

GEOCRES No. 30M13-116DIST. 6 REGION                     W.P. No. 368-87-01CONT. No. 93-93W. O. No.                     STR. SITE No. 37-1335HWY. No. 407/427LOCATION Ramp 427S-407W  
over Hwy 427 & 407No of PAGES -                     

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     REMARKS:

# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 93-93**



**Ministry of  
Transportation**

## INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3-60	Foundation Investigation Report for  Ramp 427S-407W Over Hwys, 427 & 407 W.P. 368-87-01, Site 37-1335 Hwy 427/407, District 6 Toronto  Ramp 427S - 407W Over Steeles Ave. W.P. 368-87-02, Site 37-1336 Hwy 427/407, District 6 Toronto  Ramp 407W-427S Over Steeles Ave. W.P. 368-87-03, Site 37-1337 Hwy 427/407, District 6 Toronto

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

# EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### 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						

FOUNDATION INVESTIGATION REPORT  
For  
Ramp 427S-407W over Hwys. 427 and 407  
W.P. 368-87-01, Site 37-1335  
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A multi-span (7 span) structure is proposed to carry traffic from Hwy. 427S to Hwy. 407W. The report describes the subsurface conditions at the site.

SITE DESCRIPTION AND GEOLOGY

The site is located at the proposed Hwy. 427/Hwy. 407 interchange in the Town of Vaughan, Regional Municipality of York. The site is located in a quadrant of land bounded by the existing Hwy. 50 and Hwy. 27 to the west and east respectively and Steeles Avenue and Hwy. 7 to the south and north respectively.

At the time of the investigation, the site area had become a construction site as progress continued on the construction of the Hwy. 427/Hwy. 407 interchange complex. Consequently, construction personnel, equipment and materials dominated the site area. Projects under construction at the time of the investigation included Ramp 407E-427S (W.P. 88-78-25), Hwy. 427 over Hwy. 407 structures (W.P. 150-87-01&02) and Hwy. 427 over Ramp N-407E (W.P. 153-80-05). In addition, an excavation cut for the future Hwy. 407 had been advanced in the area immediately west of the proposed Hwy. 427 for an approximate distance of 300 m.

Physiographically, the site is located in the geological domain known as the Peel Plain. The Peel Plain is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. At some locations, the till is overlain by thin deposits of varved clay.

Till sheets of varying composition comprise the Peel Plain. Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristic of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay.

The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 30 m below ground surface and consists of interbedded shale and limestone of the Dundas-Meaford Formation, Ordovician Period.

## INVESTIGATION PROCEDURE

### Field Investigation

The fieldwork for the investigation was carried out between 90 06 19 and 90 06 21 and consisted of ten (10) sampled boreholes advanced to depths ranging 9.6 m to 20 m below the natural ground surface. Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m intervals for the surficial 6 m and 1.5 m intervals thereafter. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

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

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

### Laboratory Analyses

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

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

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

### SUBSURFACE CONDITIONS

#### General

The elevation of the ground surface at the borehole locations ranged from 173.2 m to 182.1 m illustrating that the site is contoured with a combination of excavation cuts and high fills in conjunction with the Hwy. 427/Hwy. 407 interchange complex. In general, the subsoil stratigraphy at the site consists of a thin surficial veneer of a heterogeneous mixture of clayey silt, sand and gravel. This deposit is of glacial origin and exhibits a cohesive behaviour. The thickness of this deposit varies across the site ranging between 1.5 m and 5.5 m. The surface of the deposit ranges from El. 174.5 m to 176 m along the southerly portion of the site (BH's 6 to 10 inclusive) and from 181.9 m to 182.1 m at the proposed north abutment and approach area. The deposit has a very stiff to hard consistency.

At locations across the site, the above mentioned deposit of glacial origin has either been stripped in conjunction with excavation cuts advanced in the area and hence does not exist or is overlain by fill material. The fill material encountered during the subsurface investigation generally consists of a cohesionless sandy silt overlying a cohesive irregular mixture of clayey silt,

sand and gravel. The fill material has been placed for the construction of the Hwy. 427 NB & SB embankments. The ground surface elevation at the time of the investigation at the locations of the fill material varied between 178.2 m to 181.1 m. The thickness of the cohesionless fill ranged up to 4.1 m. The thickness of the underlying cohesive fill ranges from 1.2 m to 2.1 m. The denseness of the cohesionless fill ranges from very loose to compact whilst the cohesive fill has a consistency ranging from stiff to hard.

Underlying the cohesive heterogeneous mixture of clayey silt, sand and gravel deposit and existing surficially within the Hwy. 407 right-of-way (see BH's 3 to 5 inclusive) a cohesionless deposit ranging in gradation from a sandy silt to a silty sand is present. The deposit ranges in thickness from 3.5 m to 10.8 m and extends to an elevation ranging from 171.0 m to 167.3 m. The deposit typically has a dense to very dense state of denseness.

The cohesionless sandy silt to silty sand deposit is underlain by a second glacial sheet consisting of a heterogeneous mixture of clayey silt, sand and gravel. The extent of this deposit was not determined during the investigation. The deposit has a hard consistency.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 3688701-A\*.

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

#### Sandy Silt (Fill Material)

A cohesionless fill material composed of sandy silt constitutes the upper portions of the existing Hwy. 427 embankments that were under construction at the time of investigation. The thickness of this material is in the order of 1.4 m to 4.1 m and the ground surface elevation of this fill is at 179.1 m to 181.1 m. A grain size distribution curve for this fill material as determined by mechanical sieve analysis is illustrated in Figure 1 in the Appendix.

The sandy silt is brown in colour and based on 'N' values obtained from the Standard Penetration Test ranging from 3 blows/0.3 m to 22 blows/0.3 m, the fill has a state of denseness ranging from very loose to compact.

- SHEET NO 70 OF THE CONTRACT DWG'S

### Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)

The cohesionless fill material is directly underlain by a cohesive fill material composed of an irregular mixture of clayey silt, sand and gravel. At BH 6, a proposed pier location situated at the toe of the Hwy. 427 embankment, the cohesive fill extends from the ground surface and hence is not overlain by the cohesionless fill material discussed above. The thickness of this fill material varies from 1.2 m to 2.4 m extending to an elevation ranging from 176.2 m to 175.8 m. Grain size distribution curves determined by mechanical sieve and hydrometer analysis, illustrate the gradation of the fill in Figure 1 in the Appendix.

Atterberg Limit tests were carried out to evaluate the behaviour of the cohesive fill. The results on two selected representative samples ( $w_L=28-32$ ,  $I_p=14$ ) reveal that the fine grained portion of the fill has a low plasticity and hence can be categorized as a clayey silt. The results are illustrated graphically on the plasticity chart shown on Figure 2 in the Appendix.

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

The native surficial deposit at the site consists of a heterogeneous mixture of clayey silt, sand and gravel. Although not encountered during the investigation, boulders and cobbles are characteristic components of such till deposits of glacial origin and hence can exist within the deposit. Figure 3 in the Appendix illustrates a grain size distribution envelope representative of the deposit within the clay to gravel range.

The deposit exists surficially at the proposed abutment locations and adjacent approaches. The natural ground surface at the south abutment location is generally flat and at El. 175.1 m to 176.0 m. The thickness of the deposit ranges from 3.5 m to 5.5 m at the south abutment location. At the north abutment location, the natural ground surface is generally flat at the crest of the existing Hwy. 407 excavated cut slopes and at an El. 181.9 m to 182.1 m. The thickness of the deposit ranges from 2.9 m to 4.1 m at the north abutment location. At the toe of the slope and within the Hwy. 407 excavation cut area, this till deposit does not exist, presumably stripped and excavated. The ground surface ranges from 173.2 m to 174.0 m within the investigated area of the excavation cut.

Beyond the south abutment, this upper till deposit is overlain by the cohesive fill material previously discussed. In addition, the thickness of the heterogeneous mixture deposit gradually diminishes progressing northward along the proposed ramp alignment. At BH 7, the deposit is 1.5 m in thickness, and at BH 6, the deposit does not exist.

Atterberg Limit tests were carried out to evaluate the behaviour of the fine grained portion of the deposit and the results are tabulated in Table 1 below and illustrated on the plasticity chart on Figure 4.

Table 1

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	12-21	4
Liquid Limit (w <sub>L</sub> %)	27-35	4
Plasticity Index (I <sub>p</sub> %)	12-18	4

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

The deposit is brown in colour and based on 'N' values (obtained by the Standard Penetration Test), ranging from 21 blows/0.3 m to 120 blows/0.3 m, the deposit can be categorized as having a very stiff to hard consistency.

#### Sandy Silt to Silty Sand

A cohesionless sandy silt to silty sand deposit exists at varying depths and stratigraphies across the site. Basically, the deposit underlies the upper cohesive heterogeneous mixture of clayey silt, sand and gravel deposit where this upper till deposit exists. Within the Hwy. 407 right-of-way, where the excavation has already been advanced in the area of the proposed ramp, the ground surface is at an elevation of 173.2 m to 174 m and the sandy silt to silty sand deposit extends from this ground surface for a thickness ranging from 3.5 m to 3.7 m. Elsewhere at the site location, the sandy silt to silty sand deposit is overlain by the cohesive clayey silt deposit or directly overlain by

the fill material consisting of an irregular mixture of clayey silt, sand and gravel. The thickness of the deposit at these locations varies between 5.1 m to 10.8 m.

The deposit has been oxidized and hence is brown in colour for an upper thickness ranging from 1.2 m to 9.3 m. The deposit is unoxidized and grey in colour below this depth.

The sandy silt to silty sand also contains random zones of gravel intermixed within the deposit. Figure 5 in the Appendix illustrates the gradation of the deposit in envelope form and also includes individual grain size distribution curves which illustrates the gravel composition.

Based on Standard Penetration Test 'N' values ranging from 29 blows/0.3 m to 100 blows/0.15 m, the deposit can be categorized as having a compact to very dense state of denseness. In general, however, 'N' values exceed 50 blows/0.3 m and consequently the soil has a very dense state of denseness.

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

Underlying the sandy silt to silty sand deposit, a second lower glacial till deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel is present. Random interbeds of glaciolacustrine silt and clayey silt in the order of 0.5 m thickness are also present within the deposit. The extent of the deposit was not determined during the investigation.

The composition of the till deposit reflects the wide range of grain sizes typical of till deposits of glacial origin. A grain size distribution envelope illustrating the gradation of the deposit is shown on Figure 6 in the envelope. The gradation envelope includes particle sizes up to and including gravel. However, larger size boulders and cobbles are characteristics components of these deposits and hence can exist.

Atterberg Limit tests were obtained to evaluate the behaviour of the fine grained portion of the deposit and the results are plotted on the plasticity chart on Figure 7 in the Appendix and summarized in Table 2 below.

Table 2

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	9-18	6
Liquid Limit (w <sub>L</sub> %)	22-46	6
Plasticity Index (I <sub>p</sub> %)	9-28	6

The results reveal that the fine grained portion of the deposit ranges in plasticity from low to intermediate and therefore can be classified as a clayey silt to silty clay. However, in general, the liquid limit does not exceed 35% and the plasticity index is less than 20%. Hence, the fine grained portion of the deposit is generally of low plasticity and a clayey silt.

Based on Standard Penetration Test 'N' values, ranging from 41 blows/0.3 m to 186 blows/0.3 m. The deposit is considered to have a hard consistency.

#### GROUNDWATER CONDITIONS

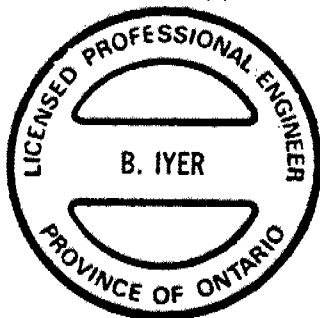
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. The groundwater condition at each of the individual boreholes is indicated on the Record of Borehole sheets in the Appendix. In general, the groundwater levels determined at the time of the investigation were at an elevation ranging from 168.6 m to 172.6 m. Higher water levels were noticed at BH's 9 and 10, a result revealing that the silty sand to sandy silt deposit at these locations is under subartesian head. Washboring techniques were required to penetrate the sloughing cohesionless soil in this stratum.

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

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, and M. Iampietro, Student Engineer, utilizing equipment owned and operated by Malone's Soil Samples Ltd. and Master Soils Investigation Ltd.

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



A handwritten signature in cursive script, appearing to read "B. Iyer", written over a horizontal line.

B. Iyer, P. Eng.  
Senior Foundation Engineer

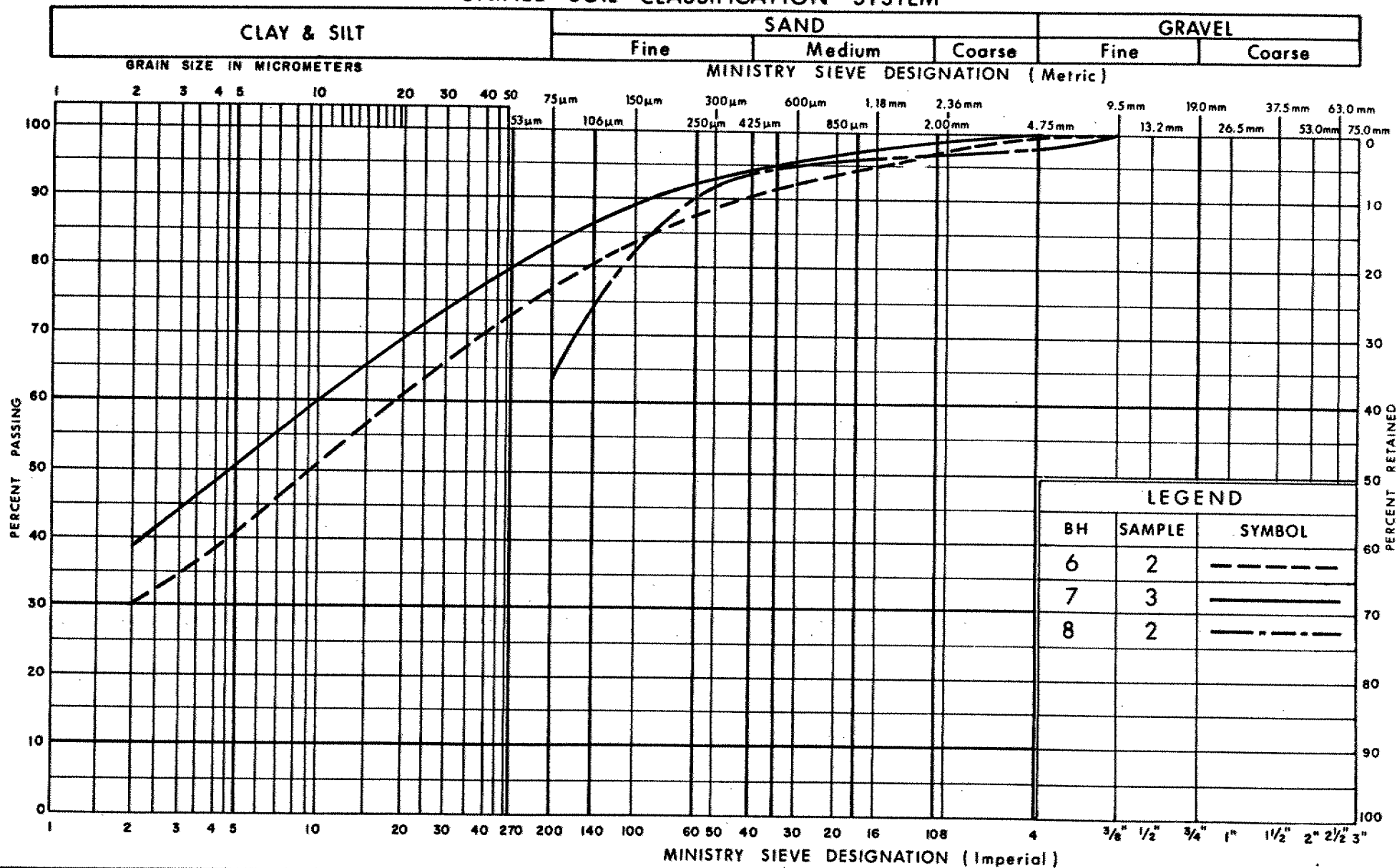


A handwritten signature in cursive script, appearing to read "M. Devata", written over a horizontal line.

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

**APPENDIX**

## UNIFIED SOIL CLASSIFICATION SYSTEM

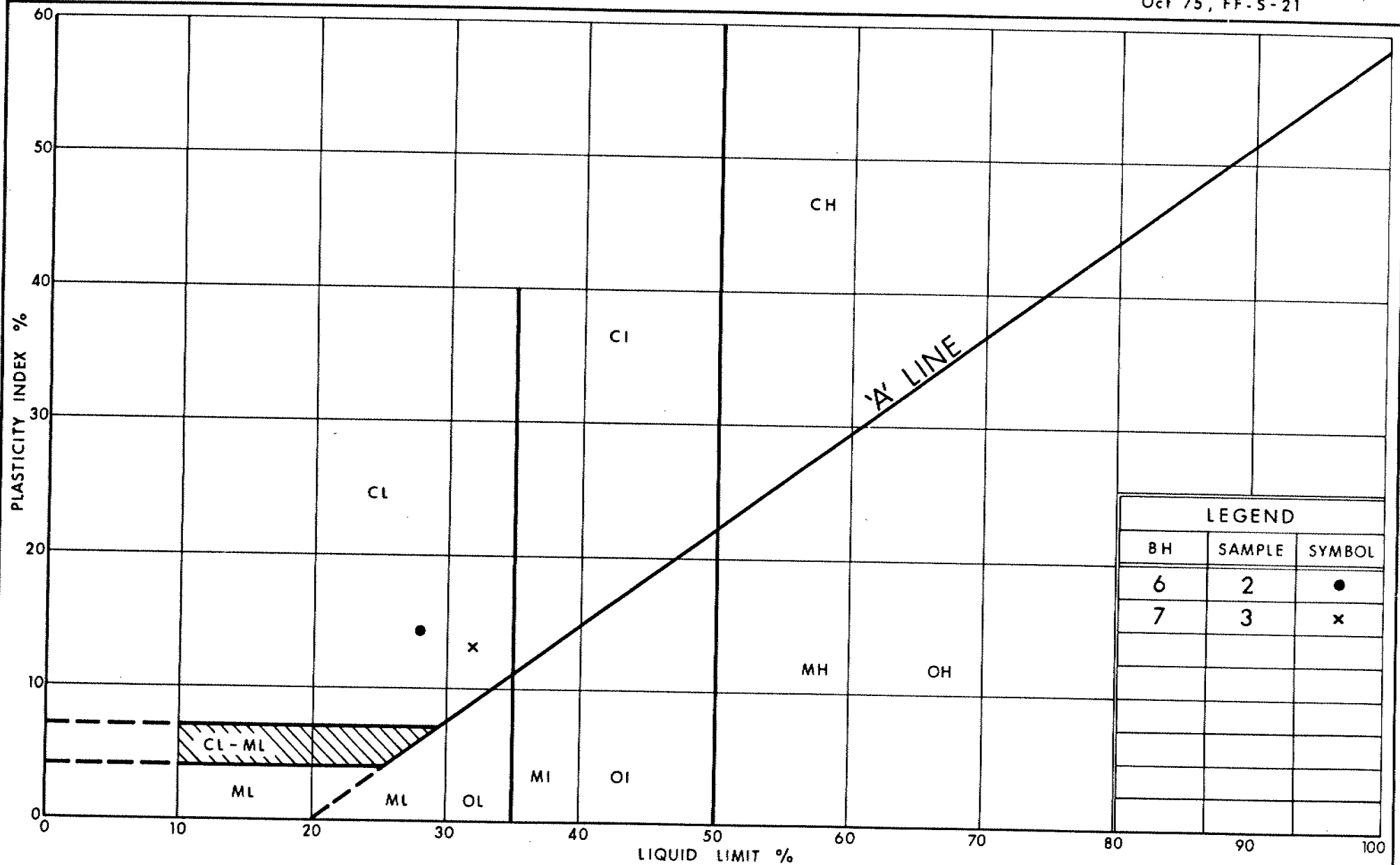


Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION (FILL MATERIAL)

FIG No 1

W P 368-87-01

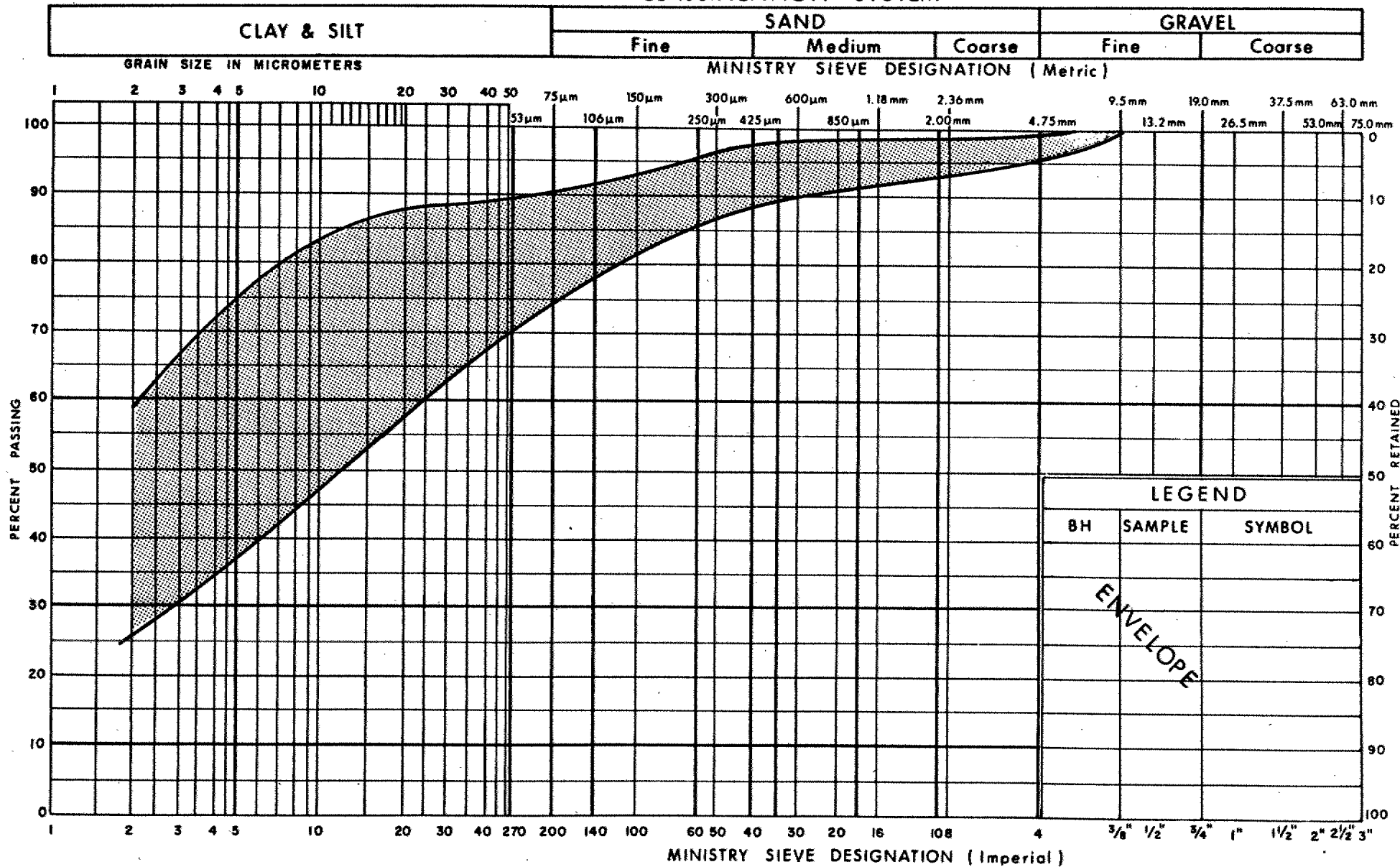
Ministry of  
Transportation

PLASTICITY CHART  
IRREGULAR MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
( FILL MATERIAL )

FIG No 2

W P 368 - 87 - 01

## UNIFIED SOIL CLASSIFICATION SYSTEM

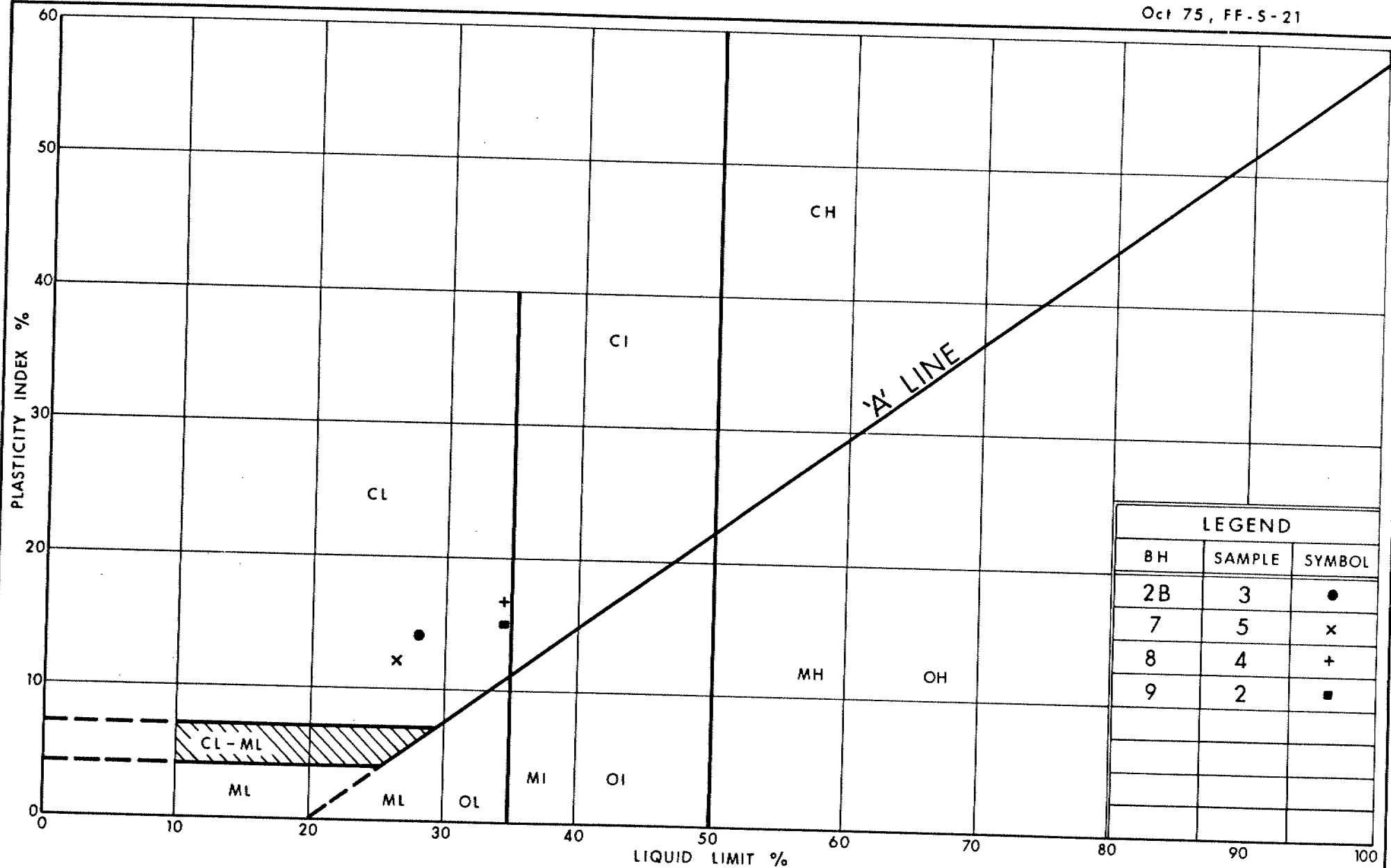


Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 3

W P 368-87-01



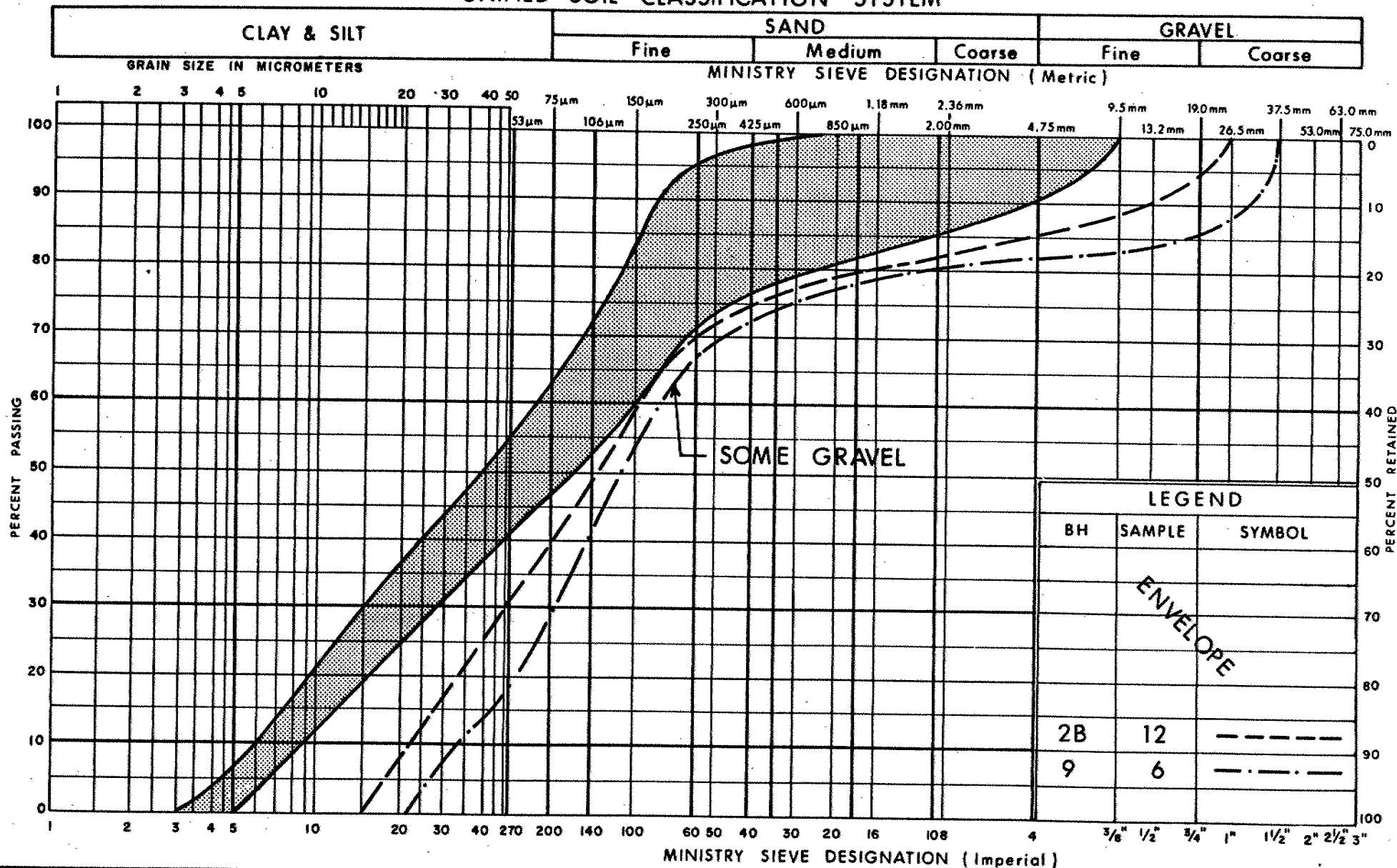
Ministry of  
Transportation  
Ontario

PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(GLACIAL TILL) UPPER

FIG No 4

W P 368-87-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



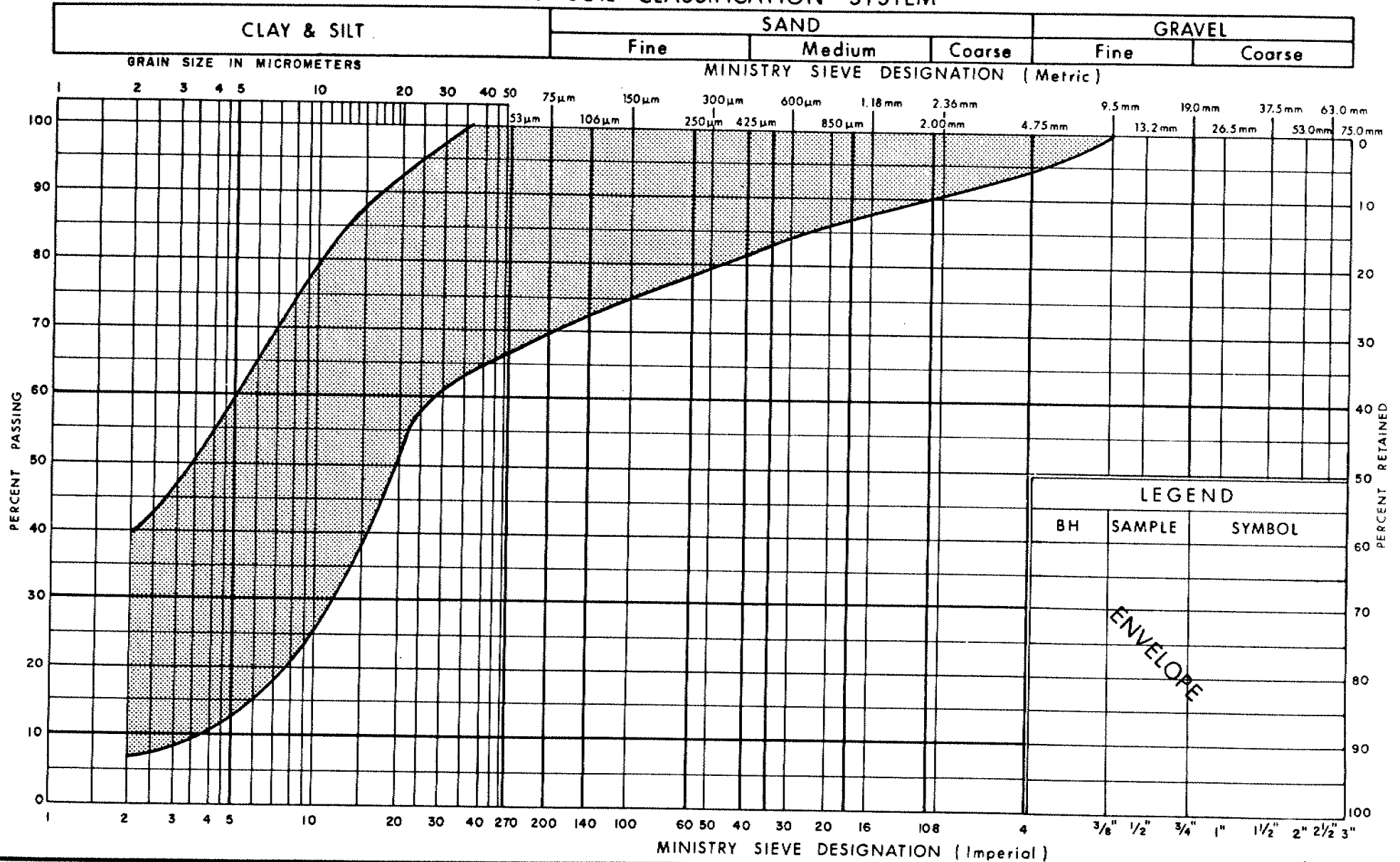
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SANDY SILT TO SILTY SAND

FIG No 5

W P 367-87-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



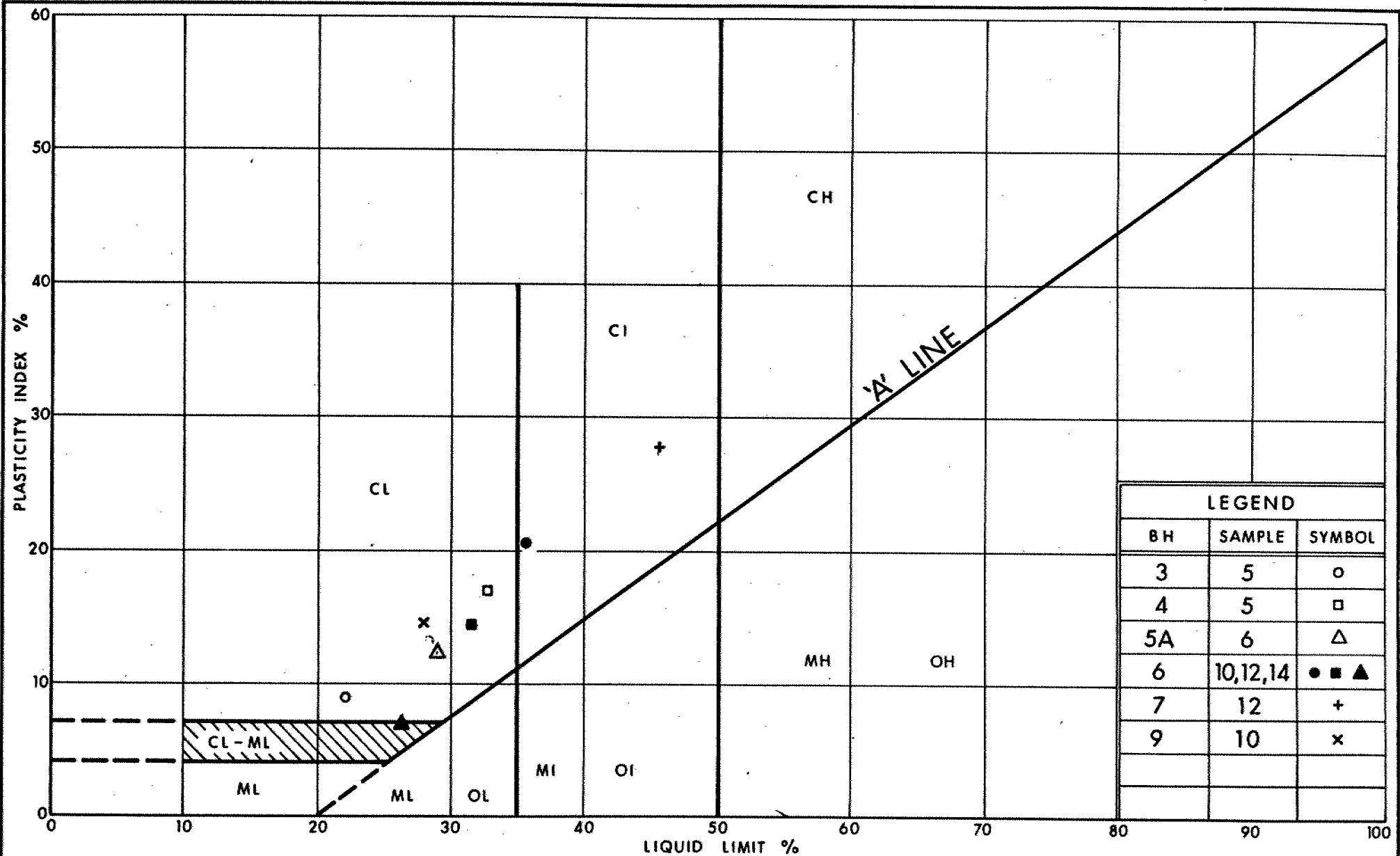
Ontario

Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 6

W P 368-87-01



Ministry of  
Transportation

Ontario

**PLASTICITY CHART**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
**(GLACIAL TILL) LOWER**

FIG No 7

W P 368-87-01

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 368-87-01

LOCATION

Co-ords: N 4 845 854.5 ; E 293 934

ORIGINATED BY MI

DIST 5

HWY 407

BOREHOLE TYPE

HS Auger

COMPILED BY MI

DATUM Geodetic

DATE

90 06 21

CHECKED BY TS

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 kPa										WATER CONTENT (%)		
								20	40	60	80	100						10	20	30
182.1	Ground Surface																			
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)					DRY														
	Brown, Hard		1	SS	54		180													
			2	SS	110															
178.0							178													
4.1			3	SS	100															
			4	SS	88		176													
	Silty Sand																			
	V. Dense		5	SS	88		174													
							172													
							170													
169.5			6	SS	120															
12.6	End of Borehole																			

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 358-87-01 LOCATION Co-ords: N 4 845 858 ; E 293 988 ORIGINATED BY MI  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 21 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>			WATER CONTENT (%) 10 20 30	GR SA SI CL	
181.9	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)		1	SS	21	DRY	180						21.7	5 19 50 26			
	V. Stiff Hard		2	SS	36												0 38 (62)
	Brown		3	SS	56												
179.0			4	SS	110				178								
2.9			5	SS	120												
			6	SS	100												
			7	SS	90				176							0 77 (23)	
			8	SS	82												
	Sandy Silt to Silty Sand		9	SS	72				174								
	V. Dense		10	SS	110				172								
			11	SS	104												
			12	SS	120			/28cm	170							14 46 (40)	
	Brown some gravel Grey																
168.2																	
13.7 167.7	Het. mixt. of Clayey Silt, sand and gravel (Glacial Till)		13	SS	86		168										
14.2	End of Borehole																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 844.5 ; E 294 022.5 ORIGINATED BY MI  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa								
173.2	Ground Surface							20 40 60 80 100								
0.0	Sandy Silt to Silty Sand Trace gravel		1	SS	90		172									
			2	SS	100											
	Brown Grey		3	SS	100	/15cm										10 43 (47)
	V. Dense		4	SS	100	/15cm	170									
169.7			5	SS	120										1.4	4 27 44 25
3.5	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Grey, Hard		6	SS	80		168									
			7	SS	47											
	Clayey Silt (Locustrine)		8	SS	80		166									
			9	SS	69		164									
163.6																
9.6	End of Borehole															

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 365-87-01 LOCATION Co-ords: N 4 845 828 ; E 294 080.5 ORIGINATED BY MM  
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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					
173.8	Ground Surface																
0.0	Sandy Silt to Silty Sand trace gravel		1	SS	49												
			2	SS	74		172										
	Brown Gray		3	SS	28												
	Dense to V. Dense		4	SS	48												
170.1			5	SS	186		170										8 41 (51)
3.7	Clayey Silt (Locustrine)		6	SS	141												0 6 55 39
			7	SS	78		168										
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		8	SS	89		166										
164.2			9	SS	111												
9.6	End of Borehole																

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 798 ; E 294 142 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 21 CHECKED BY TS




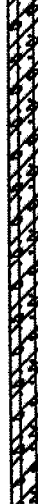
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
174.0																		
0.0	Sandy Silt to Silty Sand  Brown, Dense to V. Dense		1	SS	42													
			2	SS	40													
			3	SS	103												5 44 (51)	
			4	SS	66													
170.3			5	SS	142													
3.7	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Grey, Hard		6	SS	120	/15cm											0 0 66 34	
			7	SS	106													
			8	SS	59													
			9	SS	125													
164.4																		
9.6	End of Borehole																	

RECORD OF BOREHOLE No 6

1 OF 2

METRIC

W.P. 388-87-01 LOCATION Co-ords: N4 845 780.7; E294 167.5 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 20 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100							10 20 30			
178.2	Ground Surface																	
0.0	Irregular mixture of Clayey Silt, sand and gravel (Fill Material)  Brown, V.Stiff to Hard		1	SS	19	..	178							21.7	0 25 45 30			
178.1			2	SS	42													
2.1	Sandy Silt  V.Dense		3	SS	56		176										0 33 (67)	
			4	SS	57													
			5	SS	60		174											
			6	SS	46													
			7	SS	60		172											
			171.0	171.0														
7.2	Silt		8	SS	162			170									0 0 60 40	
9			SS	50														
Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard			10	SS	58			168										
			11	SS	40			166										
163.0			12	SS	46	164									1 18 51 30			

15.2

Continued

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

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

## METRIC

[illegible]

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 748.5 ; E 294 204.5 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 19 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m <sup>3</sup>	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	W <sub>L</sub>		
								SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE 20 40 60 80 100									
179.1	Ground Surface																
0.0	Sandy Silt (Fill Material) Brown, Compact		1	SS	22	DRY	178										
177.7																	
1.4	Irregular mixture of Clayey Silt, sand and gravel (Fill Material)  Brown, Stiff		2	SS	14												
	trace organics		3	SS	13											0 16 45 39	
176.2							176										
2.9	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, V. Stiff to Hard		4	SS	24												
			5	SS	39											3 26 47 24	
174.7																	
4.4			6	SS	100		174										
	Brown		7	SS	103												
	Gray		8	SS	53												
							172										
	Sandy Silt V. Dense		9	SS	136												
							170										
			10	SS	147												
168.9																	
10.2	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		11	SS	89		168										
			12	SS	41												
166.5																	
12.6	End of Borehole																

RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 718.5 ; E 294 231.7 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger, Washboring COMPILED BY MI  
DATUM Geodetic DATE 90 06 19 CHECKED BY TS

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										

181.1	Ground Surface															
0.0	Sandy Silt Brown, V. Loose to Loose (Fill Material)		1	SS	3	DRY	180									2 35 (63)
			2	SS	5		178									
177.0																
4.1	Irregular mixture of Clayey Silt, sand and gravel (Fill Material)		3	SS	15		176									
175.8	Brown, Stiff															
5.3	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, Hard		4	SS	32		174									
173.8																
7.2	Brown ----- Grey  Sandy Silt V. Dense		5	SS	101		172									
			6	SS	120	170										
			7	SS	132											
168.5			8	SS	143											
12.6	End of Borehole															

RECORD OF BOREHOLE No 9

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 676.5 ; E 294 260.5 ORIGINATED BY MI  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 19 CHECKED BY TS

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					
176.0	Ground Surface																
0.0																	
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)		1	SS	27												
	Brown		2	SS	29												
	V. Stiff																
	Hard		3	SS	50												
			4	SS	120												
172.5																	
3.5			5	SS	68												
	some gravel		6	SS	82												
	Sandy Silt to Silty Sand																
	Dense to V. Dense		7	SS	77												
	Brown																
	Gray		8	SS	31												
167.3																	
8.7			9	SS	45												
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)																
	Hard		10	SS	102												
			11	SS	100	/25cm											
162.0																	
			12	SS	100	/15cm											
14.0	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 625.5 ; E 294 281.5 ORIGINATED BY MI  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 20 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
175.1	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown  V. Stiff Hard		1	SS	28												
			2	SS	85												
			3	SS	105												
169.8			4	SS	55												
5.3	Sandy Silt to Silty Sand  V. Dense  Brown Grey		5	SS	53												
			6	SS	50												
165.5																	
9.6	End of Borehole																

FOUNDATION INVESTIGATION REPORT  
For  
Ramp 427S-407W Over Steeles Avenue  
W.P. 368-87-02, Site 37-1336  
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A single span steel box girder structure is proposed to carry the 427S-407W ramp over Steeles Avenue. The report describes the subsurface conditions at the site.

SITE DESCRIPTION AND GEOLOGY

The site is located between the Hwy. 427 overpass structures and the 427 S-407 E ramp structure that carries traffic over Steeles Avenue. Construction of these adjacent structures was in progress at the time of the investigation. The proposed realigned Hwy. 427 is situated approximately mid-distance between the existing Hwy. 50 and Hwy. 27. The southern half of the site is located within the City of Etobicoke whilst the northern half of the site is located within the Town of Vaughan, Regional Municipality of York. The existing Steeles Avenue is presently a 4 lane roadway.

The natural terrain at the site is generally flat but construction of the aforementioned structures has accentuated the flat terrain with approach fill contours. Construction activity also dominated the area immediately north of the site, in conjunction with the construction of the Hwy. 427/407 interchange complex.

Physiographically, the site is located in the geological domain known as the "Peel Plain". The "Peel Plain" is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. At some locations, the till is overlain by thin deposits of varved clay.

Till sheets of varying composition comprise the "Peel Plain". Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristic of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay.

The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 30 m below ground surface and consists of interbedded shale and limestone of the Dundas-Meaford Formation, Ordovician period.

### INVESTIGATION PROCEDURES

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

#### Field Investigation

The fieldwork for the investigation was carried out between 90 06 18 and 90 06 20 and consisted of 4 sampled boreholes advanced to depths ranging from 6.6 m to 12.6 m below the natural ground surface. One of the boreholes (BH 10) was advanced so that information could be obtained to evaluate the stability and settlement of the approach embankments spanning between the north abutment of this structure and the south abutment of the proposed 427S-407N ramp structure (W.P. 368-87-01). The elevation of the ground surface at the borehole locations ranged from 174.7 to 175.1.

Track mounted CME 55 equipment employing hollow stem augering and washboring techniques was used to advance the boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m intervals for the surficial 6 m and 1.5 m intervals thereafter at the structure foundation locations and at 1.5 m intervals throughout at the approaches. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

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

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

### Laboratory Analyses

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

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

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

### SUBSURFACE CONDITIONS

In general, competent and uniform subsurface conditions were encountered across the site. The soil stratigraphy consists of a surficial deposit that contains a heterogeneous mixture of clayey silt, sand and gravel that extends to a maximum depth of 5.6 m. This cohesive deposit has a very stiff to hard consistency.

Underlying the surficial deposit and explored for a maximum thickness of 7.0 m exists a cohesionless deposit that ranges in composition from a silty sand to a gravelly sand. Random interbeds of silt and sand are also present within this deposit.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 3688702-A.\*

\* SHEET NO 114 OF THE CONTRACT DWG'S

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

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

The native surficial deposit at the site consists of heterogeneous mixture of clayey silt, sand and gravel and extends for a depth approximately 5.3 to 5.6 m. Occasional boulders and cobbles as inferred during the field investigation by auger grinding are also present within the deposit. A grain size distribution envelope as determined by mechanical sieve and hydrometer analysis, that illustrates the gradation of this material is provided in Figure 1 in the Appendix. The boulder and cobble sizes are not illustrated on the indicated figure, as the figure illustrates a maximum grain size of 75 mm.

The deposit has experienced varying degrees of oxidation and hence varies in colour with depth from a mottled brown and grey to grey.

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

Table 1 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	9-16	4
Liquid Limit (w <sub>L</sub> %)	21-33	4
Plasticity Index (I <sub>p</sub> %)	7-17	4
Unit Weight (kN/m <sup>3</sup> )	21.5-22.1	2

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

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 12 blows/0.3 m to 100 blows/0.15 m. Based on these 'N' values, the material can be described as having a very stiff to hard consistency, but generally is of hard consistency.

### Silty Sand to Gravelly Sand

The surficial cohesive deposit is underlain by a granular stratum ranging from a sandy silt to silty sand with random interbedded silt/sand layers to a gravelly sand. Grain size distribution curves as determined by mechanical sieve analysis illustrate the range in gradation of the deposit (<75 mm) and are shown on Figure 3 in the Appendix. The thickness of the stratum was not determined during the investigation, but based on information obtained from this investigation, this stratum has a minimum thickness of 7.0 m.

Interpretation of Standard Penetration Test 'N' values ranging from 18 blows/0.3 m to 121 blows/0.25 m, indicates a denseness ranging from compact to very dense. In general, the deposit can be categorized as dense to very dense.

### Groundwater Conditions

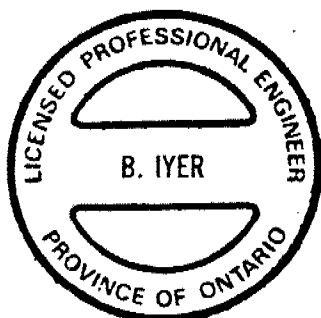
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation ranged from 2.4 to 4.4 m below the ground surface (El. 172.4 to 170.6 m). The rapid rise in the water level in the borehole at the time of the investigation upon penetration of the lower silty sand to gravelly sand stratum, reflects the subartesian water condition in the lower cohesionless stratum.

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

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano and M. Michalek, Foundation Engineers, and M. Iampietro, Engineering Student, utilizing equipment owned and operated by Malone's Soil Samples Ltd. and Master Soils Investigation.

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



A handwritten signature in cursive script, appearing to read "B. Iyer".

B. Iyer, P. Eng.  
Senior Foundation Engineer

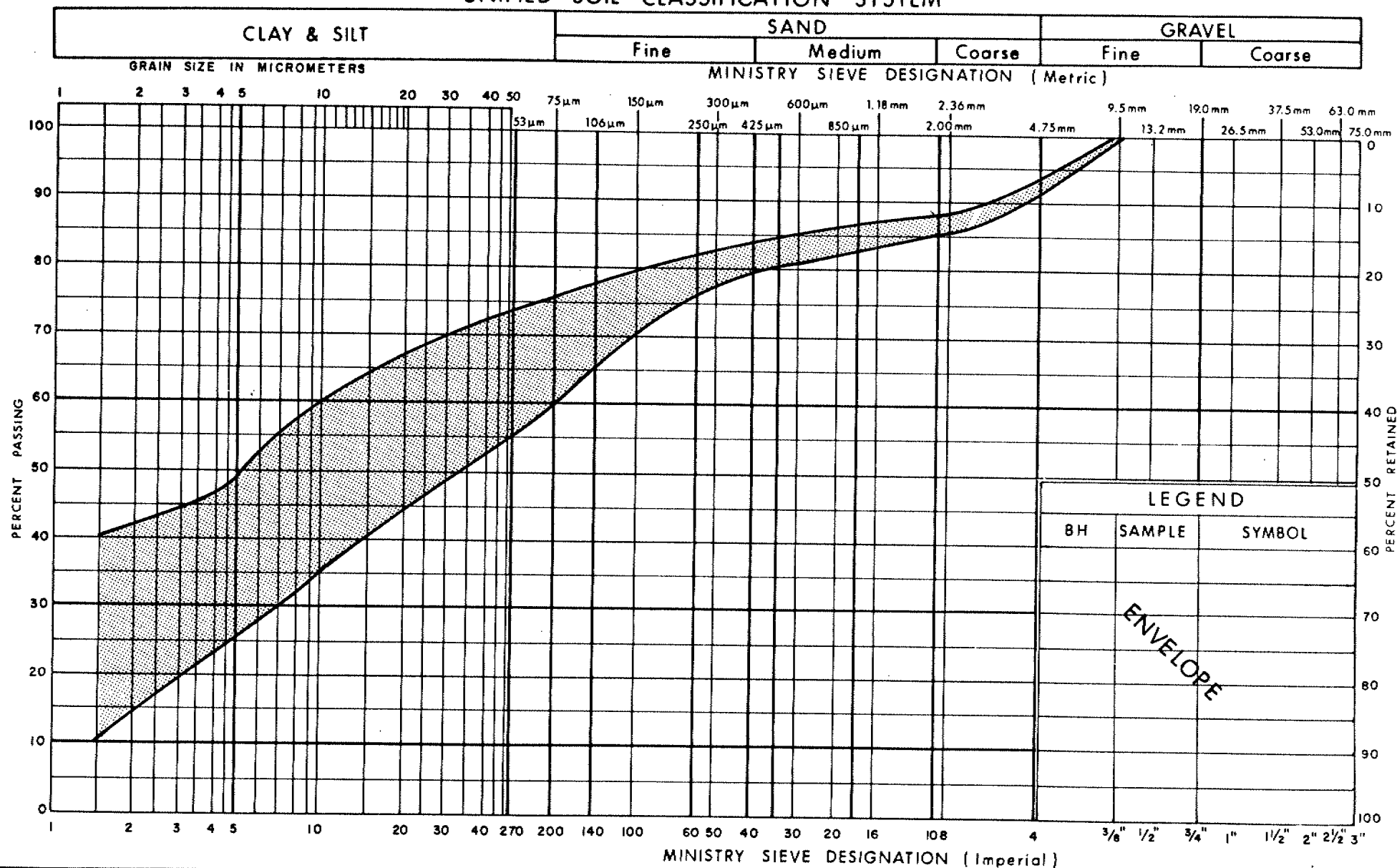


A handwritten signature in cursive script, appearing to read "M.S. Devata".

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

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM

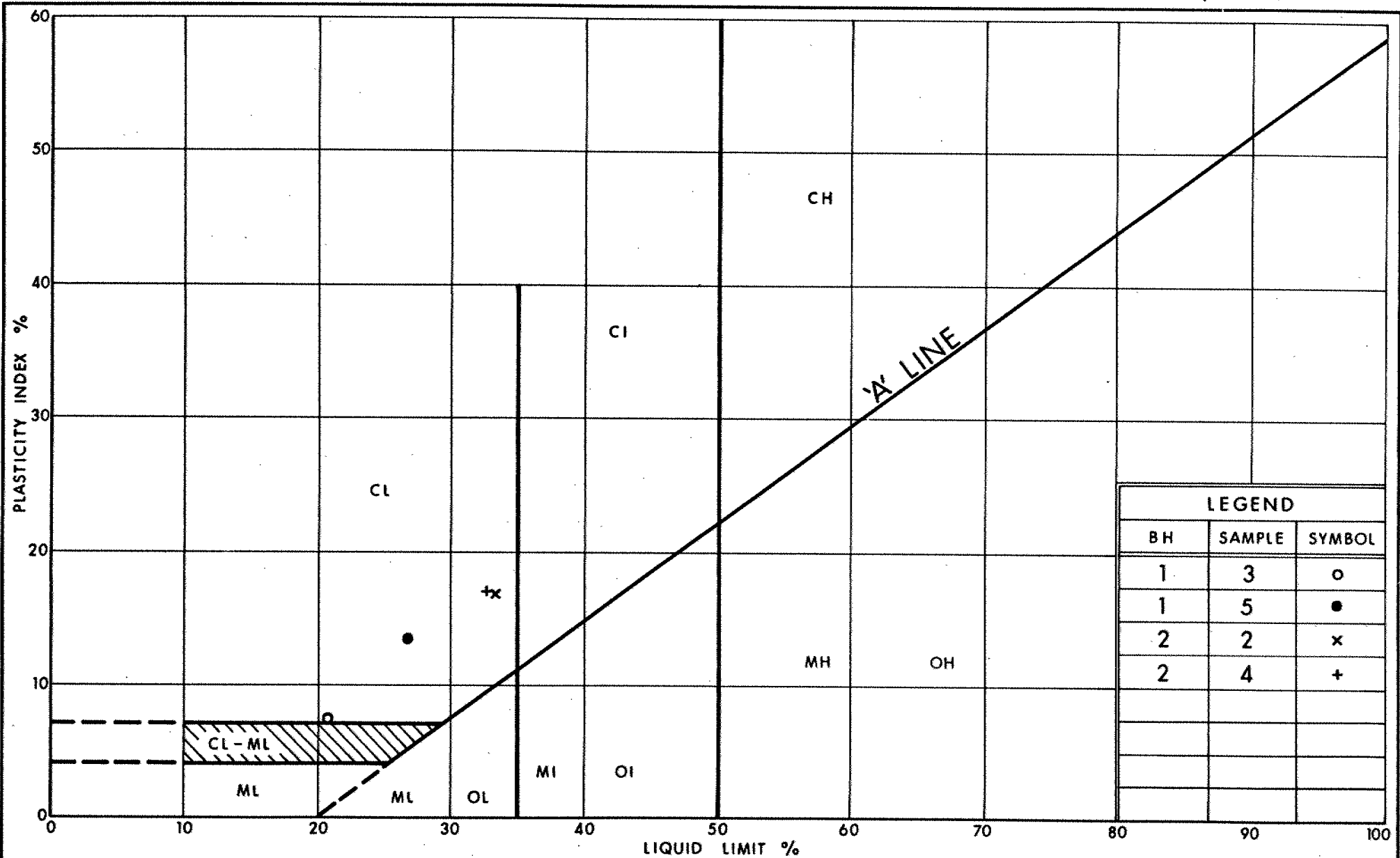


Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 1

W P 368-87-02



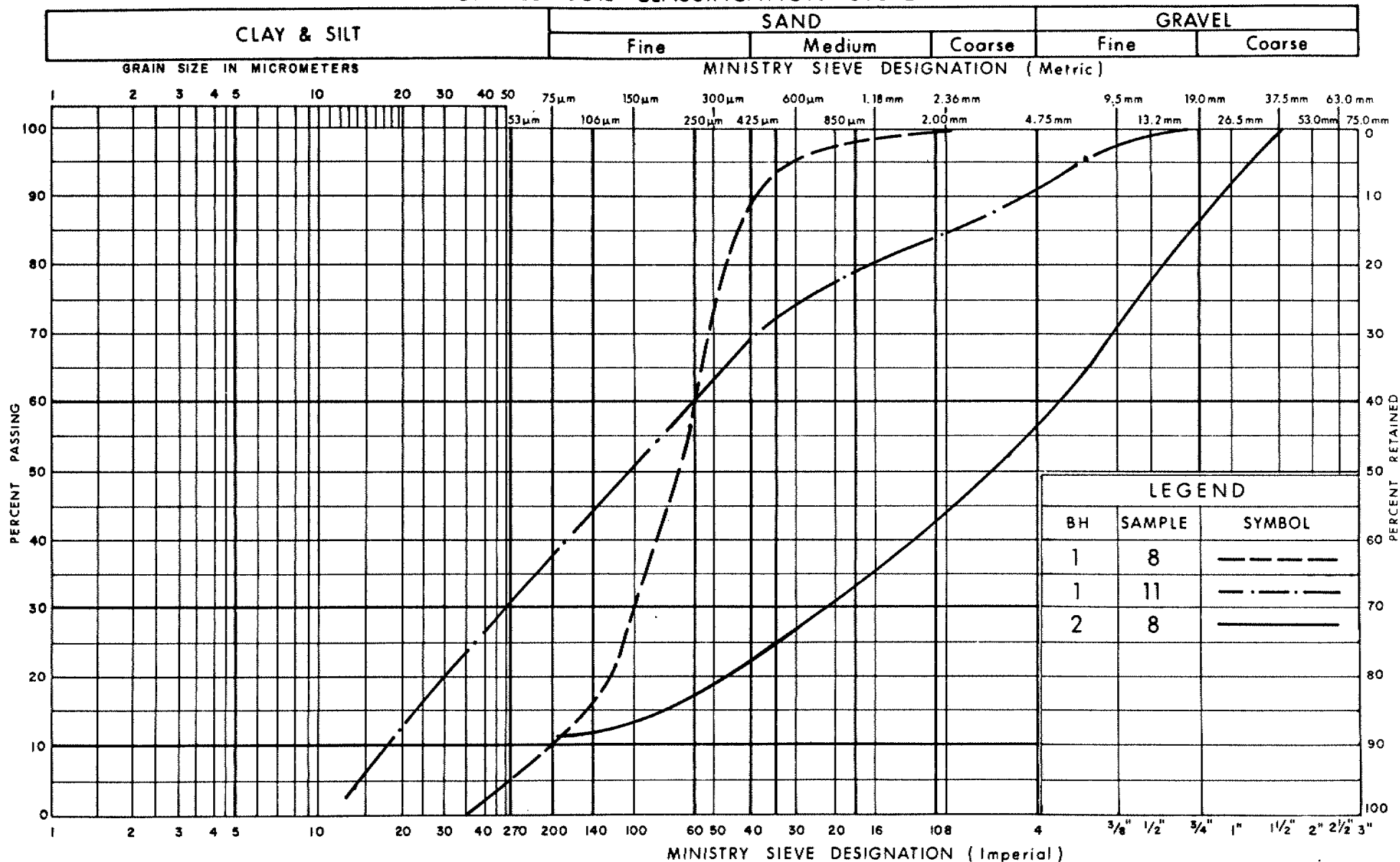
Ministry of  
Transportation

PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(GLACIAL TILL) UPPER

FIG No 2

W P 368-87-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION  
SILTY SAND TO SAND**

FIG No 3

W P 368-87-02



Ministry of  
Transportation  
Ontario

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 388-87-02 LOCATION Co-ords: N4 845 572; E294 307 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM GEODETIC DATE 90 05 18 CHECKED BY TS

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					
174.8	Ground Surface																
0.0			1	SS	41												
			2	SS	19												
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) V. Stiff to Hard		3	SS	25		172									22.1	7 32 48 13
			4	SS	37												
	Brown Grey		5	SS	58											21.5	8 26 36 30
			6	SS	63		170										
169.2			7	SS	39												
5.6			8	SS	32		168										
	sand		9	SS	28												
			10	SS	18		166										
	Silty Sand to Sand, with random interbeds of silt Grey, Compact to Dense		11	SS	48		164										
	trace gravel																
162.2																	10 52 (38)
12.6	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 368-87-02 LOCATION Co-ords: N4 845 536.5 ; E 294 302 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM GEODETIC DATE 90 06 18 CHECKED BY TS

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
175.0	Ground Surface																			
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) V. Stiff to Hard  Brown ----- Grey		1	SS	12															
			2	SS	30													8 19 31 42		
			3	SS	47															
			4	SS	38													8 15 43 34		
			5	SS	169															
			6	SS	120															
169.5																				
5.5	Silty Sand to Grovelly Sand Grey, V. Dense		7	SS	87												16 75 (9)			
			8	SS	107													44 44 (12)		
165.4			9	SS	121															
9.6	End of Borehole																			

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 368-87-02 LOCATION Co-ords: N4 845 489.3 E 294 318.5 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM GEOIDETIC DATE 90 06 19 CHECKED BY TS

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 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
174.7	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, Hard		1	SS	37												
			2	SS	88		172										
			3	SS	100	/15cm	170										
168.2																	
5.5	Gravelly Sand, Brown, V. Dense																
168.1			4	SS	118												
6.6	End of Borehole																

RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 625.5 ; E 294 281.5 ORIGINATED BY MI  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 20 CHECKED BY TS

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 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
175.1	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown  V. Stiff Hard		1	SS	28		174										
			2	SS	85		172										
			3	SS	105		170										
169.8																	
5.3	Sandy Silt to Silty Sand  V. Dense  Brown Grey		4	SS	55		168										
			5	SS	53												
			6	SS	50		166										
165.5																	
9.6	End of Borehole																

FOUNDATION INVESTIGATION REPORT  
For  
Ramp 407W-427S Over Steeles Avenue  
W.P. 368-87-03, Site 37-1337  
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A single span steel girder structure is proposed to carry the 407W-427S ramp over Steeles Avenue. The report describes the subsurface conditions at the site.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately west and adjacent to the 407E-427S ramp structure that carries traffic over Steeles Avenue. The 407E-427S ramp ascends in elevation north of Steeles Avenue and contains a multi-span structure immediately north of the site in conjunction with the Hwy. 427/407 interchange complex. Both the aforementioned structures and many other structures associated with the interchange complex were under construction at the time of investigation. The site is located approximately 300 m east of the existing Albion Road/Hwy. 50/Steeles Avenue intersection. The southern half of the site is located within the City of Etobicoke whilst the northern half of the site is located within the Town of Vaughan, Regional Municipality of York. The existing Steeles Avenue is presently a 4 lane roadway.

The natural terrain at the site is generally flat but construction of the aforementioned structures has accentuated the flat terrain with approach fill contours.

Physiographically, the site is located in the geological domain known as the "Peel Plain". The "Peel Plain" is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. At some locations, the till is overlain by thin deposits of varved clay.

Till sheets of varying composition comprise the "Peel Plain". Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristic of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay.

The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 30 m below ground surface and consists of interbedded shale and limestone of the Dundas-Meaford Formation, Ordovician period.

### INVESTIGATION PROCEDURES

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

#### Field Investigation

The fieldwork for the investigation was carried out on 90 06 18 and consisted of three (3) sampled boreholes advanced to depths ranging from 9.6 m to 12.6 m below the natural ground surface. Two additional boreholes advanced in conjunction with Ramp 407E-427S over Steeles Ave. have also been included in this report. The boreholes identified as BH 4 and 5 (formerly 1 and 3 respectively) were advanced between 82 06 28 and 82 07 01 to depths of 15.2 to 15.3 m respectively. Dynamic Cone Penetration tests advanced to depths of 2.6 m and 2.5 m respectively accompanied these boreholes.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the three (3) current boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m intervals for the surficial 6 m and 1.5 m thereafter. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

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

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

### Laboratory Analyses

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

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

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

### SUBSURFACE CONDITIONS

In general, reasonably competent and uniform subsurface conditions were encountered across the site. The soil stratigraphy consists of a surficial deposit that contains a heterogeneous mixture of clayey silt, sand and gravel that extends to a maximum depth of 3.7 m. This cohesive deposit has a very stiff to hard consistency.

Underlying the surficial deposit and explored for a maximum thickness of 9.9 m exists a cohesionless deposit consisting of a sandy silt to silty sand with interbedded silt layers to a gravelly sand that also contains occasional boulders and cobbles. This deposit is generally in a dense to very dense state of denseness.

A second lower glacial till consisting of a heterogeneous mixture of clayey silt, sand and gravel underlies the cohesionless deposit. The extent of the deposit was not determined during the investigation. The deposit has a hard consistency.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 3688703-A.\*

\* SHEET NO 137 OF THE CONTRACT DWG'S

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

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

The native surficial deposit at the site consists of a heterogeneous mixture of clayey silt, sand and gravel and extends for depths ranging from 2.6 m to 3.7 m. Occasional boulders and cobbles as inferred during the field investigation from auger grinding are also present within the deposit. A grain size distribution envelope, as determined by mechanical sieve and hydrometer analysis, that illustrates the gradation of this material is provided in Figure 1 in the Appendix. The boulder and cobble sizes are not illustrated on the indicated figure.

The deposit has been oxidized and hence is brown in colour.

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

Table 1 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	12-16	3
Liquid Limit (w <sub>L</sub> %)	17-33	3
Plasticity Index (I <sub>p</sub> %)	7-17	3
Unit Weight (kN/m <sup>3</sup> )	20.4-22.6	2

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

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 12 blows/0.3 m to 107 blows/0.3 m. Based on these 'N' values, the material can be described as having a stiff to hard consistency.

### Sandy Silt/Silty Sand to Gravelly Sand

The surficial cohesive deposit is underlain by a granular stratum ranging from a sandy silt to silty sand with interbedded silt layers in the upper portion to a gravelly sand with occasional cobbles and boulders. A grain size distribution envelope as determined by mechanical sieve analysis, that illustrates the finer gradation of the deposit ( $<75$  mm) is shown on Figure 3 in the Appendix. The thickness of the stratum encountered ranges from 9.1 m to 9.9 m.

Interpretation of Standard Penetration Test 'N' values ranging from 18 blows/0.3 m to 120 blows/0.15 m, indicates a denseness ranging from compact to very dense. In general, however, the deposit can be categorized as dense to very dense.

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

Underlying the granular deposit and explored for a maximum thickness of 2.5 m a second lower till deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel exists. Although not encountered during the investigation, boulders and cobbles are characteristic components of these deposits and hence can exist in the deposit.

'N' values determined by the Standard Penetration Test were consistently in excess of 100 blows/0.3 m indicating a hard soil consistency.

### Groundwater Conditions

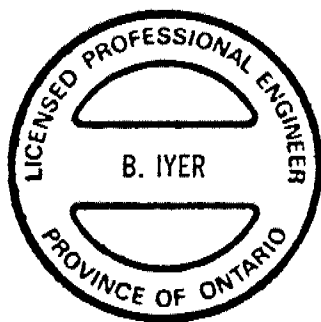
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation were approximately 6 m below the ground surface (El. 170 to 170.5 m). Soil cave-in was witnessed in the boreholes upon penetration of the cohesionless material below the prevailing groundwater due to unbalanced hydrostatic head.

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

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano and M. Michalek, Foundation Engineers, and M. Iampietro, Engineering Student, utilizing equipment owned and operated by Malone's Soil Samples Ltd. and Master Soils Investigation.

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



A handwritten signature in cursive script, appearing to read "B. Iyer", with a horizontal line drawn underneath it.

B. Iyer, P. Eng.  
Senior Foundation Engineer

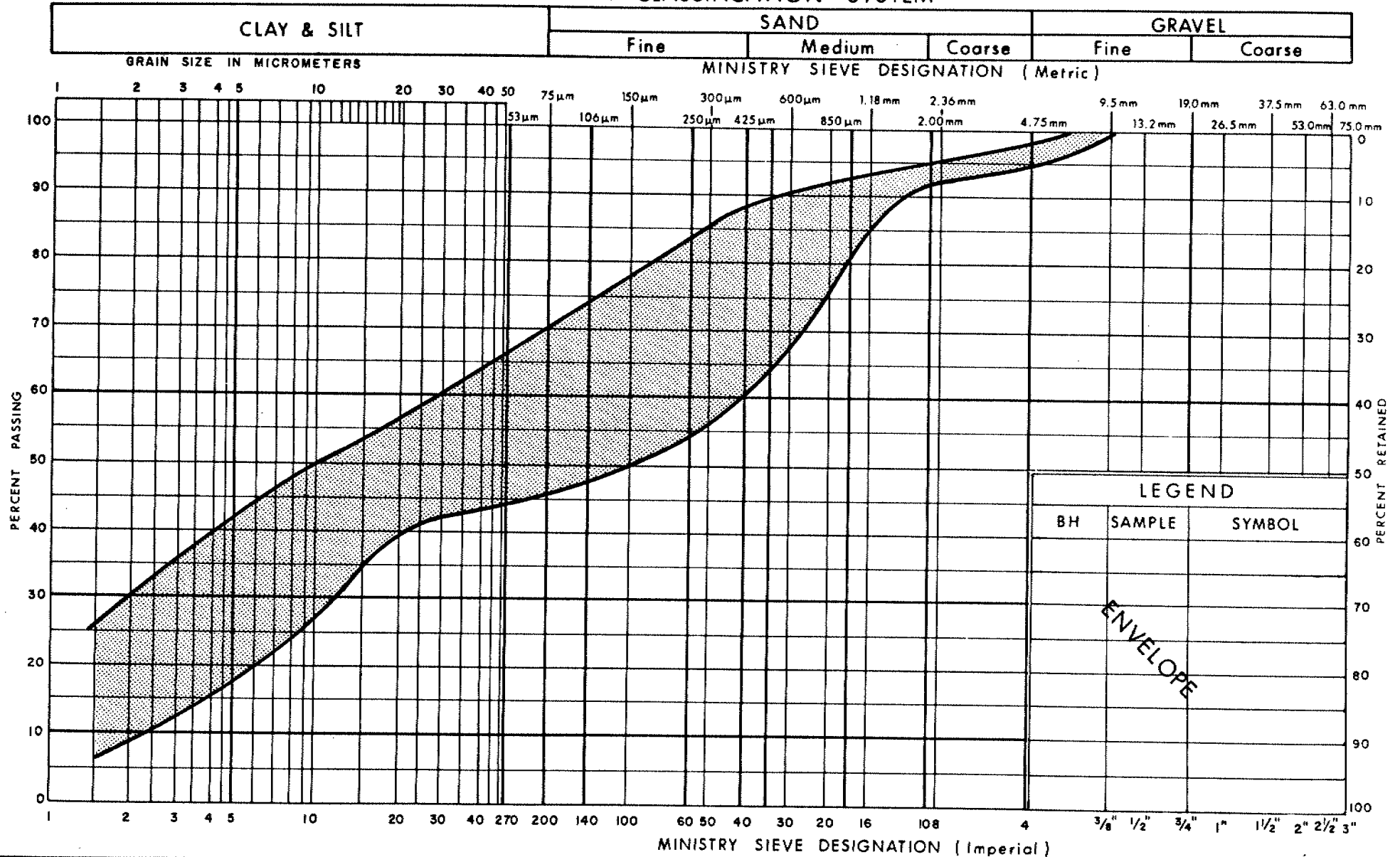


A handwritten signature in cursive script, appearing to read "M.S. Devata".

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

**APPENDIX**

## UNIFIED SOIL CLASSIFICATION SYSTEM

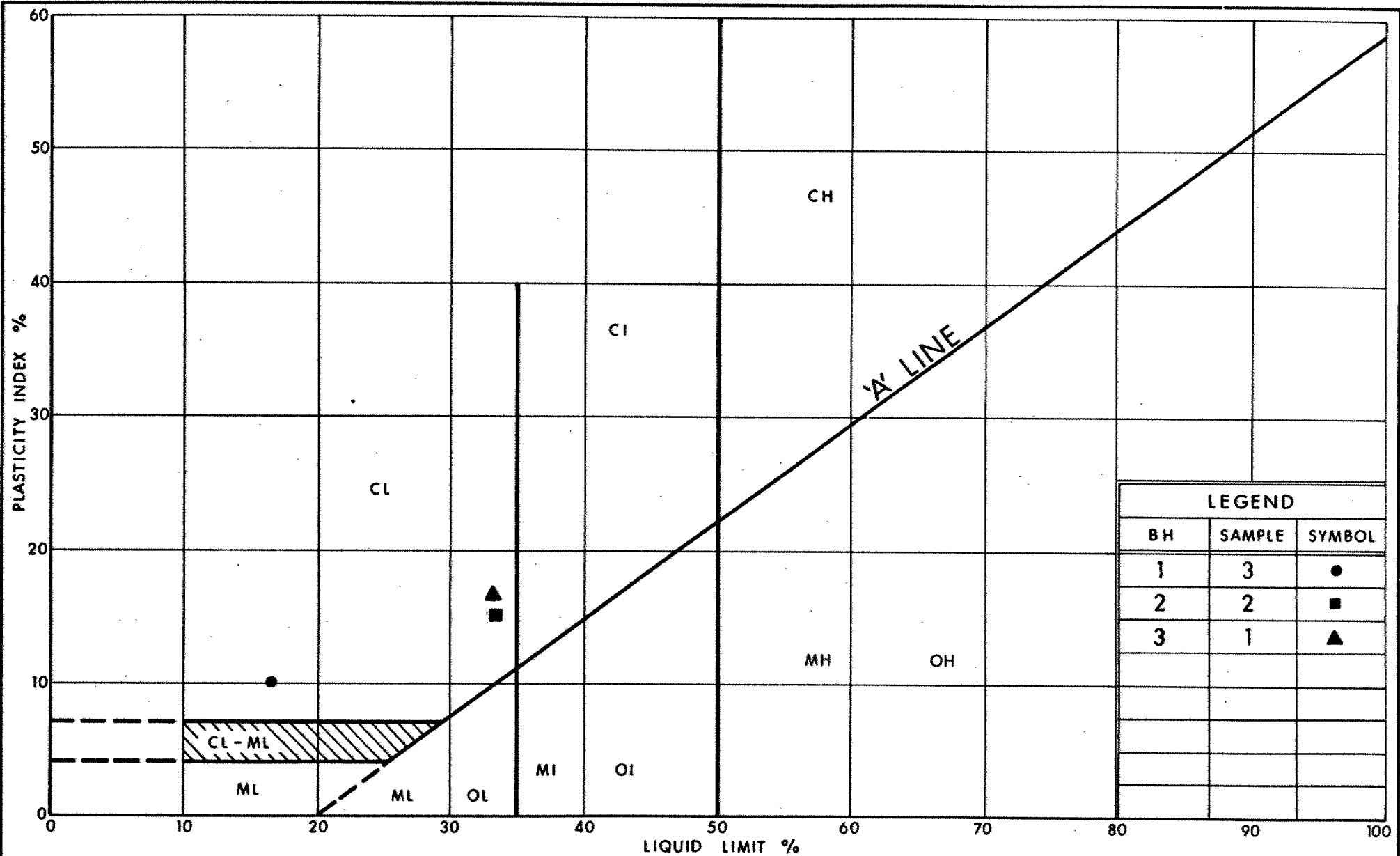


Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) (UPPER)

FIG No 1

W P 368-87-03



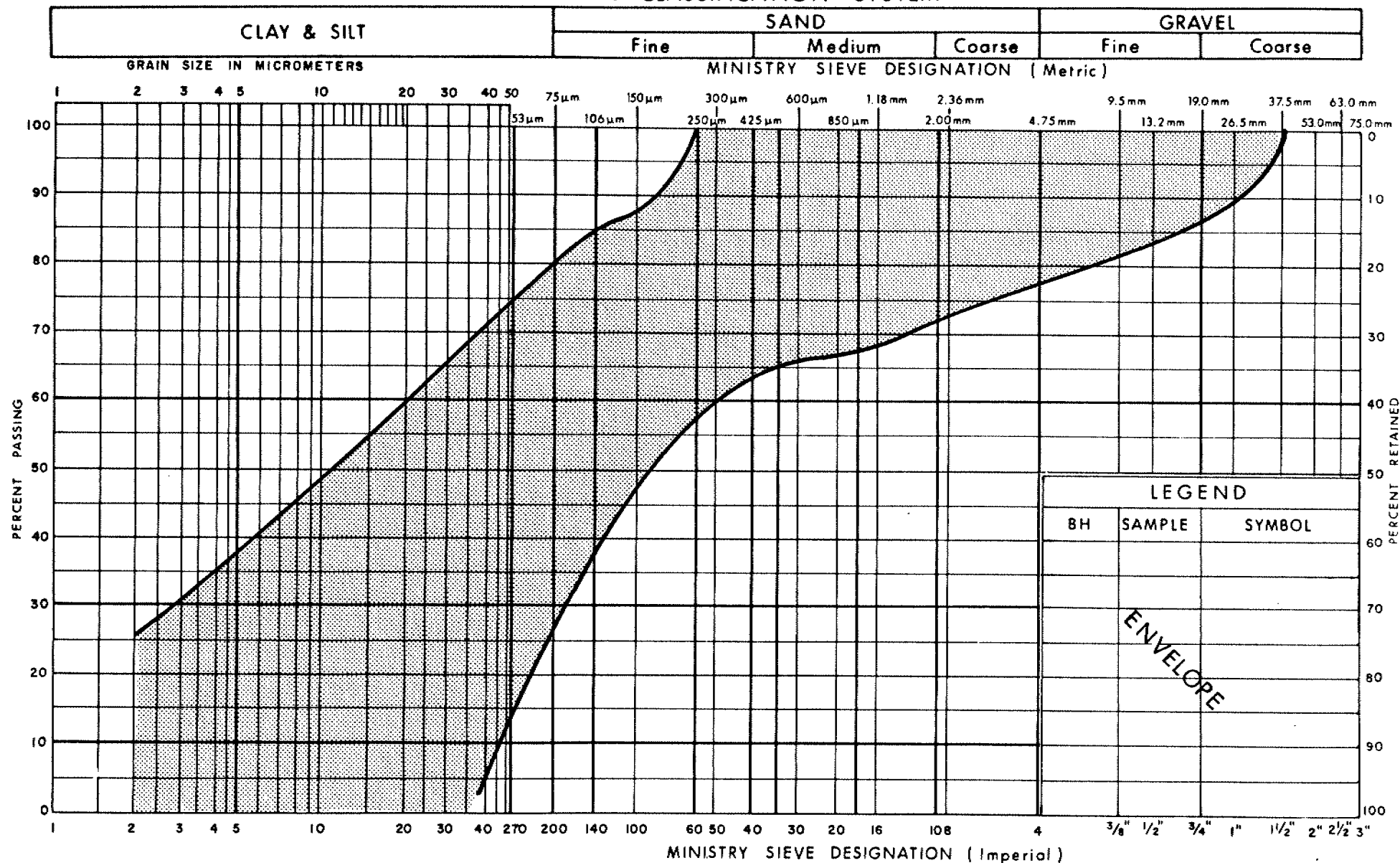
Ministry of  
Transportation

PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(GLACIAL TILL)

FIG No 2

W P 368-87-03

## UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

### SANDY SILT / SILTY SAND TO GRAVELLY SAND

FIG No 3

W P 368-87-03

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 368-87-03 LOCATION Co-ords: N4 845 510 ; E 284 074 ORIGINATED BY MM  
DIST 5 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM CEODETIC DATE 90 06 18 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										
								SHEAR STRENGTH kPo										
								• UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE										
							20 40 60 80 100					WATER CONTENT (%) 10 20 30						
176.3	Ground Surface																	
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, V. Stiff to Hard		1	SS	22													
			2	SS	26													
			3	SS	31													
173.4							174								22.6	2 36 53 9		
2.9	Sandy Silt to Silty Sand Dense to V. Dense		4	SS	55												2 28 65 5	
			5	SS	60													
			6	SS	52													
			7	SS	42				172									
			8	SS	18													
			9	SS	41													
			10	SS	66		170											

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 388-87-03 LOCATION Co-ords: N4 845 479.5 ; 294 086 ORIGINATED BY MM  
DIST 5 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM GEODETIC DATE 90 06 18 CHECKED BY TS

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
176.0	Ground Surface																	
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown, Stiff to Hard		1	SS	12										20.4	2 53 22 23		
			2	SS	30													
			3	SS	13													
173.1			4	SS	24													
2.9	Compact		5	SS	93													
			6	SS	85											1 18 (81)		
			7	SS	84													
	Silty Sand to Gravelly Sand V. Dense		8	SS	80													
			9	SS	30													
	Brown Grey		10	SS	86											22 50 (28)		
			11	SS	110	/15cm												
163.7																		
12.3	End of Borehole																	
	* Cove-in at 7.6 m depth																	

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 368-87-03 LOCATION Co-ords: N4 845 544.5 : E 294 047.5 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger/Washboring COMPILED BY TS  
DATUM GEODETIC DATE 90 06 18 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
176.4	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, Stiff		1	SS	14												5 23 43 29
173.8							174										
2.6			2	SS	30												
	Sandy Silt to Silty Sand Dense to V. Dense						172										
			3	SS	63												
	Brown Grey		4	SS	47		170										
			5	SS	49												
							168										
166.8			6	SS	38												
9.6	End of Borehole																

# RECORD OF BOREHOLE No 4 (1) 1 OF 1 METRIC

W.P. 358-87-03 (88-78-24) LOCATION Co-ords: N 4 845 511.7 ; E 294 097.8 ORIGINATED BY DW  
 DIST 6 HWY 407 BOREHOLE TYPE SS Auger & Cone Test COMPILED BY DW  
 DATUM Geodetic DATE 82 06 28 CHECKED BY JP

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
176.3	Ground Surface													
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, V. Stiff to Hard		1	SS	28									1 25 38 36
			2	SS	17									2 22 61 15
			3	SS	68									4 65 26 5
			4	SS	97	/25cm								
172.6			5	SS	80	/15cm								
3.7			6	SS	56	/15cm								
	Silty Sand with interbedded silt layers		7	SS	96									0 26 72 2
	to		8	SS	35									0 54 44 2
	Brown Grey		9	SS	67									
	Gravelly sand with occ. boulders and cobbles		10	SS	-									36 62 (2)
	Dense to V. Dense		11	SS	90	/13cm								
163.5			12	SS	105	/15cm								
12.8	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Grey, Hard		13	AS	-									
161.1														

15.2 End of Borehole

\* Note: Borehole caved in at a  
depth of 6.7m.

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 5 (3) 1 OF 2 METRIC

W.P. 368-87-03 (88-78-24) LOCATION Co-ords: N 4 845 481 ; E 294 111.6 ORIGINATED BY DW  
 DIST 6 HWY 407 BOREHOLE TYPE SS Auger & Cone Test COMPILED BY DW  
 DATUM Geodetic DATE 82 07 01 CHECKED BY JP

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
175.9	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown, V. Stiff to Hard		1	SS	28	•	174	100/25cm				4 18 30 48		
			2	SS	27									
			3	SS	107									
173.0														
2.9	Clayey Silt Layers  -----  Brown Grey -----  Silty Sand with interbedded silt layers  to  Gravelly Sand with occ. boulders and cobbles  Compact to V. Dense		4	SS	60	/13cm	172				22 38 33 7			
			5	SS	85	/20cm								
			6	SS	111	/20cm								
			7	SS	84	/38cm								
			8	SS	44									
			9	SS	16									

15.3

Continued

+3, x5, Numbers refer to  
Sensitivity

20  
15-5 (x) STRAIN AT FAILURE  
10

Continued

RECORD OF BOREHOLE No 5 (3) 2 OF 2 METRIC

W.P. 368-87-03 (88-78-24) LOCATION Co-ords: N 4 845 481 ; E 294 111.6 ORIGINATED BY DW  
DIST 6 HWY 407 BOREHOLE TYPE SS Auger & Cone Test COMPILED BY DW  
DATUM Geodetic DATE 82 07 01 CHECKED BY JP

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20					
180.6	Continued												
15.3	End of Borehole * Water Table not established												

FILE COPY



Ministry  
of  
Transportation

---

## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 368-87-01 DIST 6  
HWY 427S-407W STR SITE 37-1335  
Ramp 427S-407W Over Hwys. 427 and 407

*CONT 93-93*

DISTRIBUTION

V.F. Boehnke (3)  
G. Cautillo  
J. Cullen (2)  
A. Wittenberg  
K.G. Bassi  
S.J. Dunham  
E.A. Joseph  
B. Steeves (Cover Only)  
I. Bullen (Cover Only)  
File ✓

FOUNDATION INVESTIGATION REPORT  
For  
Ramp 427S-407W over Hwys. 427 and 407  
W.P. 368-87-01, Site 37-1335  
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A multi-span (7 span) structure is proposed to carry traffic from Hwy. 427S to Hwy. 407W. The report describes the subsurface conditions at the site and provides detailed recommendations pertaining to the structure foundations and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located at the proposed Hwy. 427/Hwy. 407 interchange in the Town of Vaughan, Regional Municipality of York. The site is located in a quadrant of land bounded by the existing Hwy. 50 and Hwy. 27 to the west and east respectively and Steeles Avenue and Hwy. 7 to the south and north respectively.

At the time of the investigation, the site area had become a construction site as progress continued on the construction of the Hwy. 427/Hwy. 407 interchange complex. Consequently, construction personnel, equipment and materials dominated the site area. Projects under construction at the time of the investigation included Ramp 407E-427S (W.P. 88-78-25), Hwy. 427 over Hwy. 407 structures (W.P. 150-87-01&02) and Hwy. 427 over Ramp N-407E (W.P. 153-80-05). In addition, an excavation cut for the future Hwy. 407 had been advanced in the area immediately west of the proposed Hwy. 427 for an approximate distance of 300 m.

Physiographically, the site is located in the geological domain known as the Peel Plain. The Peel Plain is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. At some locations, the till is overlain by thin deposits of varved clay.

Till sheets of varying composition comprise the Peel Plain. Generally, the surficial till sheets exhibit a cohesive behaviour whilst the lower till sheets are cohesionless. As characteristic of till material, these deposits contain a wide range of grain sizes ranging from boulders to clay.

The till sheets are usually separated from one another by interbeds of stratified silt or sand of variable thickness. Bedrock in the area has been found at depths ranging from 25 to 30 m below ground surface and consists of interbedded shale and limestone of the Dundas-Meaford Formation, Ordovician Period.

### INVESTIGATION PROCEDURE

#### Field Investigation

The fieldwork for the investigation was carried out between 90 06 19 and 90 06 21 and consisted of ten (10) sampled boreholes advanced to depths ranging 9.6 m to 20 m below the natural ground surface. Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m intervals for the surficial 6 m and 1.5 m intervals thereafter. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

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

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

### Laboratory Analyses

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

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

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

### SUBSURFACE CONDITIONS

#### General

The elevation of the ground surface at the borehole locations ranged from 173.2 m to 182.1 m illustrating that the site is contoured with a combination of excavation cuts and high fills in conjunction with the Hwy. 427/Hwy. 407 interchange complex. In general, the subsoil stratigraphy at the site consists of a thin surficial veneer of a heterogeneous mixture of clayey silt, sand and gravel. This deposit is of glacial origin and exhibits a cohesive behaviour. The thickness of this deposit varies across the site ranging between 1.5 m and 5.5 m. The surface of the deposit ranges from El. 174.5 m to 176 m along the southerly portion of the site (BH's 6 to 10 inclusive) and from 181.9 m to 182.1 m at the proposed north abutment and approach area. The deposit has a very stiff to hard consistency.

At locations across the site, the above mentioned deposit of glacial origin has either been stripped in conjunction with excavation cuts advanced in the area and hence does not exist or is overlain by fill material. The fill material encountered during the subsurface investigation generally consists of a cohesionless sandy silt overlying a cohesive irregular mixture of clayey silt,

sand and gravel. The fill material has been placed for the construction of the Hwy. 427 NB & SB embankments. The ground surface elevation at the time of the investigation at the locations of the fill material varied between 178.2 m to 181.1 m. The thickness of the cohesionless fill ranged up to 4.1 m. The thickness of the underlying cohesive fill ranges from 1.2 m to 2.1 m. The denseness of the cohesionless fill ranges from very loose to compact whilst the cohesive fill has a consistency ranging from stiff to hard.

Underlying the cohesive heterogeneous mixture of clayey silt, sand and gravel deposit and existing surficially within the Hwy. 407 right-of-way (see BH's 3 to 5 inclusive) a cohesionless deposit ranging in gradation from a sandy silt to a silty sand is present. The deposit ranges in thickness from 3.5 m to 10.8 m and extends to an elevation ranging from 171.0 m to 167.3 m. The deposit typically has a dense to very dense state of denseness.

The cohesionless sandy silt to silty sand deposit is underlain by a second glacial sheet consisting of a heterogeneous mixture of clayey silt, sand and gravel. The extent of this deposit was not determined during the investigation. The deposit has a hard consistency.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 3688701-A.

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

#### Sandy Silt (Fill Material)

A cohesionless fill material composed of sandy silt constitutes the upper portions of the existing Hwy. 427 embankments that were under construction at the time of investigation. The thickness of this material is in the order of 1.4 m to 4.1 m and the ground surface elevation of this fill is at 179.1 m to 181.1 m. A grain size distribution curve for this fill material as determined by mechanical sieve analysis is illustrated in Figure 1 in the Appendix.

The sandy silt is brown in colour and based on 'N' values obtained from the Standard Penetration Test ranging from 3 blows/0.3 m to 22 blows/0.3 m, the fill has a state of denseness ranging from very loose to compact.

#### Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)

The cohesionless fill material is directly underlain by a cohesive fill material composed of an irregular mixture of clayey silt, sand and gravel. At BH 6, a proposed pier location situated at the toe of the Hwy. 427 embankment, the cohesive fill extends from the ground surface and hence is not overlain by the cohesionless fill material discussed above. The thickness of this fill material varies from 1.2 m to 2.4 m extending to an elevation ranging from 176.2 m to 175.8 m. Grain size distribution curves determined by mechanical sieve and hydrometer analysis, illustrate the gradation of the fill in Figure 1 in the Appendix.

Atterberg Limit tests were carried out to evaluate the behaviour of the cohesive fill. The results on two selected representative samples ( $w_L=28-32$ ,  $I_p=14$ ) reveal that the fine grained portion of the fill has a low plasticity and hence can be categorized as a clayey silt. The results are illustrated graphically on the plasticity chart shown on Figure 2 in the Appendix.

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

The native surficial deposit at the site consists of a heterogeneous mixture of clayey silt, sand and gravel. Although not encountered during the investigation, boulders and cobbles are characteristic components of such till deposits of glacial origin and hence can exist within the deposit. Figure 3 in the Appendix illustrates a grain size distribution envelope representative of the deposit within the clay to gravel range.

The deposit exists surficially at the proposed abutment locations and adjacent approaches. The natural ground surface at the south abutment location is generally flat and at El. 175.1 m to 176.0 m. The thickness of the deposit ranges from 3.5 m to 5.5 m at the south abutment location. At the north abutment location, the natural ground surface is generally flat at the crest of the existing Hwy. 407 excavated cut slopes and at an El. 181.9 m to 182.1 m. The thickness of the deposit ranges from 2.9 m to 4.1 m at the north abutment location. At the toe of the slope and within the Hwy. 407 excavation cut area, this till deposit does not exist, presumably stripped and excavated. The ground surface ranges from 173.2 m to 174.0 m within the investigated area of the excavation cut.

Beyond the south abutment, this upper till deposit is overlain by the cohesive fill material previously discussed. In addition, the thickness of the heterogeneous mixture deposit gradually diminishes progressing northward along the proposed ramp alignment. At BH 7, the deposit is 1.5 m in thickness, and at BH 6, the deposit does not exist.

Atterberg Limit tests were carried out to evaluate the behaviour of the fine grained portion of the deposit and the results are tabulated in Table 1 below and illustrated on the plasticity chart on Figure 4.

Table 1

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	12-21	4
Liquid Limit (w <sub>L</sub> %)	27-35	4
Plasticity Index (I <sub>p</sub> %)	12-18	4

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

The deposit is brown in colour and based on 'N' values (obtained by the Standard Penetration Test), ranging from 21 blows/0.3 m to 120 blows/0.3 m, the deposit can be categorized as having a very stiff to hard consistency.

#### Sandy Silt to Silty Sand

A cohesionless sandy silt to silty sand deposit exists at varying depths and stratigraphies across the site. Basically, the deposit underlies the upper cohesive heterogeneous mixture of clayey silt, sand and gravel deposit where this upper till deposit exists. Within the Hwy. 407 right-of-way, where the excavation has already been advanced in the area of the proposed ramp, the ground surface is at an elevation of 173.2 m to 174 m and the sandy silt to silty sand deposit extends from this ground surface for a thickness ranging from 3.5 m to 3.7 m. Elsewhere at the site location, the sandy silt to silty sand deposit is overlain by the cohesive clayey silt deposit or directly overlain by

the fill material consisting of an irregular mixture of clayey silt, sand and gravel. The thickness of the deposit at these locations varies between 5.1 m to 10.8 m.

The deposit has been oxidized and hence is brown in colour for an upper thickness ranging from 1.2 m to 9.3 m. The deposit is unoxidized and grey in colour below this depth.

The sandy silt to silty sand also contains random zones of gravel intermixed within the deposit. Figure 5 in the Appendix illustrates the gradation of the deposit in envelope form and also includes individual grain size distribution curves which illustrates the gravel composition.

Based on Standard Penetration Test 'N' values ranging from 29 blows/0.3 m to 100 blows/0.15 m, the deposit can be categorized as having a compact to very dense state of denseness. In general, however, 'N' values exceed 50 blows/0.3 m and consequently the soil has a very dense state of denseness.

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

Underlying the sandy silt to silty sand deposit, a second lower glacial till deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel is present. Random interbeds of glaciolacustrine silt and clayey silt in the order of 0.5 m thickness are also present within the deposit. The extent of the deposit was not determined during the investigation.

The composition of the till deposit reflects the wide range of grain sizes typical of till deposits of glacial origin. A grain size distribution envelope illustrating the gradation of the deposit is shown on Figure 6 in the envelope. The gradation envelope includes particle sizes up to and including gravel. However, larger size boulders and cobbles are characteristic components of these deposits and hence can exist.

Atterberg Limit tests were obtained to evaluate the behaviour of the fine grained portion of the deposit and the results are plotted on the plasticity chart on Figure 7 in the Appendix and summarized in Table 2 below.

Table 2

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	9-18	6
Liquid Limit (w <sub>L</sub> %)	22-46	6
Plasticity Index (I <sub>p</sub> %)	9-28	6

The results reveal that the fine grained portion of the deposit ranges in plasticity from low to intermediate and therefore can be classified as a clayey silt to silty clay. However, in general, the liquid limit does not exceed 35% and the plasticity index is less than 20%. Hence, the fine grained portion of the deposit is generally of low plasticity and a clayey silt.

Based on Standard Penetration Test 'N' values, ranging from 41 blows/0.3 m to 186 blows/0.3 m. The deposit is considered to have a hard consistency.

#### GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. The groundwater condition at each of the individual boreholes is indicated on the Record of Borehole sheets in the Appendix. In general, the groundwater levels determined at the time of the investigation were at an elevation ranging from 168.6 m to 172.6 m. Higher water levels were noticed at BH's 9 and 10, a result revealing that the silty sand to sandy silt deposit at these locations is under subartesian head. Washboring techniques were required to penetrate the sloughing cohesionless soil in this stratum.

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

## DISCUSSION AND RECOMMENDATIONS

As a component of the Hwy. 427-Hwy. 407 interchange complex, a multi-span structure consisting of seven (7) spans ranging from 40 to 60 m in length is proposed to accommodate traffic from Hwy. 427 south to Hwy. 407 west. A cast-in-place post-tensioned concrete deck is proposed for the structure that has an overall length in the order of 340 m and a width of 13.5 m.

The ramp structure is a third level structure at the site situated at an elevation above the proposed Hwy. 407 grade (El. 174 m) and the proposed Hwy. 427 grade (El. 182 m). The proposed profile grade for the Ramp Hwy. 427S-Hwy. 407W varies from an approximate elevation of 190 m at the south approach to El. 184 m at the north approach. The existing ground surface at the site varies from 175 m to 176 m at the south approach location whereas at the north approach, the existing ground surface varies in accordance with the slope geometry of the Hwy. 407 excavation cut advanced in the area (El. 179 m to 182.5 m). Consequently, approach fills in the order of 14 to 15 m are proposed at the south approach embankment overlying the existing relatively flat ground surface and approach fills up to 5 m superimposed on the Hwy. 407 excavation slope are proposed at the north approach.

The Hwy. 407E-Hwy. 427S Ramp structure under construction at the time of the investigation is the fourth and uppermost level of the Hwy. 427/Hwy. 407 interchange complex. The proposed grade of this five (5) span structure is at an elevation of 194 to 195 m.

Recommendations pertaining to the following foundation and geotechnical considerations are included in the purview of this report.

I - Structure Foundations

II - Approach Embankments

III - Construction Considerations

## I - STRUCTURE FOUNDATIONS

Recommendations for the abutment and pier foundations for the ramp structure are given below. In general, competent subsoil conditions are present at the site, but the designer has to consider the presence of existing cut slopes and embankment fills at the proposed structure foundations locations. In some instances, alternative designs have been recommended. In all cases, the most economical and practically feasible method shall be selected.

### NORTH ABUTMENT

The structure foundation at the north abutment can be founded on a shallow foundation spread footing or alternatively deep foundation steel H-piles. Discussion pertaining to the design and construction for either alternative is given below. Regardless of the alternative that is selected, in view of the fact that the structure foundation is located amidst an existing slope, a 3 m bench with 2H:1V slopes is required in the longitudinal and transverse direction for the preservation of overall (global) stability (see Approach Embankments - Slope Stability section of report).

#### a) Shallow Foundations

The north abutment structure foundations can be founded on spread footings bearing on the competent surficial clayey silt till deposit or the underlying sandy silt to silty sand deposit at an elevation of 180.4 m or lower. For purposes of the O.H.B.D.C., the following bearing capacities are provided.

Table 3 - Shallow Foundations (North Abutment)

Factored Capacity at U.L.S.	= 1000 kPa
Bearing Capacity at S.L.S. Type II	= 500 kPa

In view of the existing slope and varying elevations that it presents at the structure foundation location, a stepped foundation can be considered.

As mentioned earlier, a 3 m bench will be required for stability purposes. This bench also serves as assurance in maintaining the bearing capacities tabulated in Table 3 above. Without this minimum bench requirement, a reduction of bearing capacity would be required.

Settlements induced as a result of the applied pressures recommended in Table 3 will be due to the recompression of the native soil and elastic in nature. These settlements will occur during or immediately following construction and are anticipated to be within 25 mm total or differential. It is recommended that all softened/loosened material at the footing founding elevation be removed and replaced with a granular material and/or mass concrete. Furthermore, to protect the founding soil against these disturbance effects and also against weathering, a working slab consisting of the granular material and/or mass concrete should be placed.

The reduction for inclination of load acting on a shallow foundation shall be carried out in accordance with Section 6-7.3.3.5 of the O.H.B.D.C. In all likelihood, it appears that the foundation will be primarily, if not entirely, supported on the cohesionless sandy silt to silty sand stratum. Consequently, the appropriate reduction curves for granular soil should be applied.

The computation of the sliding resistance of the foundation shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. An unfactored friction angle of  $35^{\circ}$  can be used between the concrete footing and the founding soil. If additional sliding resistance is required, consideration can be given to employing shear keys beneath the footing. The passive resistance developed by the shear key can be computed using the above mentioned friction angle of  $35^{\circ}$ .

All founding soil shall be protected against frost penetration. Consequently, all footings must have a minimum 1.2 m of earth cover or equivalent frost protection.

No dewatering problems are anticipated because footing excavation is not anticipated to intercept the groundwater level. Any perched groundwater seepage or surface runoff that occurs can be easily discharged using conventional sump pumping techniques with perimeter ditches.

Temporary slopes to facilitate the footing excavation can be constructed at 1.5H:1V.

b) Deep Foundation Units

Alternatively, the north abutment foundation can be supported on deep foundation elements consisting of driven steel H-piles or bored concrete caissons. Pertinent design parameters and construction considerations for either alternative are given below.

i) Driven Steel H-Piles

The north abutment structure foundations can be founded on steel H-piles driven in the very dense sandy silt to silty sand stratum to a pile tip elevation of 172.5 m±. The design axial capacities for vertical piles are given in Table 4 below.

Table 4 - Axial Capacities - Driven Steel H-Piles

<u>Pile Type</u>	Factored Capacity	Bearing Capacity
	at U.L.S.	at S.L.S. Type II
	<u>(kN)</u>	<u>(kN)</u>
HP 310x110	1600	1150
HP 310x79	1150	890

Settlements as a result of the applied loadings are anticipated to be within 25 mm. These settlements are expected to be realized during or immediately following construction.

Reduction of axial capacities for inclined loadings shall conform to factors provided in Section 6.8.3.4.3 of the O.H.B.D.C.

Pile spacing shall conform with Section 6.8.3.10 of the O.H.B.D.C. Adjacent piles should be checked for heaving during pile installation. For centrally

loaded piles equal load sharing on the deep foundation units can be assumed. The design of eccentric loaded deep foundation units shall comply with Section 6.8.3.4.2 of the O.H.B.D.C.

The lateral resistance for both vertical and battered piles shall be computed in accordance with Section 6.8.3.8 of the O.H.B.D.C.

To facilitate pile penetration during installation, it is recommended that all piles be equipped with reinforced tips. Pile driving shall be carefully monitored and controlled by employing the Hiley Dynamic Pile Driving Formula driven in accordance with MTO Standards SS103-10 or SS103-11 assuming an ultimate capacity as tabulated in Table 5 below.

Table 5 - Ultimate Capacity Employing  
Hiley Dynamic Formula

<u>Pile Type</u>	<u>Ultimate Capacity (kN)</u>
HP 310x110	3450
HP 310x79	2670

In view of the silty composition of the end bearing stratum, a temporary reduction in pore pressure and a corresponding increase in driving resistance may result because of soil dilation caused by driving. Where these factors are significant, a reduction in the bearing capacity may result with time. Although the groundwater table was below the proposed tip elevation at the time of the investigation, these conditions may change and hence redriving to confirm soil relaxation is warranted. Observations made during redriving the initial piles can be used to confirm the extent of the redriving test. The piles should be subject to the redriving test no earlier than seven day following initial installation.

ii) Drilled Concrete Caissons

Alternatively, structure foundations can be founded on end bearing reinforced concrete caissons installed in drilled shafts to the sandy silt to silty sand stratum. For caissons founded at a tip elevation of 172.5 m±, the following design values are recommended.

Table 6 - Axial Capacities - Caissons

Caisson Diameter	Factored Capacity at U.L.S.	Bearing Capacity at S.L.S. Type II
<u>(m)</u>	<u>(kN)</u>	<u>(kN)</u>
0.76	2250	1500

Capacities for other caisson diameters can be obtained in proportion to the respective end bearing areas. Settlements as a result of the applied loadings is anticipated to be within 25 mm and is expected to be realized during or shortly after construction.

Resistance to lateral load shall be computed in accordance with Section 6.8.3.8 of the O.H.B.D.C. A coefficient of horizontal subgrade reaction equivalent to 17 MPa/m and an unfactored angle of internal friction of 35° can be used in the computations of the lateral resistance of the sandy silt to silty sand.

The proposed method of caisson installation shall be in accordance with OPSS 903.07.03 and subject to review by this office. It is important that the contractor maintain the shaft of the caisson throughout the installation without any soil cave-in.

#### Frost Protection and Dewatering

Pile caps shall be protected against frost protection by providing a minimum 1.2 m of earth cover. No dewatering problems are anticipated for the construction of pile caps because footing excavation is not anticipated to intercept the groundwater level. Any perched groundwater seepage or surface runoff that occurs can be easily discharged using conventional sump pumping techniques.

#### PIERS

In view of the varying surface conditions and topographs at the site, recommendations for the pier foundations have been divided into three categories.

- (a) Piers within Hwy. 407 excavation cut (Piers #1, #2 and #3)
- (b) Pier #4 at toe of Hwy. 427 embankment
- (c) Piers at top of Hwy. 427 embankment (Piers #5 and #6)

For clarity, the piers have been identified numerically in ascending order from north to south.

(a) Piers Within Hwy. 407 Excavation Cut

The structure foundations within the Hwy. 407 excavation cut, namely piers 1, 2 and 3, can be founded on conventional spread footings supported on the very dense sandy silt to silty sand stratum at an elevation of 172.0 m. For purposes of the O.H.B.D.C., the following bearing capacities are provided.

Table 7 - Spread Footings

Factored Capacity at U.L.S.	= 1000 kPa
Bearing Capacity at S.L.S. Type II	= 500 kPa

Settlements induced as a result of the applied pressures tabulated in Table 7 will be due to the recompression of the founding soil and elastic in nature. These settlements will occur during or immediately following construction and are anticipated to be within 25 mm total or differential.

The computation of sliding resistance of the foundation shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. An unfactored friction angle of 35° can be used between the concrete footing and the founding soil. If additional sliding resistance is required, consideration can be given to employing shear keys beneath the footing. The passive resistance developed by the shear key can be computed using the above mentioned friction angle of 35°.

No dewatering problems are anticipated for footing excavations into the sandy silt to silty sand deposit provided groundwater levels remain below the founding elevation. For higher water levels, a dewatering scheme including an oversized excavation with perimeter ditches and conventional sump pumps will be required. Soil migration shall be prevented if this latter operation is required. This can be accomplished by placing filter fabric on the sloped drainage ditches. Temporary slopes are to be excavated at 2H:1V if the slope is below the groundwater.

All other design parameters and construction criteria including:

- (1) reduction for inclination of load
- (2) subexcavation of loosened material
- (3) placement of working slab
- (4) frost penetration
- (5) temporary slopes

that were discussed in conjunction with the spread footing alternative at the north abutment are equally applicable for piers 1, 2 and 3.

(b) Pier #4 at toe of Hwy. 427 embankments

Pier #4, located at the toe of the Hwy. 427 embankment, also partially encroaches into the Hwy. 427 embankment. The pier can be founded on a shallow foundation or deep foundation as described below.

#### Shallow Foundation

Pier #4 can be supported on a spread footing at an elevation of 176.0 m or lower within the very dense sandy silt stratum. The bearing capacities recommended for the piers within the Hwy. 407 excavation cut (Piers 1, 2 and 3) can be applied for the design of Pier #4 provided that the foundation is a minimum 3 m from the crest of the Hwy. 407 excavation slope. Should this not be the case, this office should be contacted so that a revised recommendation can be given. Similarly, all other design and construction parameters outlined for piers 1, 2 and 3 are also applicable for the spread footing at Pier #4.

#### Deep Foundation

Alternatively, Pier #4 can be supported on deep foundation units, end bearing within the lower till deposit at a tip elevation of 159.5  $\pm$ m. The deep foundation units can be driven steel H-piles or drilled concrete caissons with corresponding axial capacities equivalent to the values given in Table 4 and Table 6 respectively. All other design and construction criteria given for the north abutment foundation are also applicable for the design of the foundation at Pier #4. The following additional comments are provided.

(1) An undrained shear strength of 250 kPa can be used for the computation of the lateral resistance of the lower till deposit.

(2) The lateral capacity of the fill should be ignored.

Regardless of the alternative selected, a temporary shoring scheme will be required to facilitate the foundation construction within the existing embankment. Details of the recommended shoring scheme and design parameters are provided within a subsequent section of this report entitled "Construction Considerations".

In addition, lateral and vertical loads attributable to the sloping embankment fill shall be included in the foundation design.

(c) Piers At Top of Hwy. 427 Embankment (Piers #5 and #6)

The surficial fill material located at the proposed pier foundation locations, is unsuitable for the support of shallow foundations. Consequently, deep foundation units are recommended at these locations. End-bearing steel H-piles driven or concrete caissons drilled to the elevations given in Table 8 can be used.

Table 8 - Deep Foundation Tip Elevations

<u>Structure</u>	<u>Tip Elevation (m)</u>
Pier #5	174.5 ±
Pier #6	173.5 ±

The axial capacities of the piles are given in Table 4 and 6 for the driven steel H-piles and drilled concrete caissons respectively. All other design and construction parameters and comments given for the deep foundation units at the north abutment and at Pier #4 are also applicable at these locations. Additional comments that supersede the previous comments include the fact that the pile cap construction will take place within the embankment fill. No major dewatering problems are anticipated for this construction.

## SOUTH ABUTMENT

In view of the high embankment fills proposed at the south abutment, it is recommended that the structure foundations be 'perched' within the approach fills. The structure foundations can be supported on deep foundation units or a shallow foundation Granular 'A' pad as discussed below.

### (a) Deep Foundation Units

The south abutment structure can be founded on end-bearing driven steel H-piles or drilled concrete caissons within the lower till deposit at a tip elevation of 165.3 m. The axial capacities tabulated in Table 4 and 6 can be used for the steel H-piles and concrete caissons respectively. All other pertinent design and construction parameters and comments discussed previously for deep foundation steel H-piles are also applicable at the south abutment. In addition, to avoid pile impediment within the fill, the gradation of all fill placed in the zone of pile penetration should be restricted to a maximum size of 75 mm. Also, the following design parameters should be employed in computing the contribution of the lateral resistance of the caisson within the fill material.

(1) The design for caisson embedment can be calculated neglecting lateral resistance in the frost penetration zone but including lateral loads within the frost penetration zone.

(2) The caisson should be a minimum 3 m from the crest of the 2H:1V slope.

(3) The upper 60% of the embedment length within the fill (taken from the frost penetration depth) should be disregarded for lateral resistance.

Finally, it is recommended that the embankment be placed as far as in advance as scheduling permits to avoid the settlement effects of the approach embankment on the deep foundation units (see "Approach Embankments - Settlement" in subsequent section of the report).

(b) Shallow Foundation

Alternatively, the 'perched' abutment can be supported on a shallow foundation founded on a well compacted Granular 'A' pad. The granular pad shall be constructed according to the geometry shown in Figure 8 in the Appendix. As illustrated, the Granular 'A' pad shall be constructed to a minimum 1 m edge distance from the top of the footing to the crest of the pad and with 1H:1V slopes. The footings must have a minimum 1.2 m earth cover. For purposes of the O.H.B.D.C., the following bearing capacities are given.

Table 9 - Perched Abutment on Granular 'A' Pad

Factored Capacity at U.L.S.	= 900 kPa
Bearing Capacity at S.L.S. Type II	= 350 kPa

Settlement of the foundation granular pad as a result of the applied footing pressure will be elastic in nature and consequently is expected to take place during or immediately following the construction period. The magnitude of this settlement is anticipated to be within 25 mm, provided the granular material is not loosened by construction or related activities.

Additional settlement within the granular fill itself and as a result of the elastic recompression of the native soil can be expected. The total magnitude of this settlement is anticipated to be in the order of magnitude of 75 mm and is expected to be realized during or immediately following construction. This settlement prediction is contingent on proper fill placement and compaction.

The Granular 'A' material must be placed and compacted to achieve 100% of the Proctor maximum dry density as outlined in OPSS 501.08.02 (Method A). Quality control in the form of material inspection and field density measurements shall be conducted. Any softened and/or organic material present within the natural subgrade must be removed prior to the placement of the granular pad.

It is recommended that the granular pad be placed as far in advance of foundation construction as scheduling permits to allow for the development of the granular embankment settlements.

The computation of the sliding resistance of the foundation shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. An unfactored friction angle of  $35^\circ$  can be used between the concrete footing and the Granular 'A' material. If additional sliding resistance is required, consideration can be given to employing shear keys beneath the footing. The passive resistance developed by the shear key can be computed using the parameters of the granular material tabulated in Table 9 (see "Lateral Earth Pressures on Structures" in subsequent section of the report).

## II - APPROACH EMBANKMENTS

Approach fills in the order of magnitude of 14-15 m at the south approach and 5 m superimposed on the Hwy. 407 excavation cut at the north approach will be required for the structure approach embankments. Discussion of the lateral earth pressures on the structure, stability, settlement and construction of the approach embankments are provided below.

### Lateral Earth Pressure on Structure

Free draining material such as Granular 'A' or Granular 'B' shall be used within a wedge behind the abutments and retaining walls bounded by a plane rising at  $60^\circ$  to the horizontal as shown in Figure 6-9.6.1 in the O.H.B.D.C. The application of granular material combined with weep holes in the abutment walls to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up. Design parameters of the soil are given in Table 10 below.

Table 10 - Backfill Properties

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction ( $\phi$ ) (unfactored)	$35^\circ$	$30^\circ$
Unit Weight ( $\text{kN/m}^3$ )	22.8	21.2
*Coefficient of Active Earth Pressure ( $K_a$ )		
- S.L.S.	0.27	0.33
- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure at Rest ( $K_o$ )		
- S.L.S.	0.43	0.5
- U.L.S.	0.5	0.58

\*These earth pressure coefficients apply to horizontal backfill surfaces only. The appropriate consideration shall be given to account for sloping surface backfill.

The earth pressure coefficient at rest is to be used in design if the abutment/retaining walls are rigid and unyielding.

Fill material beyond the 60° wedge mentioned above can consist of material other than Granular 'A' or Granular 'B' provided it satisfies the specifications outlined in OPSS 212 series.

### Stability

In view of the competent nature of the subsoil, no deep-seated stability problems are anticipated for the proposed embankment fill heights at either approach. However, at the south approach, where approach embankments are in the order of 14 to 15 m, it is recommended that the approach embankment be constructed with a stability midheight berm of 2 m and 2H:1V slopes to assure the internal (surficial) stability of the embankment both in the transverse and longitudinal directions. The berm should be constructed at a nominal 2% gradient to facilitate surface runoff. In addition, an effective erosion control protection scheme, such as sodding, should be provided to protect the exposed slopes.

Spacing restrictions between the proposed Hwy. 427S-407W Ramp and the Hwy. 427 embankment must be considered in the design of ramp embankments. Should a conflict exist between the proposed and existing embankments, retaining walls can be considered. The recommendations given for the south abutment foundation can be applied for the design of these retaining walls.

At the north approach, the abutment foundation has been proposed along the existing Hwy. 407 excavation cut slope. To determine the overall (global) stability of the foundation on the slope, an effective stress analysis representing the long term (drained) condition was implemented. Stability computations were carried out using Bishop's method on an in-house mainframe

program employing static loading conditions and incorporating a factor of safety of 1.3. The properties of the approach fill material and subsoil and the surface geometry examined is shown in Figure 9 in the Appendix.

The results of stability analyses indicate that a three(3) m bench and 2H:1V slopes should be cut in the slope in both the longitudinal and transverse directions.

Drained stability analyses of the slopes are very sensitive to groundwater levels and pore pressures that can develop in the slope. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. By employing a 0.6 m thick granular blanket consisting of free draining material such as Granular 'A' material, softening of material due to freeze-thaw cycles and development of excess pore water pressures can be prevented. Inabilities to control these parameters usually result in surficial slope failures.

The granular blankets should be designed in conjunction with a permanent drainage system that will discharge drained water from the slope. It is recommended that toe drains be constructed consisting of a perforated pipe encased with a suitable geotextile filter fabric and in turn surrounded by a suitable granular soil filter material. The toe drains should then be connected to an appropriate integrated drainage system. At the site, the toe drains can be constructed in conjunction with the highway perimeter drainage system.

Normal slope vegetation cover should be established as soon as possible after completion of the excavation cut to control surficial erosion.

### Settlements

Settlements in the order of magnitude of 25 mm and 75 mm are anticipated at the north and south approach respectively as a result of the elastic recompression of the native subsoil and settlement within the fills under its own weight. It is predicted that the majority of these settlements will be realized during or immediately following the construction of the embankment.

### Embankment Construction

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Any new fill placement shall be connected to existing fills or cuts by "benching" the earth slopes in accordance with MTO Standards (OPSD 208.01).

Heavy compaction equipment should not be used behind the abutment/retaining walls within a lateral distance equal to the current height of fill above the wall footing in order to avoid imposing damage or deflection to the wall during the fill placement.

### III - CONSTRUCTION CONSIDERATIONS

The Hwy. 427 will be in operation during the construction of the proposed Hwy. 427S-407W Ramp. Consequently, a roadway protection scheme combined with possible lane closure may be required for the construction of Piers #4, #5 and #6. The proposed Hwy. 407 is scheduled to be constructed after the Hwy. 427S-407W Ramp construction and hence no shoring requirements are anticipated for Piers #1, #2 and #3. Recommendations for the design and construction of a roadway protection scheme for Piers #4, #5 and #6 is discussed below.

#### Temporary Roadway Protection

It appears that to facilitate the construction of the structure foundations at Piers #4, #5 and #6, whilst maintaining traffic on Hwy. 427, a temporary shoring system will be required. A cantilever or braced timber lagging-soldier pile shoring wall is recommended at the site.

The design of the shoring system shall include the appropriate earth pressures computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. The loadings induced by the surcharge traffic and adjustment for any sloping surfaces shall be incorporated in the design. Soil design parameters to facilitate the shoring wall design are summarized in Table 11 below.

Table 11 - Shoring Design Soil Parameters

<u>Soil type</u>	<u>Saturated Unit Weight (kN/m<sup>3</sup>)</u>	<u>Unfactored Effective Shear Strength Parameters (<math>\phi^\circ</math>)</u>
Sandy Silt (Fill)	20	30
Irregular mixture of clayey silt, sand and gravel (Fill)	20	30
Het. mixture of clayey silt, sand and gravel (Glacial Till) - Upper	21	32
Sandy Silt	20	35
Het. mixture of clayey silt, sand and gravel (Glacial Till) - Lower	21	32

The shoring system must be designed to achieve earth pressure equilibrium. This equilibrium can be provided by a cantilevered wall or a braced (strutted) wall. The feasibility of a cantilever wall is contingent on the practicality of the soldier pile embedment length.

Soldier piles can be installed employing conventional pile driving or augering techniques.

### Existing Construction Activity

During the time of the investigation, considerable construction activity was in progress in conjunction with other Hwy. 427-Hwy. 407 interchange structures adjacent to the proposed Hwy. 427S-Hwy.407W Ramp. Conditions, hence, may or may not change at the proposed structure foundation locations and approach areas depending on the extent of current construction activity. It is therefore important that the conditions described in this report be confirmed by site inspection both during the design and construction stages.

### MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, and M. Iampietro, Student Engineer, utilizing equipment owned and operated by Malone's Soil Samples Ltd. and Master Soils Investigation Ltd.

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



A handwritten signature in black ink, appearing to read "T. Sangiuliano", written over a horizontal line.

T. Sangiuliano, P.Eng.  
Foundation Engineer

A handwritten signature in black ink, appearing to read "B. Iyer", written over a horizontal line.

for

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

## **APPENDIX**

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	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
$\mu$	1	COEFFICIENT OF FRICTION

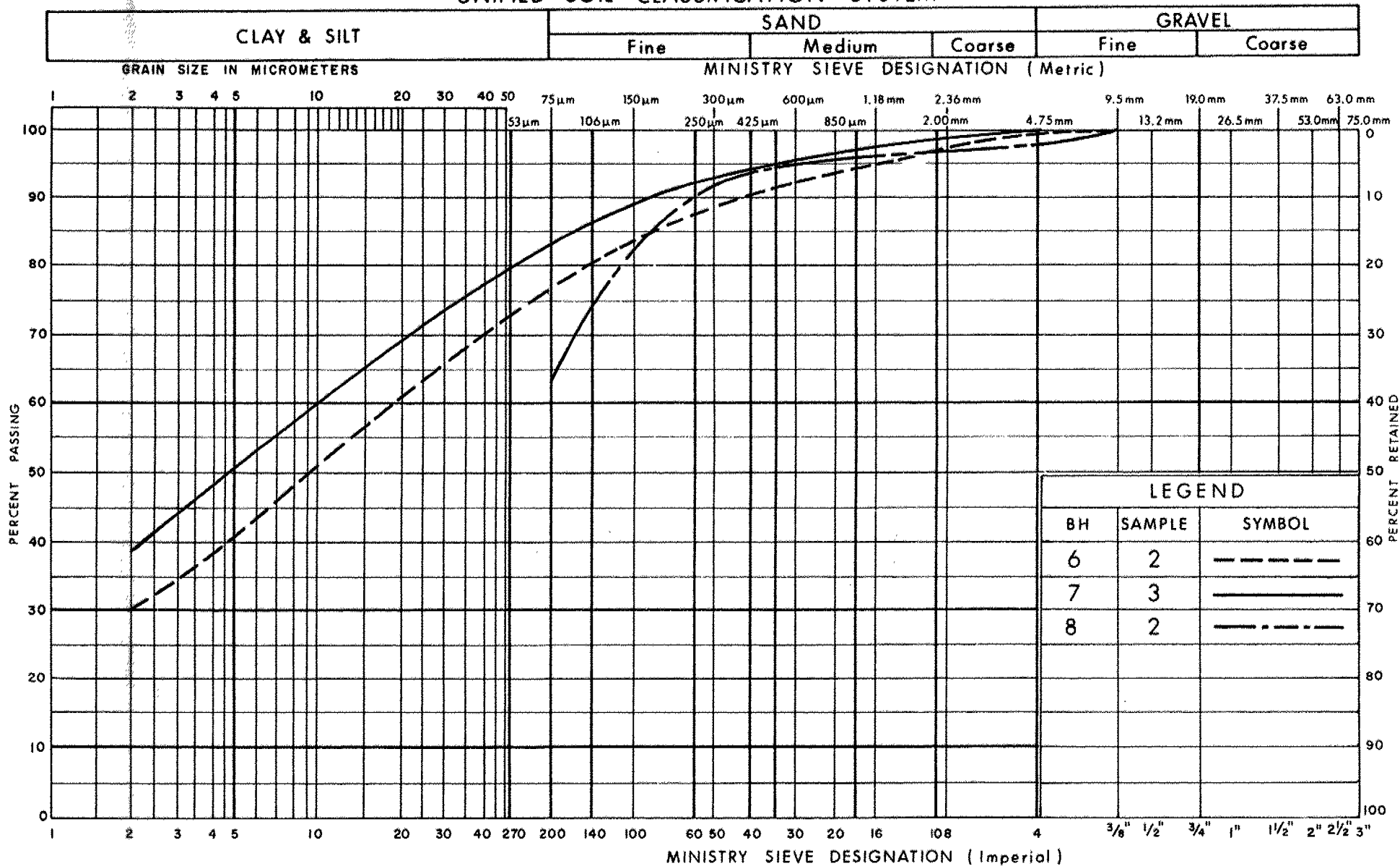
### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	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
$S_t$	1	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	$I_D$	1	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	$C_u$	1	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	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	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						

## UNIFIED SOIL CLASSIFICATION SYSTEM

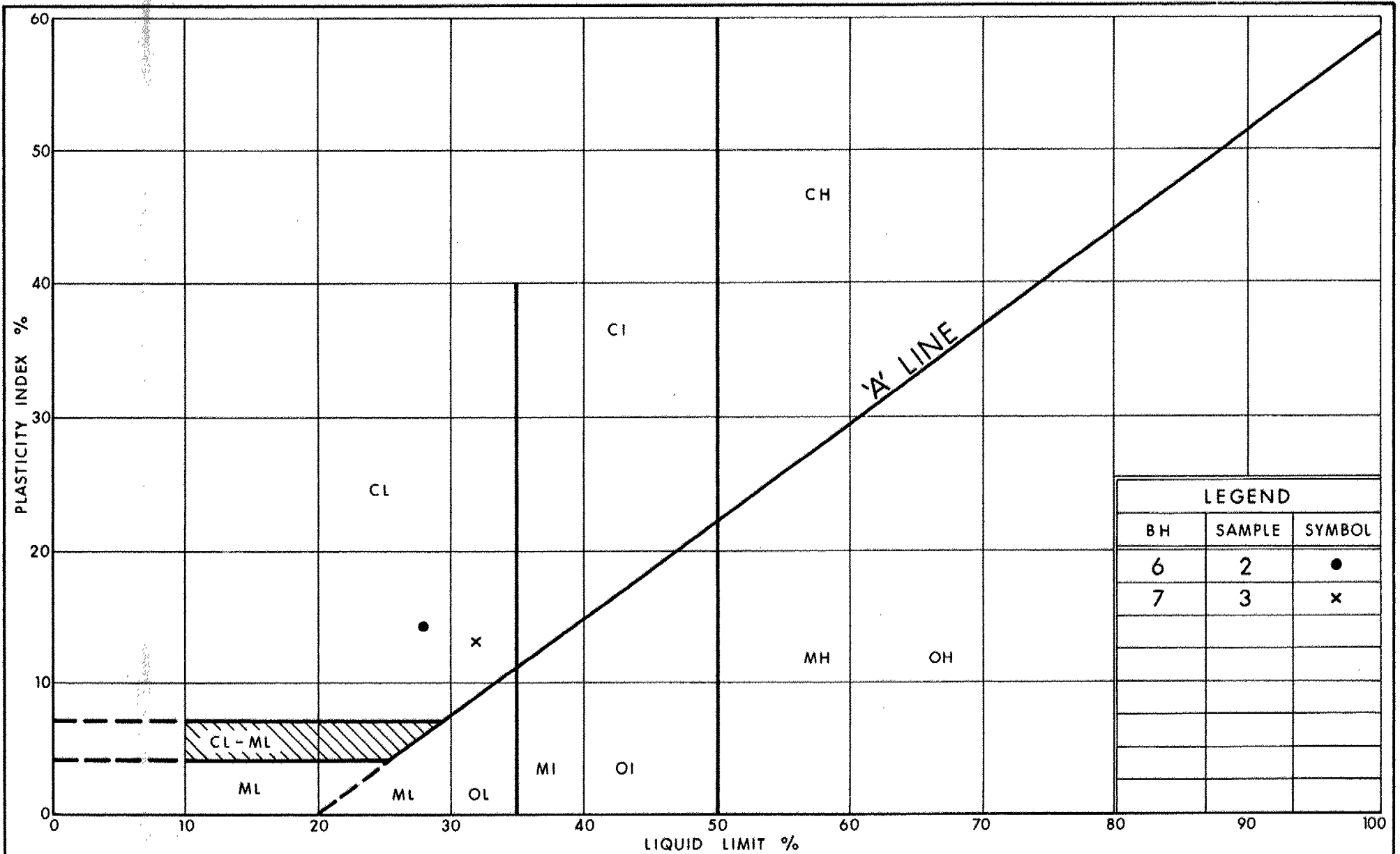


Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION (FILL MATERIAL)

FIG No 1

W P 368-87-01



Ministry of  
Transportation

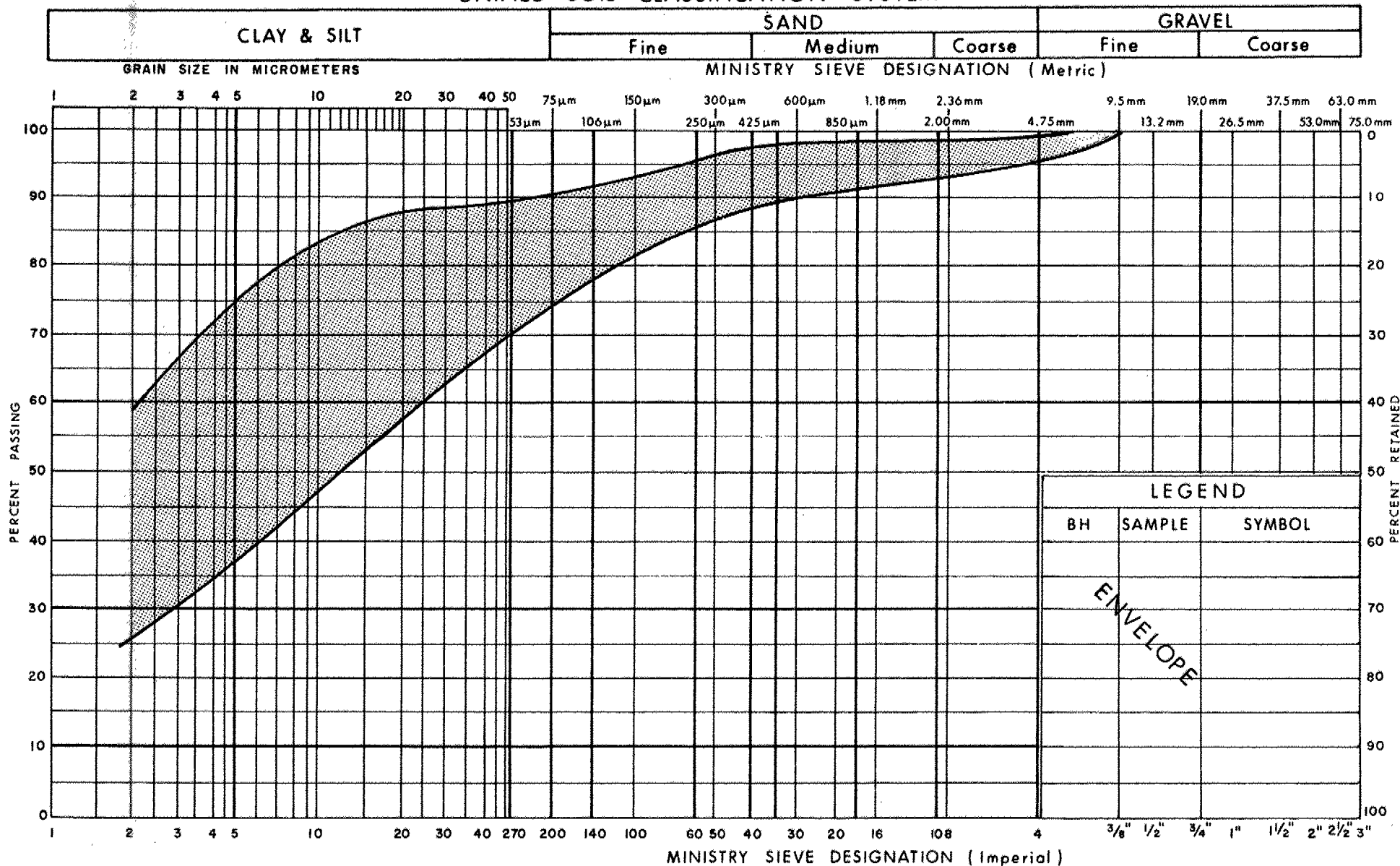
Ontario

PLASTICITY CHART  
IRREGULAR MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
( FILL MATERIAL)

FIG No 2

W P 368 -87-01

## UNIFIED SOIL CLASSIFICATION SYSTEM

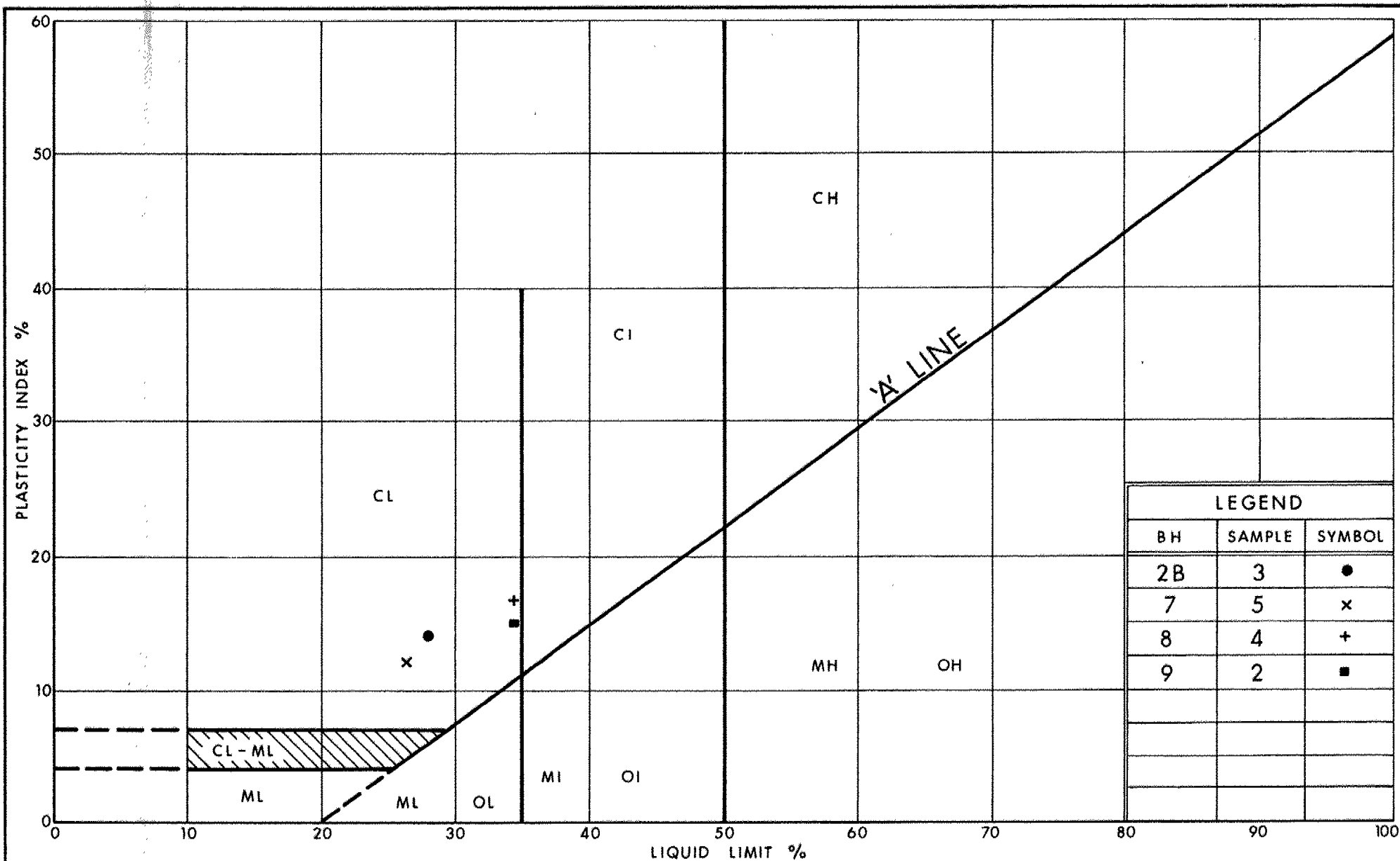


Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 3

W P 368-87-01



Ministry of  
Transportation

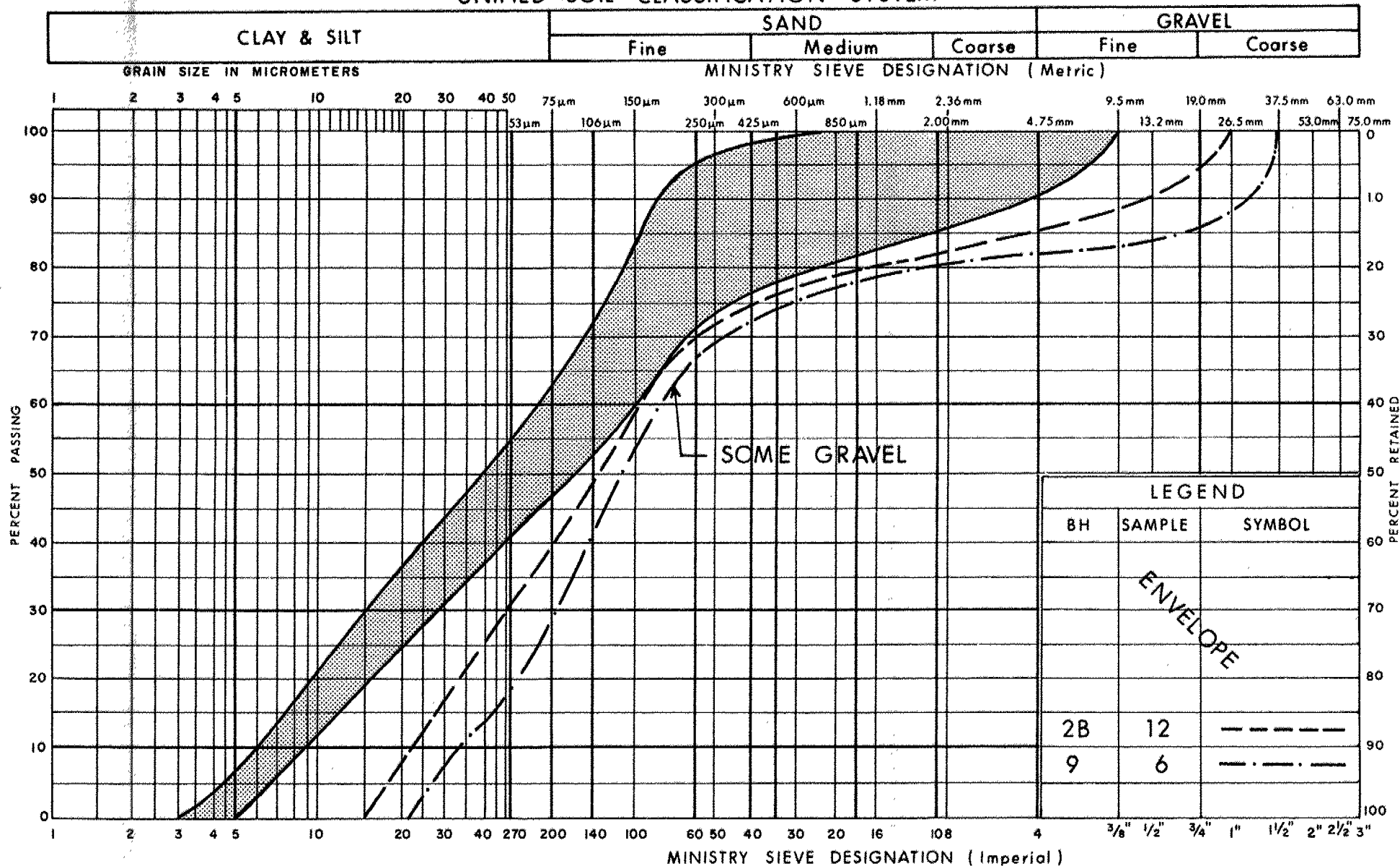
Ontario

PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(GLACIAL TILL) UPPER

FIG No 4

W P 368-87-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



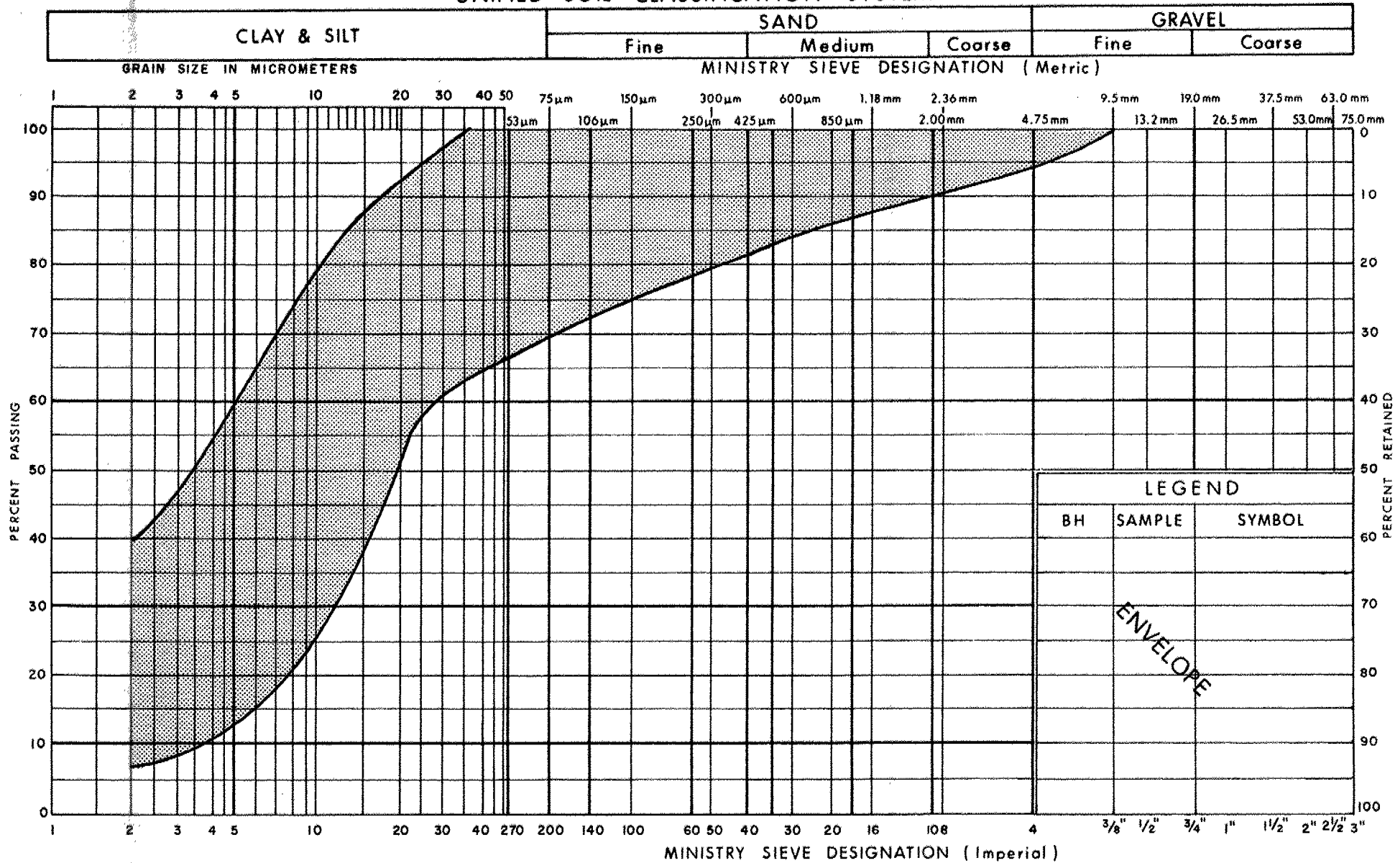
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SANDY SILT TO SILTY SAND

FIG No 5

W P 367-87-01

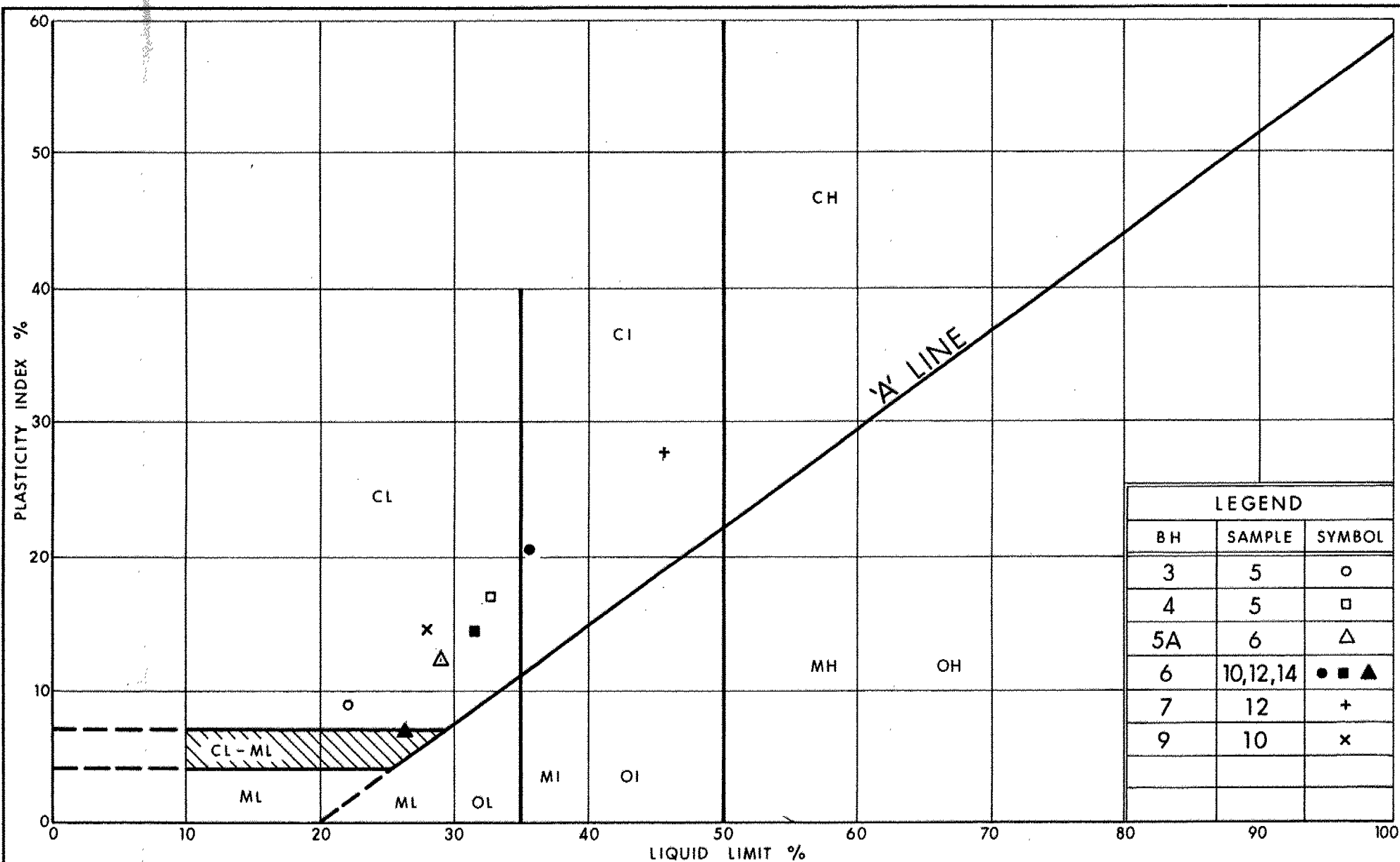
## UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 6

W P 368-87-01

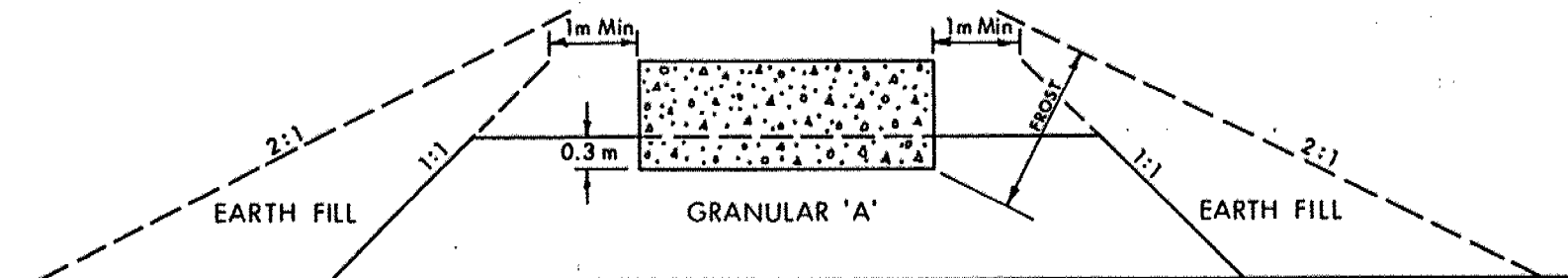


Ministry of  
Transportation

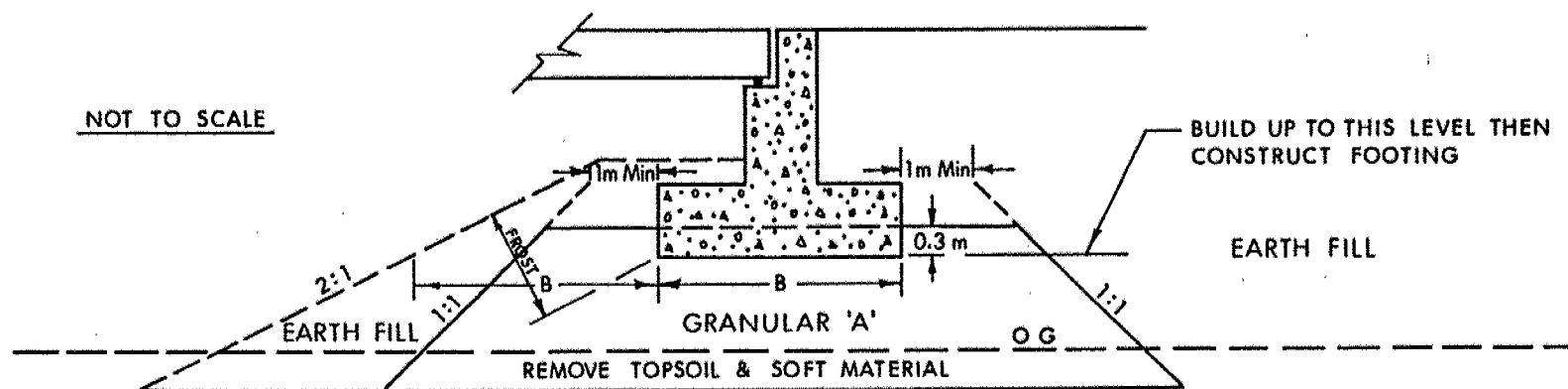
PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(GLACIAL TILL) LOWER

FIG No 7

W P 368-87-01



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T O STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

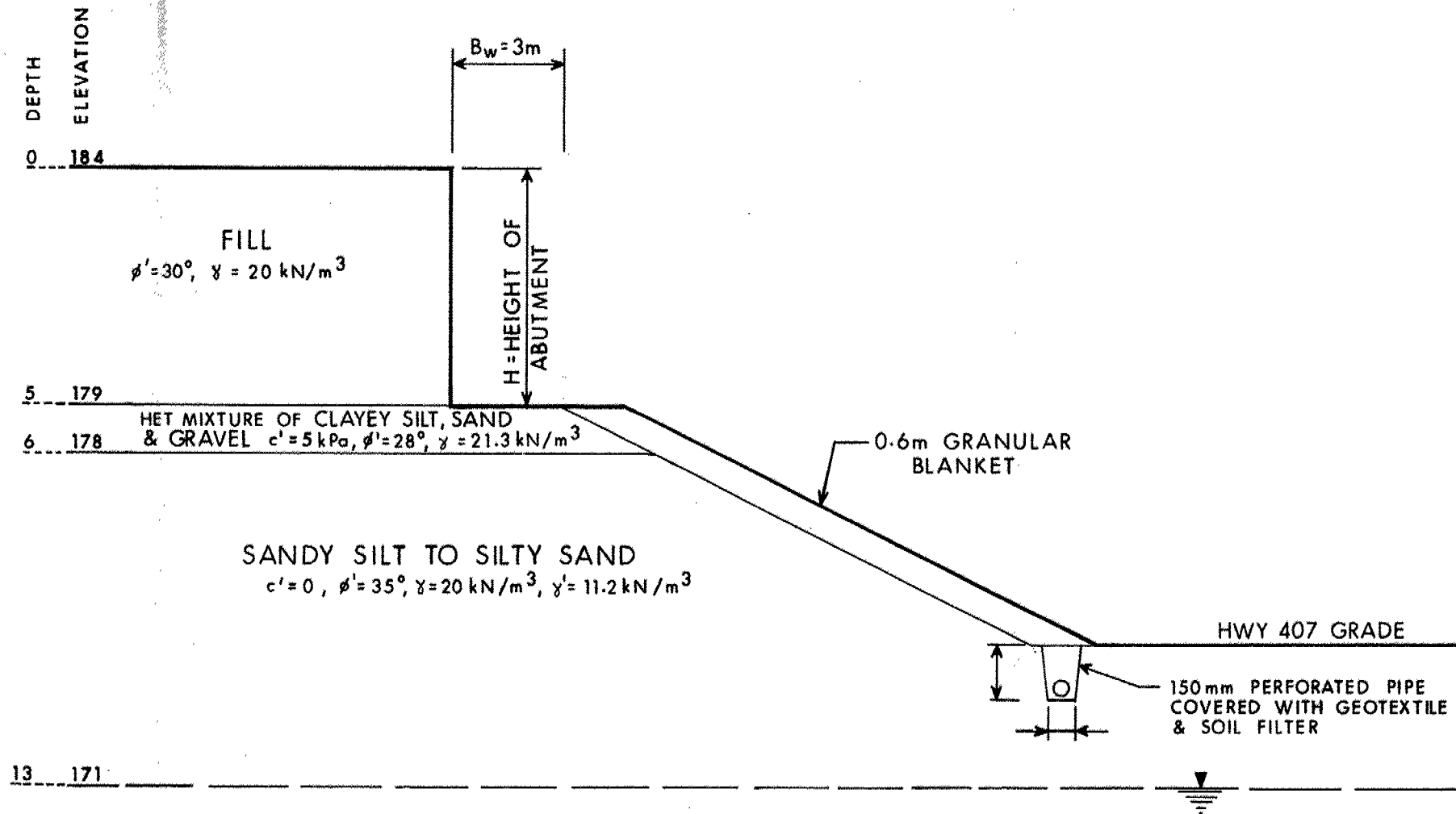


Ministry of  
Transportation

ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE

FIG No 8

W P 368-87-01



SLOPE STABILITY ANALYSIS  
NORTH APPROACH  
(NTS)

WP 368-87-01  
FIG-9

# RECORD OF BOREHOLE No 1

1 OF 1 METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 854.5 ; E 293 934 ORIGINATED BY MI  
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Ceodetic DATE 90 06 21 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
182.1	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown, Hard		1	SS	54	DRY											
			2	SS	110		180										
178.0							178										
4.1			3	SS	100												
			4	SS	89		176										
			5	SS	88		174										
	Silty Sand V. Dense						172										
			6	SS	120		170										
169.5																	
12.6	End of Borehole																

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 858 ; E 293 988 ORIGINATED BY MI  
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
181.9	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)		1	SS	21	DRY											
	V. Stiff Hard		2	SS	36												
	Brown		3	SS	56		180									21.7	5 19 50 26
179.0			4	SS	110												0 38 (62)
2.9			5	SS	120		178										
			6	SS	100												
			7	SS	90												0 77 (23)
	Sandy Silt to Silty Sand		8	SS	82		176										
			9	SS	72												
	V. Dense		10	SS	110		174										
			11	SS	104												
			12	SS	120	/28cm	172										
	Brown some gravel Grey		13	SS	86		170										14 46 (40)
168.2																	
13.7 167.7	Het. mixt. of Clayey Silt, sand and gravel (Glacial Till)						168										
14.2	End of Borehole																

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 844.5 ; E 294 022.5 ORIGINATED BY MI  
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100									
							WATER CONTENT (%) 10 20 30										
173.2	Ground Surface																
0.0	Sandy Silt to Silty Sand Trace gravel		1	SS	90		172										
			2	SS	100												
	Brown Grey		3	SS	100	/15cm										10 43 (47)	
	V. Dense		4	SS	100	/15cm	170										
169.7			5	SS	120												
3.5	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Grey, Hard		6	SS	80		168									4 27 44 25	
			7	SS	47												
	Clayey Silt (Locustrine)		8	SS	60		166										
			9	SS	69		164										
163.6																	
9.6	End of Borehole																

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 828 ; E 294 080.5 ORIGINATED BY MM  
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
173.8	Ground Surface																
0.0	Sandy Silt to Silty Sand trace gravel		1	SS	49												
			2	SS	74												
	Brown Grey		3	SS	29												
	Dense to V. Dense		4	SS	48												
170.1																	8 41 (51)
3.7	Clayey Silt (Locustrine)		5	SS	186												
			6	SS	141												0 6 55 39
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		7	SS	78												
			8	SS	89												
164.2			9	SS	111												
9.6	End of Borehole																

# RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 798 ; E 294 142 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 21 CHECKED BY TS

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										
174.0																		
0.0	Sandy Silt to Silty Sand  Brown, Dense to V. Dense		1	SS	42													
			2	SS	40													
			3	SS	103												5 44 (51)	
			4	SS	66													
170.3	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Grey, Hard		5	SS	142													
3.7			6	SS	120	/15cm										0 0 66 34		
			7	SS	106													
			8	SS	59													
			9	SS	125													
164.4																		
9.6	End of Borehole																	

# RECORD OF BOREHOLE No 6

1 OF 2 METRIC

W.P. 368-87-01 LOCATION Co-ords: N4 845 780.7; E294 167.5 ORIGINATED BY MM  
 DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 20 CHECKED BY TS

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
178.2	Ground Surface														
0.0	Irregular mixture of Clayey Silt, sand and gravel (Fill Material) Brown, V.Stiff to Hard		1	SS	19		178							21.7	0 25 45 30
176.1			2	SS	42										
2.1	Sandy Silt V.Dense		3	SS	56		176								0 33 (67)
			4	SS	57										
			5	SS	60		174								
	Brown		6	SS	46										
	Grey		7	SS	60		172								
171.0			8	SS	162										
7.2	Silt		9	SS	50		170								
			10	SS	58		168								0 0 60 40
	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		11	SS	40		166								
			12	SS	46		164								1 18 51 30
163.0															

15.2 Continued

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

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

## METRIC

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 748.5 ; E 294 204.5 ORIGINATED BY MM  
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
DATUM Geodetic DATE 90 06 19 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
179.1	Ground Surface															
0.0	Sandy Silt (Fill Material) Brown, Compact		1	SS	22	DRY										
177.7							178									
1.4	Irregular mixture of Clayey Silt, sand and gravel (Fill Material) Brown, Stiff trace organics		2	SS	14											
176.2			3	SS	13											0 16 45 39
2.8	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, V. Stiff to Hard		4	SS	24		176									
174.7			5	SS	39											3 26 47 24
4.4			6	SS	100		174									
	Brown Grey		7	SS	103											
			8	SS	53											
	Sandy Silt V. Dense		9	SS	136		172									
			10	SS	147		170									
168.9																
10.2	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		11	SS	69		168									
166.5			12	SS	41											
12.6	End of Borehole															

# RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 718.5 ; E 294 231.7 ORIGINATED BY MM  
 DIST 6 HWY 407 BOREHOLE TYPE H5 Auger, Washboring COMPILED BY MI  
 DATUM Geodetic DATE 90 06 19 CHECKED BY TS

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					
181.1	Ground Surface																
0.0	Sandy Silt Brown, V. Loose to Loose (Fill Material)		1	SS	3	DRY	180										
			2	SS	5		178										2 35 (63)
177.0																	
4.1	Irregular mixture of Clayey Silt, sand and gravel (Fill Material)		3	SS	15		176										
175.8	Brown, Stiff																
5.3	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown, Hard		4	SS	32		174										2 13 50 35
173.9																	
7.2	Brown ----- Grey		5	SS	101		172										
	Sandy Silt V. Dense		6	SS	120												
			7	SS	132		170										6 34 (60)
168.5			8	SS	143												
12.6	End of Borehole																

# RECORD OF BOREHOLE No 9

1 OF 1 METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 676.5 ; E 294 260.5 ORIGINATED BY MI  
 DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 19 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
176.0	Ground Surface													
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Brown		1	SS	27									
	V. Stiff		2	SS	29									0 12 30 58
	Hard		3	SS	50									
172.5			4	SS	120									
3.5	some gravel		5	SS	68									
	Sandy Silt to Silty Sand		6	SS	82									16 56 (28)
	Dense to V. Dense		7	SS	77									
	Brown		8	SS	31									0 18 62 20
	Grey													
167.3			9	SS	45									
8.7	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till) Hard		10	SS	102									5 24 46 25
			11	SS	100	/25cm								
162.0			12	SS	100	/15cm								
14.0	End of Borehole													

# RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 368-87-01 LOCATION Co-ords: N 4 845 625.5 ; E 294 281.5 ORIGINATED BY MI  
 DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI  
 DATUM Geodetic DATE 90 06 20 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT UNIT			UNIT WEIGHT 7 kN/m <sup>3</sup>	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 W <sub>L</sub>				
								SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					10 20 30				
175.1	Ground Surface																
0.0	Heterogeneous mixture of Clayey Silt, sand and gravel (Glacial Till)  Brown  V. Stiff ----- Hard		1	SS	28		174										
			2	SS	85		172										
			3	SS	105		170										
169.8																	
5.3	Sandy Silt to Silty Sand  V. Dense  Brown ----- Grey		4	SS	55		168										
			5	SS	53		166										
			6	SS	50												
165.5																	
9.6	End of Borehole																

**METRIC**

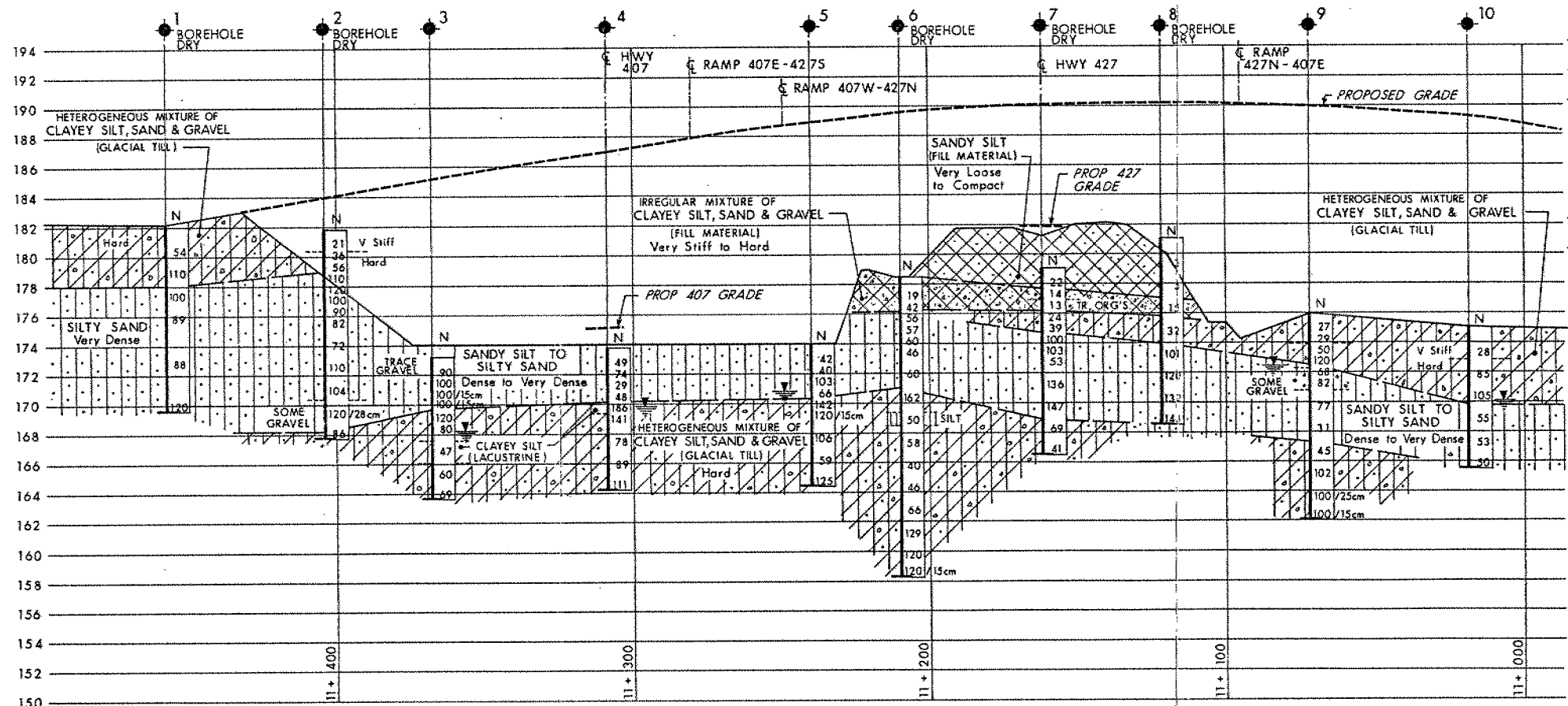
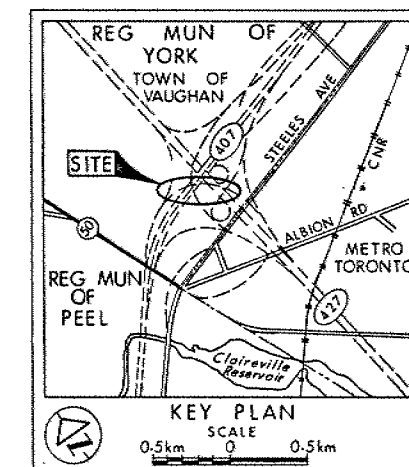
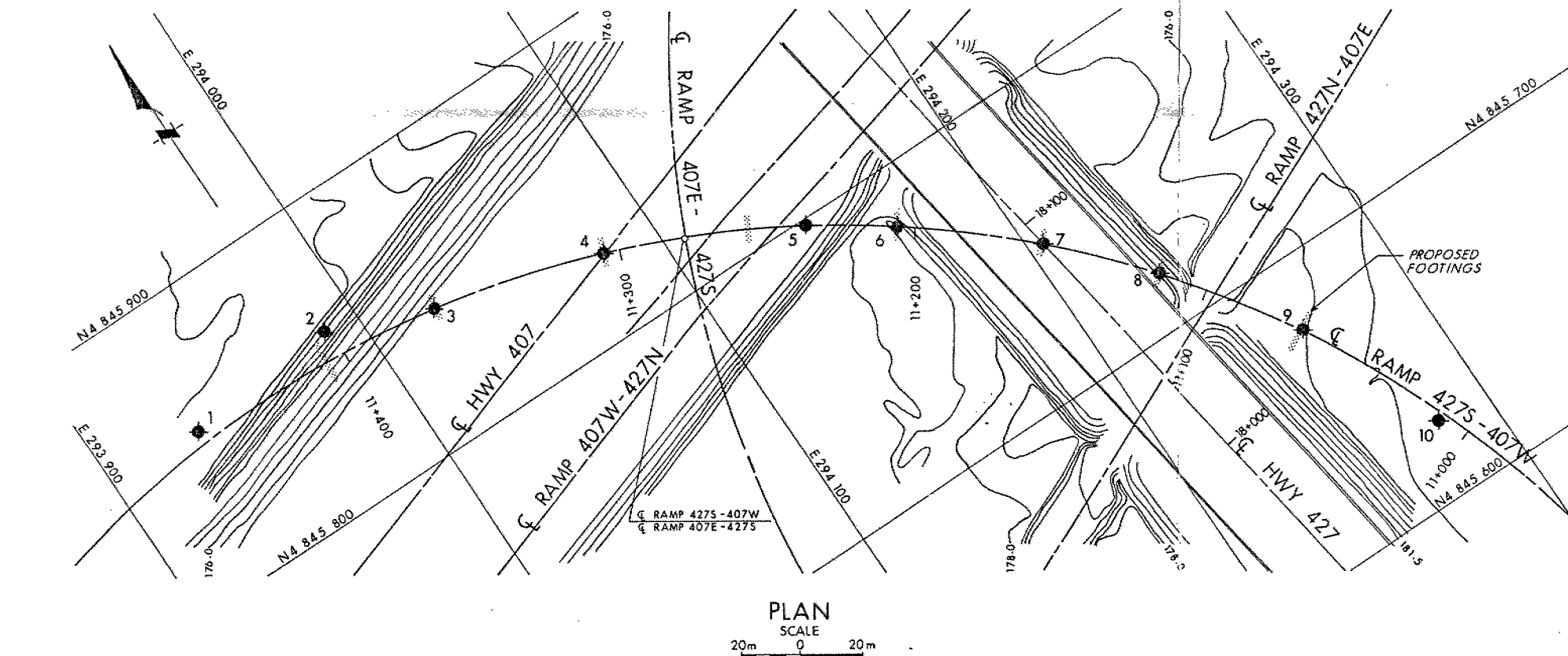
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

CONT No  
WP No 368-87-01



RAMP 427S-407W  
OVER HWY 427 & HWY 407  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- Wt at time of investigation 90 06

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	182.1	4 845 854.5	293 934.0
2	181.9	4 845 858.0	293 988.0
3	173.2	4 845 844.5	294 022.5
4	173.8	4 845 828.0	294 080.5
5	174.0	4 845 798.0	294 142.0
6	178.2	4 845 780.7	294 167.5
7	179.1	4 845 748.5	294 204.5
8	181.1	4 845 718.5	294 231.7
9	176.0	4 845 676.5	294 260.5
10	175.1	4 845 625.5	294 281.5

**NOTE**

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 30M13-116

HWY No 407	SUBMITTS	CHECKED	DATE 90 10 15	DIST 6
DRAWN DT	CHECKED	APPROVED		SITE 37-1335
				DWG 3688701-A

**NOTE:**

- HWY 427 WILL BE IN OPERATION DURING RAMP CONSTRUCTION
- HWY 407E-427S RAMP EXISTING
- HWY 407 TO BE CONSTRUCTED AFTER THE RAMP STRUCTURE CONSTRUCTION
- SOIL FILL EMBANKMENT EXISTED AT TIME OF INVESTIGATION TO FACILITATE FALSEWORK SUPPORT FOR 407E-427S RAMP DECK

Structural Section  
Central Region  
1201 Wilson Avenue  
Atrium Tower, 4th Floor  
Downsview, Ontario, M3M 1J8  
Telephone: 235-5512

**MINISTRY OF TRANSPORTATION**

---

**m e m o r a n d u m**

**TO:** Mr. M. Devata  
Head, Foundation Section  
  
Attn.: Mr. T. Sanguiliano

**DATE:** November 15, 1990

**RE:** Hwy. 407/427 Interchange  
Advanced Structures  
G.W.P. 368-87-00

---

We are now considering the alternative of using 3:1 slope instead the conventional 2:1 slope for the embankment for maintenance and aesthetic reasons. A copy of the memo from Planning and Design is attached for your information. This will affect three structures, sites; 37-1335, 1336 and 1337 which are currently under design.

Please comment if the proposed 3:1 slope is stable or the mid-height berm is still necessary.

*Dennis Wong*  
Dennis Wong  
Sr. Structural Engineer  
for:  
V. F. Boehnke  
Head, Structural Section

DW/ld

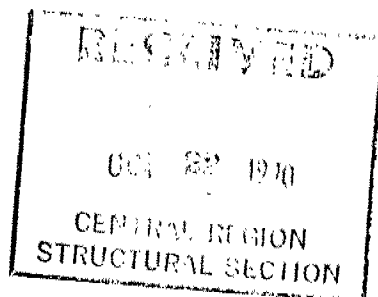
cc: W. Lachmaniuk - Giffels  
C. Gauer - R.E. Winter





Planning & Design Section  
Central Region  
Atrium Tower, 4th Floor  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1J8  
Telephone (416) 235-5538

October 19, 1990



To: Hwy 407 Design Consultants

Re: Hwy 407 Slide Slopes at Bridge Structures

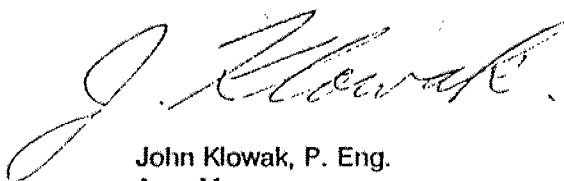
This provides technical direction regarding side-slope considerations at Hwy 407 bridges.

You will find enclosed an excerpt from the minutes of mini-meeting #90-30, dated 90/07/30.

On Hwy 407 contracts where it has been decided that a 3:1 side-slope should be used for roadway cross-sections, the alternative of using 3:1 slopes at bridge structures should be investigated.

Side slopes of 3:1 are readily maintained with tractor equipment where steeper slopes require hand mowers. Providing 3:1 side slopes for both roadway and structure cross-sections is also more aesthetically pleasing. However, the capital cost premium (if any) should be weighted against these maintenance and aesthetic benefits.

Please take appropriate action.



John Klowak, P. Eng.  
Area Manager

Enclosure

c.c. Distribution List



Structural Section  
Central Region  
1201 Wilson Avenue  
Atrium Tower, 4th Floor  
Downsview, Ontario  
M3M 1J8

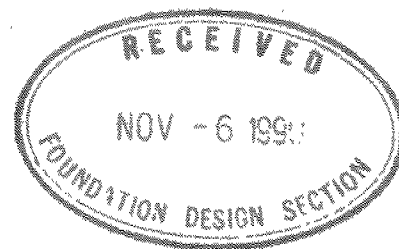
Tele. #(416) 235-5512

November 05, 1990

Mr. W. Lachmaniuk  
Giffels Associates Ltd.  
30 International Blvd.  
Rexdale, Ontario  
M9W 5P3

Dear Mr. Lachmaniuk:

Re: Hwy. 427/407 Interchange  
Advanced Structures  
G.W.P. 368-87-00



Change from the conventional 2:1 slope to flatter 3:1 slope could affect the structures in the following ways:

- i) Depth of foundation
- ii) Location of abutment
- iii) Length of wingwall.

The "existing" topography could also change. Since the grading from Cont. 89-62 which forms the "existing" topography of this W.P. could also be affected.

In order to maintain the present schedule and prevent possible re-design of structures for sites 37-1335, 37-1336 and 37-1337, it is important that revised E-Plans and new contour plans be issued within the next two weeks so that the addendum can be made on time.

Yours truly,

*Dennis Wong*  
Dennis Wong  
Sr. Structural Engineer  
for:  
V. F. Boehnke  
Head, Structural Section

DW:dd

*C.C. Mr. C. Gauer, R.E. Winter*  
*Mr. M. Chan, P&D*  
*Mr. T. Sanguiliano, Foundation*