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 13-21 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

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				
152.1	Ground Surface						152									
0.0	Clayey Silt With Interbedded Layers of Sand (Fill) Brown to Grey V. Soft to Stiff		1	SS	2		150									
			2	SS	3		148									0 32 64 4
			3	SS	3		146									
			4	SS	6		144								20.0	0 2 78 20
			5	SS	6		142									
			6	SS	8		140									
			7	SS	15		138								20.2	4 22 49 25
139.9			8	SS	20		136									
12.2	Clayey Silt Grey, Stiff to Hard		9	SS	25		134									
			10	SS	30		132									
	Sandy Silt		11	SS	52		130								22.0	0 1 79 20
			12	SS	32		128									
			13	SS	17		126									
			14	SS	11		124									
			15	SS	13		122									0 0 88 12

121.9
30.2

Continued

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-4 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
121.9 30.2	Continued																
	Clayey Silt Grey Stiff to Hard		16	SS	10		120										
118.6 33.5			17	SS	45		118										
	Sand Some Silt Grey, Compact to V. Dense		18	SS	20		116										
			19	SS	72		114										
			20	SS	120/8 cm		112										0 85 14 1
	Occ. Cobbles Boulders and Gravel		21	SS	65		110										
107.1 45.0	Bedrock Shale		22	NQ RC	REC 60%		108										RQD = 8%
105.8 46.3	End of Borehole						106										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 520.0: E 298 212.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
DATUM Geodetic DATE 1989 11 30 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					
143.5 0.0	Ground Surface																GR SA SI CL
	Sand, Tr. Gravel (Fill)		1	SS	6		142										
	Brown, Loose to Compact		2	SS	21		140										
138.9 4.6	Clayey Silt With Interbedded Layers of Sand (Fill)		3	SS	37		138										
136.9 6.6	Brown, Stiff to Hard End of Borehole *Borehole Dry		4	SS	22												

OFFICE REPORT ON SOIL EXPLORATION

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
[%] STRAIN AT FAILURE

RECORD OF BOREHOLE No D-5

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 605.0; E 298 115.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 16-17 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
154.3	Ground Surface															
0.0	Silty Clay to Clayey Silt Trace Gravel Grey, Firm to V. Stiff Occ. Sand Seams (Glacial Till)		1	SS	7										19.5	0 4 61 35
			2	SS	3			2								
			3	TW	PH			2	q							
			4	TW	PH				3							
			5	SS	11											
			6	SS	8											
			7	SS	10										20.1	6 7 60 27
			8	SS	5											
			9	SS	10											
139.1			10	SS	12											
15.2	Clayey Silt Grey, Stiff to V. Stiff		11	SS	22										20.0	0 2 74 24
			12	SS	32											
134.0			13	SS	22											
20.3	End of Borehole *Borehole Dry															

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 511.1; E 298 240.4 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 89 11 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPo							WATER CONTENT (%)					
152.5	Ground Surface						20	40	60	80	100	10	20	30						
0.0	Sand, Tr. Silt (Fill) Brown, V. Loose		1	SS	4															
150.5			2	SS	6															
2.0	Clayey Silt With Interbedded Layers of Sand (Fill) Brown, Firm		3	SS	6															
			4	SS	5															
			5	SS	7															
			6	SS	6															
141.8			7	SS	4															
10.7	Sand, Some Silt (Fill) Brown, Very Loose to Loose		8	SS	6															
			9	SS	7															
138.6			10	SS	14															
13.9	Clayey Silt, Tr. Gravel Tr. Organics Grey, Firm to Stiff																			
136.8																				
15.7	End of Borehole *Borehole Dry																			

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-6A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 504.0; E 298 229.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 29 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

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					
143.5	Ground Surface															
0.0	Sand, Some Gravel, Trace Silt (Fill)		1	SS	2	*										20 77 (3)
			2	SS	6											
			3	SS	8											
			4	SS	9											
			5	SS	12											
	Brown, V. Loose to Compact															26 59 (15)
138.9	Clayey Silt (Fill) Brown, V. Stiff		6	SS	19											
4.6																
137.3	Clayey Silt															4 6 65 25
138.6	Grey, Tr. Organics		7	SS	29											
6.6	End of Borehole															
	* Borehole Dry															

RECORD OF BOREHOLE No D-7

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 530.8; E 298 232.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
 DATUM Geodetic DATE 89 11 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					
152.5	Ground Surface																GR SA SI CL
0.0						*	152										
			1	SS	2												11 62 23 4
			2	SS	3		150										
	Clayey Silt Brown, Firm		3	SS	8		148										0 12 66 22
			4	SS	4		146										
	Silty Sand to Sandy Silt (Fill)		5	SS	5		144										2 41 54 3
			6	SS	5												
	V. Loose to Loose		7	SS	8		142										
			8	SS	9		140										0 30 66 4
			9	SS	9												1 63 31 5
			10	SS	8		138										4 73 19 4
136.3																	
16.2	End of Borehole Auger Refusal Probable Culvert Roof																
	*Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-8

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
DATUM Geodetic DATE 89 11 02-08 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
150.6	Ground Surface													
0.0	Sand, Some Silt With Interbedded Layers of Clayey Silt Brown, Loose (Fill)		1	SS	9		150	2					14 56 29 1	
			2	SS	6		148	3						
			3	SS	4		146						0 13 75 12	
144.5			4	SS	4		144	3					0 7 52 41	
6.1	Clayey Silt Grey, Firm to Stiff Occ. Sand Seams (Glacial Till)		5	SS	8		142	2					20.2	
			6	SS	12									
			7	SS	4		140	3						
139.9			8	SS	17									
10.7	Clayey Silt Grey, Firm to Hard		9	SS	22		138						2 1 72 25	
			10	SS	19								20.3	
			11	SS	22									
			12	SS	28	Seal	136						21.6	
			13	SS	25	Piezometer								
			14	SS	23	Seal	134							
			15	SS	19		132							
			16	SS	16		130						0 5 60 35	
			17	SS	14		128							
			18	SS	18		126							
			19	SS	10		124							
							122							
120.4														

30.2 Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-8 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
120.4	Continued		20	SS	9		120										
30.2							118										
	Silt, Tr Sand V. Dense		21	SS	107		116										0 7 79 14
	Clayey Silt Grey Firm to Hard		22	SS	36		114										
111.9							112										
38.7	Sand With Silt Grey, Compact		23	SS	12		110										
							108										17 38 31 14
107.7	Some Gravel		24	SS	120	15 cm	106										RQD = 15%
42.9	Bedrock Shale Weak to Very Weak		25	NQ RC	REC 100%												
105.9																	
44.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4										METRIC				
W P 88-78-32; 88-78-15		LOCATION				ORIGINATED BY RF								
DIST 6 HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ASP								
DATUM Geodetic		DATE March 21, 1990				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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES			20 40 60 80 100	20 40 60 80 100					
135.17	Ground Surface													
134.52	Topsoil													
0.65	Sand, fine, some silt to sandy silt, trace clay & organics		1	SS	3									
133.17	Very loose Brown		2	SS	2									
2.00	Sand and Gravel.		3	SS	3									
132.89	Clayey Silt, trace sand, occasional gravel (Till-like texture)													
2.50	Stiff to very stiff Grey		4	SS	5									
			5	SS	14									
129.67	Silt, trace sand, some silty sand interlayers.		6	SS	7									
5.50	Loose Grey		7	SS	4									
126.67	Clayey Silt, trace sand, occasional gravel (Till-like texture). Occasional silt seams.		8	SS	4									
8.50	Stiff to hard Grey		9	SS	11									
			10	SS	74									
122.07	Silt and Sand, trace clay.		11	SS	25									
13.10	Compact Grey													1 51 42.6
120.27	Silt, trace sand and clay.		12	SS	159									
14.90	Very dense Grey		13	SS	188									0 3 90 7
117.57	Silty Sand, some gravel trace clay (Till)		14	SS	130									
17.60	Very dense Grey													15 56 27 2
116.42	End of Borehole													
18.75														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 88-78-32;88-78-15 LOCATION _____ ORIGINATED BY RF
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ASP
 DATUM Geodetic DATE March 19 and March 20, 1990 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. (m)	DEPTH (m)	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20	40	60	80	100					
135.85	0.00	Ground Surface															
135.25	0.60	Topsoil															
133.85	2.00	Sandy Silt, trace clay, some organics, occasional shell fragments. Loose Brown		1	SS	4											
133.25	2.60	Sand and Gravel. Compact		2	SS	7											
131.25	2.60	Clayey Silt, trace sand, occ. gravel (Till-like texture) Stiff Grey		3	SS	22											
				4	TW	PH											
				5	SS	6											
				6	SS	4											
130.05	5.80	Silt, some sand, occ. clayey silt seam. Compact Grey		7	SS	11											
129.15	6.70	Stratified Clayey silt and silty clay, trace sand, frequent silt seams. Stiff to very stiff Grey		8	SS	5											
				9	SS	5											
				10	SS	13											
123.55	12.30	Clayey Silt, some sand & gravel (Till). Hard Grey		11	SS	93											
122.45	13.40	Clayey Silt, trace sand & interlayered with silt and silty sand. Hard Grey		12	SS	53											
121.25	14.60	Silt, trace clay and sand. Very dense Grey		13	SS	134											
119.65	16.20	Heterogeneous mixture of silt and gravel, some sand and clay (Till). Very dense Grey		14	SS	100/100 mm											
				15	SS	182											
116.65	19.20	Silty Sand, some gravel, trace clay (Till) Very dense Grey		16	SS	142											
115.73	20.12	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 6

METRIC

W P 88-78-32; 88-78-15

LOCATION

ORIGINATED BY SB

DIST 6 HWY 407

BOREHOLE TYPE

Hollow Stem Augers

COMPILED BY ASP

DATUM Geodetic

DATE

March 9, March 15 and March 16, 1990.

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 (m)	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
135.16	Ground Surface																
134.36	Topsoil						135									49.7	
0.80	Sandy Silt, trace clay		1	SS	6												
133.35	Loose Brown		2	SS	11												
1.80	Sand and Gravel, some silt.		3	SS	14												
132.26	Compact Brown/Grey		4	SS	6												
2.90	Clayey Silt, trace to some sand, occasional gravel (Till-like texture).		5	SS	12												
	Very Stiff Grey		6	SS	12												
			7	SS	5												
127.96			8	SS	3												
7.20	Silt, trace clay, interlayers of sandy silt and clayey silt.		9	SS	8												
	Very loose to loose Grey		10	SS	19												
125.16			11	SS	70												
10.00	Clayey silt, some silt partings		12	SS	117												
	Very Stiff Grey		13	SS	43												
123.56			14	SS	76/225 mm												
11.60	Clayey Silt, trace to some sand, trace gravel.		15	SS	92												
122.06	Hard Grey		16	SS	75												
13.10	Silt to sandy silt, trace clay.		17	SS	34												
	Dense to very dense Grey																
118.96																	
16.20	Clayey Silt, and gravel some sand (Till).																
117.66	Hard Grey																
17.50	Sandy Silt, some gravel (Till).																
	Very Dense Grey																
115.96																	
19.20	Silty sand, trace gravel.																
114.89	Dense Grey																
20.27	End of Borehole																

+3, x5: Numbers refer to Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11

METRIC

W P 88-78-32; 88-78-15 LOCATION _____ ORIGINATED BY JR
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger; BW Casing - Wash Boring COMPILED BY ASP
 DATUM Geodetic DATE February 14 to February 20, 1990 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
135.44	Ground Surface.													
0.00	Topsoil						135							
134.95														
0.50	Sandy Silt, trace clay and organics. Loose		1	SS	8									
134.04														
1.40	Silty Sand, silt inter layers. Very Loose		2	SS	3									
133.34														
2.10	Silty clay, gravel seams. Stiff		3	SS	10									
132.54														
2.90	Clayey Silt, trace to some sand, occasional to trace gravel (Till-like texture). Very Stiff Grey		4	SS	15									
			5	SS	14									
			6	SS	15									
							130							
128.84			7	SS	12									
6.60	Silty Clay, stratified with silt partings. Very Stiff Grey		8	TW	PH									
			9	SS	13									
126.94														
8.50	Clayey Silt, some sand, trace gravel (Till). Very Stiff Grey		10	SS	13									
125.44														
10.00	Silt and sand, fine, trace clay. Occasional interlayer of clayey silt. Loose Grey		11	SS	9		125							
			12	SS	WR									
122.04														
13.40	Silty Clay and clayey silt, stratified with silt partings. Hard Grey		13	SS	110									
			14	SS	115		120							
118.98			15	SS	184									
16.46	End of Borehole.						115							

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 12

METRIC

W P 88-78-32; 88-78-15 LOCATION _____ ORIGINATED BY JR
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger; Wash Boring COMPILED BY ASP
 DATUM Geodetic DATE February 23 to February 27, 1990. 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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
							20	40	60	80	100	10	20	30						
135.55	Ground Surface																			
0.00	Topsoil																			
135.03							135													
0.50	Sandy Silt, trace clay and gravel. Loose		1	SS	7															
134.15							Water Level Elev. 134.3 April 1990.													
1.40	Sand and Gravel, trace silt.		2	SS	6															
132.63																				
2.90	Loose to Compact Grey		3	SS	14															
	Clayey Silt, trace to some sand, occasional to trace gravel (Till- like texture).		4	SS	23															
			5	SS	24															
	Very Stiff Grey		6	SS	19															
							130													
			7	SS	14															
			8	SS	16															
126.15																				
9.40	Silty Clay, stratified with silt partings.		9	SS	17															
	Very Stiff Grey						125													
			10	SS	14															
123.95																				
11.60	Silt and Sand, fine, trace clay.		11	SS	2															
	Very Loose Grey																			
122.15																				
13.40	Clayey Silt to silty clay, trace to some sand (Till-like texture).		12	SS	48															
	Hard Grey		13	SS	140		120													
			14	SS	142															
			15	SS	146															
118.15							Water Level Elev. 136.4 April 1990.													
17.40	Clayey Silt Hard		16	SS	134															
117.72																				
17.83	End of Borehole.																			
							115													

RECORD OF BOREHOLE No 17										METRIC				
W P 88-78-32; 88-78-15		LOCATION				ORIGINATED BY JR								
DIST 6 HWY 407		BOREHOLE TYPE Hollow Stem Auger; BW Casing - Wash Boring				COMPILED BY ASP								
DATUM Geodetic		DATE February 14 to February 20, 1990				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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
135.50	Ground Surface													
0.00														
134.90	Topsoil													
0.60	Sandy Silt, trace clay and organics. Compact		1	SS	11									
134.10														
1.40	Silty Sand, trace organics. Loose		2	SS	6									
133.40														
2.10	Organic Silt with peat seams. Soft		3	SS	2									
133.60														
2.90	Silty Sand and gravel, occ. organics.		4	SS	15									
131.10	Compact Grey		5	SS	10									
4.40	Silty Clay and clayey silt, trace sand.		6	SS	11									
	Interlayered with frequent silt partings and seams.		7	SS	7									
	Occasional interlayer of sandy silt, trace of clay.		8	TW	PH									
			9	SS	7									
	Stiff to very stiff.		10	SS	9									
124.83	Grey		11	TW	PH									
10.6	Silt, some sand, trace clay.		12	SS	9									
123.90	Loose Grey													
11.60	Sandy Silt, trace gravel and clay.		13	SS	20									
122.70	Compact Grey													
12.80	Clayey Silt to silty clay, trace to some sand, trace gravel. (Till-like texture)		14	SS	172									
	Hard Grey		15	SS	130									
118.70														
16.80	Silt, trace clay and sand.													
	Very dense Grey		16	SS	115									
114.80														
20.70	Sand and Gravel, trace silt.		17	SS	79									
113.00	Very dense Grey													

22.00 Borehole Continued

+³, x⁵: Numbers refer to Sensitivity20
15 ÷ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 17

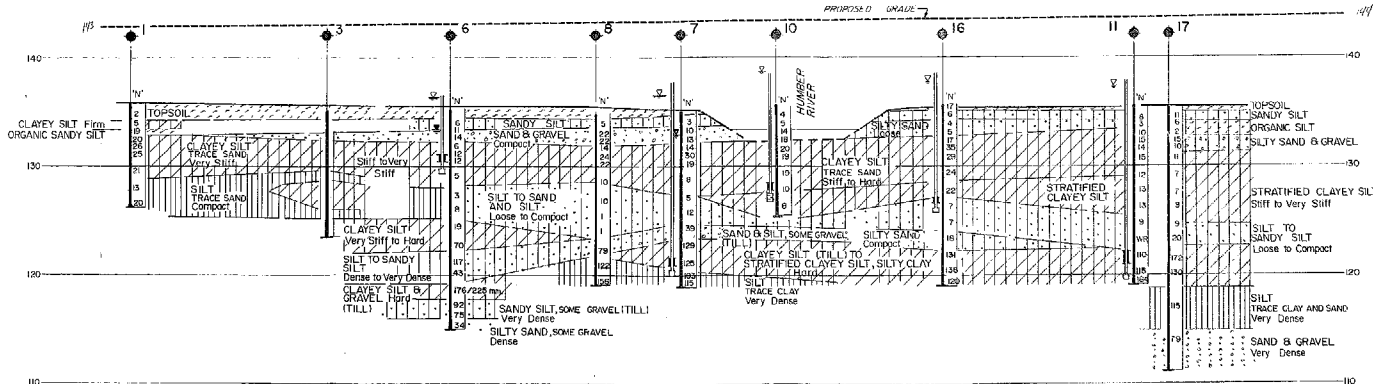
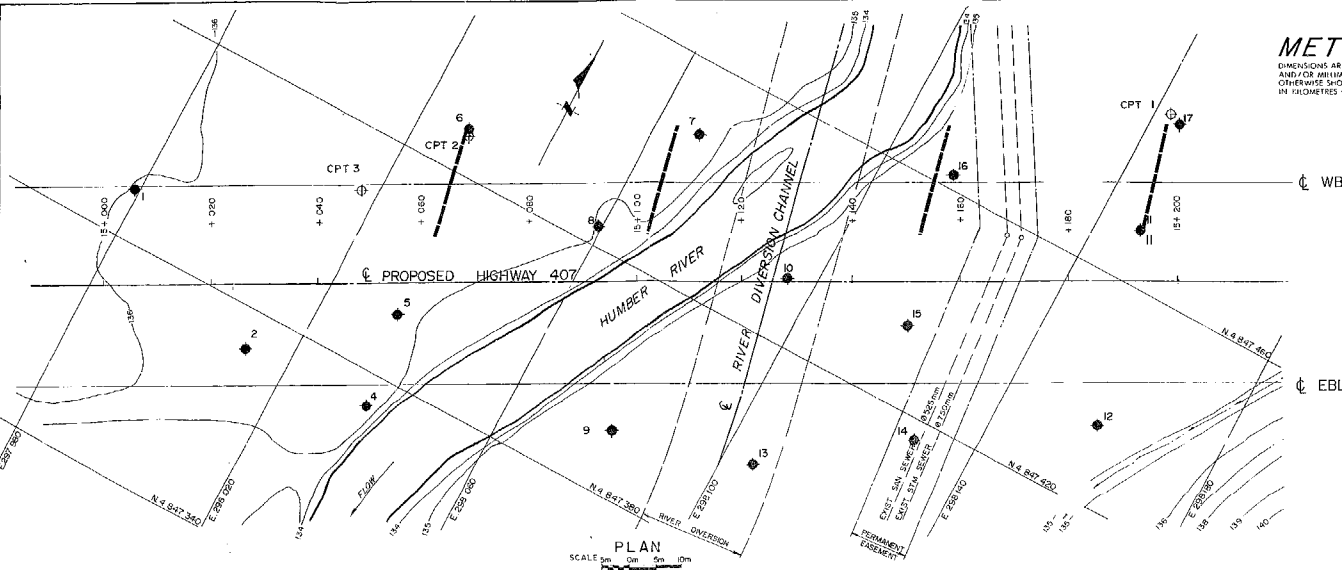
METRIC

W P 88-78-32; 88-78-15 LOCATION _____ ORIGINATED BY RF
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger; BW Casing - Wash Boring COMPILED BY ASP
 DATUM Geodetic DATE February 14 to February 20, 1990 CHECKED BY _____

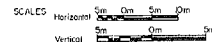
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
113.00	Continued																
22.50	Sand and Gravel, trace silt.																
111.12	Very dense Grey																
24.38	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x⁵: Numbers refer to
Sensitivity20
15 5 (%) STRAIN AT FAILURE
10



WESTBOUND LANES



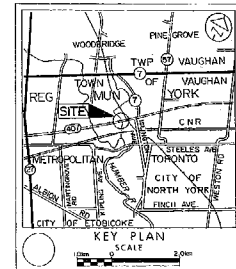
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES.

CONT No
WP No 88-78-15
HUMBER RIVER
(AT WESTBOUND LANES)
PROPOSED HIGHWAY 407
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

Golder Associates



LEGEND

- Bore Hole
- Piezometer Test (Canal)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation
- W.L. in Piezometer at time of investigation (April, 1990.)
- Denestible Seal
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	135.78	4,847,389.6	297,984.7
3	135.01	4,847,408.4	298,017.0
6	135.12	4,847,427.6	298,029.1
7	134.86	4,847,447.0	298,067.7
8	134.74	4,847,423.9	298,059.6
10	135.62	4,847,430.8	298,084.8
11	135.33	4,847,469.3	298,147.6
16	135.65	4,847,461.9	298,123.8
17	135.48	4,847,480.3	298,144.9

MTO Ref. No. E-73-407-17,8907

NOTE

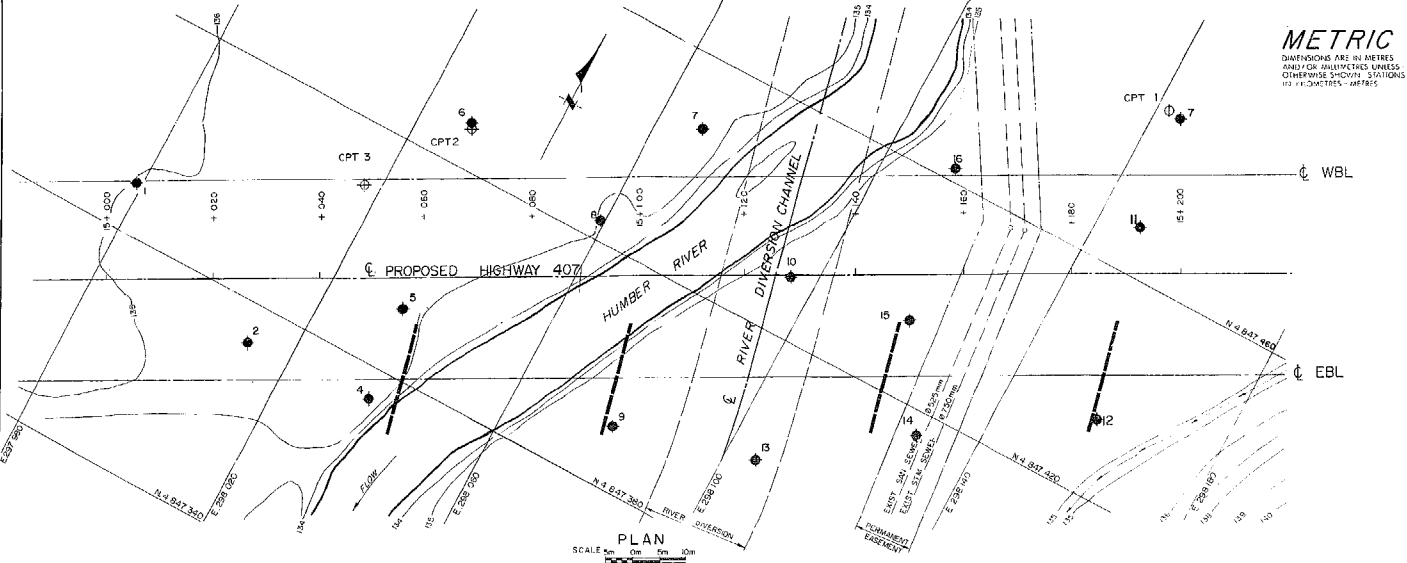
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

REV	DATE	BY	DESCRIPTION
1			

Geocore No 30 M13-108

STUDY No 407	DIST 6
SUBMIT	CHECKED
DRAWN	CHECKED
	DATE
	SITE 37-973
	DWG 087815-A



METRIC

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

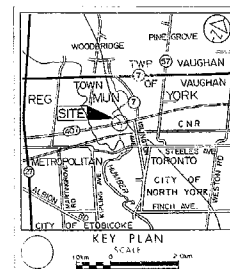
CONT No
WP No 88-78-32

HUMBER RIVER
(AT EASTBOUND LANES
PROPOSED HIGHWAY 407)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

Golder Associates



LEGEND

- Bore Hole
- Automatic Test Flame
- Bore Hole & Core Penetration
- N Flows 0.3m (Sta Pen Test, 475 J/blow)
- CONE Flows 0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- W L in piezometer at time of investigation (April, 1940.)
- Benicome Seal
- Piezometer

No	ELEVATION	CO - ORDINATES	
		NORTH	EAST
2	135.11	4,847,372.8	298,011.6
4	135.08	4,847,374.3	298,036.6
5	135.20	4,847,391.7	298,034.2
9	135.44	4,847,391.3	298,079.6
10	135.62	4,847,430.8	298,094.8
12	135.50	4,847,433.8	298,157.4
13	135.45	4,847,398.4	298,105.4
14	135.17	4,847,406.1	298,129.0
15	135.41	4,847,433.8	298,116.1

VIO Ref. No. E-73-407-17, 8907

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Manager's Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 107-2 of Form 100.

REV	DATE	BY	DESCRIPTION
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Geocres No 30 MIG - IQB

HWY No 407	DIST 6
SURAND	SITE 37 - 973

SURV DRAWN	CHECKED	DATE	SHEET NO - 575
	CHECKED	APPROVED	DWG 007032 - A

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¢ EASTBOUND LANES

SCALES

Horizontal 5m 0m 5m 10m

Vertical 5m 0m 5m 10m