

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30 M 15-64

DIST. 7 REGION

W.P. No. 7-79-04

CONT. No. 83-67

W. O. No.

STR. SITE No. 21-187

HWY. No. 35 / 115

LOCATION C.P.R. O/H Whidening  
1.4 km N of Hwy 2

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 67



Ministry of  
Transportation and  
Communications

INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3-58	Foundation Investigation Reports For W.P. 7-79-04 Hwy. 35/115 C.P.R. Overhead W.P. 7-79-05 Third Line Overpass W.P. 7-79-06 Fourth Line Overpass W.P. 7-79-12 Retaining Wall Third Line W.P. 36-82-02 Clarke Township Rd. Underpass

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

## EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	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
$U$	%	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$		COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$		COMPRESSION INDEX
$C_s$		SWELLING INDEX
$C_\alpha$		RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$		TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$		SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$		DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kn/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$		UNIFORMITY COEFFICIENT
$\gamma$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kn/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$		LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i		HYDRAULIC GRADIENT
$\gamma_{sat}$	kn/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$		CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kn/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

3

FOUNDATION INVESTIGATION REPORT  
For  
W.P. 7-79-04, Site 21-187  
Widening of C.P.R. Overhead  
Hwy. 35/115, District 7, Port Hope

INTRODUCTION:

This report describes the findings of a geotechnical investigation carried out at the site of the above-mentioned project. The purpose of the investigation was to determine the subsoil and groundwater conditions at the site and to establish the engineering properties of the substrata. The field work was carried out in July 1981, and consisted of drilling four boreholes to depths ranging from 3.0 to 10.7 m. The location of the boreholes are shown on Drawing No. 2 and the subsurface conditions encountered are presented on the Record of Borehole sheets.

REGIONAL GEOLOGY

The site is located near the northwest corner of the Town of Newcastle and 1.4 km north of Highway No. 2.

Geologically, the site is situated in the Lake Iroquois Plain, which is an area of low relief inundated during the Pleistocene times by the waters of the post glacial Lake Iroquois. The old abandoned shoreline of Lake Iroquois lies several kilometers to the north.

The bedrock underlying the basin is of Ordovician age and consists of the Whitby formation which is a black calcareous shale unit with interbeds of limestone. The bedrock surface is irregular and regional studies suggest that there are strong similarities between the existing surface topography and that of the bedrock surface. Available geological information suggests that the bedrock at the site is probably 25 m below the ground surface.

The surficial deposits consist of sediments of Pleistocene and Recent ages. Glacio-lacustrine deposits south of the abandoned Lake Iroquois shoreline range from sand and gravel of a near shore and deltaic nature to offshore sediments such as varved silt and clay. These were deposited on top of a ground moraine of generally coarse sandy texture.

The surface of the till is irregular and drumlinized and the surface of the drumlins are exposed in many places in the area. More recent deposits consisting of organic and alluvial soils are found in the valleys of the creeks.

## SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are shown on the Record of Borehole sheets and inferred subsoil sections are presented on Drawing No. 2.

Briefly, underlying some fill, at elevations ranging between 108.1 and 103.7 m a 1.2 to 4.7 m thick layer of glacial till was encountered which in turn is underlain by sand. Boreholes 1 and 4 were terminated in this sand deposit after penetrating it to between 0.6 and 2.5 m. In Boreholes 2 and 3, the sand is 2.4 to 3.2 m thick, below which, a lower till sheet was encountered at elevation 101.0 and 99.3 m.

The relevant index and engineering properties of the principal soil strata are briefly described in the following paragraphs.

### Topsoil

The boreholes encountered 0.15 m of organic topsoil.

### Fill

Below the topsoil, fill and material suspected to be fill was encountered extending to depths ranging between 1.2 and 5.5 m below the ground surface (i.e. to elevations 108.1 and 103.7).

The fill generally consists of sand some gravel, silt and occasional cobbles in the western and southwestern sections of the site. The grain size distribution of two representative samples from the fill is presented in Figure 2 and penetration indices ranging between 4 and 41 blows/0.3 m suggest that the fill is unevenly compacted and that it is loose to dense.

In the northeastern area the material within the top 1.2 m consists of clayey silt and silty sand and is suspected to be fill. 'N'-values of 6 and 7 blows/0.3m indicate a firm consistency.

### Upper Glacial Till

The fill is underlain by a 1.2 to 4.7 m thick relatively coarse textured glacial till. The grain size distribution of typical samples are shown in Figure No. 1. The tests indicate 15 to 40% gravel, 25 to 55% sand, 23 to 32% silt and 7 to 10% clay size particles. The moisture content of the till was measured to range from 6.6 to 8.2%. The till exhibits very little cementation. Penetration indices recorded within the till

generally range from 60 to more than 100 blows/0.3m indicating a very dense material. Exception to this was found within the upper zone of Borehole 4 where an 'N'-value of 19 blows/0.3 m shows that the material is compact. Based on the grain size distribution curves, the coefficient of permeability of the till is estimated to range between  $10^{-4}$  and  $5 \times 10^{-5}$  cm/sec.

#### Sand and Gravelly Sand

Underlying the glacial till, at depths ranging between 2.4 and 6.7 m below the ground surface, that is between elevations 103.7 and 102.5 m, the boreholes encountered a deposit of sand or gravelly sand. Boreholes 1 and 4 were terminated in this deposit after penetrating it to 2.5 and 0.6 m respectively. In Boreholes 2 and 3, the sand is 2.4 and 3.2 m thick respectively.

Based on Penetration Indices of 81 blows/0.3 m or greater, the sand is inferred to be very dense. The results of grain size analyses performed on samples from the deposit are presented on Figures 2, 3 and 4. These tests indicate 2 to 30% gravel, 58 to 80% sand and 10 to 35% silt content. From the grading curves the sand is considered to be considerably more pervious than the overlying till deposit with an estimated coefficient of permeability (k) of between  $10^{-2}$  and  $5 \times 10^{-4}$  cm/sec. This material will "boil" if subjected to an unbalanced hydrostatic head.

#### Lower Glacial Till

Boreholes 2 and 3 encountered a second till deposit at elevations 101.0 and 99.3 respectively. Penetration indices greater than 100 blows/0.3 m indicate that this lower till is also very dense. The till is a well graded mixture of gravel, sand and silt. The coefficient of permeability is estimated to be less than  $5 \times 10^{-5}$  cm/sec.

#### GROUNDWATER CONDITIONS

Groundwater conditions in the boreholes were observed during the drilling and at the completion of each borehole. After penetrating the sand deposit which underlies the upper till sheet a slight sub-artesian pressure was encountered in Boreholes 1, 2 and 3 and water had to be used to balance this hydrostatic head and to facilitate drilling.

Free-standing water levels in the open boreholes were also observed, where possible, after the completion of the boreholes. In addition, a piezometer was installed in Borehole 2 and to prevent surface water from seeping into the hole a bentonite seal was placed near the ground surface and also at a depth of approximately 8 m. The final recorded values in the open boreholes and in the piezometer showed a groundwater table ranging between elevations 105.0 and 103.7 m.

These observations indicate that the average water table at the time of the investigation was at elevation  $104.0 \pm$  m. Seasonal fluctuation can however, be expected in the groundwater level.

It should be of interest to note that one source indicates a flowing well from the overburden located about 1.3 km east of the site.



H. Sturm, P. Eng.  
Project Foundations Engineer



for  
M. Devata, P. Eng.  
Senior Foundations Engineer



A P P E N D I X

Our Reference No. 81-7-3



Ministry of  
Transportation and  
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 1

METRIC

8

W P 7-79-04 LOCATION Co-ords. 4 864 909 N; 376 726 E ORIGINATED BY S.H.C.  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
DATUM Geodetic DATE 07-21-81 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	W VALUES			20	40	60	80	100					
109.7	Ground Surface																
0.0	15m Sandy topsoil		1	AS	-		109										
	Fill - Sand some gravel, occasional silt lenses. compact brown to loose		2	SS	16												
			3	SS	4												
			4	SS	11												
105.7							107										
4.0	Het. mixture of sand, silt and gravel (Glacial Till) very dense greyish		5	SS	82/0	15m	105										40 25 28 7
			6	SS	60/0	15m											23 70 7 -
103.7			7	SS	97												
6.0	Sand, some gravel, silt v. dense grey		8	SS	54/0	15m	103										
			9	SS	137												
101.2			10	SS	100/0	12m											10 80 10 -
8.5	END OF BOREHOLE																

\*<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

Ministry of  
Transportation and  
Communications  
Ontario

## HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE No. 2

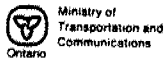
METRIC 9

W P 7-79-04 LOCATION Co-ords. 4 864 909 N; 376 741 E. ORIGINATED BY S.H.C.  
 DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
 DATUM Geodetic DATE 07-23-81 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
109.5	Ground Surface																
0.0	0.15m Sandy topsoil		1	AS	-												
108.1	Sand some gravel and cobbles (probably fill) brown																
1.4	Het. mixture of sand, silt and gravel occasional cobbles (Glacial Till) very dense grey		2	SS	69												
			3	SS	80												26 34 30 10
			4	SS	65/0	15m											
103.4			5	SS	75/0	15m											15 45 32 8
6.1	Sand - fine to medium Silty, traces of gravel. v. dense grey		6	SS	81												
			7	SS	75/0	15m											
			8	SS	65/0	15m											2 63 35
101.0																	
8.5	Het. mixture of sand silt & gravel (glacial till) v. dense, grey		9	SS	100/0	10 m											
100.1																	
9.4	END OF BOREHOLE																

+3, x5: Numbers refer to  
Sensitivity20  
15  
10  
5 (%) STRAIN AT FAILURE

Our Reference No. 81-7-3



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 3

METRIC

10

W P 7-79-04 LOCATION Co-ords. 4 864 937.3 N; 376 749.7 E. ORIGINATED BY S.H.C.  
 DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
 DATUM Geodetic DATE 07-27-81 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
109.2	Ground Surface																
0.0	0.15 m SANDY TOPSOIL						109										
	Fill - Sand		1	SS	18												
	some gravel						107										
	traces of silt		2	SS	4												30 62 8 -
	loose to dense						105										
	brown and greyish		3	SS	41												40 52 8 -
103.7			4	SS	60												15 55 23 7
5.5	Het. mixture of sand, silt and gravel (Glacial Till) v. dense, grey		5	SS	100/6	0.08m	103										
102.5			6	SS	135												30 58 10 2
6.7	Gravelly Sand some silty zones very dense grey		7	SS	150/6	.15m											
			8	SS	100/6	.15m	101										
			9	SS	100/6	.05m											
			10	SS	150/6	.10m											
99.3																	
9.9	Het. mixture of sand, silt and gravel (Glacial Till) v. dense, grey		11	SS	70/0	.05m	99										
98.5																	
10.7	END OF BOREHOLE																

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE

Our Reference No. 81-7-3



Ministry of  
Transportation and  
Communications  
Ontario

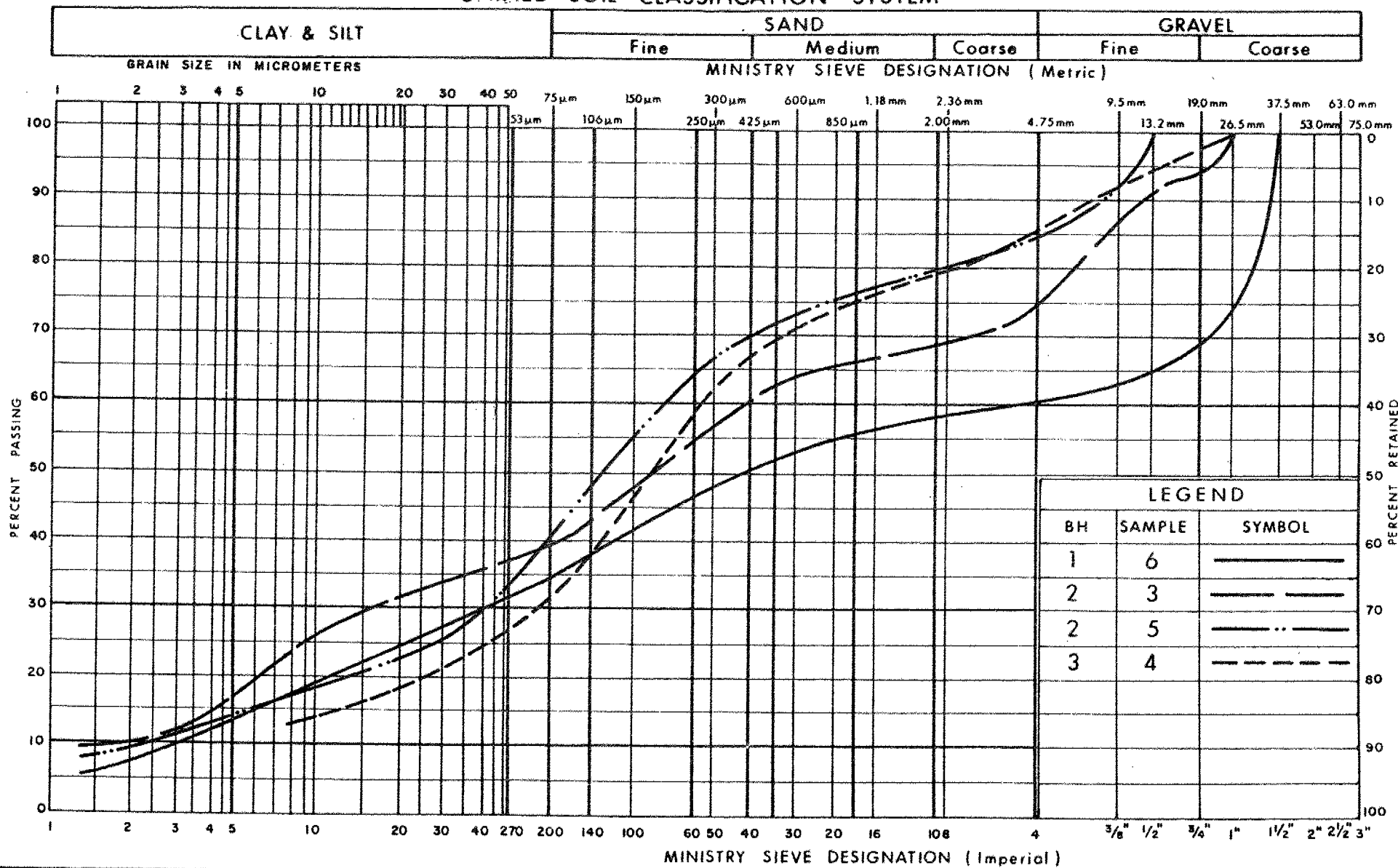
HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 4										METRIC		11		
W P 7-79-04		LOCATION Co-ords. 4 864 932 N; 376 765 E.				ORIGINATED BY S.H.C.								
DIST 7 HWY 35/115		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY S.H.C.								
DATUM Geodetic		DATE 07-23-81				CHECKED BY								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
105.4	Ground Surface													
0.0	0.15m topsoil		1	SS	7									
104.2	Silty Clay & Silty Sand (probably fill)		2	SS	6									
1.2	Het. mixture of compact sand, silt & gravel		3	SS	19									
103.0	occ. cobbles, v. dense		4	SS	164									
2.4	Gravelly sand, v. dense		5	SS	164									
102.4	Gravelly sand, some silt													
3.0	END OF BOREHOLE													

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



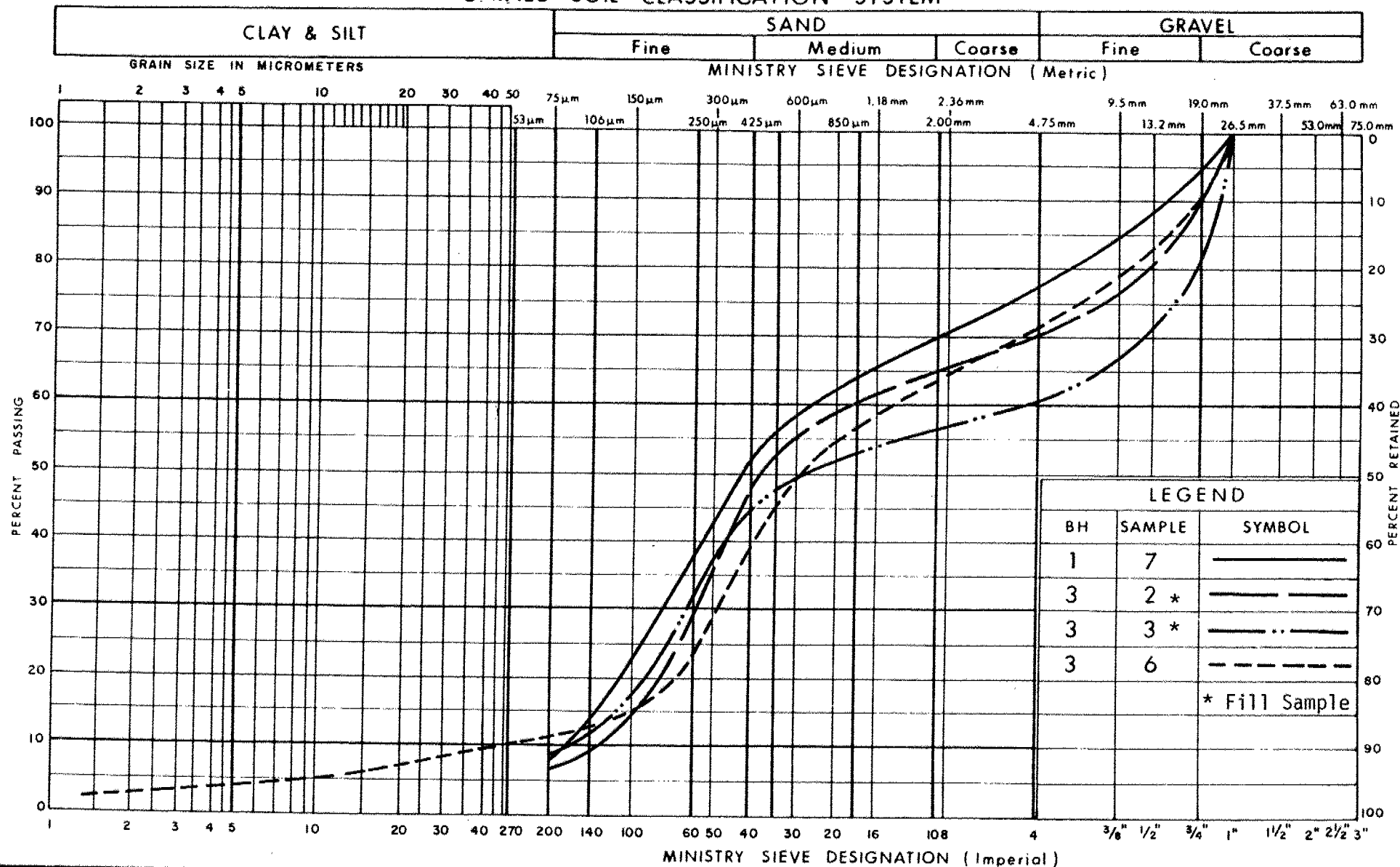
Ministry of  
Transportation and  
Communications

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

FIG No 1

W P 7-79-04

## UNIFIED SOIL CLASSIFICATION SYSTEM



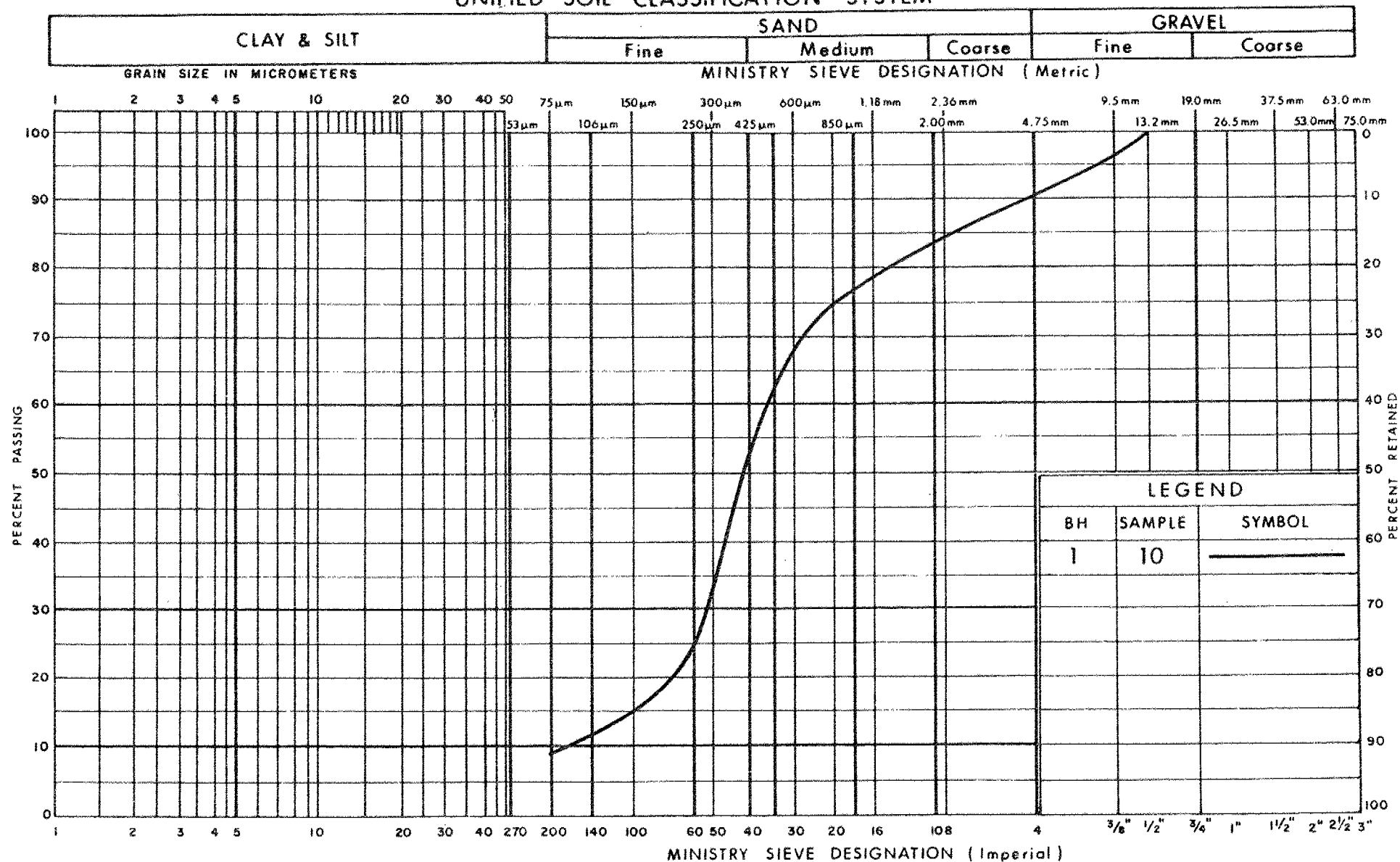
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
GRAVELLY SAND, SOME SILT

FIG No 2

W P 7-79-04

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

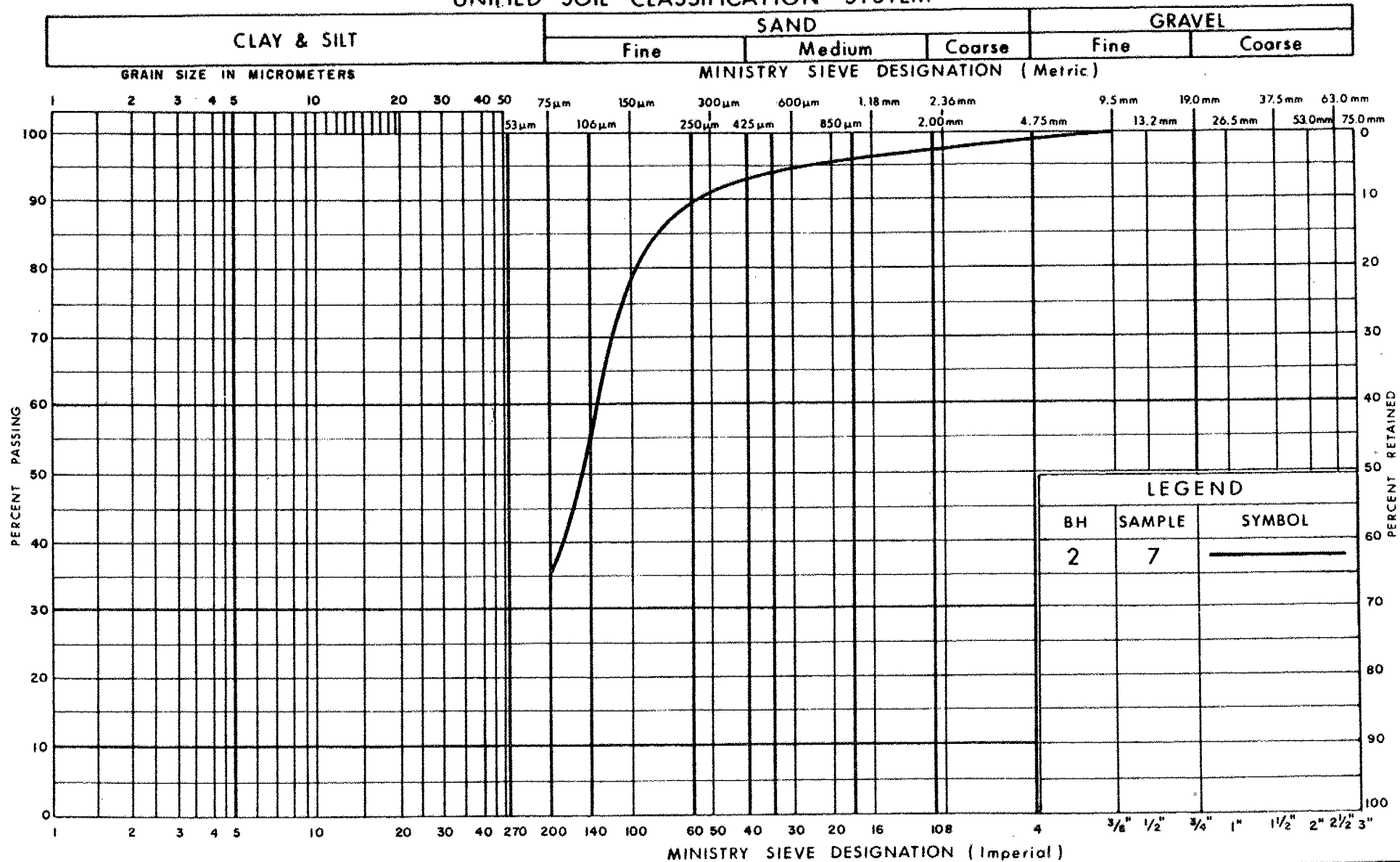
GRAIN SIZE DISTRIBUTION  
SAND, SOME GRAVEL & SILT

FIG No 3

W P 7-79-04



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY SAND, TRACE OF GRAVEL

FIG No 4

W P 7-79-04

FOUNDATION INVESTIGATION REPORT  
For  
Third Line Overpass  
4.5 km North of Hwy. 401  
W.P. 7-79-05, Site 21-429  
Hwy. 35/115, District 7, Port Hope

INTRODUCTION:

This report presents the results of a foundation investigation program carried out for the above-mentioned structure location between 81-05-19 and 81-05-21. The fieldwork consisted of 6 sampled boreholes advanced by means of continuous flight augers for depths ranging from 7.9 to 12.5 m below ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located on Hwy. 35/115 some 170 m north of the existing Clarke 3rd Line Concession Road intersection, in the Town of Newcastle, Regional Municipality of Durham.

The topography across the site is moderately undulating with the terrain south of the site sloping towards Lake Ontario. The predominant land use is commercial mixed farming and grain crops.

Physiographically, the site is located on the South Slope Region which is characterized in this area by surficial fine sands and silt overlying highly calcareous sandy glacial tills.

SUBSURFACE CONDITIONS

Uniform subsurface conditions were encountered across the site. Underlying the existing roadway fill and explored to a maximum depth of 12.5 m is an overconsolidated glacial till deposit. Bedrock was not encountered in any of the borings at the site.

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

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

### Existing Fill Material

The existing Hwy. 35/115 roadway fill was found to range in thickness from 2.0 to 3.6 m on the west side and non-existent on the east side which indicates the sloping nature of the ground surface at this site. This fill consists of 0 to 1.5 m of a compact silty sand with gravel overlying a firm to stiff silty clay fill of low plasticity with sand. The cohesive portion of the fill is probably indigenous to the parent glacial till of the area.

### Silt to Silty Clay (Glacial Till)

The predominant deposit underlying the site and explored to a maximum depth of 12.5 m is an overconsolidated glacial till deposit consisting of a slightly plastic silt to silty clay with sand and varying amounts of gravel. Gradation curves of representative samples of this deposit are plotted in envelope form on Figure 1. Occasional seams and layers of silty sand were encountered throughout this relatively incompressible deposit.

Results of laboratory tests consisting of Atterberg Limit and water contents are summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(W)%	4 - 21	9
Liquid Limit	(w <sub>L</sub> )%	12 - 25	15
Plastic Limit	(w <sub>p</sub> )%	9 - 13	10
Plasticity Index	(I <sub>p</sub> )%	2 - 13	4

These results are plotted on the plasticity chart, figure 2, and indicate the glacial till deposit to be an inorganic slightly plastic silt to silty clay of low plasticity (ML - CL).

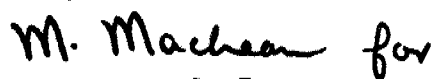
Based on interpretation of Standard Penetration Test 'N' values and augering operations, the consistency of this deposit is assessed generally as hard.

### Groundwater

Overnight stabilized borehole water levels were encountered within the glacial till deposit at elevations of 118.2 to 118.7 on the west side and elevations 120 to 120.8 on the east side. This indicates that the groundwater has a westerly gradient which reflects the natural sloping terrain across the site.



H. Sturm, P. Eng.  
Project Foundations Engineer



M. Devata, P. Eng.  
Senior Foundations Engineer



# RECORD OF BOREHOLE No 1

METRIC 19

W P 7-79-05 LOCATION Co-ords. 4 866 411.2 N; 376 999.5 E ORIGINATED BY Z. M.  
DIST 7 HWY 115/35 BOREHOLE TYPE Hollow Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 19 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
122.7	Pavement shoulder																
0.0	Fill																
	Silty sand with gravel		1	SS	13		122										0 37 43 20
120.7	Silty clay with sand		2	SS	6												
2.0	(Glacial Till) Silt to silty clay of low plasticity with sand traces of gravel		3	SS	23		120										20 43 27 10
			4	SS	82												
			5	SS	91												
			6	SS	96		118										0 46 38 16
	Hard		7	SS	136		116										
	Brown																
	Grey		8	SS	67												9 65 24 2
	Occasional silty sand layers						114										
113.3			9	SS	112	20 cm											
9.4	End of borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 2

METRIC 20

W P 7-79-05 LOCATION Co-ords. 4 866 390.8 N.; 377 006.1 E. ORIGINATED BY Z M  
DIST 7 HWY 115/35 BOREHOLE TYPE Hollow Stem Flight Augers COMPILED BY Z M  
DATUM Geodetic DATE 81 05 19 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100
122.5	Pavement shoulder																
0.0	(Fill) Silty sand some gravel						122										
	Silty clay with sand and gravel		1	SS	7									20	23	36	21
119.8	Firm						120										
2.7	(Glacial Till)		2	SS	41												
	Silt to silty clay of low plasticity with sand and varying amounts of gravel		3	SS	92		118							21	31	33	15
			4	SS	101	23 cm	116										
	Hard		5	SS	60	10 cm								11	45	34	10
	Brown		6	SS	69	10 cm	114										
	Grey		7	SS	104	25 cm								0	63	31	6
	Occasional layers of silty sand		8	SS	35	5 cm											
			9	SS	101	18 cm	112							0	40	46	14
110.0			10	SS	100	15cm											
12.5	End of borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 → 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 3

METRIC 21

W P 7-79-05 LOCATION Co-ords. 4 866 380.3 N.; 377 009.5 E. ORIGINATED BY Z M  
DIST 7 HWY 115/35 BOREHOLE TYPE Hollow Stem Flight Augers COMPILED BY Z M  
DATUM Geodetic DATE 8105 20 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
122.2	Pavement shoulder																
0.0	(Fill) silty sand some gravel		1	SS	13		122										
			2	SS	7												0 31 48 21
	Silty clay of low plasticity with sand		3	SS	10		120										
	Firm to stiff		4	SS	6												
118.6			5	SS	14												0 24 51 25
3.6	Brown (Glacial Till) Grey		6	SS	89/25 cm		118										23 40 24 13
	Silt to silty clay of low plasticity with sand and varying amounts of gravel		7	SS	96/15 cm		116										0 21 66 13
	Silty sand layers throughout		8	SS	110/20 cm		114										
112.9	Hard		9	SS	52/5 cm												
9.3	End of borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 ± 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 4

METRIC

22

W P 7-79-05 LOCATION Co-ords 4 866 390.0 N.; 377 035.0 E. ORIGINATED BY Z M  
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M  
 DATUM Geodetic DATE 81 05 20 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
121.9	Ground surface															
0.0	(Glacial Till) Silt to silty clay of low plasticity with sand and varying amounts of gravel Brown Grey Silty sand layers throughout Hard		1	SS	23	↓										12 33 39 16
			2	SS	75											41 34 24 1
			3	SS	78											
			4	SS	115											
			5	SS	107	20 cm										11 45 30 14
			6	SS	90											
			7	SS	63											
			8	SS	44											
			9	SS	85											
110.8			10	SS	134											
11.1	End of borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 5

METRIC

23

W P 7-79-05 LOCATION Co-ords 4 866 411.8 N.; 377 025.7 E.

ORIGINATED BY Z M

DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers

COMPILED BY Z M

DATUM Geodetic DATE 81 05 20

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
121.9	Ground surface																
0.0	(Glacial Till) Silt to silty clay of low plasticity with sand and varying amounts of gravel		1	SS	57		120										
			2	SS	120/25 cm		118										
	Brown		3	SS	124		116										
	Grey		4	SS	64/5 cm		114										16 40 30 14
	Silty sand layers throughout		5	SS	60/8 cm		112										37 38 19 6
			6	SS	80/10 cm		110										0 67 27 6
			7	SS	56/8 cm												
	Hard		8	SS	100/14 cm												
			9	SS	100/13 cm												
109.6			10	SS	100/13 cm												
12.3	End of borehole																

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (% STRAIN AT FAILURE



# RECORD OF BOREHOLE No 6

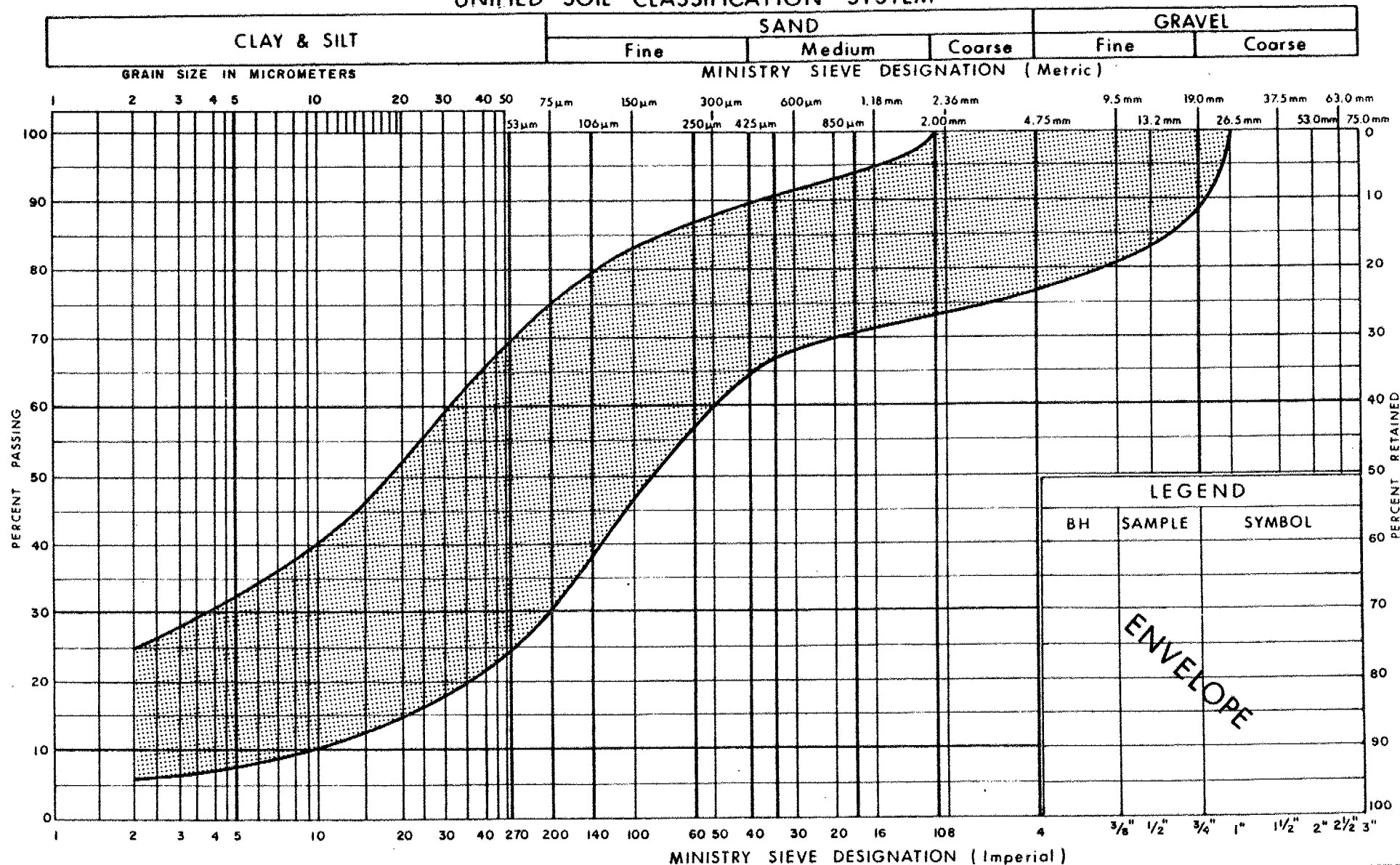
METRIC 24

W P 7-79-05 LOCATION Co-ords 4 866 420.3N; 377 024.6 E. ORIGINATED BY Z M  
DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M  
DATUM Geodetic DATE 81 05 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
122.8	Ground surface																GR SA SI CL
0.0	Fill silty clay some sand and gravel stiff		1	SS	10		122										
121.4			2	SS	29												0 43 42 15
1.4	(Glacial Till)		3	SS	74												
	Silt to silty clay of low plasticity with sand		4	SS	106		120										14 43 28 15
	Some gravel. Brown		5	SS	88												
	Grey		6	SS	43		118										14 32 39 15
	Occasional silty sand		7	SS	137	25 cm											
	Seams hard						116										
114.9			8	SS	100	10 cm											
7.9	End of borehole																

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

## UNIFIED SOIL CLASSIFICATION SYSTEM

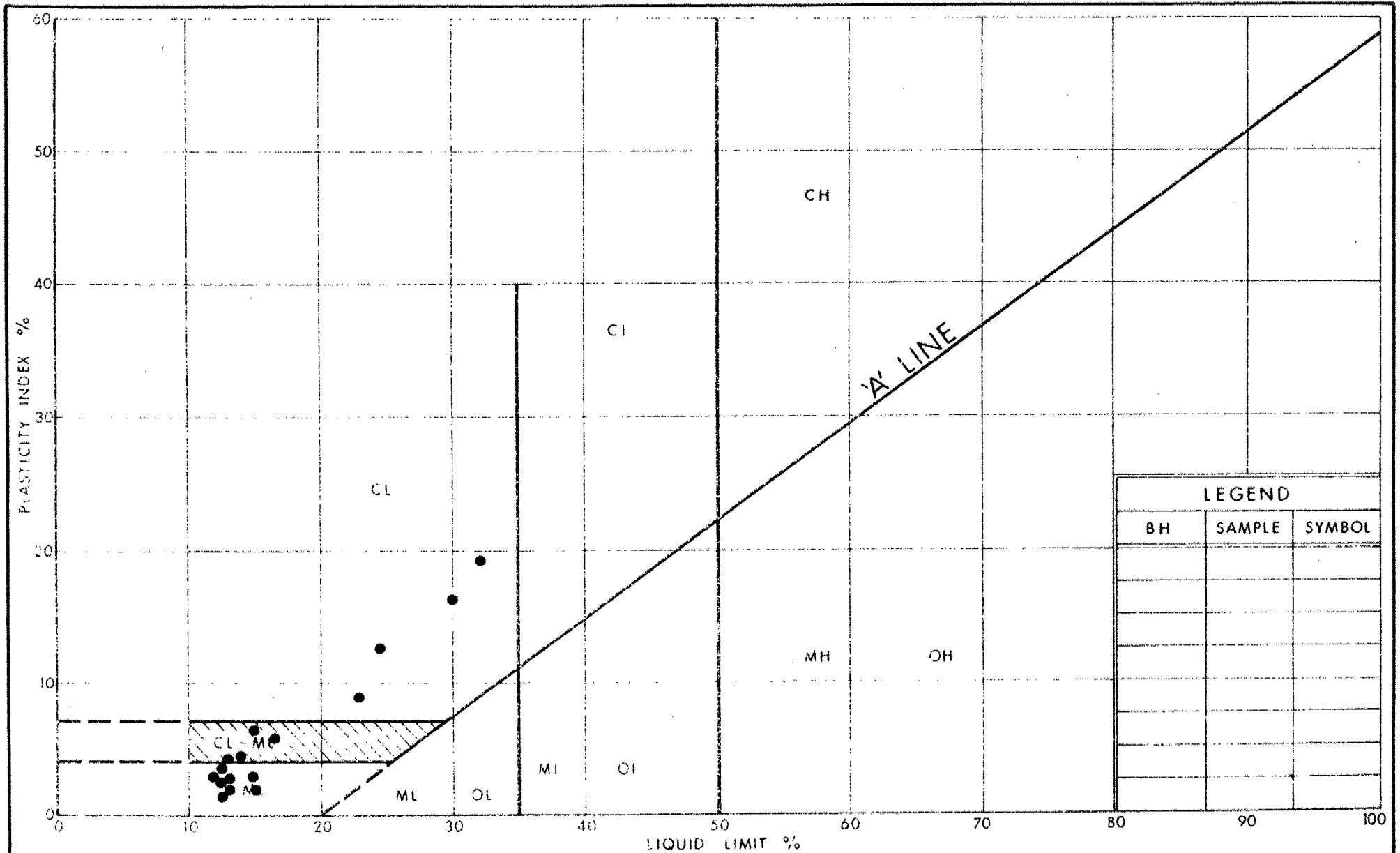


Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILT TO SILTY CLAY OF LOW PLASTICITY**  
**WITH SAND & VARYING AMOUNTS OF GRAVEL (Glacial Till)**

FIG No 1

W P 7 - 79 - 05



Ontario

Ministry of  
Transportation and  
Communications

PLASTICITY CHART  
SILT TO SILTY CLAY OF LOW PLASTICITY  
WITH SAND & VARYING AMOUNTS OF GRAVEL (Glacial Till)

FIG No 2

W P 7 - 79 - 05

FOUNDATION INVESTIGATION REPORT  
For  
Fourth Line Overpass  
W.P. 7-79-06, Site 21-430  
Hwy. 35/115, District 7, Port Hope

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned site. The fieldwork was carried out between 81 05 21 and 81 05 26 and consisted of advancing 7 sampled boreholes by means of continuous flight augers for depths ranging from 9.3 to 15.4 m below ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located on Hwy. 35/115 some 100 m south of the existing Clarke 4th Line Concession Road, in the Town of Newcastle, Regional Municipality of Durham.

The topography across the site is moderately undulating with the predominant land use being for commercial mixed farming and grain crops. The proposed site traverses an existing Hwy. 35/115 fill over a local valley. Intermittent drainage is provided through a 1.2 x 0.9 x 3.9 m concrete box culvert which crosses the proposed south abutment location.

Physiographically, the site is located on the South Slope Region which is characterized in this area by a surficial mantle of fine sands and silt overlying highly calcareous sandy glacial tills.

SUBSURFACE CONDITIONS

Uniform subsurface conditions, similar to those at the 3rd Line Overpass site, were encountered across the site. Existing embankment fills, ranging in depth from 4.9 to 5.5 m, consisted of approximately 1 m of granular fill overlying up to 4.5 m of a silty clay fill material. Underlying the fill and surficial beyond the fill is an overconsolidated glacial till deposit explored for a maximum thickness of 13.9 m.

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

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

### Existing Fill Material

The existing Hwy. 35/115 embankment fill consists of approximately 1 m of loose granular roadway subbase material (silty sand with gravel) overlying up to 4.5 m of a firm to very stiff silty clay fill material of low to medium plasticity (CL-CI) with a trace to some sand. The cohesive portion of the fill is probably indigenous to the parent materials of the area. A plot of grain size distribution curves for the cohesive fill portion is shown in envelope form on Figure No. 1.

### Silt to Silty Clay (Glacial Till)

The predominant deposit underlying the fill and surficial beyond the existing embankment limits is an overconsolidated glacial till deposit composed of a slightly plastic silt to silty clay of low plasticity (ML-CL) with sand and varying amounts of gravel. Typical gradation curves of representative samples of this deposit are plotted in envelope form on Figure 2. Occasional seams and layers of silty sand and gravel were encountered throughout the deposit. This glacial deposit was explored for a maximum thickness of 13.9 m.

Results of laboratory testing involving Atterberg Limit and water content determination are summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(W)%	5 - 11	7
Liquid Limit	(w <sub>L</sub> )%	12 - 17	14
Plastic Limit	(w <sub>p</sub> )%	8 - 11	10
Plasticity Index	(I <sub>p</sub> )%	2 - 7	5

These results are plotted on the plasticity chart, figure 3, and indicate the matrix of the till deposit to be an inorganic slightly plastic silt to silty clay of low plasticity (ML-CL).


Based on interpretation of Standard Penetration Test 'N' values and field observation of augering operations, the consistency of this deposit is assessed generally as hard.

### Groundwater

Borehole water level readings were taken at elevations ranging from 120.8 to 124.3 over the site. In general, the water table can be assumed to lie at or immediately below natural ground surface (i.e., elevation 123) across the site.



H. Sturm, P. Eng.  
Project Foundations Engineer

for 

M. Devata, P. Eng.  
Senior Foundations Engineer

APPENDIX

# RECORD OF BOREHOLE No 1

METRIC 30

W P 7-79-06 LOCATION Co-ords 4 868 115.2 N; 376 515.3 E ORIGINATED BY Z. M.  
 DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
 DATUM Geodetic DATE 81 05 21 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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								
124.7	Ground Surface														GR SA SI CL	
0.0																
			1	SS	32		124									
			2	SS	45										0 49 37 14	
			3	SS	33		122									
			4	SS	40										0 31 49 20	
			5	SS	73											
			6	SS	91		120									
			7	SS	111		118									
			8	SS	101											
			9	SS	80		116									
							114									
113.6			10	SS	100											
11.1	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 2

METRIC <sup>31</sup>

W P 7-79-06 LOCATION Co-ords 4 868 105.8 N; 376 516.3 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 21 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100				
124.4	Ground Surface														
0.0															
	Silt to silty clay of low plasticity with sand and varying amounts of gravel  (Glacial Till)		1	SS	46										22 41 23 14
			2	SS	70										34 33 22 11
	Hard		3	SS	85										0 52 32 16
	Sand Trace		4	SS	52										
	Silt and gravel		5	SS	113										4 85 8 3
	Occasional silty sand layers throughout		6	SS	95										
			7	SS	101										
			8	SS	50	5 cm									
	Sand layer		9	SS	48										
			10	SS	113	20 cm									
			11	SS	100	10 cm									
110.5															
13.9	End of Borehole														

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 ± 5 (%) STRAIN AT FAILURE  
10





# RECORD OF BOREHOLE No 3

METRIC 32

W P 7-79-06 LOCATION Co-ords 4 868 090.2N: 376 519.6 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 25 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									WATER CONTENT (%)
123.8	Ground Surface															GR SA SI CL	
0.0	Silty to silty clay of low plasticity with sand and varying amounts of gravel  (Glacial Till)  Stiff to Hard Silty sand and gravel  Sand layer  Occasional granular layers throughout		1	SS	8	122										0 37 53 10	
			2	SS	27												12 46 28 14
			3	SS	118	23 cm	120										29 40 20 11
			4	SS	104	23 cm	118										
			5	SS	76	10 cm											
			6	SS	109	23 cm	116										15 35 38 12
			7	SS	50	5 cm											0 88 11 1
			8	SS	60	5 cm											0 42 48 10
			9	SS	100	8 cm	114										
111.5					10	SS	100	15 cm	112								
12.3	End of Borehole																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10

5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 4

METRIC 33

W P 7-79-06 LOCATION Co-ords 4 868 081.1 N; 376 519.3 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE								● QUICK TRIAXIAL		
123.2	Ground Surface																			
0.0																				
	Silt to silty clay of low plasticity with sand and some gravel		1	SS	18		122									20 29 39 12				
			2	SS	47															
	(Glacial Till)		3	SS	89											0 54 34 12				
	Hard		4	SS	52		120									0 56 28 16				
			5	SS	63											15 69 13 3				
	Sand some silt and gravel		6	SS	49		118													
	Occasional granular layers throughout		7	SS	135	28 cm														
							116													
	Sand some gravel		8	SS	58											20 71 7 2				
113.9			9	SS	100	15 cm	114													
9.3	End of Borehole																			

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

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



# RECORD OF BOREHOLE No 6

METRIC 34

W P 7-79-06 LOCATION Co-ords 4 868 121.8 N; 376 537.5 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 26 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100				
128.1	Pavement Shoulder														
0.0	Granular Fill					128									
126.9	Loose		1	SS	8										
1.2	Fill		2	SS	15										
	Silty clay of low to medium plasticity		3	SS	15	126									0 4 46 50
	Trace of sand		4	SS	4										0 9 37 54
	Firm to stiff		5	SS	7	124									0 10 46 44
123.2			6	SS	28										
4.9	Silt to silty clay of low plasticity with sand and varying amounts of gravel		7	SS	21	122									23 38 34 5
	(Glacial Till)		8	SS	128										
	Very stiff to hard		9	SS	118	120									
117.1			10	SS	100	118									
11.0	End of Borehole														

+3, x5: Numbers refer to  
Sensitivity

20  
15 x 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 7

METRIC 35

W P 7-79-06 LOCATION Co-ords 4 868 098.8 N; 376 540.8 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Gondaric DATE 81 05 26 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
127.9	Pavement Shoulder													
0.0	Granular Fill													
127.0	Loose													
0.9														
	Fill		1	SS	16		126							
	Silty clay of low to medium plasticity		2	SS	19		124							0 13 42 45
	Trace to some sand													
	Very Stiff		3	SS	24									
122.4														
5.3			4	SS	43		122							0 35 50 15
	Silt to silty clay of low plasticity with sand		5	SS	87									
	some gravel		6	SS	95		120							17 40 32 11
	(Glacial Till)		7	SS	54									
	Hard		8	SS	142									
	Occasional granular layers throughout		9	SS	120/23 cm		118							
			10	SS	115/20 cm		116							
	Sand and gravel		11	SS	80/5 cm		114							
112.5			12	SS	100/10 cm									
15.4	End of Borehole													

# RECORD OF BOREHOLE No 8

METRIC 36

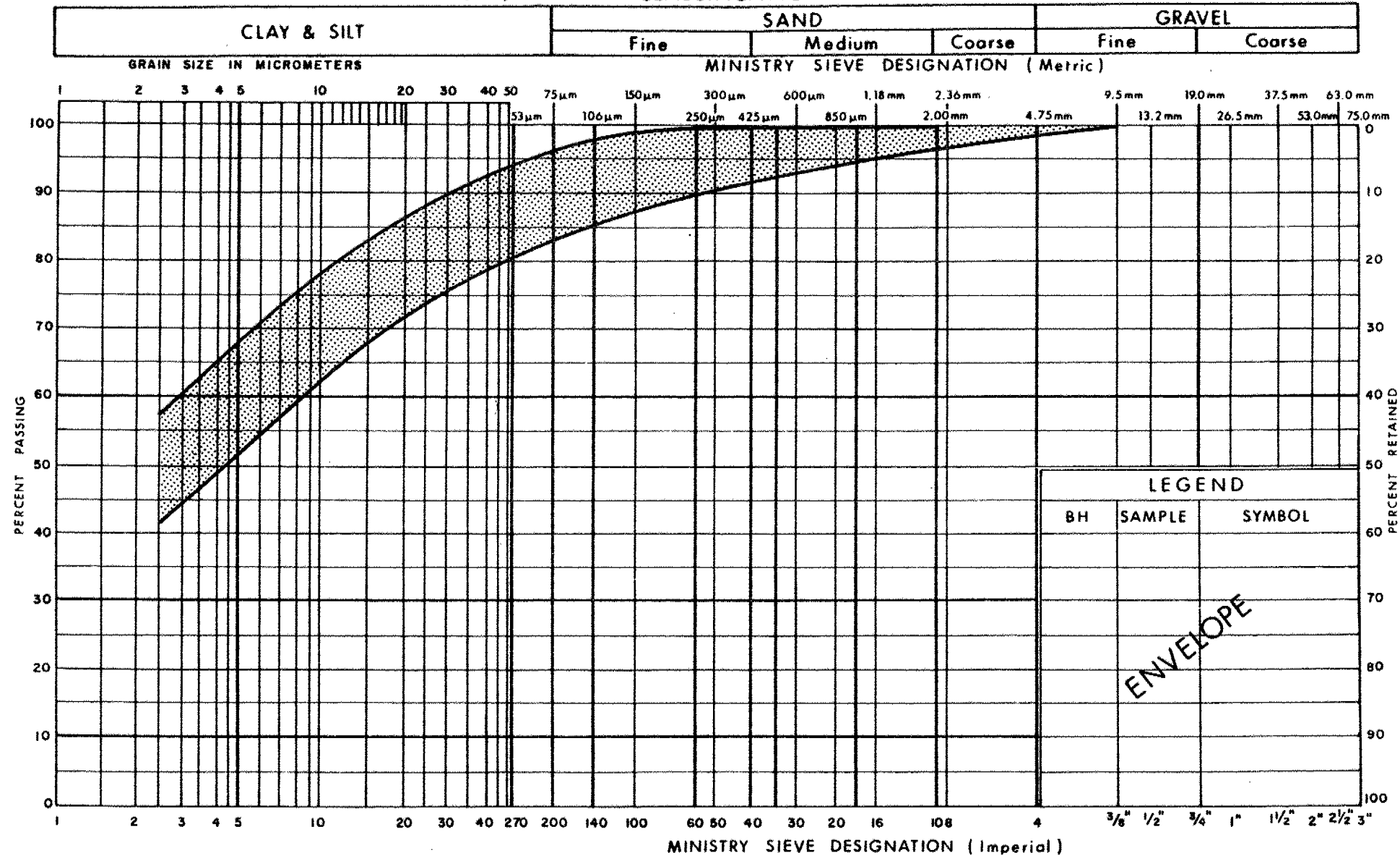
W P 7-79-06 LOCATION Co-ords 4 868 088.7 N; 376 542.5 E ORIGINATED BY Z. M.  
 DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
 DATUM Geodetic DATE 81 05 26 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
127.8	Pavement Shoulder															
0.0	Granular Fill															
126.6	Loose		1	SS	6											
1.2	Fill Silty clay of low to medium plasticity Some sand and gravel Stiff to very stiff		2	SS	19		126									0 7 49 44
			3	SS	10											
			4	SS	13											1 16 44 39
			5	SS	16		124									24 20 34 22
122.6			6	SS	14											
5.2	Silt to silty clay of low plasticity with sand and varying amounts of gravel  (Glacial Till)  Hard		7	SS	24		122									0 52 37 11
			8	SS	71											
			9	SS	114		120									
			10	SS	116	23 cm	118									
116.8			11	SS	100	13 cm										
11.0	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



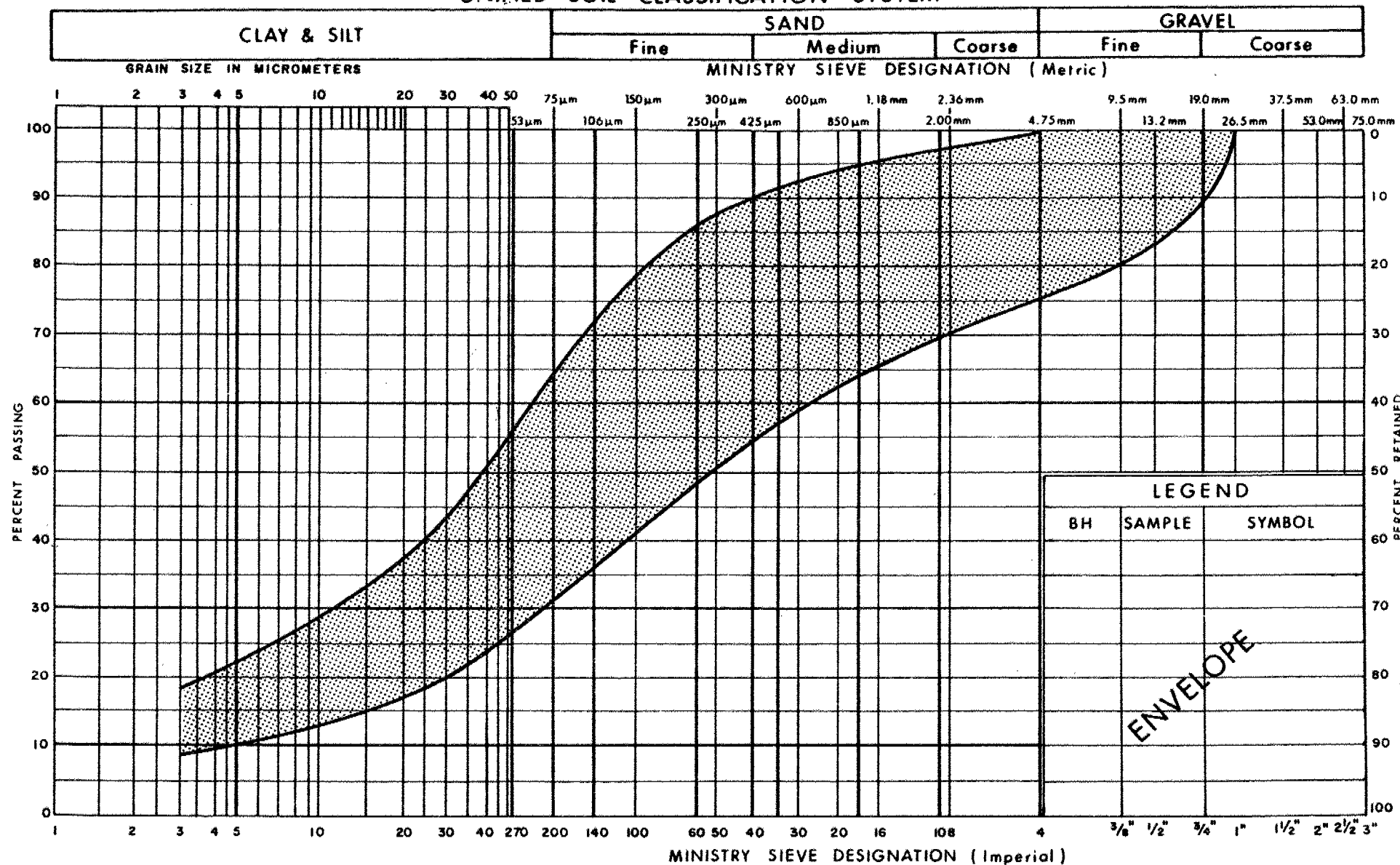
Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY (LOW TO MEDIUM PLASTICITY)**  
**TRACE TO SOME SAND (FILL)**

FIG No 1

W P 7-79-06

## UNIFIED SOIL CLASSIFICATION SYSTEM

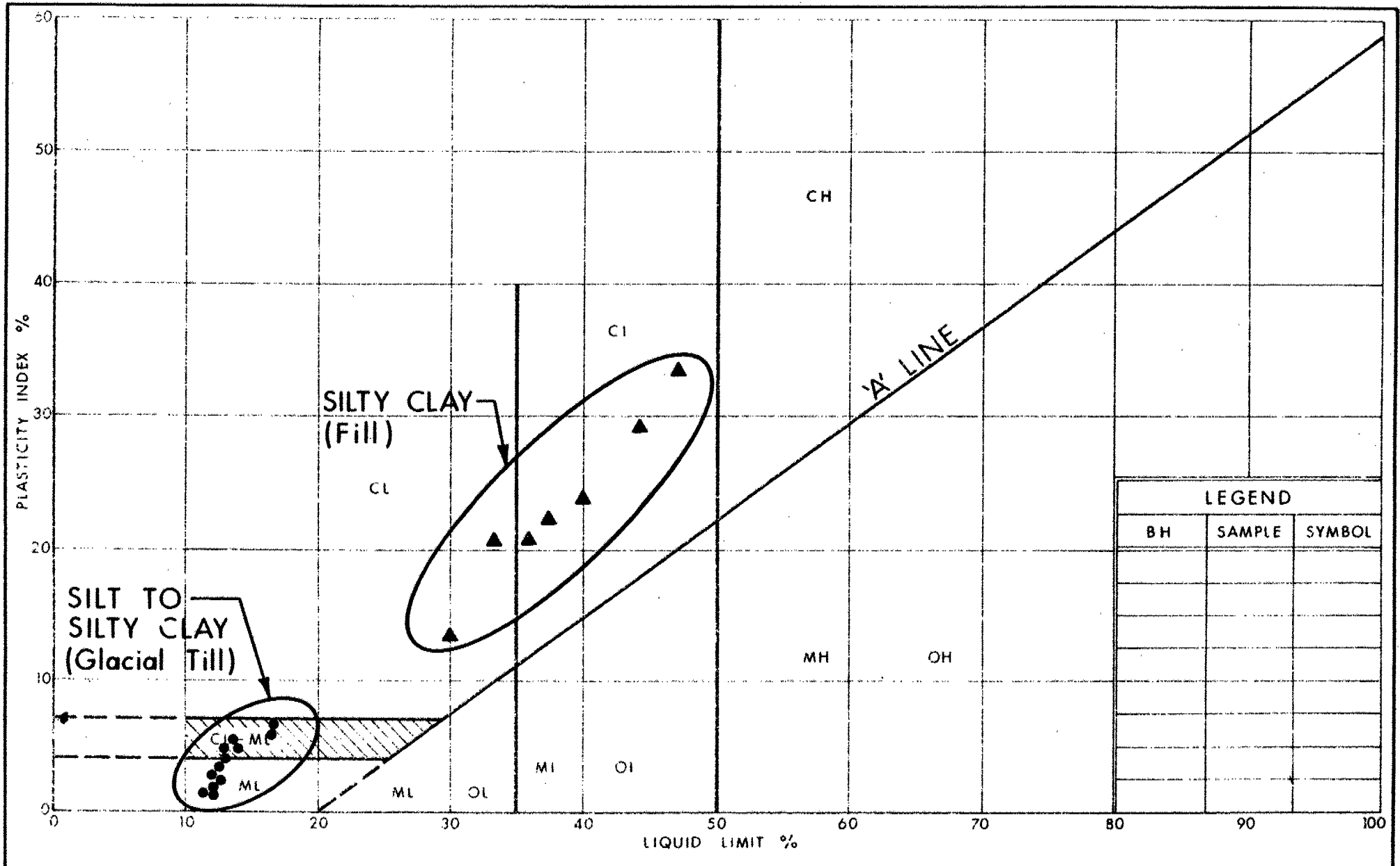


Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILT TO SILTY CLAY OF LOW PLASTICITY**  
**WITH SAND & VARYING AMOUNTS OF GRAVEL (Glacial Till)**

FIG No 2

W P 7-79-06



Ministry of  
Transportation and  
Communications

# PLASTICITY CHART

FIG No 3

W P 7-79-06



FOUNDATION INVESTIGATION REPORT  
For  
Proposed Retaining Wall  
Third Line Connection  
W.P. 7-79-12, Site 21 RW  
Hwy. 35/115, District 7, Port Hope

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned site. The fieldwork was carried out between 81 05 20 and 81 09 09, and consisted of advancing 4 sampled boreholes by means of continuous flight augers for depths ranging from 9.4 to 12.3 m below ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located off the existing Hwy. 35/115 some 170 m north of the existing Clarke 3rd Line Concession Road intersection, in the Town of Newcastle, Regional Municipality of Durham.

The topography across the site is moderately undulating with the terrain south of the site sloping towards Lake Ontario. The predominant land use is commercial mixed farming and grain crops.

Physiographically, the site is located on the South Slope Region which is characterized in this area by surficial fine sands and silt overlying highly calcareous sandy glacial tills.

SUBSURFACE CONDITIONS

Uniform subsurface conditions were encountered across the site. Underlying the surficial deposit of silty sand to sand, and explored to a maximum depth of 11.1 m, is an overconsolidated glacial till deposit. Bedrock was not encountered in any of the borings at the site.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized groundwater levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile and four estimated stratigraphical sections based on borehole data, are shown on Drawing No. 3.

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

### Silty Sand to Sand

The surficial deposit overlying most of the site consists of a silty sand to sand with gravel ranging in depths from 0.6 to 1.8 m. Interpretation of Standard Penetration Test 'N' values and augering operations indicate a compact average denseness for this deposit.

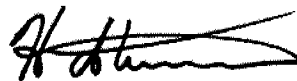
### Glacial Till

The predominant deposit underlying the site and explored for depths ranging from 7.8 to 11.1 m is an overconsolidated glacial till consisting of a heterogeneous mixture of sand, silt, clay with varying amounts of gravel. Occasional distinct seams and layers of sand, silty clay and gravel were encountered throughout this relatively incompressible deposit. Typical gradation curves of representative samples from this deposit are plotted in envelope form on Figure 1. In general, the plasticity of the fine grained matrix material for this deposit ranged from nil to slight, with slightly higher plasticity values obtained at the north end of the site.

Based on interpretation of Standard Penetration Test 'N' values generally in excess of 100 blows per 0.3 m, the denseness of this deposit is assessed as very dense.

### Groundwater

Overnight stabilized borehole water level readings were encountered within the glacial till deposit at elevations ranging from 116.6 to 117.4 for the 3 southerly boring locations, and a elevation 120.8 at the northerly borehole location. This localized elevated water table reflects increased drainage associated with the highway collector ditch beside the borehole. In general, the water table at the time of investigation, is assumed to have a fairly level gradient across the site (approx. elevation 117.0) with a high localized condition in the highway ditch area.



H. Sturm, P. Eng.  
Project Foundations Engineer



M. Devata, P. Eng.  
Senior Foundations Engineer

for

APPENDIX



# RECORD OF BOREHOLE No 1

METRIC 43

W P 7-79-12 LOCATION Co-ords N 4866 405.3; E377 055.6 ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. J. K.  
DATUM Geodetic DATE 81 09 09 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
123.0	Ground Surface																
0.0	Topsoil																
	Sandy silt, trace of clay		1	SS	20		122										0 45 49 6
121.2	Compact		2	SS	64												
1.8	Gravel		3	SS	50/5	cm	120										12 47 29 12
	(Glacial Till)		4	SS	75												
	Silty sand varying amounts of gravel		5	SS	87												
			6	SS	100	15 cm	118										10 53 28 9
	trace of clay		7	SS	50/5	cm	116										
	occasional thin layers of sand		8	SS	133	28 cm	114										15 38 35 12
113.4	Very Dense																
			9	SS	127												
9.6	End of Borehole																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 2

METRIC 44

W P 7-79-12 LOCATION Co-ords N 4 866 400.0; E 377 093.0 ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. J. K.  
DATUM Geodetic DATE 81 09 09 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
123.4	Ground Surface												
122.8	Silty sand compact												
0.6	(Glacial Till)		1	SS	43		122						19 46 24 11
			2	SS	110	23 cm							
	Gravel		3	SS	50	8 cm	120						7 51 33 9
	Silty sand, trace of clay		4	SS	100	13 cm							
	Varying amounts of gravel		5	SS	100	20 cm	118						
	Very dense silty clay		6	SS	30	5 cm	116						
114.1	silty sand		7	SS	50	8 cm							
9.3	End of Borehole												

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 3

METRIC 45

W P 7-79-12 LOCATION Co-ords N 4 866 381.2; E 377 116.4 ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. J. K.  
DATUM Geodetic DATE 81 09 09 CHECKED BY JS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
124.3	Ground Surface																
0.0	Sand with gravel some silt Compact		1	SS	100	25 cm											
122.9			2	SS	47												
1.4	(Glacial Till)		3	SS	100	15 cm											
			4	SS	100	10 cm											
	Silty clay some sand		5	SS	100	15 cm											
	Silty sand trace clay		6	SS	100	15 cm											
	Varying amounts of gravel		7	SS	100	15 cm											
	Very Dense		8	SS	100	15 cm											
			9	SS	100	15 cm											
	Fine silty sand		10	SS	100	13 cm											
112.0			11	SS	100	15 cm											
12.3	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

5 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 (Formerly BH 4) METRIC 46  
(WP 7-79-05)

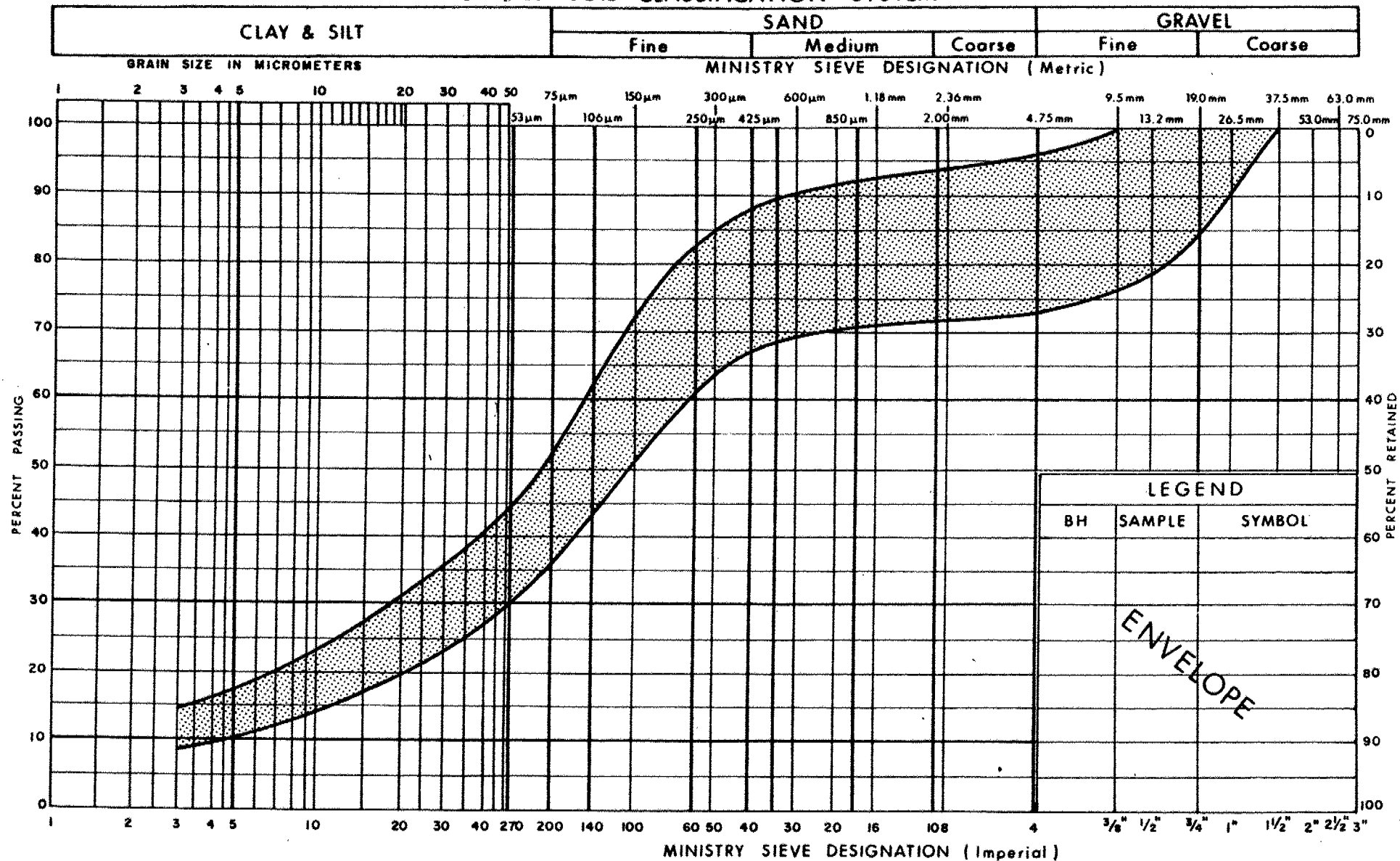
W P 7-79-12 LOCATION Co-ords 4 866 390.0 N; 377 035.0 E ORIGINATED BY Z. M.  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z. M.  
DATUM Geodetic DATE 81 05 20 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
121.9	Ground surface															
0.0	(Glacial Till) Silt to silty clay of low plasticity and sand with varying amounts of gravel Brown Grey Silty sand layers throughout Hard		1	SS	23											12 33 39 16
			2	SS	75											41 34 24 1
			3	SS	78											
			4	SS	115											11 45 30 14
			5	SS	107	20 cm										
			6	SS	90											
			7	SS	63											
			8	SS	44											
			9	SS	85											
110.8			10	SS	134											
11.1	End of Borehole															

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (% STRAIN AT FAILURE

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILTY SAND, TRACE OF CLAY & VARYING AMOUNTS OF GRAVEL**  
**(Glacial Till)**

FIG No 1

W P 7-79-12



For

W.P. 36-82-02, Site 21-437

Clarke Township Road Underpass

Hwy. 35/115, District 7, Port HopeINTRODUCTION:

This report contains the results of a foundation investigation carried out at the above mentioned site for a proposed structure. Initial fieldwork was carried out between 82 07 08 and 82 07 09, with additional work performed on 82 09 28. The fieldwork consisted of advancing five sampled boreholes to depths ranging from 9.0 to 12.0 m. In addition, two dynamic cone penetration tests were also carried out during the investigation in the vicinity of two of the five boreholes.

SITE DESCRIPTION AND GEOLOGY

The site is located on Hwy. 35/115, some 700 m south of Hwy. 2, west of the Town of Newcastle in the Regional Municipality of Durham.

Physiographically, the site is located in the region known as the Iroquois Plain, which is a mosaic of till plains, drumlins, and areas of silty lacustrine deposits.

Topography across the site is gently undulating, with land use primarily agricultural.

SUBSURFACE CONDITIONS

Generally competent subsurface conditions were encountered across the site. Underlying approximately 1.6 m of roadway fill (sand with silt and gravel) and surficial beyond the fill is a stratum of a very dense sandy silt with traces of gravel and clay, which varies in thickness from 2.9 to 4.7 m. This stratum is underlain by a slightly cohesive hard glacial till comprised of a heterogeneous mixture of silty clay, sand, and gravel. The till material was penetrated to a maximum thickness of 7.7 m at which point borings were terminated.

Reference should be made to the Record of Borehole Sheets contained in the Appendix of this report. These sheets contain the description and extent of the soil types encountered, and in summarized form, field and laboratory test results. The stratigraphical profile shown on Drawing No. 2 is based on this information and shows the location and elevation of the borings.

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

#### Fill Material

An approximate 1.6 m thick layer of fine sand with silt and gravel (fill) was encountered in 4 boreholes. Cobble-size fragments were also found towards the bottom of this fill material.

This roadway fill had been placed during the original construction of Hwy. 35/115, and upon completion of initial borings, additional Granular 'A' fill was placed for the roadway base during the double-laning of Hwy. 35/115 under Contract 82-03.

Visual observations of augering operations indicated the fill material had undergone a moderate degree of compaction.

#### Sandy Silt, Trace of Gravel and Clay

Immediately below the fill material is a stratum of sandy silt with traces of gravel and clay. The deposit ranged in thickness from 2.9 to 4.7 m.

Grain size distribution curves for samples taken from this deposit are shown in envelope form on Figure 1.

Results of Atterberg Limits and water content testing indicates the deposit exhibits very slight plasticity (SM-ML). Based on augering operations and Standard Penetration Test 'N' values, which were generally in excess of 100 blows per 0.3 m, the deposit is assessed as being very dense throughout.

This material is subject to "boiling" if subjected to an unbalanced hydrostatic head.

#### Silty Clay, Sand, and Gravel (Glacial Till)

Immediately underlying the sandy silt stratum is a slightly cohesive glacial till that was explored to a maximum depth of 12.4 m below ground surface. The till consists of a heterogeneous mixture of silty clay, sand and gravel.

Typical grain size distribution curves for this deposit appear in Figure 2. Although the grain size distribution curves are very similar to those of the overlying sandy silt deposit, visual identification indicates the deposit to be glacially derived with slight plasticity.

Atterberg Limit tests indicate the matrix of the till deposit to range from an inorganic sandy silt of very slight plasticity to an inorganic silty clay and sand of slight to low plasticity (ML to CL-ML).

Based on an interpretation of 'N' values and augering operations, the consistency of the till deposit is assessed as being very stiff to hard, but predominantly hard throughout, with 'N' values in excess of 100 blows per 0.3 m below elevation 94.0.

#### Groundwater Conditions

An overnight stabilized water level reading taken in one open borehole was found at elevation 102.1. This approximately corresponds to the observed highway ditch water level.



H. Sturm, P. Eng.  
Project Foundations Engineer



for

M. Devata, P. Eng.  
Senior Foundations Engineer

A P P E N D I X

# RECORD OF BOREHOLE No 1

METRIC 52

W P 36-82-02 LOCATION Co-ords. N 4 863 179.8; E 375 417.2 ORIGINATED BY RZ  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY RZ  
DATUM Geodetic DATE 82 07 08 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
103.0	Fill Surface															GR SA SI CL
0.0	Brown Fill Sand with Silt & Gravel, Compact		1	SS	28		102									
101.5			2	SS	100/	25 cm										8 42 43 7
1.5	Sandy Silt		3	SS	100/	10 cm										7 34 49 10
	Trace of Gravel & Clay	Brown Grey	4	SS	100/	25 cm	100									4 35 51 10
98.4	Very Dense		5	SS	100/	25 cm										4 46 43 7
4.6	(Glacial Till)		6	SS	100		98									
	Het. Mixture of Silty Clay, Sand and Gravel		7	SS	22		96									
	Grey		8	SS	31		94									
	Very Stiff to Hard		9	SS	100/	28 cm	92									6 43 44 7
			10	SS	100/	23 cm										
90.7			11	SS	100/	13 cm										
12.3	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 2

METRIC 53

W P 36-82-02 LOCATION Co-ords. N 4 863 207.0, E 375 400.4 ORIGINATED BY RZ  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RZ  
DATUM Geodatic DATE 82 07 09 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N <sup>o</sup> VALUES			20	40	60	80	100					
103.0	Fill Surface																
0.0	Brown Fill Sand With Silt & Gravel					*	102										
101.3	Compact																
1.7	Sandy Silt		1	SS	100												
	Brown		2	SS	100/	23 cm											5 21 72 2
	Trace of		3	SS	100/	28 cm	100						o				9 44 37 10
	Gray		4	SS	100/	28 cm											
	Gravel & Clay																
97.8	Very Dense		5	SS	100/	23 cm	98										5 40 45 10
5.2	(Glacial Till)																
	Hat. Mixture of		6	SS	33								o				4 39 49 8
	Silty Clay, Sand and Gravel		7	SS	43		96						o				
	Gray		8	SS	100/	20 cm	94										
	Hard		9	SS	100/	23 cm	92						o				8 40 34 18
90.6			10	SS	100/	25 cm											
12.4	End of Borehole																
	Note: Water Level not established																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 3

METRIC

54

W P 36-82-02 LOCATION Co-ords. N 4 863 193.0; E 375 409.9 ORIGINATED BY EC  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY KC  
DATUM Geodetic DATE 82 09 28 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE									
103.5	Pavement Surface																
0.0	Brown Fill					*											
	Sand with Silt and Gravel		1	SS	100/	20 cm											
102.0	Very Dense		2	SS	100/	15 cm	102										
1.5	Grey-Brown Sandy Silt		3	SS	100												
	Trace of Gravel and Clay		4	SS	100/	25 cm	100										
98.9	Very Dense																
4.6	(Glacial Till)		5	SS	98		98										
	Het. Mixture of		6	SS	45												
	Silty Clay, Sand and Gravel		7	SS	65		96										
	Gray																
93.9	Hard		8	SS	100/	27 cm	94										
9.6	End of Borehole																
	* Note: Water Level not Established																

+3, x5: Numbers refer to  
Sensitivity

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



# RECORD OF BOREHOLE No 4

METRIC

55

W P 36-82-02 LOCATION Co-ords. N 4 863 187.1; E 375 427.8 ORIGINATED BY KC  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid Stem Augers and Cone Test COMPILED BY KC  
DATUM Geodetic DATE 82 09 28 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
102.3	Ditch Surface												
0.0	Grey Sandy Silt Trace of Gravel and Clay  Very Dense		1	SS	100/	8 cm							
99.2			2	SS	100/	10 cm							
3.1	(Glacial Till)  Het. Mixture of  Silty Clay, Sand and Gravel  Grey		3	SS	100/	15 cm							
			4	SS	52								
92.7	Hard		5	SS	100/	15 cm							
9.6	End of Borehole  * Note: Water Level not Established												





Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 5

METRIC 56

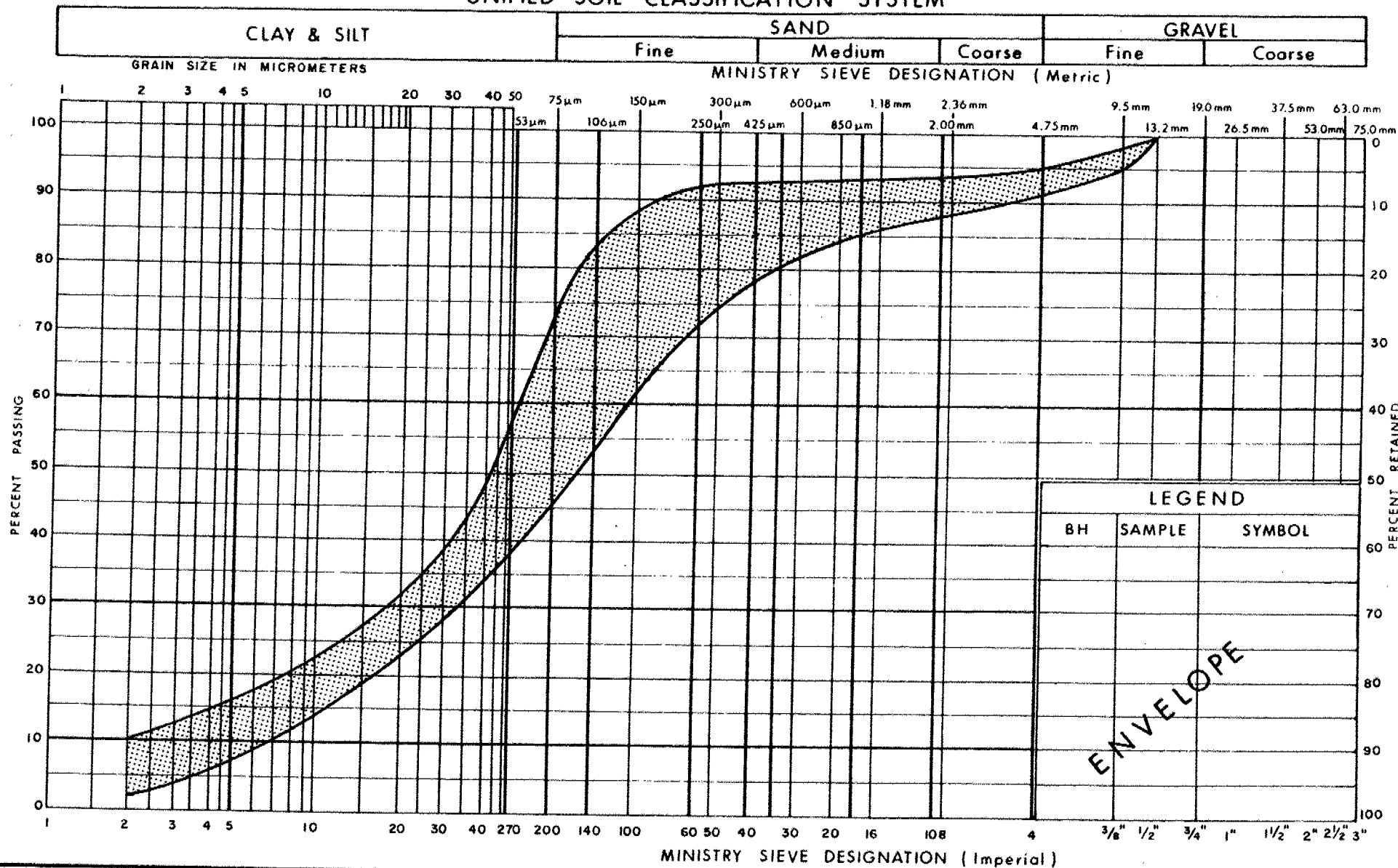
W P 36-82-02 LOCATION Co-ords. N 4 863 200.0; E 375 412.6 ORIGINATED BY KC  
DIST 7 HWY 35/115 BOREHOLE TYPE Solid and Hollow Stem Augers COMPILED BY KC  
DATUM Geodetic DATE 82 09 28 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
103.5	Pavement Surface																
0.0	Brown Fill					*											
102.1	Sand with Silt & Gravel Very Dense																
1.4	Gray-Brown Sandy Silt		1	SS	100/	25 cm	102										
	Trace of Gravel and Clay		2	SS	100		100										
	Very Dense		3	SS	100/	8 cm	98										
97.4	(Glacial Till)		4	SS	63		96										
6.1	Est. Mixture of Silty Clay, Sand and Gravel Grey		5	SS	35												
94.4	Hard		6	SS	50/	5 cm											
9.2	End of Borehole																
	* Note: Water Level not Established																

+3, x5 : Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM

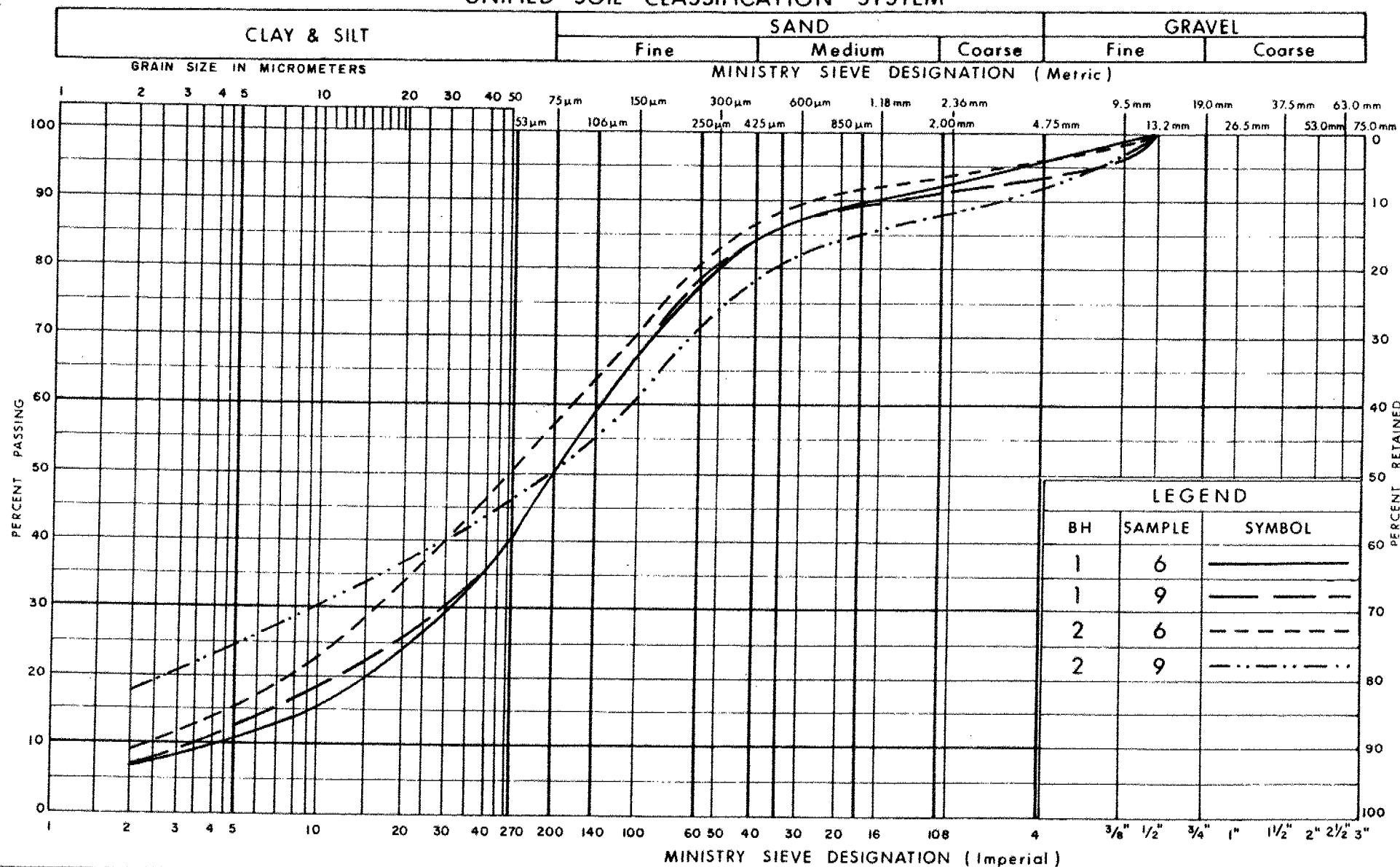
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SANDY SILT  
TRACE OF GRAVEL & CLAY

FIG No 1<sup>st</sup>

W P 36-82-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
HET MIXTURE OF SILTY CLAY, SAND & GRAVEL  
( GLACIAL TILL )

FIG No 2

W P 36-82-02

**DOMINION SOIL INVESTIGATION INC.**

CONSULTING ENGINEERS

TORONTO KITCHENER LONDON WINDSOR THUNDER BAY SARNIA



# DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6

(416) 751-6565

## GEOTECHNICAL INVESTIGATION

PROPOSED WIDENING OF C.P.R. OVERHEAD

HIGHWAY 35/115, BRIDGE SITE 21-187

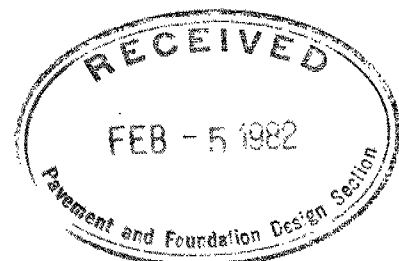
W.P. NO. 7-79-04

Ref. No. 81-7-3

October 1981

### Prepared For:

Ministry of Transportation And Communications  
Pavement And Foundation Design Section  
Central Building  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1H3



### Distribution

13 copies - Ministry of Transportation And Communications  
2 copies - Dominion Soil Investigation Inc.

*GEOTECH NR 30M15-64*

## C O N T E N T S

1.0 INTRODUCTION.....	1
2.0 REGIONAL GEOLOGY.....	2
3.0 SUBSOIL CONDITIONS.....	4
3.1 Topsoil.....	4
3.2 Fill.....	4
3.3 Upper Glacial Till.....	5
3.4 Sand and Gravelly Sand.....	6
3.5 Lower Glacial Till.....	6
4.0 GROUNDWATER CONDITIONS.....	7
5.0 DISCUSSION.....	8
5.1 Foundation Design.....	8
5.2 Lateral Earth Pressures.....	10
5.3 Construction.....	10

## E N C L O S U R E S

RECORD OF BOREHOLES.....	Enclosures 1 to 4
GRAIN SIZE DISTRIBUTION CURVES.....	Figures 1 to 4
DRAWING NO. 77904-A.....	Drawing 1



1.0 INTRODUCTION

This report describes the findings of a geotechnical investigation carried out at the site of the proposed widening of the C.P.R. Overhead Structure on Highway 35/115 (Bridge Site 21-187) approximately 1.4 km north of Highway No. 2 in District 7. The investigation was requested by the Ontario Ministry of Transportation and Communications and authorization to carry out the work was received from the Pavement and Foundation Design Section of the Ministry.

The purpose of the investigation was to determine the subsoil and groundwater conditions at the site; to establish the engineering properties of the substrata; and to make recommendations pertaining to design and construction of the foundations of the proposed widening.

The field work was carried out in July 1981, and consisted of drilling four boreholes to depths ranging between 3.0 and 10.7 m. The location of the boreholes are shown on Drawing No. 77904-A, and the subsurface conditions encountered are presented on the Record of Borehole sheets.

.../...



2.0 REGIONAL GEOLOGY

The site is located near the north-west corner of the Town of Newcastle and 1.4 km north of Highway No. 2.

Geologically, the site is situated in the Lake Iroquois Plain, which is an area of low relief inundated during the Pleistocene times by the waters of the post glacial Lake Iroquois. The old abandoned shoreline of Lake Iroquois lies several kilometers to the north.

The bedrock underlying the basin is of Ordovician age and consists of the Whitby formation which is a black calcareous shale unit with interbeds of limestone. The bedrock surface is irregular and regional studies suggest that there are strong similarities between the existing surface topography and that of the bedrock surface. Available geological information suggests that the surface of the bedrock at the site is probably 25 m deep.

The surficial deposits consist of sediments of Pleistocene and Recent age. Glacio-lacustrine deposits south of the abandoned Lake Iroquois shoreline range from sand and gravel of a near shore and deltaic nature to offshore sediments such as varved silt and clay. These were deposited on top of a ground moraine of generally coarse sandy texture.

.../...





The surface of the till is irregular and drumlinized and the surface of the drumlins are exposed in many places in the area. More recent deposits consisting of organic and alluvial soils are found in the valleys of the creeks.

.../...



3.0 SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are shown on the Record of Borehole sheets and inferred subsoil sections are presented on Drawing No. 77904-A.

Briefly, underlying some fill, at elevations ranging between 108.1 and 103.7 m the boreholes encountered a 1.2 to 4.7 m thick layer of glacial till which in turn is underlain by sand. Boreholes 1 and 4 were terminated in this sand deposit after penetrating it to between 0.6 and 2.5 m. In Boreholes 2 and 3, the sand is 2.4 to 3.2 m thick, below which, a lower till sheet was encountered at Elevation 101.0 and 99.3 m.

The relevant index and engineering properties of the principal soil strata are briefly described in the following paragraphs.

3.1 Topsoil

The boreholes encountered 0.15 m of organic topsoil.

3.2 Fill

Below the topsoil, the boreholes encountered fill and material suspected to be fill extending to depths ranging between 1.2 (Borehole 4) and 5.5 m (Borehole 3) below the ground surface (i.e. to Elevations 108.1 and 103.7 m).

.../...



In Boreholes 1, 2 and 3 the fill consists generally of sand with some gravel, silt and occasional cobbles. The grain size distribution of two representative samples from the fill is presented in Figure 2 and penetration indices ranging between 4 and 41 blows/0.3 m suggest that the fill is unevenly compacted and that it is loose to dense but generally loose to compact.

In Borehole 4, the material within the top 1.2 m consists of silty clay (Cl-ML) and silty sand and is suspected to be fill. 'N'-values of 6 and 7 blows/0.3 m indicate a firm consistency.

### 3.3 Upper Glacial Till

The fill is underlain by a 1.2 m (Boreholes 3 and 4) to 4.7 m (Borehole 2) thick and relatively coarse textured glacial till. The grain size distribution of typical samples are shown in Figure No. 1. The tests indicate 15 to 40% gravel, 25 to 55% sand, 23 to 32% silt and 7 to 10% clay size particles. The moisture content of the till was measured to range from 6.6 to 8.2%. The till exhibits very little cementation. Penetration indices recorded within the till generally range from 60 to more than 100 blows/0.3 m indicating a very dense relative density. Exception to this was found only within the upper zones of Borehole 4 where an 'N'-value of 19 blows/0.3 m shows that the material is compact. Based on the grain size distribution curves, the coefficient of permeability of the till is estimated to range between  $10^{-4}$  and  $5 \times 10^{-5}$  cm/sec.

.../...



### 3.4 Sand and Gravelly Sand

Underlying the glacial till, at depths ranging between 2.4 (Borehole 4) and 6.7 m (Borehole 3) below the ground surface, that is between Elevations 103.7 and 102.5 m, the boreholes encountered a deposit of sand or gravelly sand. Boreholes 1 and 4 were terminated in this deposit after penetrating it to 2.5 and 0.6 m respectively. In Boreholes 2 and 3, the sand is 2.4 and 3.2 m thick respectively.

Based on Penetration Indices of 81 blows/0.3 m or greater, the sand is inferred to be very dense. The results of grain size analyses performed on samples from the deposit are presented on Figures 2, 3 and 4. These tests indicate 2 to 30% gravel, 58 to 80% sand and 10 to 35% silt content. From the grading curves the sand is considered to be considerably more pervious than the overlying till deposit with an estimated coefficient of permeability (k) of between  $10^{-2}$  and  $5 \times 10^{-4}$  cm/sec.

### 3.5 Lower Glacial Till

Boreholes 2 and 3 encountered a second till deposit at Elevations 101.0 and 99.3 m respectively. Boreholes 1 and 4 were terminated in the sand at Elevations 101.2 and 102.4 m without penetrating into this lower glacial till. Penetration indices greater than 100 blows/0.3 m indicate that this lower till is also very dense. The till is a well graded mixture of gravel, sand and silt. The coefficient of permeability is estimated to be less than  $5 \times 10^{-5}$  cm/sec.

.../...

4.0 GROUNDWATER CONDITIONS

Groundwater conditions in the boreholes were observed during the drilling and at the completion of each borehole. After penetrating the sand deposit which underlies the upper till sheet a slight sub-artesian pressure was encountered in Boreholes 1, 2 and 3 and water had to be used to balance this hydrostatic head and to facilitate drilling.

Free-standing water levels in the open boreholes were also observed, where possible, after the completion of the boreholes. In addition, a piezometer was installed in Borehole 2 and to prevent surface water from seeping into the hole a bentonite seal was placed near the ground surface and also at a depth of approximately 8 m. The final recorded values in the open boreholes and in the piezometer showed a groundwater table ranging between Elevations 105.0 and 103.7 m.

These observations indicate that the average water table at the time of the investigation was at Elevation 104.0<sup>±</sup> m. Seasonal fluctuation can however, be expected in the groundwater level.

It should be of interest to note that one source\* indicates a flowing well from the overburden located about 1.3 km east of the site.

---

Note: \* "Geology and Water Resources of the Bowmanville, Soper and Wilmot Creeks IHD Representative Drainage Basin Map 6" Ontario Ministry of the Environment, Water Resources Report 9a 1977.

.../...



## 5.0 DISCUSSION

It has been proposed to reconstruct Highway 35/115 between Highway 2 and Enterprise Hill to a four-lane divided highway. As a part of this widening, the C.P.R. Overhead structure, located 1.4 km north of Highway 2, is to be widened on the east side, and a retaining wall will be constructed easterly as the extension of the north abutment as shown on Drawing No. 77904-A.

The ground surface elevation at the railway level beneath the overhead structure is approximately between 105.0 m and 104.3 $\pm$  m. Four boreholes put down at the site encountered a predominantly sand fill extending to between Elevations ranging from 108.1 to 103.7 m. Below the fill, the boreholes show a generally very dense coarse grained, 1.2 to 4.7 m thick till sheet. The till is underlain by a very dense sand deposit which contains water under a slight sub-artesian pressure. Below the sand there is another till sheet. The average groundwater table at the time of the investigation was at Elevation 104 $\pm$  m.

### 5.1 Foundation Design

Drawing No. 77904-A shows that the existing ground surface elevation at the base of the existing abutments is about 104.3 $\pm$  m. As a permanent earth cover of at least 1.2 m or equivalent must be provided for frost cover, the underside of the footings will probably be at Elevation 103.0 $\pm$  m. The boreholes show that at this elevation, the footings will be near the base of the upper till stratum or in some cases within the underlying sand deposit.

.../...



At or below Elevation 103 m, the factored bearing capacity at ultimate limit states ( $q_f$ ) is 900 kPa providing that the footings have a minimum surcharge of 1.2 m and are at least 2.0 m wide. The bearing capacity at serviceability limit state Type II is 400 kPa. Under inclined loading conditions the bearing capacity at ultimate limit state should be reduced in accordance with Clause 6.7.3.3.5 of the Ontario Highway Bridge Design Code, 1979 (O.H.B.D.C.). Provided that the subsoil is not unduly disturbed during the construction, total and differential settlements are expected to be less than 25 mm and 15 mm respectively.

However, should the till or the sand be disturbed due to inadequate groundwater control, greater settlements can be expected. Because of this, as will be discussed in Section 5.3, careful dewatering techniques will have to be followed during construction. To minimize dewatering problems it would be advantageous to keep the foundation level as high as possible (perhaps by providing additional fill in front of the abutments and retaining wall).

It is recommended that the footing excavations be inspected and approved by a geotechnical engineer to ensure that footings rest on undisturbed natural subsoil capable of sustaining the design pressure. It would be prudent, in our opinion, to separate the new section of the bridge and the footings from the existing structure by means of construction joints.

The resistance of the foundations against sliding can be calculated using an ultimate friction angle of 22 degrees between the concrete and the subgrade.

.../...

## 5.2 Lateral Earth Pressures

Assuming that free draining granular material and adequate drainage is provided behind the abutment and retaining walls, (Figure 6.9.6.1 O.H.B.D.C.), the unit weight of the backfill can be taken as  $21.0 \text{ kN/m}^3$ .

For the retaining walls, the lateral earth pressure can be calculated using the active earth pressure and an angle of friction,  $\phi$  for the granular backfill equal to 30 degrees. For this case, the coefficient of earth pressure at ultimate limit states is 0.41, and at serviceability limit states Type II is 0.33.

The rigid abutment walls should, however, be designed to withstand the at-rest earth pressure, provided that the backfill is not heavily compacted (in which case much higher earth pressures could occur). For the at-rest earth pressure condition the coefficient of earth pressure can be calculated from the empirical formula  $K_0 = 1 - \sin \phi_f$ . Using a  $\phi_f$  - value of 24.8 degrees, the coefficient of lateral earth pressure at-rest at the ultimate limit and the serviceability limit states are obtained to be 0.58 and 0.5 respectively. The backfill material shall be drained by perforated pipes or weep holes.

## 5.3 Construction

The groundwater table at the time of the investigation was recorded near or above the anticipated foundation depths. Where the excavations extend

.../...



below the water table but terminate within the till, the hydrostatic head in the underlying sand must be lowered prior to the excavation to at least 0.5 m below the proposed foundation level. The sides of the till below the water table will be stable at steep side slopes but for only short periods of time. As the till does not appear to be cemented, ravelling and sloughing can be expected to occur with the passage of time, giving rise to flatter side slopes.

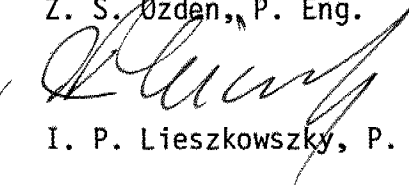
Where the excavations extend to the sand deposit underlying the till, the sides of the excavations will be stable at only flat side slopes unless the water table is sufficiently lowered. To facilitate construction therefore, and to preserve the bearing capacity of the subsoil, it will be necessary to lower the water table by means of filtered deep wells or well points. To preserve the load carrying capability of the subsoil, it is essential that careful dewatering and construction techniques be applied and the dewatering should be continued until the footings are poured and sufficiently loaded and backfilled.

To reduce potential problems with the groundwater seepage, therefore, it will be advantageous to keep the excavations as shallow as possible.

DOMINION SOIL INVESTIGATION INC.



Z. S. Ozden, P. Eng.



I. P. Lieszkowszky, P. Eng.

ZS0:jd  
IPL:jd



ENCLOSURES



RECORD OF BOREHOLE No. 1										METRIC			
W.P. 7-79-04		LOCATION Co-ords. 4 864 909 N; 376 726 E				ORIGINATED BY S.H.C.							
DIST 7 HWY 35/115		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY S.H.C.							
DATUM Geodetic		DATE 07-21-81				CHECKED BY							
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100					
109.7	Ground Surface		1	AS	-								
0.0	0.15m Sandy Topsoil		2	SS	16								
	Fill - Sand some gravel, occasional silt lenses.		3	SS	4								
	compact brown to loose		4	SS	11								
105.7			5	SS	82/0	15m							
4.0	Het. mixture of sand, silt and gravel (Glacial Till) very dense greyish		6	SS	60/0	15m							
103.7			7	SS	97								
6.0	Sand, some gravel, silt v. dense grey		8	SS	54/0	15m							
			9	SS	137								
101.2			10	SS	100/0	12m							
8.5	END OF BOREHOLE												

+3, x5 : Numbers refer to Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No. 2										METRIC							
W P 7-79-04		LOCATION Co-ords. 4 864 909 N; 376 741 E.				ORIGINATED BY S.H.C.											
DIST 7 HWY 35/115		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY S.H.C.											
DATUM Geodetic		DATE 07-23-81				CHECKED BY											
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA Si CL
			NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
109.5	Ground Surface		1	AS	-												
0.0	0.15m Sandy topsoil Sand, some gravel and cobbles (probably fill) brown		2	SS	69		109										
108.1			3	SS	80		107										26 34 30 10
1.4	Het. mixture of sand, silt and gravel occasional cobbles (Glacial Till) very dense grey		4	SS	65/0	15m	105										15 45 32 8
103.4			5	SS	75/0	15m											
6.1	Sand - fine to medium Silty, traces of gravel. v. dense Gravelly grey		6	SS	81		103										2 63 35
			7	SS	75/0	15m											
101.0			8	SS	65/0	15m	101										
8.5	Het. mixture of sand silt & gravel (Glacial Till) v. dense, grey		9	SS	100/0	10 m	PIEZOMETER										
100.1																	
9.4	END OF BOREHOLE																

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 3

METRIC

W P 7-79-04 LOCATION Co-ords. 4 864 937.3 N; 376 749.7 E. ORIGINATED BY S.H.C.  
DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
DATUM Geodetic DATE 07-27-81 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
109.2	Ground Surface																
0.0	0.15 m SANDY TOPSOIL						109										
	Fill - Sand some gravel traces of silt		1	SS	18		107										
	loose to dense brown and greyish		2	SS	4		105										30 62 8 -
103.7			3	SS	41		103										40 52 8 -
5.5	Het. mixture of sand, silt and gravel (Glacial Till) v. dense, grey		4	SS	60		101										15 55 23 7
102.5			5	SS	100/6	0.08m	99										30 58 10 2
6.7	Gravelly Sand some silty zones very dense grey		6	SS	135												
			7	SS	150/6	0.15m											
			8	SS	100/6	0.15m											
			9	SS	100/6	0.05m											
99.3			10	SS	150/6	0.10m											
9.9	Het. mixture of sand, silt & gravel (Glacial Till) v. dense, grey		11	SS	70/0	0.05m											
10.7	END OF BOREHOLE																

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

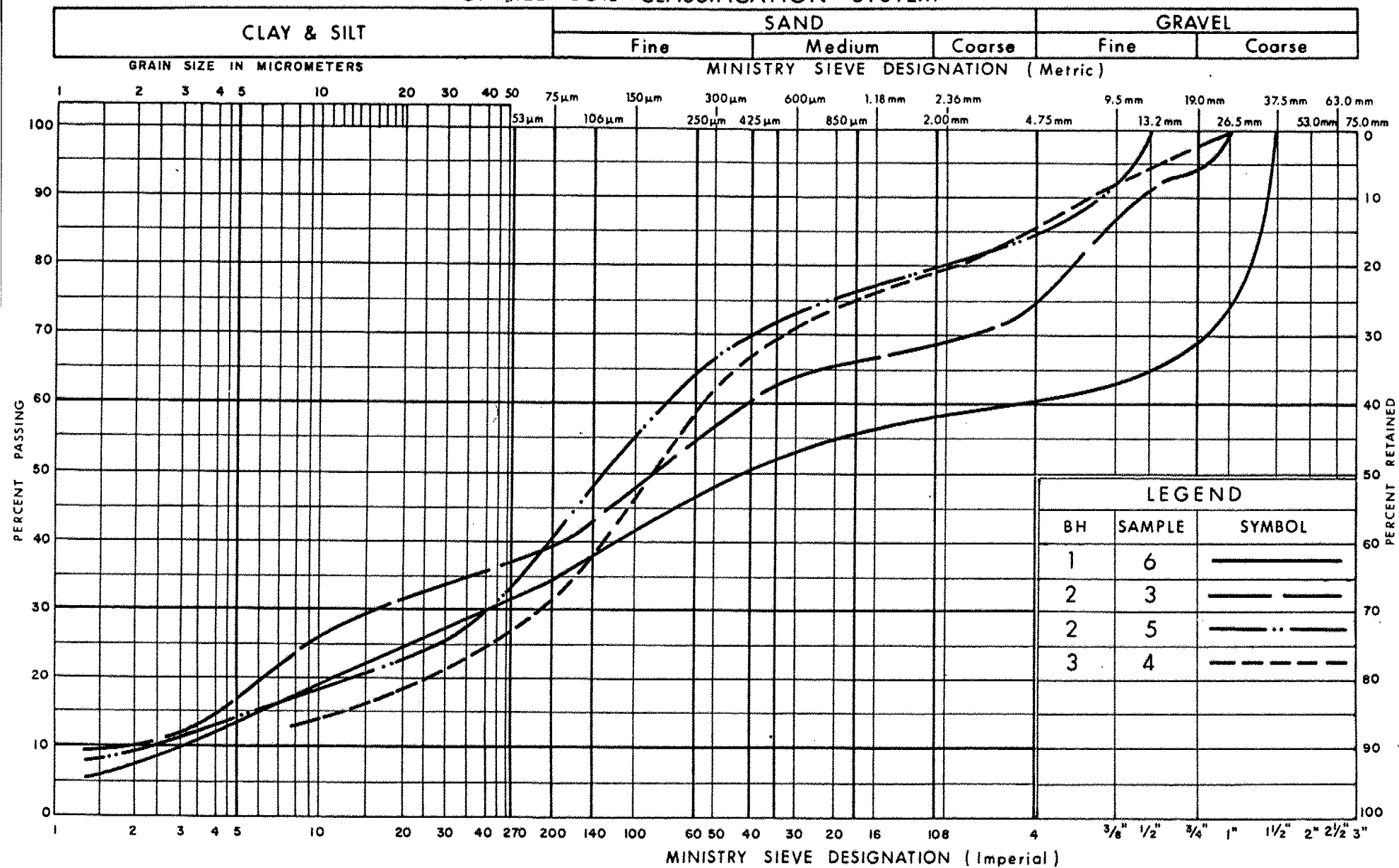
20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No. 4										METRIC				
W P 7-79-04		LOCATION Co-ords. 4 864 932 N; 376 765 E.				ORIGINATED BY S.H.C.								
DIST 7 HWY 35/115		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY S.H.C.								
DATUM Geodetic		DATE 07-23-81				CHECKED BY								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
105.4	Ground Surface													
0.0	0.15m topsoil,		1	SS	7									
104.2	Silty Clay & Silty Sand (probably fill)		2	SS	6									
1.2	Het. mixture of compact sand, silt & gravel		3	SS	19									
103.0	occ. cobbles, v. dense		4	SS	164									
2.4	(bl. clay fill) grey		5	SS	164									
102.4	Gravelly sand, v. dense													
3.0	greyish, some silt													
	END OF BOREHOLE													

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

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

FIG No 1

W P 7-79-04

## UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY &amp; SILT

SAND

GRAVEL

Fine

Medium

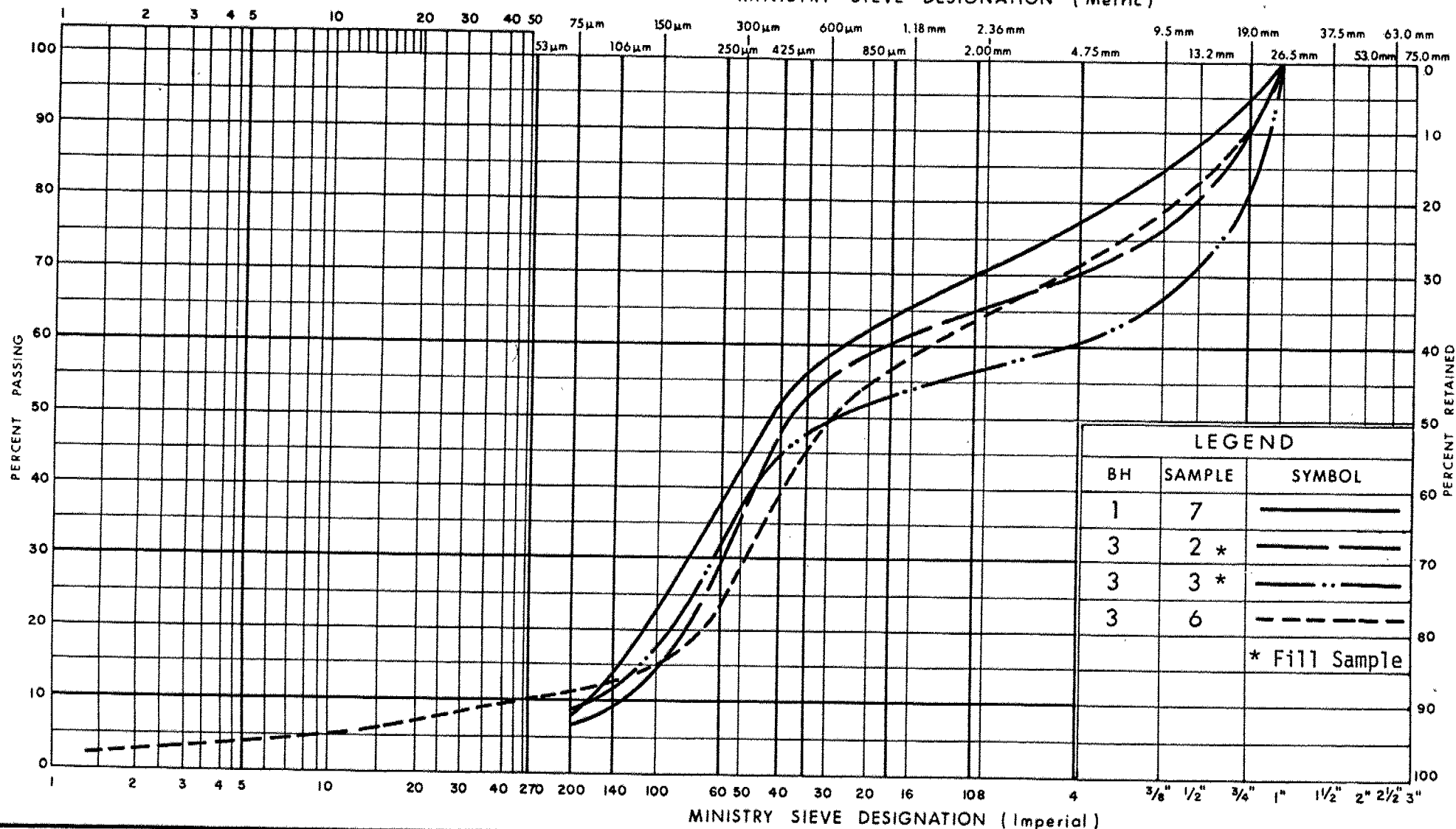
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



GRAIN SIZE DISTRIBUTION  
GRAVELLY SAND, SOME SILT

FIG No 2

W P 7-79-04

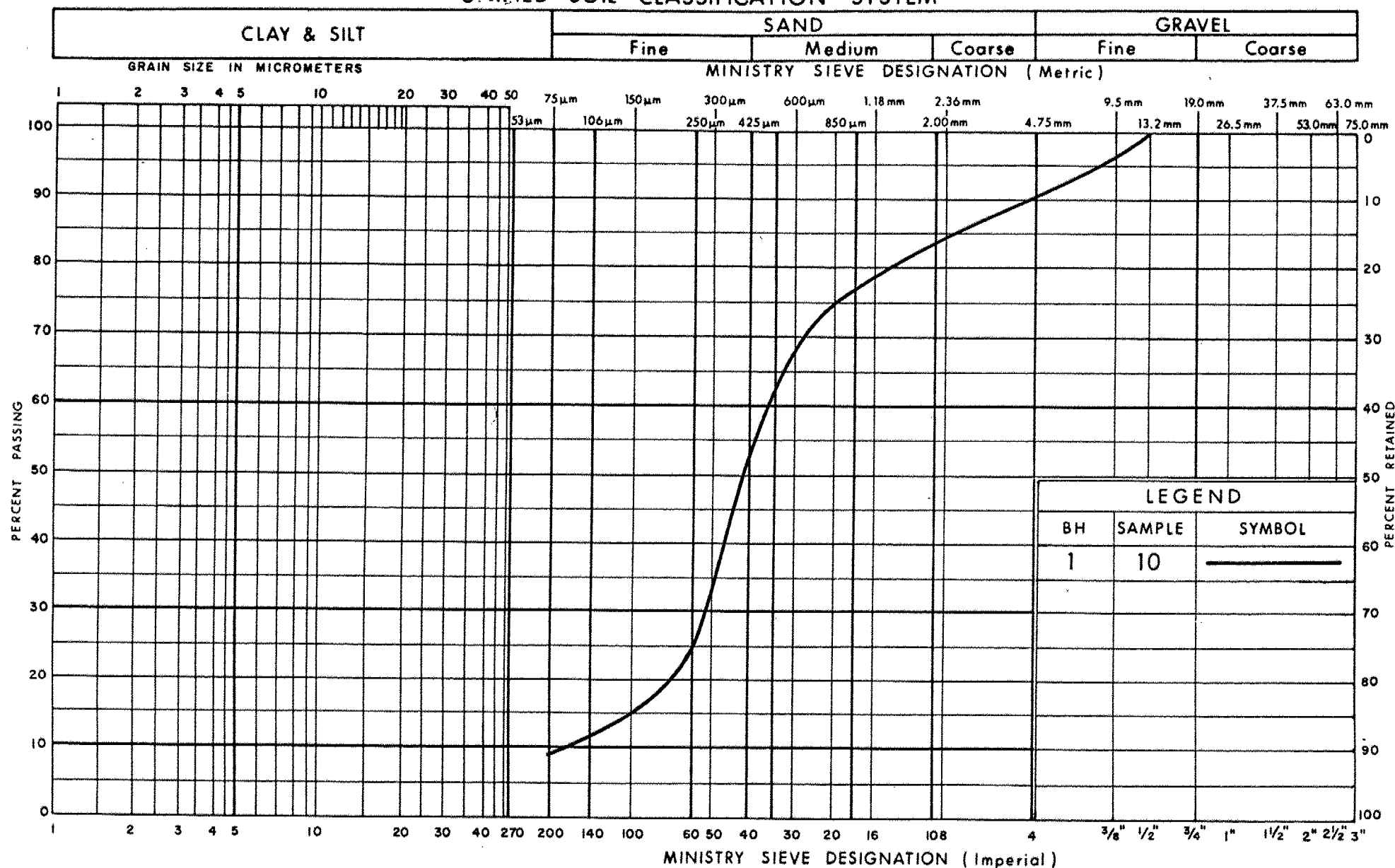


Ministry of  
Transportation and  
Communications

Ontario



## UNIFIED SOIL CLASSIFICATION SYSTEM



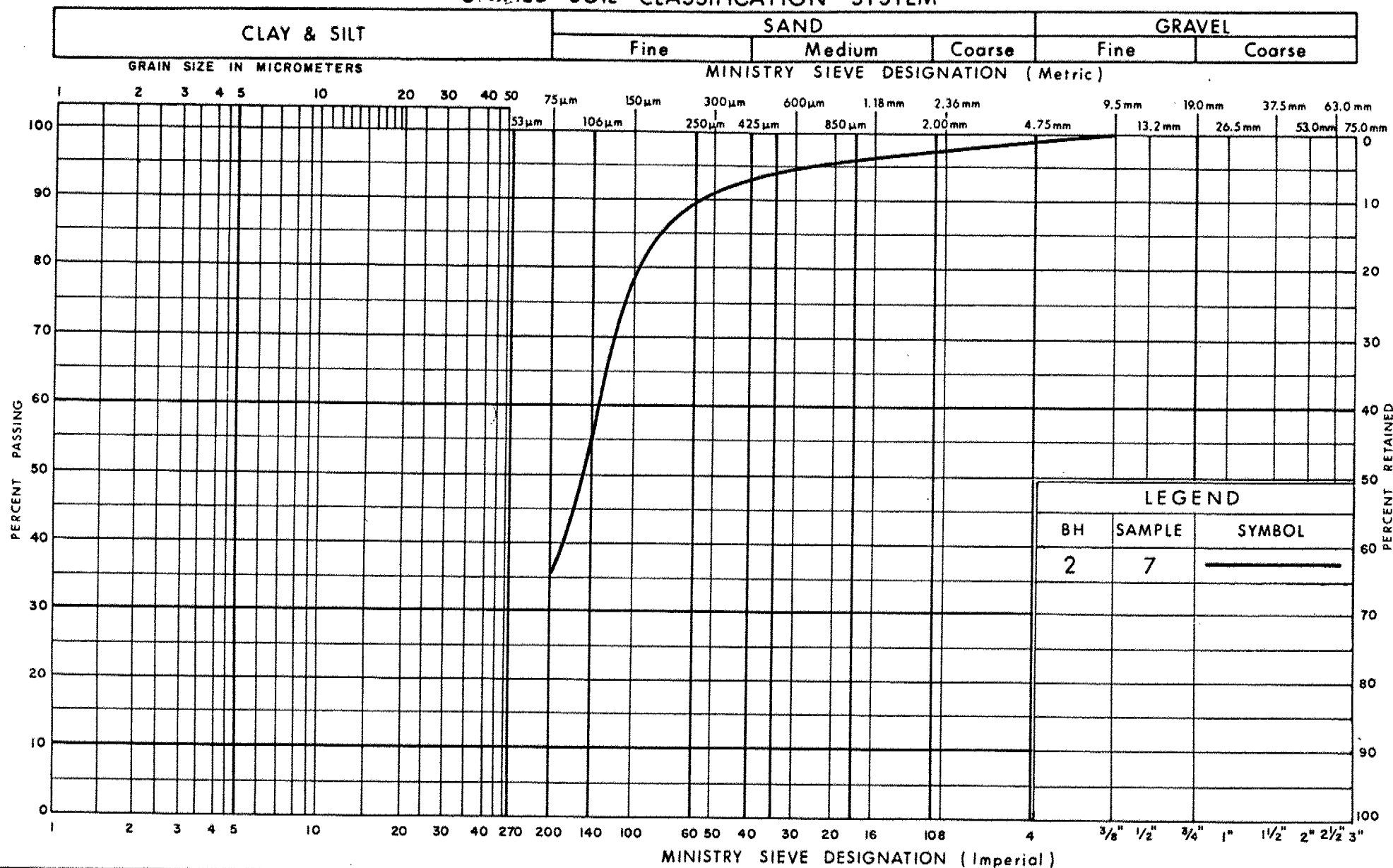
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SAND, SOME GRAVEL & SILT

FIG No 3

W P 7-79-04

## UNIFIED SOIL CLASSIFICATION SYSTEM

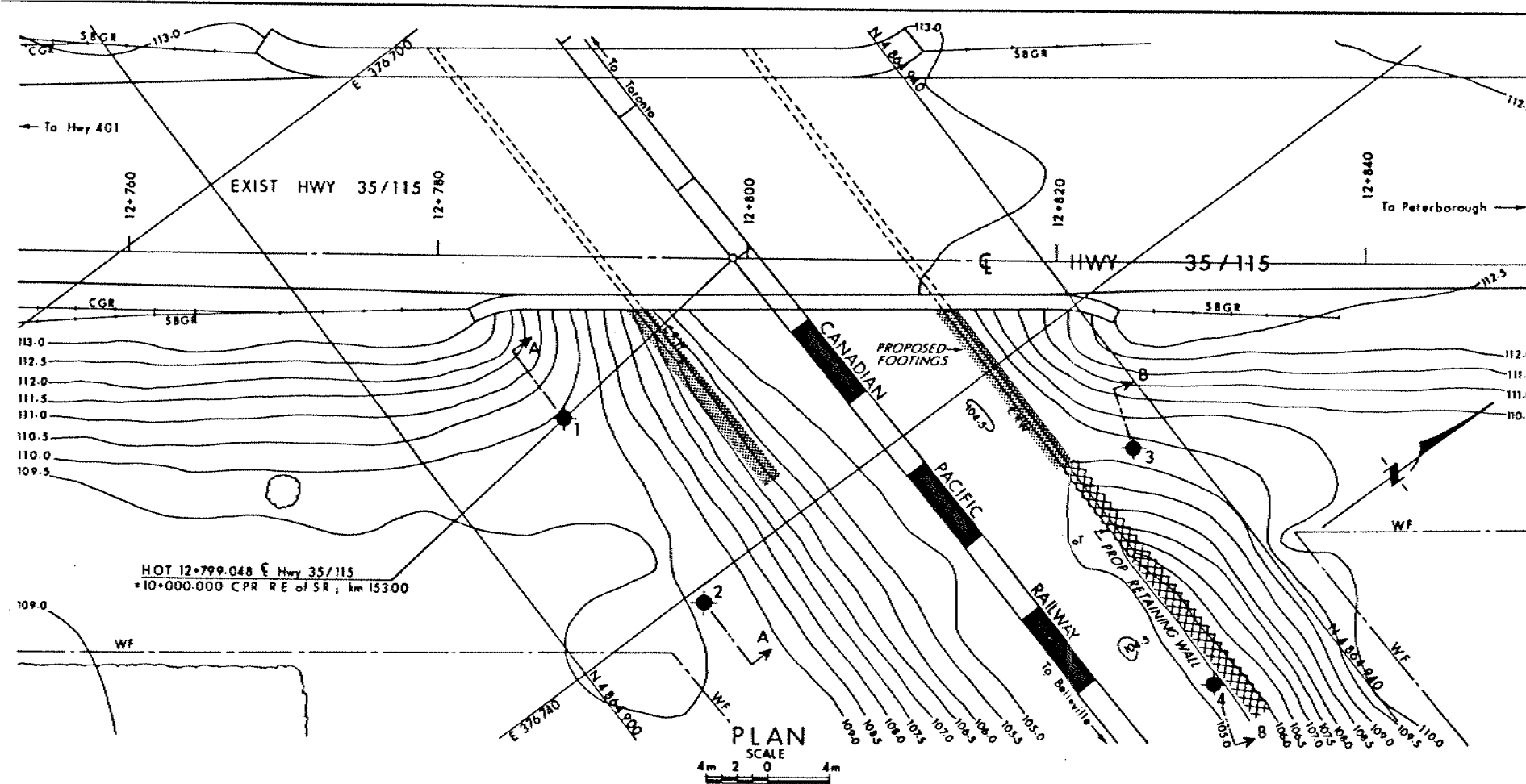


Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY SAND, TRACE OF GRAVEL

FIG No 4

W P 7-79-04



**METRIC**

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

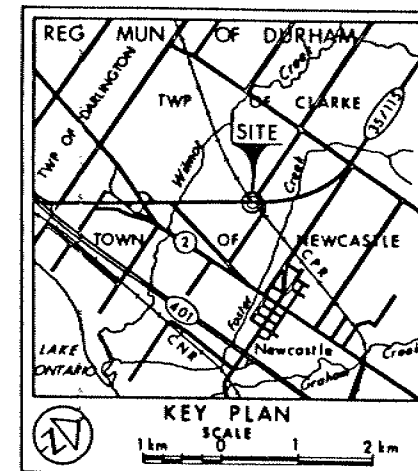
CONT No  
WP No 7-79-04

C.P.R. OVERHEAD  
(2.7 km North of Hwy 401)  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

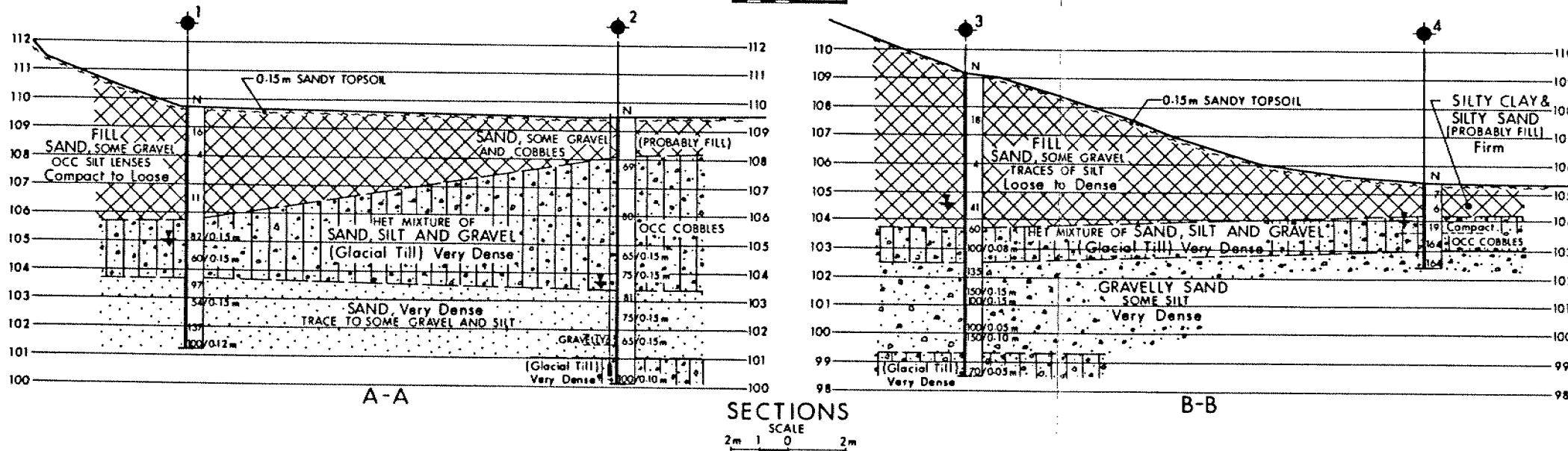
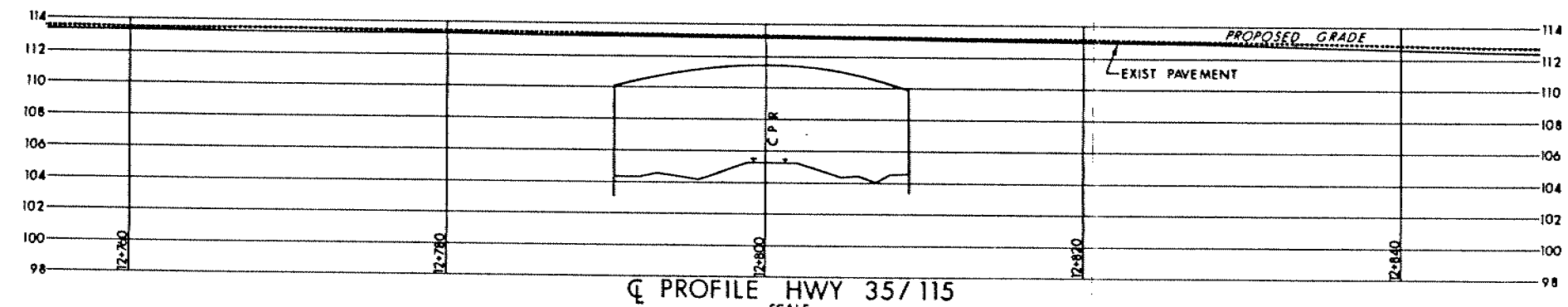
DOMINION SOIL INVESTIGATION INC



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1981 07
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	109.7	4 864 909.0	376 726.0
2	109.5	4 864 909.0	376 741.0
3	109.2	4 864 937.3	376 749.7
4	105.4	4 864 932.0	376 765.0



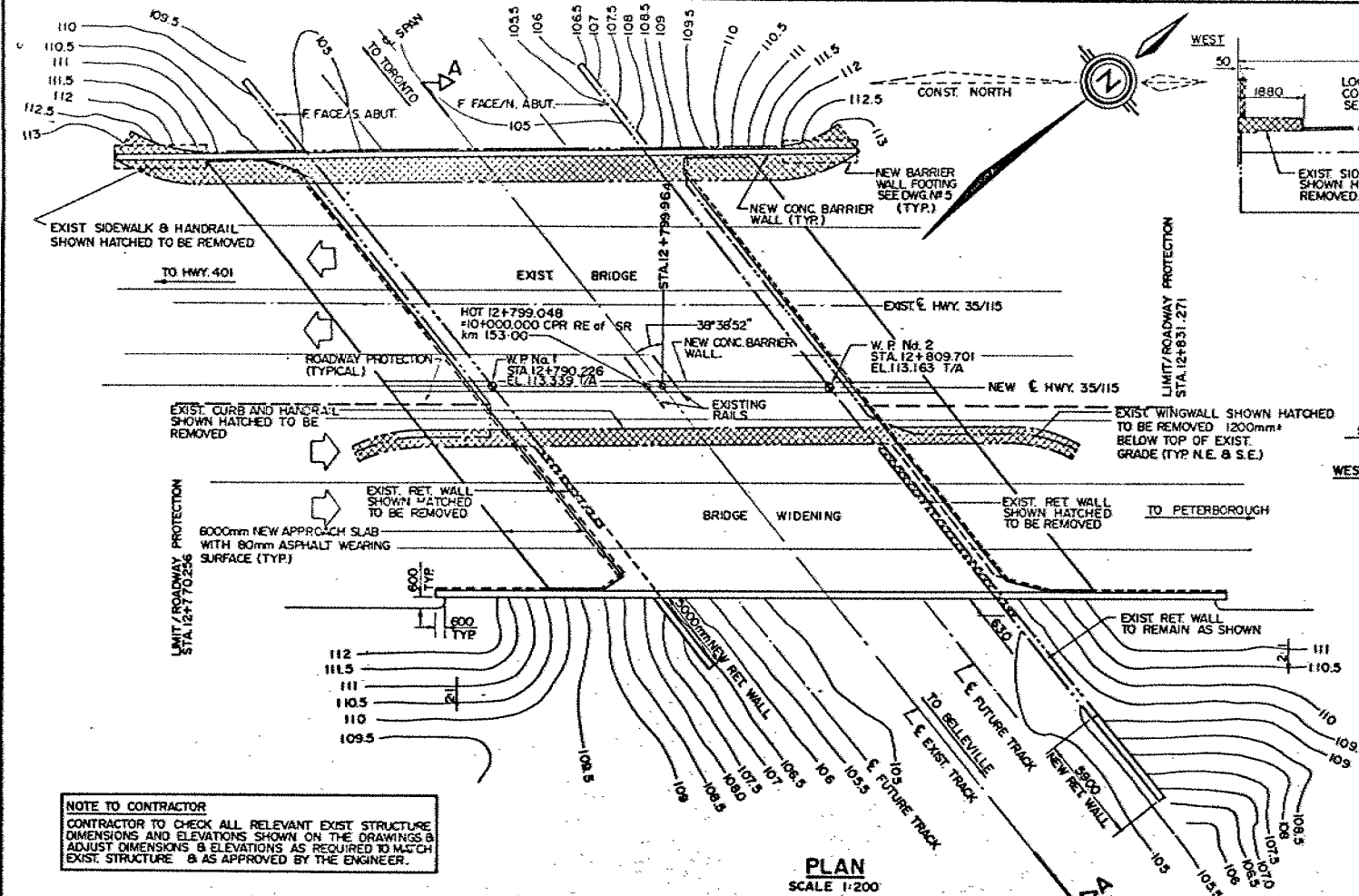
**NOTE**

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



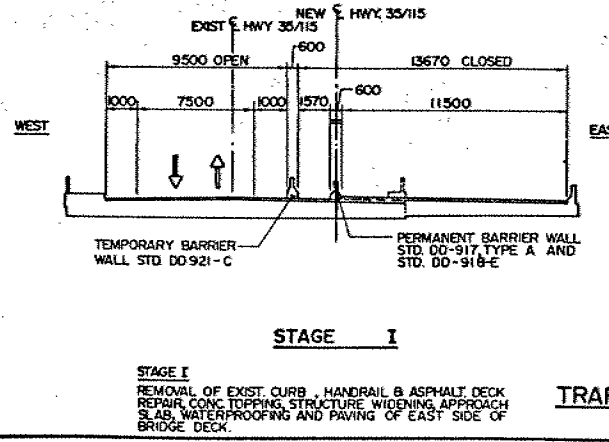
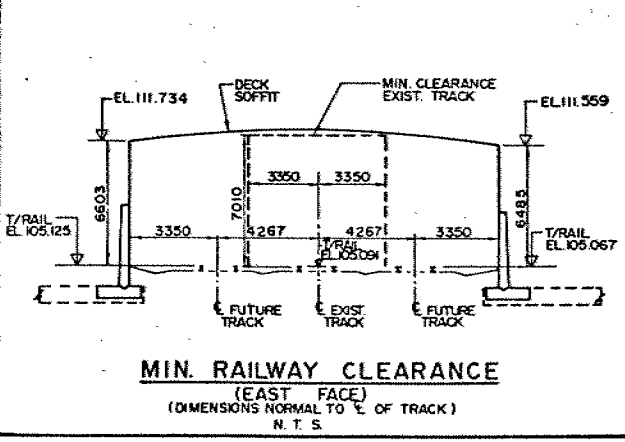
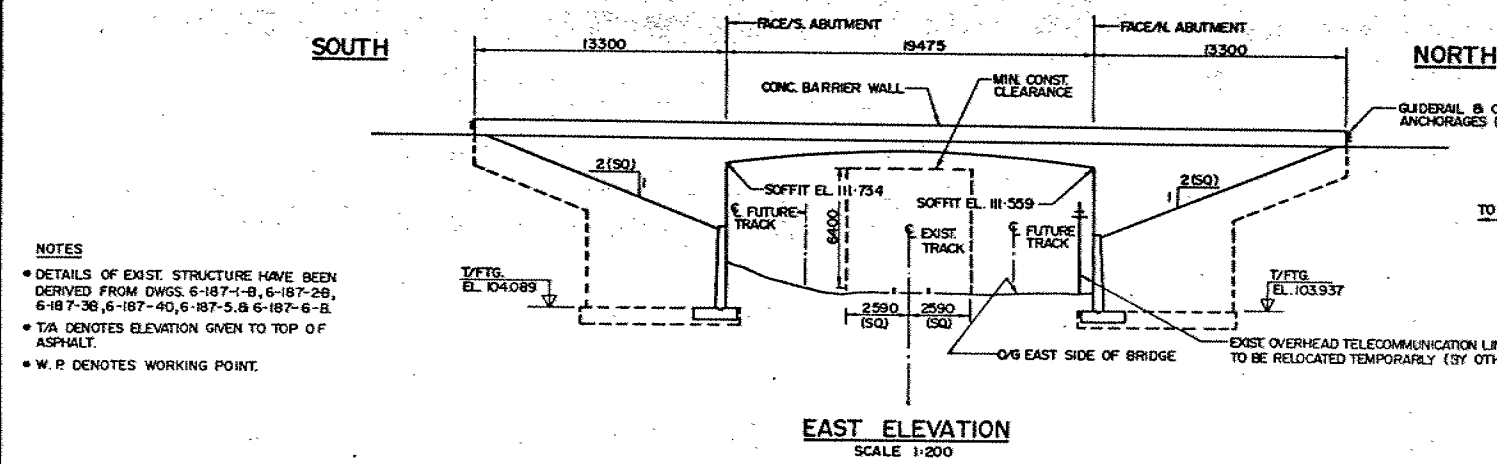
REVISIONS	DATE	BY	DESCRIPTION

Geocres No 3201-2-64  
HWY No 35/115  
SUBMDSHC CHECKED DATE 1981 09 11 SITE 21-187  
DRAWN FL CHECKED APPROVED DWG 77904-A

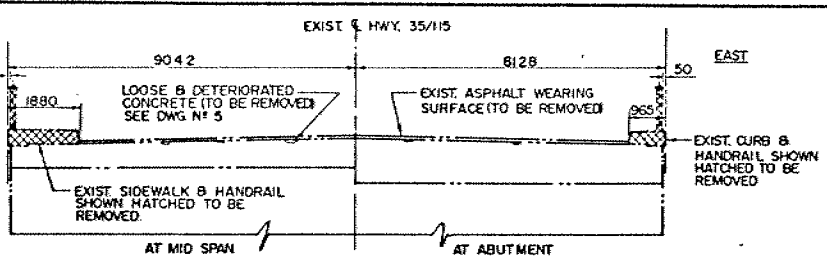


**NOTE TO CONTRACTOR**  
CONTRACTOR TO CHECK ALL RELEVANT EXIST. STRUCTURE DIMENSIONS AND ELEVATIONS SHOWN ON THE DRAWINGS & ADJUST DIMENSIONS & ELEVATIONS AS REQUIRED TO MATCH EXIST. STRUCTURE & AS APPROVED BY THE ENGINEER.

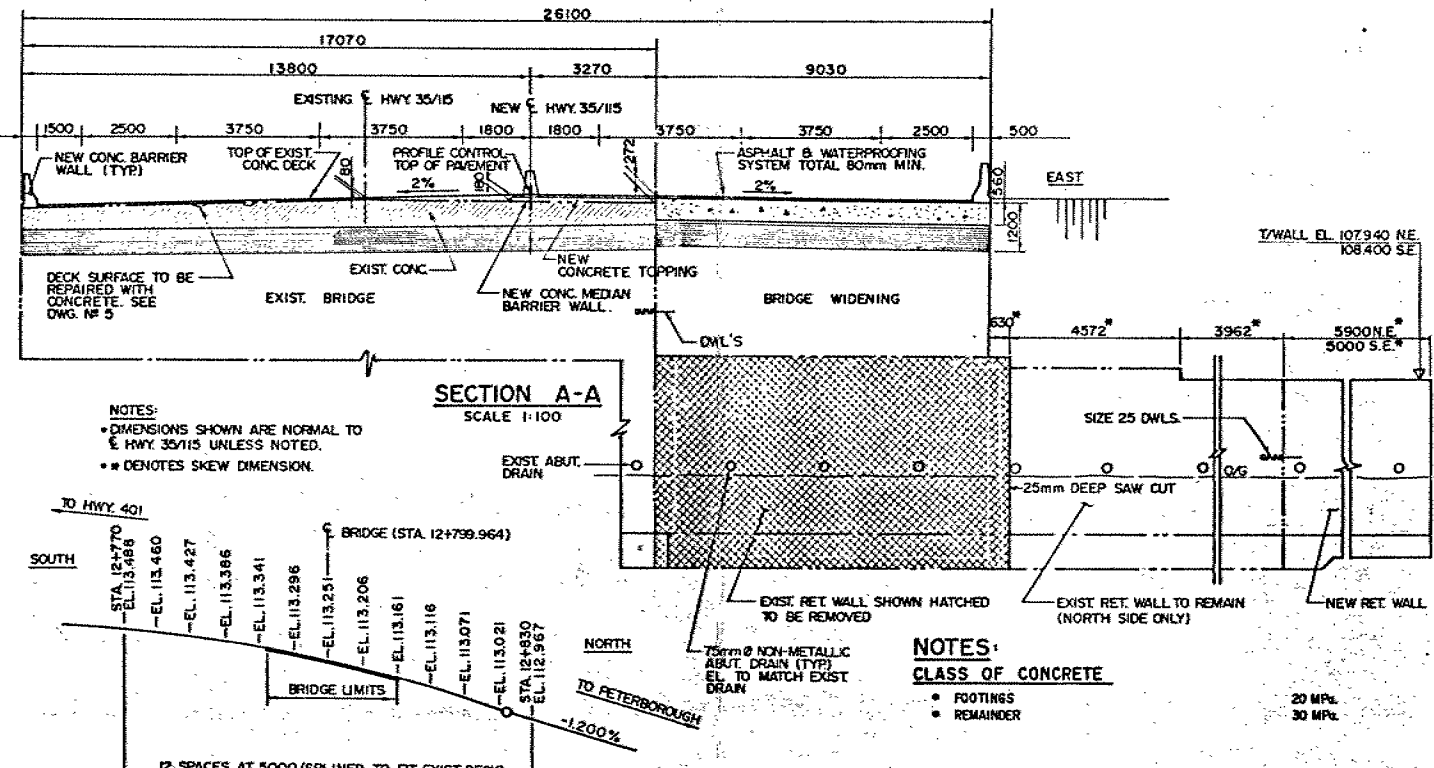
- NOTES**
- DETAILS OF EXIST. STRUCTURE HAVE BEEN DERIVED FROM DWGS. 6-187-1-B, 6-187-2-B, 6-187-3-B, 6-187-4-B, 6-187-5-B & 6-187-6-B.
  - T/A DENOTES ELEVATION GIVEN TO TOP OF ASPHALT.
  - W.P. DENOTES WORKING POINT.



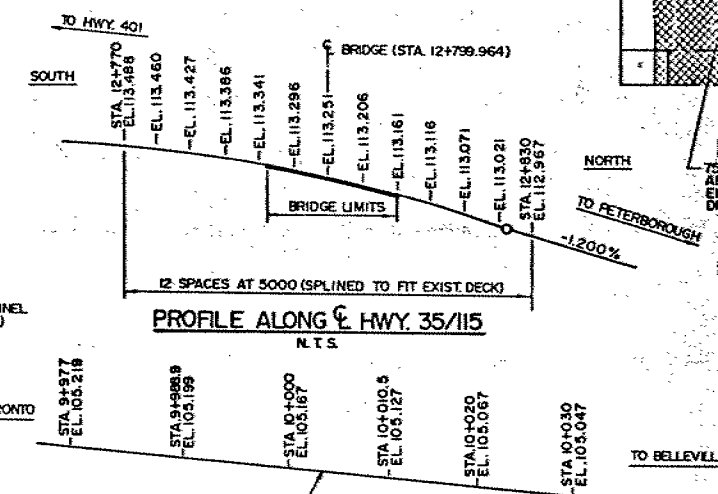
**TRAFFIC STAGING**  
N.T.S.



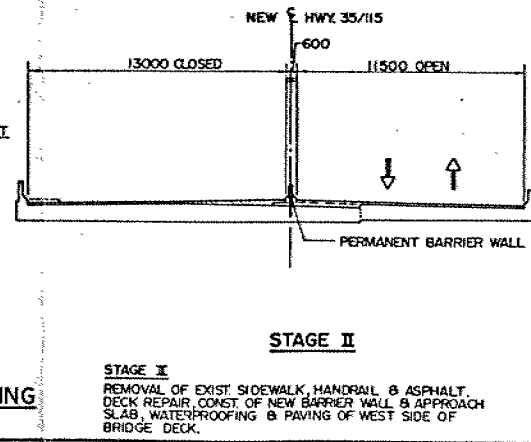
**EXISTING DECK SECTION**  
SCALE 1:100



- NOTES:**
- DIMENSIONS SHOWN ARE NORMAL TO E. HWY 35/115 UNLESS NOTED.
  - \* DENOTES SKEW DIMENSION.



**PROFILE OF C.P. RAIL TRACK**  
N.T.S.



**CONCRETE QUANTITIES**

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

• CONCRETE IN BRIDGE	499 m <sup>3</sup>
• CONCRETE IN BARRIER WALLS	40 m <sup>3</sup>
• CONCRETE IN RETAINING WALLS	22 m <sup>3</sup>
• CONCRETE IN APPROACH SLABS	87 m <sup>3</sup>

**NOTES:**  
**CLASS OF CONCRETE**

- FOOTINGS 20 MPa
- REMAINDER 30 MPa

**CLEAR COVER TO REINF. STEEL**

- FOOTINGS 100 + 25mm
- ABUTMENTS, WINGWALLS & RETAINING WALLS 80 + 20mm
- DECK 70 + 20mm TOP
- BARRIER WALLS 50 + 10mm BOT.
- REMAINDER 70 + 20mm
- 70 + 20mm UNLESS NOTED.

**REINFORCING STEEL**

- REINFORCING STEEL SHALL BE GRADE 400 EXCEPT AS NOTED.
- REINFORCING BARS WITH THE DESIGNATION 'C' AT THE END OF THE BAR MARKS SHALL BE COATED BARS.

**CONSTRUCTION**

- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 600 mm.

**LIST OF DRAWINGS**

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS & SOIL STRATA
3. FOOTINGS AND SUGGESTED ROADWAY PROTECTION
4. FRAME DETAILS
5. DECK REPAIRS, REMOVALS AND BARRIER WALL FOOTINGS
6. WINGWALLS
7. RETAINING WALLS
8. BARRIER WALLS
9. 6000mm APPROACH SLABS
10. STANDARDS
11. AS CONSTRUCTED ELEV. & DIM.
12. BRIDGE DATE & SITE NUMBER DATA



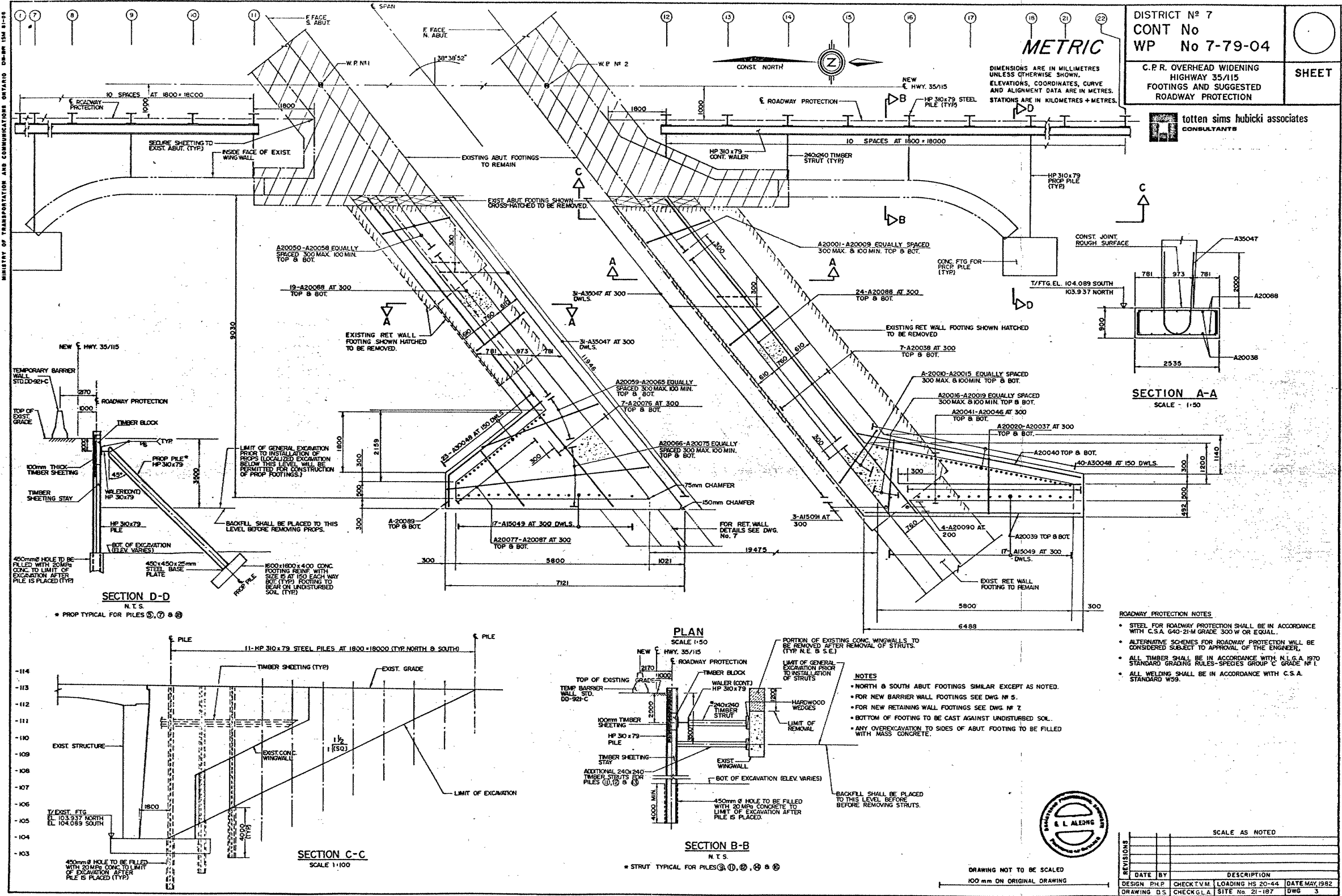
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN	P.H.P.	CHECK T.V.M.	LOADING HS 20-44
DRAWING	D.S.	CHECK G.L.A.	SITE No 21-187
			DATE MAY 1992
			DWG 1

DISTRICT No 7  
CONT No  
WP No 7-79-04  
C.P.R. OVERHEAD WIDENING  
HIGHWAY 35/115  
GENERAL ARRANGEMENT

totten sims hubicki associates  
CONSULTANTS

SHEET





Ontario



Ministry of  
Transportation and  
Communications

Structural Section,  
Central Region,  
5000 Yonge Street,  
Willowdale, Ontario.  
M2N 6E9  
Telephone: 224-7428

December 2, 1982

C.C. Parker Consultants Ltd.,  
1450 Rymal Road East,  
Hamilton, Ontario.  
LOR 1P0

Atten: Mr. E. Wilson

Dear Sir:

RE: Unwatering Structure Excavations,  
C.P.R. Overhead Widening,  
W.P. 7-79-04, Site 21-187,  
Highway 35/115, District 7, Port Hope

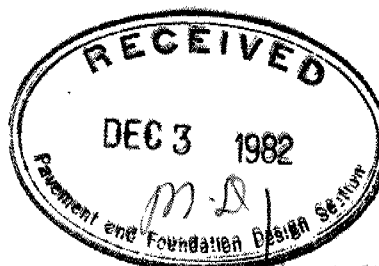
Please add the item "Unwatering Structure Excavations" to the D4 for the above structure. This addition is being made at the request of Mr. M. Holowka, Structural Office on the advice of the Foundations Section.

Yours truly,

P. Stuart,  
Senior Structural Engineer,  
for:  
G.C.E. Burkhardt,  
Head, Structural Section.

PS: gj

c.c. V. Mitranic  
M. Holowka  
M. Devata



T.R.  
↓  
Folks

# memorandum



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

Date: 82 08 26

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

Re: C.P.R. Overhead Widening  
Hwy. 35/115, W.P. 7-79-04  
Site 21-187, District 7, Port Hope

We have reviewed the final bridge plan drawing for the above-mentioned structure widening and present the following comment:

- Footings excavations carried out below the water table are susceptible to 'boiling', a special provision for unwatering should be included in the contract package.

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

Tom Kazmierowski, P. Eng.  
Foundations Engineer

TK:syc

# memorandum



To: Mr.T.C.Kingsland  
Head, Structural Section,  
Eastern Region

Date: 82 01 08

From; Pavement and Foundtion Design Section,  
Room 315, Central Building

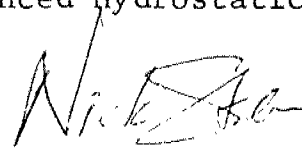
Re: C.P.R.Overhead Widening,  
W.P; 7-79-04, Site:21-187  
Hwy 35/115, District #7.

We have reviewed the preliminary general arrangement plans for the above mentioned structure and provide the following comments:

1. Depending on the sequence of construction between the removal of the retaining wall foundations and the building of the new footings, it may be necessary to provide a temporary protection scheme to maintain the existing slope adequately in this area.

2. Since the excavation for the footings and the retaining walls will be located below the possible ground water level in a granular type of subsoil, a dewatering scheme will be necessary in order to prevent 'boiling' of the foundation material due to unbalanced hydrostatic head.

NS/MD/md

  
N.Stea, P.Eng  
Project Foundations Engineer

For M.Devata, P.Eng  
Senior Foundations Engineer





# DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6

(416) 751-6565

August 6, 1981

Ref. No. 81-7-3

Ministry of Transportation & Communications  
Pavement & Foundation Design Section  
Central Building  
1201 Wilson Avenue  
DOWNSVIEW, Ontario  
M3M 1H3

Attention: Mr. M. Devata, P. Eng.  
Senior Foundation Engineer

Re: Geotechnical Investigation  
Proposed Widening of C.P.R. Overhead  
Highway 35/115 Bridge Site 21-187  
W.P. No. 7-79-04

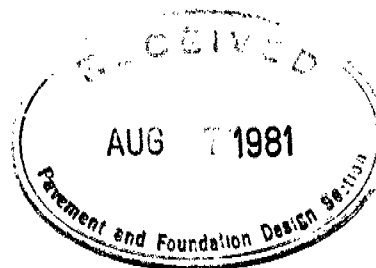
Dear Sirs:

We have now completed the field work for the above project and take pleasure in presenting our preliminary findings in this letter.

The field work was carried out during the period of July 21 to 27, 1981, and consisted of drilling four boreholes.

As shown on the preliminary Borehole Logs, enclosed with this letter, the boreholes encountered fill to elevations ranging between 108.1 (Borehole 2) and 103.7 m (Borehole 3). The fill generally consists of sand with some gravel and is underlain by a silty sand to sandy silt glacial till. The till is 1.2 m (Boreholes 3 and 4) to 4.7 m (Borehole 2) thick and extends to elevations ranging between 103.7 (Borehole 1) and 102.5 m (Borehole 3). Based on 'N'-values ranging from 60 to more than 100 blows/0.3 m, its relative density is described as very dense.

.../...



The till is underlain by a gravelly sand layer. This sand layer contains water under a slight sub-artesian pressure with a head at Elevation 104.7 to 104 m. Based on penetration indices of 81 or greater the sand is considered to be very dense. Boreholes 1 and 4 were terminated in this deposit after penetrating it to between 0.6 and 2.5 m. In Boreholes 2 and 3, the sand is 2.4 to 3.2 m thick below which a second till deposit was encountered at Elevations 101.0 and 99.3 m.

As the ground surface elevation adjacent to the railway tracks is approximately 105.0 m, the probable foundation level will be  $103.8^{\pm}$  m. On the south side (Boreholes 1 and 2) the subsoil at this level is very dense till but on the north side (Boreholes 3 and 4) the surface of the dense till, is at about El. 103.5 m. In all cases, the foundation level is close to the surface of the gravelly sand stratum.

For footings placed below the fill and on the very dense till, an allowable bearing value of  $500 \text{ kN/m}^2$  can be used.

Due to the subartesian conditions observed in the sand layer which is interbedded in the till, however, some special precautions will be required for the construction of the footings. It is our opinion that the hydrostatic head in this sand deposit should be lowered to at least 0.5 m below the proposed foundation level before the excavations are extended to their final levels. It is believed that this can be achieved by pumping from properly filtered deep wells until the foundations are completed and sufficiently backfilled.

We trust that the preliminary information contained in this letter is sufficient for your present purposes. Presently the laboratory testing is underway, and our final report will be submitted as soon as the testing is completed. Meanwhile if you have questions or need more information, please feel free to call this office.

Yours very truly,  
DOMINION SOIL INVESTIGATION INC.

  
for Z. S. Ozden, P. Eng.

ZSO:ji

RECORD OF BOREHOLE No. 1										METRIC						
W P 7-79-04		LOCATION Crossing at CP Rail and Hwy. 115/35		ORIGINATED BY S.H.C.												
DIST 7 HWY 115/35		BOREHOLE TYPE Hollow Stem Auger		COMPILED BY S.H.C.												
DATUM Geodetic		DATE July 21, 1981		CHECKED BY												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					SHEAR STRENGTH			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 <sub>p</sub>			W
109.7	0.15m Sandy topsoil		1	AS												
109.0	0.11 Fine sand, traces of gravel brown		2	SS	16											
0.7	Fill - Sandy some gravel, traces of silt lenses.		3	SS	4											
	compact brown to 1.8 m.		4	SS	11											
105.7	loose greyish brown below 1.8 m.															
4.0	Het. mixture of sand, silt and gravel (Glacial till) very dense greyish		5	SS	82/0	15m										
103.7			6	SS	60/0	15m										
6.0	Gravelly Sand some silt v. dense, greyish		7	SS	97											
103.0			8	SS	54/0	15m										
6.7	Sand, some gravel		9	SS	137											
101.2	v. dense grey		10	SS	100/0	12m										
8.5	END OF BOREHOLE															

OFFICE REPORT ON SOIL EXPLORATION

+3, x<sup>5</sup>: Numbers refer to Sensitivity

20  
15  
10

5 (% ) STRAIN AT FAILURE

# RECORD OF BOREHOLE No.2

METRIC

W P 7-79-04 LOCATION Co-ords. 4 864 909 N; 376 741 E. ORIGINATED BY S.H.C.  
 DIST 7 HWY 115/35 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
 DATUM Geodetic DATE July 23, 1981 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
							20	40	60	80	100						
109.5	0.15m Sandy topsoil Sand some gravel and cobbles (probably fill) brown		1	AS	-												
108.1	Het. mixture of sand, silt and gravel occasional cobbles (Glacial Till) very dense grey		2	SS	69												
			3	SS	80												
			4	SS	65/0	15m											
			5	SS	75/0	15m											
103.4	Sand - fine, some silt, traces of gravel v. dense grey		6	SS	81												
			7	SS	75/0	15m											
			8	SS	65/0	15m											
101.0	Gravelly fine to medium																
8.5	Het. mixture of sand & gravel (Glacial silt) v. dense, grey		9	SS	100/0	10m											
100.1																	
9.4	END OF BOREHOLE																

OFFICE REPORT ON SOIL EXPLORATION






+3, x<sup>5</sup>; Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No. 3

METRIC

W P 7-79-04 LOCATION Co-ords. 4 864 934 N; 376 749 E. ORIGINATED BY S.H.C.  
 DIST 7 HWY 115/35 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.H.C.  
 DATUM Geodetic DATE July 27, 1981 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH								
							20	40	60	80	100					
109.2																
0.0	Fill - Sand some gravel traces of silt lenses loose to dense brown and greyish		1	SS	18											
			2	SS	4											
			3	SS	41											
103.7			4	SS	60											
5.5	Het. mixture of sand, silt and gravel (Glacial till) v. dense, grey		5	SS	100/6	0.08m										
102.5			6	SS	35											
6.7	Gravelly Sand some silty zones very dense grey		7	SS	150/6	.15m										
			8	SS	100/6	.15m										
			9	SS	100/6	.05m										
99.3			10	SS	150/6	.10m										
9.9	Het. mixture of sand, silt & gravel (Glacial till) v. dense, grey		11	SS	70/0	.05m										
98.5																
10.7	END OF BOREHOLE															

OFFICE REPORT ON SOIL EXPLORATION

\*<sup>3</sup>, \*<sup>5</sup>: Numbers refer to  
Sensitivity

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

