

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-109A

DIST. 6 REGION                     

W.P. No. 632-89-00

CONT. No. 92-78

W. O. No.                     

STR. SITE No. 37-127

HWY. No. 400

LOCATION Hwy 400 & Rutherford Rd.  
H. M. L.

No of PAGES -                     

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

REMARKS:

# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 92-78**



Ministry of  
Transportation

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HML at Rutherford Road  
W.P. 632-89-00, Site -  
Hwy. 400, District 6 Toronto

Rutherford Road Interchange  
W.P. 632-89-01, Site 37-127  
Hwy. 400, District 6 Toronto

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

**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						

FOUNDATION INVESTIGATION REPORT  
For  
Proposed High Mast Lighting  
Highway 400/Rutherford Road Interchange  
W.P. 632-89-00 Site No. N/A  
District 6, Toronto

INTRODUCTION

A foundation investigation was carried out at the above-mentioned site for proposed high mast lighting of the reconstructed Highway 400/Rutherford Road Interchange.

During this investigation, boreholes were drilled at two of the proposed locations for the high mast lights. Subsurface information for three other locations was obtained from two previous borehole investigations (W.P. 96-78-02 and W.P. 632-89-01).

This report contains the factual information obtained from this and selected boreholes from the two previous investigations, which pertain to the structural foundations for the proposed five high mast lights, at the locations shown on Dwg. No. 6328900-A.

SITE DESCRIPTION AND GEOLOGY

The site is located in the area immediately surrounding (i.e. within 600 m) the existing Highway 400/Rutherford Road Overpass, in the Town of Vaughan, Regional Municipality of York.

There are two existing reinforced rigid frame concrete structures at the site. The first one consists of a 29 m span overpass which carries Rutherford Road over the existing Highway 400. The second is a smaller, more westerly structure with a span of 8.2 m, which carries Rutherford Road over the existing EW-S Ramp.

The site is located in the Bolton Area, which lies adjacent to the northwestern corner of Metropolitan Toronto. The Bolton physiographic area is characterized by drumlins, till plains, moraines and numerous other features associated with Wisconsinan glaciation (approximately 50,000 years ago) and its subsequent retreat (some 15,000 years ago).

Geological maps indicate that the overburden at the site consists of clayey silt morainic tills (Halton Till) underlain by stratified silt, clayey silt and/or silty clay sediments which were deposited in a ponded body of water known as Lake Peel. These soils are underlain by Paleozoic bedrock consisting of thinly bedded shales interbedded with limestone (Dundas/Meaford Formation) which, according to bedrock topography maps, lies at depths of about 70 to 80 m beneath the existing ground surface.

### PROCEDURES

The field work, for this project, which was carried out by this office on May 5 and 6, 1991, consisted of two sampled boreholes advanced to depths of 11.1 and 13.7 m by means of continuous flight, hollow stem augers driven by a bombardier-mounted drilling rig equipped with standard soil sampling equipment. Additional information was obtained from dynamic cone penetration testing adjacent to the two boreholes and at the base of one of them.

Groundwater levels were measured in the open boreholes immediately upon completion of sampling and then the augers were withdrawn and the boreholes backfilled.

The locations of the boreholes were staked in the field and their elevations determined by the Central Region Surveys and Plans Office.

The soil samples obtained in the field were examined in the laboratory by visual and tactile methods.

### SUBSURFACE CONDITIONS

BH's HM4 and HM5 were drilled at the proposed locations for high mast pole no.'s 4 and 5, respectively. Subsurface information for the remaining high mast poles was obtained from BH's 1, 2, 4 and 7 from Project No. W.P. 632-89-01, dated July 30, 1990 (and henceforth referred to as the 1990 investigation) as well as BH's MTC8 and MTC11 from Project No. 96-78-02, dated February 15, 1979 (and henceforth referred to as the 1979 investigation). The relevant borehole logs

and laboratory testing from these previous investigations are included in the Appendix at the back of this report.

The subsurface conditions appear to be fairly consistent at the proposed locations for the high mast lights. Topsoil, approximately 0.3 m thick, is underlain by a heterogeneous mixture of generally very stiff, silty clay to clayey silt (Glacial Till) (or sand to silty sand at one of the boreholes) which is, in turn, underlain by deposits of stiff to very stiff silty clay to clayey silt and compact to very dense, sandy silt to sand and gravel. The groundwater table is expected to be found at elevations varying from about 217 m to 218.5 m.

Detailed descriptions of the various soil and groundwater conditions encountered in the two boreholes, drilled during this investigation, as well as additional information obtained from previous investigations are given in the following sections.

#### Topsoil

A surficial layer of topsoil, approximately 300 mm thick, was contacted at BH HM5.

#### Clayey Silt (Fill)

A layer of clayey silt containing traces of topsoil enclosures was contacted at the ground surface at BH HM4. Since it appears that the clayey silt has been disturbed due to past farming activity, this material has been referred to as fill. It should be noted that such surficial disturbance is likely to be found at other high mast light locations as well.

In any case, it should be noted that, in our experience at many sites, the thickness of topsoil and/or soils disturbed by farming activity can vary significantly between boreholes.

### Sand to Silty Sand

A cohesionless deposit of brown sand to silty sand was contacted at the ground surface at BH 4 during the 1990 investigation. This deposit extended to a depth of approximately 6.6 m (or an elevation of about 216.8 m). 'N' values, measured during Standard Penetration Testing (SPT), ranged from 8 to 28 blows/0.3 m, indicating loose to compact conditions.

### Heterogeneous Mixture of Clayey Silt to Silty Clay, some Sand, Trace of Gravel (Glacial Till) (Upper)

Beneath the topsoil and/or disturbed soils, BH's HM4 and HM5 contacted a heterogeneous mixture of clayey silt to silty clay with some sand and a trace of gravel, which extended to depths of 2.1 m and 3.7 m (or elevations of about 216.9 m and 216.3 m, respectively). One of the boreholes, drilled during the 1990 investigation, indicated that the till extended to depths of at least 6.1 m. Visual examination of the fabric of the soil indicates that this soil is likely to be of glacial origin and therefore, may be considered a glacial till.

Atterberg Limits Tests carried out on several samples of the till obtained during the 1990 investigation, (and shown as Figure 3 in the Appendix), indicate that these soils range from low plasticity clayey silts to silty clays of intermediate plasticity. Grain Size Distribution Tests also presented in the Appendix (Figure 2) reveal a fairly well-graded mixture of 71 to 91 percent silt and clay-sized particles and from 10 to 25 percent sand.

Measured 'N' values from 6 blows/0.3 m to 88 blows/0.3 m indicate that the till is of firm to hard consistency. However, since, 'N' values generally range from 25 to 30+ blows/0.3 m, this deposit can be considered very stiff to hard.

### Silt, trace/some Sand

Some of the boreholes drilled during the 1990 investigation contacted a cohesionless deposit of silt with a trace to some sand at depths of 2.3 m to 6.6 m which extended to depths of 5.3 m (BH 7A) to the maximum depth explored in BH's 1 and 2.



The results of a Grain Size Distribution Test carried out on a sample of soil obtained from this deposit (and shown on Figure 4 of the Appendix) indicate soils ranging from silts (occasionally with up to 18 percent clay and 3 percent sand) to soils with about 67 percent silt, 26 percent sand and 2 percent gravel.

'N' values, carried out in this deposit, ranged from 9 to 108 blows/0.3 m indicating loose to very dense compactness conditions. However, since 'N' values generally ranged from 20 to 40 blows/0.3 m, the deposit can be considered compact to dense.

#### Silty Clay to Clayey Silt, some Sand

A deposit of silty clay to clayey silt with some sand, was encountered in BH's HM4 and HM5 at depths of 2.1 m and 3.7 m (elevations of 216.9 m and 216.3 m), respectively. This deposit extended to a depth of about 10.1 m in both boreholes.

Some of the soil in this deposit was found to be quite sandy and often contained partings and thin layers of sandy silt to fine sand indicating soils of glacio-lacustrine origin.

It is likely that this deposit represents the fringes of a similar deposit comprised of a heterogeneous mixture of clayey silt containing some sand and a trace of gravel which was encountered in a few of the boreholes (3, 7 and 7A) drilled during the 1990 investigation. Although this material was referred to as the 'Lower Glacial Till' in the 1990 report, random interbeds of layered clayey silt of possible glacio-lacustrine origin were found within it as well. The results of Atterberg Limits and Grain Size Distribution Tests carried out on samples of this deposit obtained during the 1990 investigation are shown (Figures 5 and 7) of the Appendix.

'N' values, measured in this deposit at BH's HM4 and HM5, ranged from 5 to 59 blows/0.3 m indicating soils of firm to hard consistency. However, in general, 'N' values ranged from 15 to 30 blows/0.3 m indicating soils of very stiff consistency.

### Sandy Silt to Silty Sand

A layer of sandy silt to silty sand was encountered in BH's HM4 and HM5 at depths of about 10.1 m (elevation 208.9 m to 209.9 m). This deposit appears to be an extension of the sand and gravel deposit encountered at much greater depth (19.1 m or elevation 204.5 m) in BH 7, which was drilled during the 1990 investigation (see the Grain Size Distribution Tests results shown on Figure 6 of the Appendix).

In both cases, these deposits were found to be water bearing and consequently, when the boreholes penetrated into them, sand and silt-sized particles quickly moved up into the augers due to the unbalanced hydrostatic head.

'N' values measured during this investigation ranged from 5 to 51 blows/0.3 m indicating loose to very dense compactness conditions in this deposit. It should be noted, however, that the 5 blows/0.3 m recorded at BH HM4 was likely to be unrepresentative, due to the unbalanced hydrostatic head and resulting disturbance of the sand beneath the augers. 'N' values of 34 to 75 blows/0.3 m were consistently recorded in the coarser deposits encountered in BH 7 which is more in line with the measured results obtained at BH HM5. Therefore, the soil can generally be considered dense to very dense.

### GROUNDWATER CONDITIONS

The groundwater levels, measured in BH's HM4 and HM5, immediately upon completion of sampling, were found to be at depths of 6.5 m and 9.5 m (or elevations of 212.5 m and 210.5 m), respectively.

Similar observations were made during the two previous investigations (W.P. 96-78-02 and W.P. 632-89-01) which also indicated that several of the boreholes were either dry or the water levels were relatively close to the bottom of the boreholes upon completion of sampling.

It should be noted, however, that, where the very permeable cohesionless sand and gravel layer was encountered in BH 7, (during Project No. 632-89-01), a much higher water level was recorded (elevation 217.4 m). Although the water levels

recorded in our observations were much lower than this, it was observed that the water levels continued to rise in both BH's HM4 and HM5 until the augers were withdrawn and the surrounding soil collapsed into the boreholes.

Such observations indicate that these permeable soils had simply allowed the groundwater level to stabilize more quickly and the low groundwater levels observed in most of the boreholes, probably reflects the relatively impervious nature of the clayey soils above these layers rather than the existence of a very low groundwater table.

Based on moisture contents and colour changes in the soil, as well as groundwater observations during this and previous investigations, it appears that the long term groundwater table is likely to be at the highest levels recorded or at elevations of about 215.6 m to 218 m.

In any case, it should be noted that the groundwater table is always subject to seasonal fluctuations and is expected to rise during the spring freshet and during and immediately following any periods of prolonged heavy rainfall.

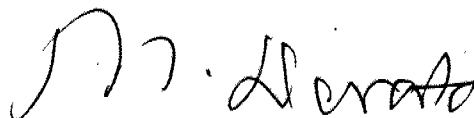
#### MISCELLANEOUS

The field investigation was supervised by Messrs. J. Blair, D. Tari and M. Iampietro, using equipment owned and operated by Malone's Soil Samples Inc.

This report was written by Mr. J. Blair, Project Foundation Engineer, reviewed by Dr. B. Iyer, Senior Foundation Engineer and approved by Mr. M. Devata, Chief Foundation Engineer.



B. Iyer, P. Eng.  
Senior Foundation Engineer



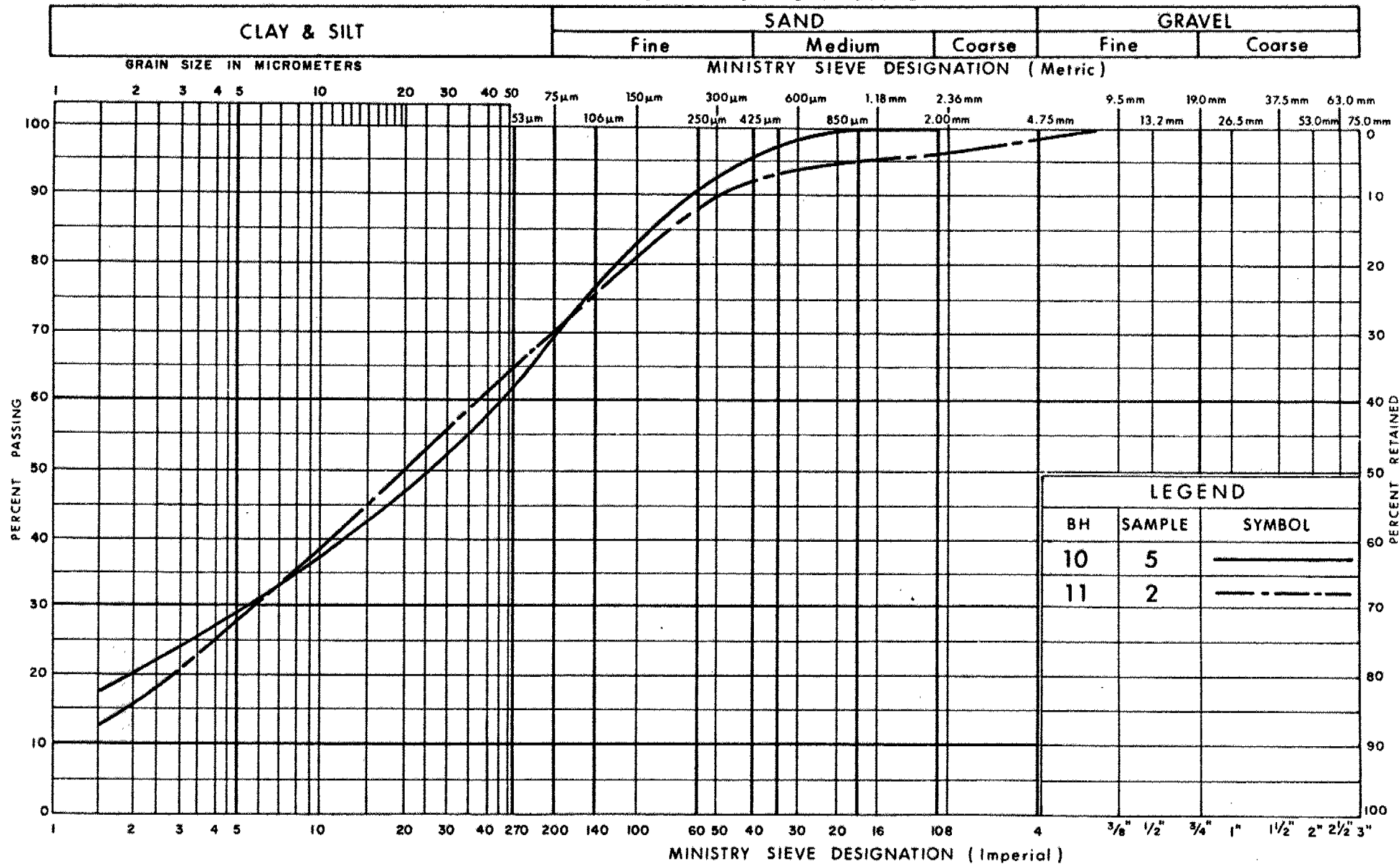
M.S. Devata, P. Eng.  
Chief Foundation Engineer

## APPENDIX

Table I

Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Design Parameters				
	Original (m)	Finished Grade (m)	Upper (m)	Lower (m)	Cohesive (C) Non-Cohesive (NC)	$\phi$ Degrees	qu kPa	$\gamma$ kN/m <sup>3</sup>	Assumed Water Level (m)	Borehole No.
1	222.6	223	221.8	221.4	Cohesive		400	22.4	220.5	1,2
			221.4	218.0	Non-Cohesive	36		21.0		
			218.0	215.0	Non-Cohesive	33		21.0		
			215.0	213.0	Non-Cohesive	40		21.5		
			213.0	211.0	Non-Cohesive	31		21.0		
2	223.3	223.0	S A M E A S A B O V E							2,MTC11
3	224.1	224.0	222.8	222.0	Non-Cohesive	28		18.0	217.5	4
			222.0	217.0	Non-Cohesive	33		20.5		
			217.0	215.0	Cohesive		400	21.0		
			215.0	213.0	Cohesive		300	20.7		
			213.0	211.0	Cohesive		600	21.8		
4	219.0	220.0	218.8	218.3	Cohesive		300	20.7	216.0	HM4
			218.3	216.9	Cohesive		400	21.0		
			216.9	216.0	Cohesive		350	20.7		
			216.0	214.5	Cohesive		150	20.3		
			214.5	211.5	Cohesive		350	20.8		
			211.5	208.8	Cohesive		400	21.0		
			208.8	207.0	Non-Cohesive	31		20.5		
5	220.0	220.0	218.8	217.1	Cohesive		500	22.5	215.6	HM5
			217.1	216.3	Cohesive		400	22.0		
			216.3	214.4	Cohesive		400	21.0		
			214.4	212.8	Cohesive		300	20.7		
			212.8	211.2	Cohesive		200	20.7		
			211.2	209.9	Cohesive		400	21.0		
			209.9	208.9	Non-Cohesive	40		21.5		

## UNIFIED SOIL CLASSIFICATION SYSTEM

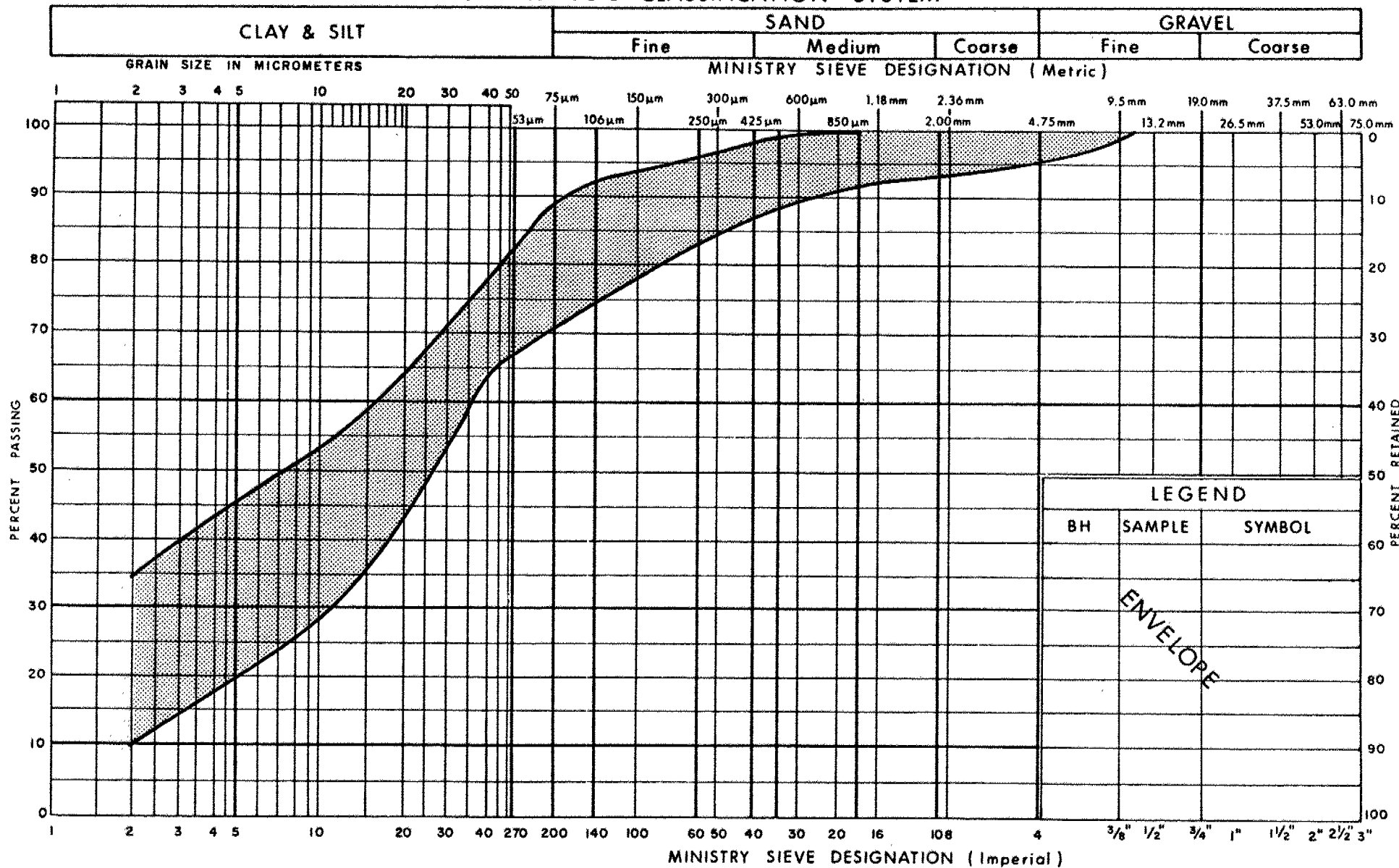


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## GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SANDY SILT

FIG No 1

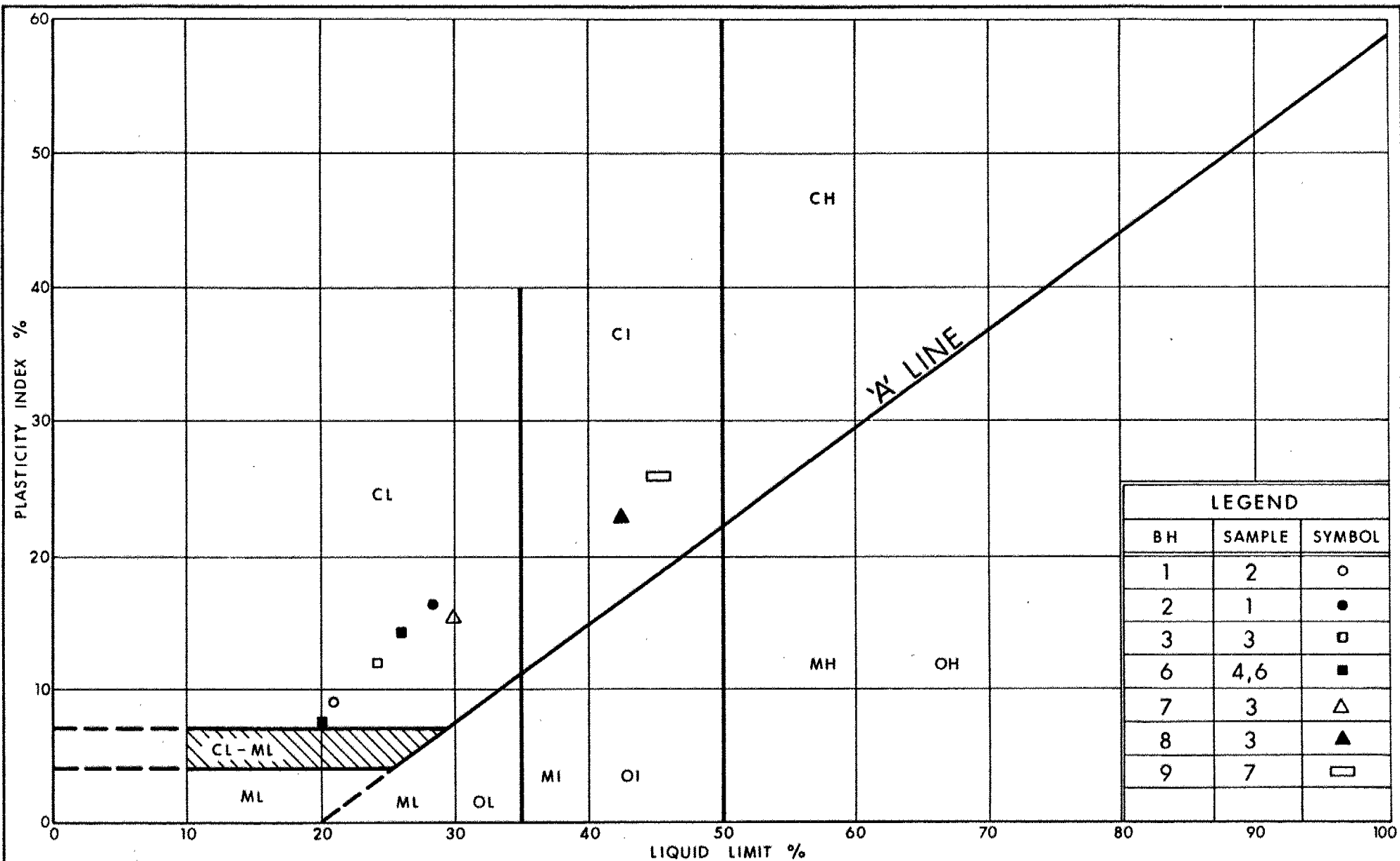
W P 632-89-01

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GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TO SILTY CLAY SOME SAND, TR GRAVEL  
(GLACIAL TILL) UPPER

FIG No 2

W P 632-89-01



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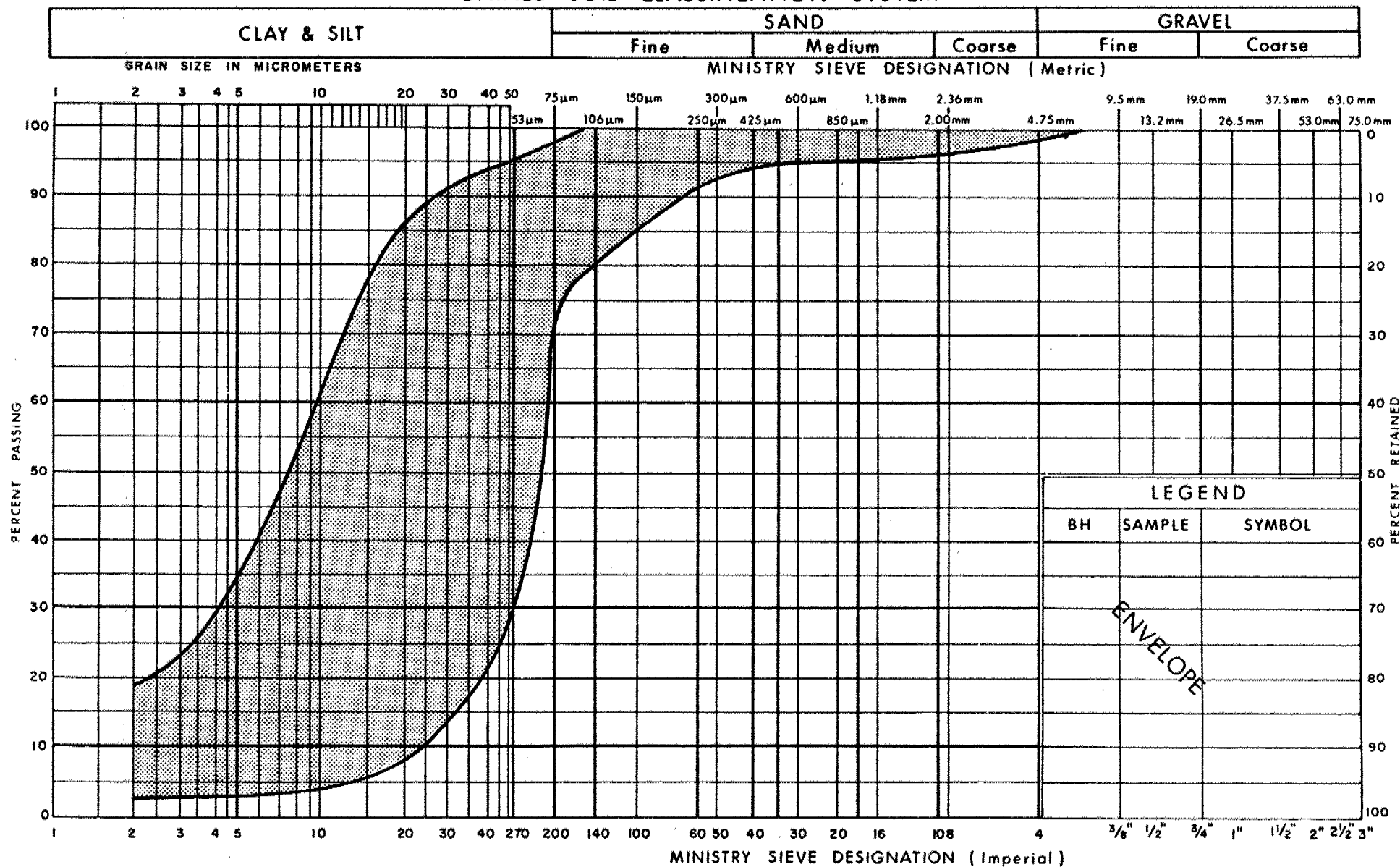
PLASTICITY CHART  
CLAYEY SILT, SOME SAND, TR GRAVEL  
(GLACIAL TILL) UPPER

FIG No 3

W P 632-89-01



## UNIFIED SOIL CLASSIFICATION SYSTEM

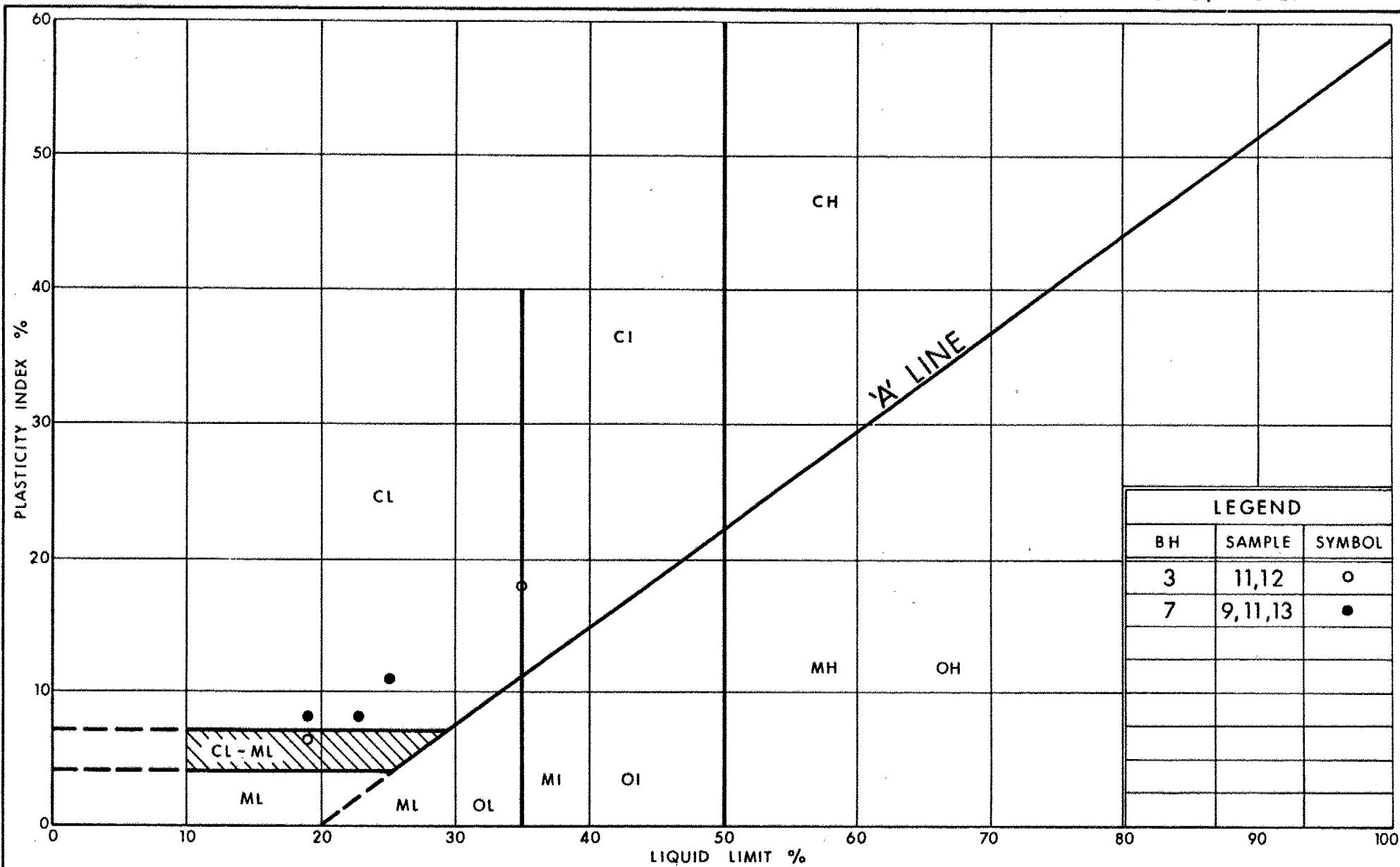


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GRAIN SIZE DISTRIBUTION  
SILT, TRACE / SOME SAND

FIG No 4

W P 632-89-01



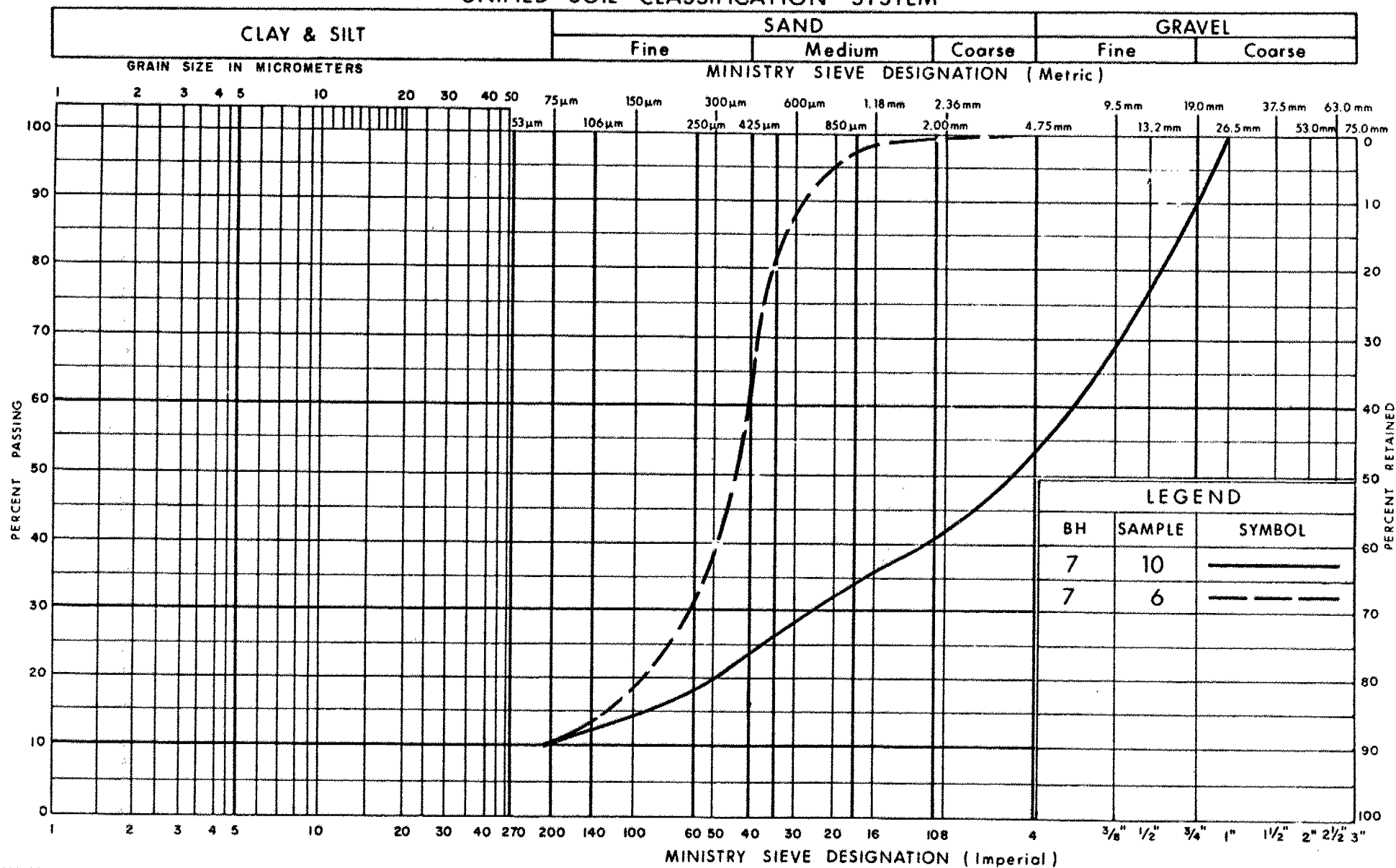
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Ontario

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

FIG No 5

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



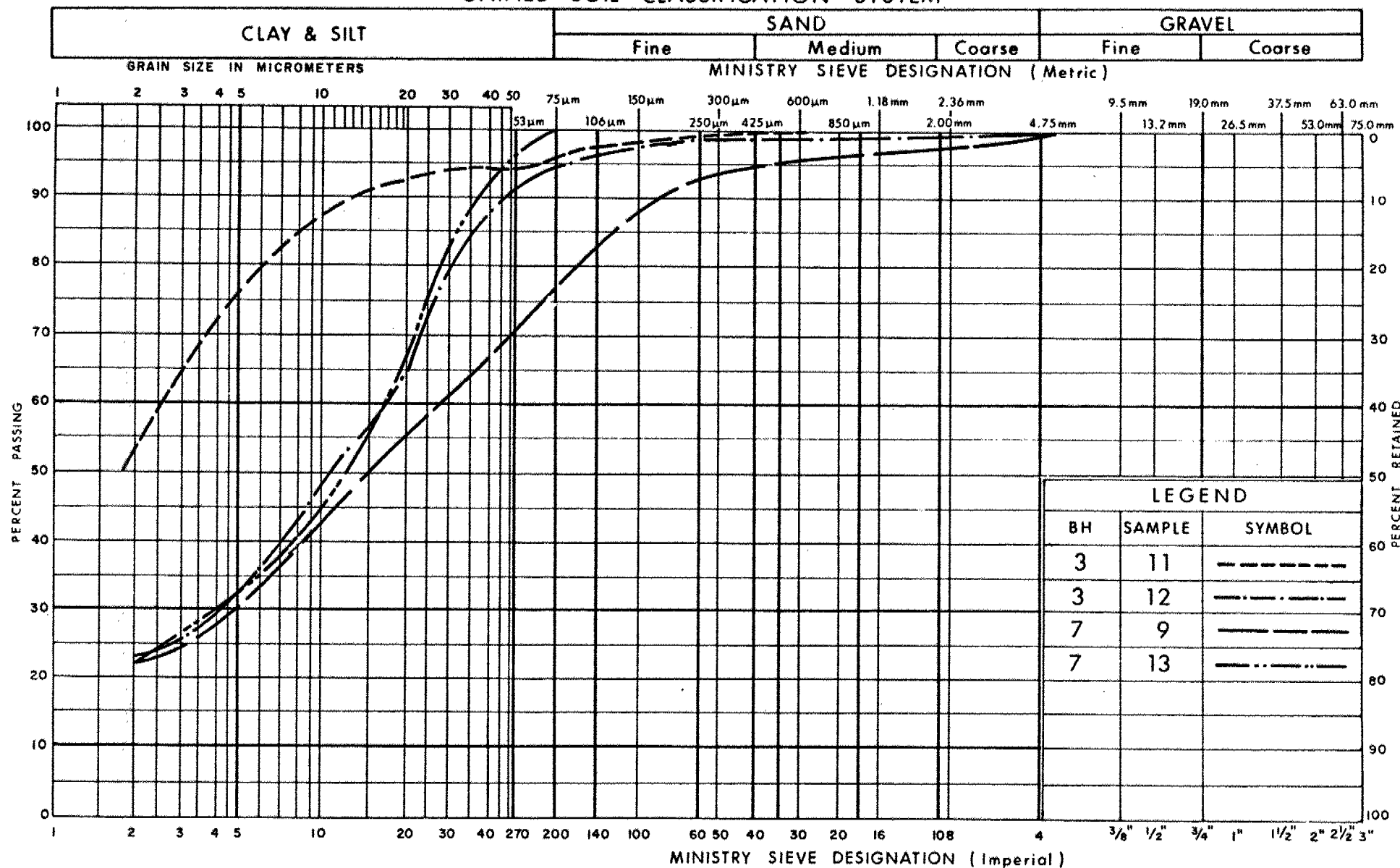
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Transportation

# GRAIN SIZE DISTRIBUTION SAND & GRAVEL

FIG No 6

W P 632 - 89 - 01

## UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION  
CLAYEY SILT, SOME SAND, TR GRAVEL  
(GLACIAL TILL) (LOWER)

FIG No 7

W P 632-89-01

RECORD OF BOREHOLE No HM4

1 OF 1

METRIC

W.P. 632-89-00 LOCATION Co-ords. N 4 853 890; E 300 811 ORIGINATED BY JB  
DIST 6 HWY 400 BOREHOLE TYPE H.S. Auger COMPILED BY JB  
DATUM Geodetic DATE 91 06 06 CHECKED BY BI

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					
219.0														
0.0	300 mm Topsoil Heterogeneous Mixture of Clayey Silt, some Sand, tr. of Gravel (Upper Glacial Till)		1	SS	10									
			2	SS	32									
216.9	Stiff to Hard Brown		3	SS	28									
2.1	Brownish Grey		4	SS	17									
	Silty Clay to Clayey Silt, Some Sand		5	SS	5									
	Contains Numerous Thin Partings and Layers of Sandy Silt to Silty Fine Sand		6	SS	9									
	(Occasionally 'Till-Like')		7	SS	16									
	Stiff to Hard		8	SS	17									
			9	SS	14									
			10	SS	15									
			11	SS	27									
208.9			12	SS	30									
10.1	Sandy Silt to Silty Sand		13	SS	14									
	Compact to Very Dense		14	SS	5 **									**Soil probably disturbed due to unbalanced hydrostatic head.
205.3														
13.7	End of Borehole													
202.2														
16.8	End of Cone Test													
	Note: The water level in the open borehole was at a depth of 6.5 m immediately upon com- pletion of sampling. However, it is unlikely that the water level has had sufficient time to stabilize.													

RECORD OF BOREHOLE No HM5

1 OF 1

METRIC

W.P. 632-89-00 LOCATION Co-ords. N 4 854 560; E 300 985 ORIGINATED BY JB  
DIST 6 HWY 400 BOREHOLE TYPE H.S. Auger COMPILED BY JB  
DATUM Geodetic DATE 91 06 07 CHECKED BY BI

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					
220.0														
0.0	300 mm Topsoil Heterogeneous Mixture of Clayey Silt, Some Sand, Trace of Gravel (Upper Glacial Till)  Very Stiff to Hard	Brown	1	SS	3									
			2	SS	32									
			3	SS	88									
			4	SS	88									
216.3		Grey	5	SS	27									
3.7	Silty Clay to Clayey Silt, Trace Sand  Contains Occasional Thin Layers and Portings of Sand  Stiff to Hard		6	SS	71									
			7	SS	59									
			8	SS	28									
			9	SS	10									
209.9			10	SS	42									
10.1	Sandy Silt to Silty Sand Very Dense		11	SS	51									
208.9														
11.1	End of Borehole  *Note: The water level in the open borehole was at a depth of 9.5 m immediately upon com- pletion of sampling. However, it is unlikely that the water level has had sufficient time to stabilize.													

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 048.5 ; E 301 100 ORIGINATED BY FLR  
DIST 5 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
DATUM Geodetic DATE 90 03 27 CHECKED BY TS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
223.7	Ground Surface												
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	11								
221.4	Brown, Stiff to Hard		2	SS	26								
2.3	Silt, Trace/ Some Sand Compact to Very Dense  Brown Grey		3	SS	36								
			4	SS	36								
			5	SS	29								
			6	SS	22								
			7	SS	17								
			8	SS	108								
			9	SS	66								
			10	SS	14								
211.1			11	SS	15								
12.6	End of Borehole												

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords N 4 854 047.5 ; E 301 132 ORIGINATED BY FLR  
 DIST 5 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
 DATUM Geodetic DATE 90 03 27-28 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
223.5	Ground Surface																
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	21		222									21.0	0 15 55 30
221.3	Brown, Very Stiff		2	SS	28												
2.3	Brown Gray		3	SS	28		220										0 10 80 10
			4	SS	37												
			5	SS	22												
	Silt, Trace Sand Compact to Very Dense		6	SS	33		218										0 3 82 15
			7	SS	22												
			8	SS	21		216										
			9	SS	60		214										
			10	SS	39		212										
210.9			11	SS	18												
12.6	End of Borehole																



RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 016 ; E 300 987 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY TS  
 DATUM Geodetic DATE 90 04 11 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 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>		
223.4	Ground Surface															
0.0			1	SS	8											
			2	SS	10											
			3	SS	20											
			4	SS	15											
			5	SS	14											
			6	SS	28											
216.8			7	SS	21											
6.6			8	SS	30											
			9	SS	18											
			10	SS	39											
210.8			11	SS	32											
12.8	End of Borehole															
	* GWL - Dry upon completion															

## RECORD OF BOREHOLE No 7

1 OF 2

METRIC

W.P. 632-89-01

LOCATION Co-ords: N 4 854 013.5 : E 301 027

ORIGINATED BY TS

DIST 6 HWY 400

BOREHOLE TYPE HS Auger , NW Casing , Washboring

COMPILED BY TS

DATUM Geodetic

DATE 90 04 02

CHECKED BY TS

[illegible]

Continued

+3, x5: Numbers refer to Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

Continued

## METRIC

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No MTC 8 (96-78-02) METRIC

W.P. 832-89-01 LOCATION Co-ords: N 4 854 004 : E 301 019 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE November 24, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
223.4																
0.0	Topsail - Organics, 150 mm		1	SS	32											
			2	SS	25	222										21.4
			3	SS	28	221										21.5
	Silty Clay, Traces of Sand and Gravel, Sand layers Brown, Very Stiff to Hard		4	SS	31	220										19.8
			5	SS	20	219										
						218										
217.3																
6.1 216.9	*		6	SS	70	217										22.9
6.5	End of Borehole															
	* Sandy Silt to Clayey Silt, Traces of Gravel Very Dense															
	Water level at 6.0 m depth and borehole open to 6.1 m depth upon completion.															

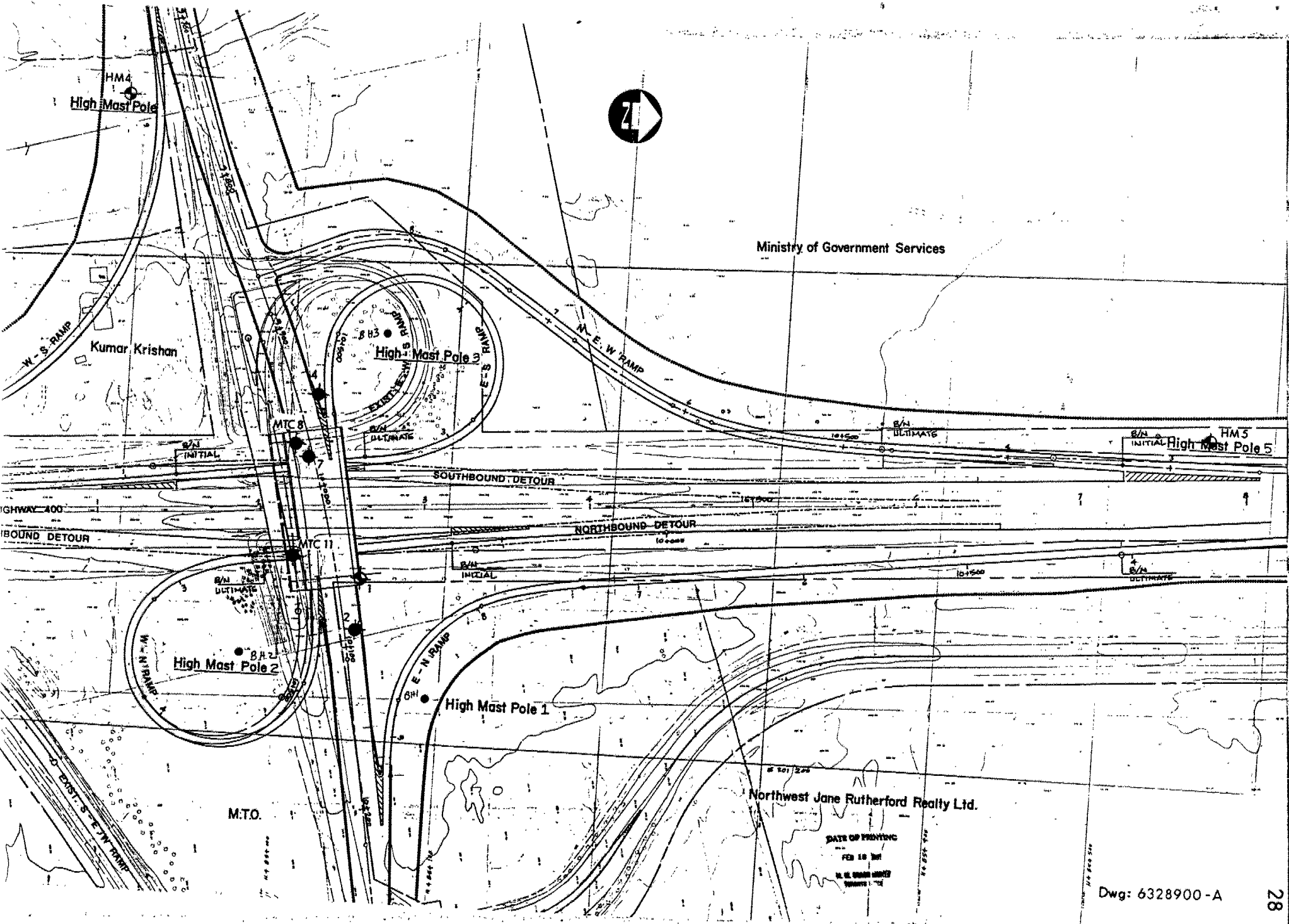
# RECORD OF BOREHOLE No MTC 11(96-78-02) METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 006 ; E 301 088 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE December 4, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	WATER CONTENT (%) 7	UNIT WEIGHT 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						
231.0																		
0.0	Gravel - Some Sand, 150 mm																	
			1	SS	16		230										22.1	
			2	SS	7													2 27 53 18
			3	SS	8		229											
			4	SS	8		228											
							227											
			5	SS	22													
							226											
							225										22.1	
			6	SS	26		224											
223.4																		
7.6	Topsoil - Silty Sand, Black, Organics		7	SS	26		223											
222.9																		
8.1							222											
			8	SS	35												21.9	4 23 44 29
							221											
							220											
			9	SS	27													
							219											
218.4			10	SS	57													
12.6	End of Borehole																	
	Borehole Dry and open to 8.2 m depth upon completion.																	



Ministry of Government Services



Northwest Jane Rutherford Realty Ltd.

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FOUNDATION INVESTIGATION REPORT  
For  
Proposed Crossing at  
Rutherford Road and Highway 400  
W.P. 632-89-01, Site 37-127  
Highway 400, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to reconstruct the entire Hwy. 400-Rutherford Interchange immediately north of the existing interchange. A two span structure is proposed.

The proposed profile grade of Rutherford Road is approximately 232.5 m to 233.5 m with an elevation ascension occurring in the westerly direction. The grade of Hwy. 400 will remain unchanged at approximately 225.5 m. The natural ground surface is generally at El. 223 to 224 and hence up to 10.5 m of approach fill will be required to the structure.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately north and adjacent to the existing Hwy. 400-Rutherford Road Overpass approximately 0.5 km south of Canada's Wonderland which is bounded by Major Mackenzie Drive to the north and Hwy. 400 and Jane Street to the west and east respectively in the Town of Vaughan, Regional Municipality of York.

Two structures adjoin each other at the site. One structure carries Rutherford Road over the existing Hwy. 400 and the second westerly structure carries Rutherford over the existing EW-S ramp. Both structures are reinforced concrete rigid frame structures with spans of approximately 29 m and 8.2 m for the Hwy. 400 and ramp structure respectively. The Hwy. 400 structure was constructed in the early 1950's and the ramp structure extension was built under Contract #79-100.

The aging of the older structure is evidenced by the spalling and delamination of the concrete. This is particularly pronounced at the bridge deck soffit

where exposed corroded reinforcing steel is present. Despite the concrete deterioration, no signs of distress caused by foundation subsidence or earth pressure exists. No signs of structural distress or deterioration are present for the newer ramp structure.

Approach fills for the structure and the EW-S ramp contour the generally flat to gently undulating terrain at the site. Approach fills to the structures are in the order of 8 m and embankment fills for the existing EW-S ramp is in the order of 4 m.

Corrugated steel plate culverts and shallow surface drainage channels also occupy the site as part of the surface runoff drainage regime.

The land surrounding the site consists mainly of grassland and forestland.

Physiographically, the site lies in the geological domain known as the Bolton Area, an area that covers approximately 1200 square kilometres located at the northwestern border of the Municipality of Metropolitan Toronto. The Bolton area has drumlins, till plains, moraines and numerous other features associated with deglaciation. The area was covered with the Wisconsin glacier of the Pleistocene period that advanced into the region approximately 50,000 years ago and retreated approximately 15,000 years ago.

The overburden deposits at the site consist of moraine tills of the Halton Till Formation underlain by glaciolacustrine sediments deposited by Lake Peel, a body of water impounded between lobes of projecting ice. The Halton Till is primarily a clayey silt till composed of varying percentages of clay, silt, sand and gravel. The glaciolacustrine deposits generally consist of stratified silt, clayey silt and/or silty clay.

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



that the bedrock exists at depths approximately 70-80 m below the natural ground surface at the site location.

### INVESTIGATION PROCEDURES

#### Field Investigation

The fieldwork for the investigation was carried out between 90 03 27 to 90 04 11 and consisted of 7 sampled boreholes advanced to depths ranging from 12.6 m to 41.6 m below the ground surface. The elevation of the ground surface at the borehole locations range from 223.2 to 225.2. Four boreholes (BH's 8-11 inclusive) previously advanced between 78 11 24 and 78 12 04 in conjunction with the existing structures have also been included in this report.

Track mounted CME 55 equipment employing hollow stem augering techniques and also washboring/casing methods was used to advance the boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m 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 Limits
- 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

The soil stratigraphy at the site consists of fill material that comprises the approach embankments to the existing structure. This fill material consists of an irregular mixture of clayey silt to sandy silt. The height of the embankment fill material is in the order of 8 m.

Underlying the fill material and present surficially adjacent to the fill at all proposed structure foundation locations and the east approach location, exists a deposit of clayey silt to silty clay with some sand and a trace of gravel. The thickness of this till deposit varies across the site ranging from 2.3 m to 4.5 m at the proposed east abutment, 6.6 m at the proposed pier location and 3.1 m to 6.1 m at the proposed west abutment. The consistency of the deposit also varies ranging from firm to hard.

At the west approach (BH 4), the clayey silt to silty clay deposit is overlain by a cohesionless deposit of sand to silty sand. The thickness of this deposit is approximately 6.6 m and its state of denseness varies from loose to compact.

Underlying the clayey silt to silty clay till deposit, a cohesionless deposit of varying percentages of silt and sand exists. The extent of this deposit was not determined at the proposed east abutment and pier locations. At the west abutment location, the thickness of this deposit varied from approximately 1.5 to 6.1 m. The deposit is generally in a compact to dense state of condition.

At the west abutment location, the cohesionless silt and sand deposit is underlain by a second till deposit consisting of a clayey silt with some sand and a trace of gravel. This deposit also contains random interbeds of layered clayey silt of glaciolacustrine origin. The thickness of this deposit, determined at BH 7, is equivalent to 10.7 m.

A deposit of sand and gravel underlies the lower clayey silt deposit at the west abutment location. This deposit extends to a depth of approximately 33.5 m below the existing natural ground surface (EL. 190 m) and is approximately 14.4 m in thickness. The deposit has a very dense state of denseness.

The sand and gravel deposit is further underlain by a cohesive stratum consisting of a clayey silt. This stratum has a thickness, as determined at BH 7, of approximately 4.6 m and has a hard consistency.

The cohesive clayey silt stratum is underlain by a very dense silt deposit that contains traces of sand. The extent of this deposit was not determined in the investigation.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 6328901-A.\*

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

#### Clayey Silt to Sandy Silt (Fill Material)

The existing Rutherford Road approach embankments consist of an irregular mixture of clayey silt to sandy silt and hence the material varies in behaviour from cohesive to cohesionless respectively. Traces of gravel and occasional shale fragments are also present within the fill. Traces of organics and topsoil were found at the bottom of the embankment fill immediately overlying

\* DWG NO 2 OF THE CONTRACT DWG'S

the natural subgrade. Figure 1 in the Appendix illustrates grain size distribution curves for representative samples of the fill material.

The material is brown in colour and contains natural moisture contents ranging from 10 to 20%. The unit weight of the material ranges from 21.1 to 22.1 kN/m<sup>3</sup>.

Based on 'N' values obtained from the Standard Penetration Test ranging from 7 blows/0.3 m to 43 blows/0.3 m, the fill material is in a firm to hard/loose to dense state. In general, however, the fill material can be categorized as very stiff/compact.

#### Sand to Silty Sand

At the proposed west approach embankment (BH 4), a surficial cohesionless deposit of brown sand to silty sand exists. This deposit is approximately 6.6 m in thickness and based on 'N' values obtained from the Standard Penetration Test ranging from 8 blows/0.3 m to 28 blows/0.3 m, the deposit can be categorized as having a loose to compact denseness.

#### Clayey Silt to Silty Clay, some Sand, trace of Gravel (Glacial Till) (Upper)

The native surficial deposit across the site, except at the west approach embankment, is composed of a clayey silt to silty clay with some sand and also traces of gravel. The deposit is a till deposit of glacial origin and hence, although not encountered during the field investigation, boulders and cobbles are characteristic components of these deposits and hence can exist. Figure 2 in the Appendix provides a grain size distribution envelope illustrating the gradation of this deposit. The envelope reveals that a significant portion of the deposit is comprised of clay and silt (71 to 90%) and sand composition ranges from 10 to 25%.

Traces of black organics are also present within the surficial metre or so of the deposit. This deposit has been completely oxidized and hence is brown in colour.

The thickness of the deposit varies across the site. At the proposed east abutment, the thickness ranges from 2.3 to 4.5 m, whilst at the proposed pier and west abutment the thickness is 6.6 m and 3.1 to 6.1 m respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 3 in the Appendix. A summary of the indices is provided in Table 1 below.

Table 1 - Clayey Silt to Silty Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	11-16	8
Liquid Limit (w <sub>L</sub> %)	21-45	8
Plasticity Index (I <sub>p</sub> %)	8-25	8
Unit Weight (kN/m <sup>3</sup> )	19.5-22.4	9

The results reveal that the fine grained portion of the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay). The fine grained portion of the deposit constitutes the main component of the deposit and hence the behaviour of the overall deposit is governed by this fine grained portion.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 6 blows/0.3 m to 74 blows/0.3 m. Lower 'N' values were obtained at the proposed west abutment location where values between 6 to 20 were more frequent at varying depths. Aside from these localized lower 'N' values, 'N' values are generally in the 25 to 30 range. Based on these 'N' values, the material can be described as having a firm to hard consistency.

#### Silt, trace/some Sand

Underlying the clayey silt to silty clay till deposit exists a cohesionless deposit composed of a silt with traces to some sand. The extent of this deposit was not established at the proposed east abutment and pier but at the west abutment the thickness of the deposit varied between 1.5 and 6.1 m. Minor traces of gravel are also present within this deposit.

A grain size distribution envelope for this deposit is provided in Figure 4 in the Appendix.

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

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 9 blows/0.3 m to 108 blows/0.3 m indicating that the deposit ranges in denseness from loose to very dense. In general, 'N' values are in the 25 to 40 range and consequently, the deposit can be categorized as having a compact to dense denseness.

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

At the proposed west abutment location, a second till deposit consisting of a clayey silt with some sand and a trace of gravel underlies the silt deposit. The thickness of this deposit was determined at BH 7 only and is equivalent to 10.7 m.

The deposit also contains random interbeds of clayey silt that is layered and of glaciolacustrine origin. Boulders and cobbles are generally characteristic components of till deposits and although not encountered in the investigation can exist. Grain size distribution curves derived from representative samples of this material is illustrated in Figure 5 in the Appendix.

Atterberg Limit Tests were carried out to evaluate the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 6 in the Appendix and summarized in Table 2 below.

Table 2 - Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	11-26	5
Liquid Limit (w <sub>L</sub> %)	19-35	5
Plasticity Index (I <sub>p</sub> %)	6-18	5

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

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 60 blows/0.3 m. Localized weaker zones that reflect in the lower 'N' value exist randomly in the deposit, particularly at BH 3 where 'N' values ranged from 2 blows/0.3 m to 9 blows/0.3 m. In general, the deposit has a very stiff to hard consistency with localized very soft to firm zones.

#### Sand and Gravel

At the west abutment location, the clayey silt lower till deposit is underlain by a cohesionless sand and gravel deposit that is approximately 14.4 m in thickness. Figure 6 in the Appendix illustrates the varying grain size distributions of the sand and gravel.

The sand and gravel deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head. Washboring and casing techniques were required to facilitate borehole advancement through this deposit.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 34 blows/0.3 m to 75 blows/0.3 m, indicating a denseness of dense to very dense. In general, 'N' values exceeded 50 blows/0.3 m and hence the deposit can be categorized as very dense.

#### Clayey Silt

The cohesionless sand and gravel deposit is underlain by a stratum of clayey silt that is cohesive and of low plasticity. Its thickness at BH 7 was equivalent to 4.6 m and based on 'N' values of 70 blows/0.3 m and 95 blows/0.3 m, the clayey silt stratum can be categorized as having a hard consistency.

#### Silt

The clayey silt stratum is further underlain by a cohesionless deposit of silt with traces to some sand. This stratum exists at elevation 185.4 m which is approximately 38.1 m below the natural ground surface at the proposed west

abutment location. The extent of this deposit was not determined during the investigation. Figure 7 in the Appendix illustrates a grain size distribution curve for this soil.

Based on 'N' values ranging from 100 blows/0.15 m to 165 blows/0.3 m, the soil can be categorized as very dense. The soil did not require protection against cave-in during borehole advancement using conventional washboring techniques.

#### GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. In general, the water levels obtained at the time of the investigation were below or close to the depth of the borings that were advanced except at BH 7. The relatively shallow boreholes were advanced to depths ranging from 12.6 m to 14.2 m or Elevations ranging from approximately 209 to 212.5 m. At the deeper BH 7, the elevation of the groundwater level was approximately 216 m, approximately 7.5 m below the natural ground surface. This latter groundwater level reflects the subartesian water condition in the lower sand and gravel deposit.

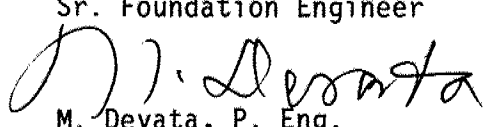
Groundwater levels in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

#### MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer and F. Reynolds, Construction Technician, utilizing equipment owned and operated by Malone's Soil Samples 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 by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

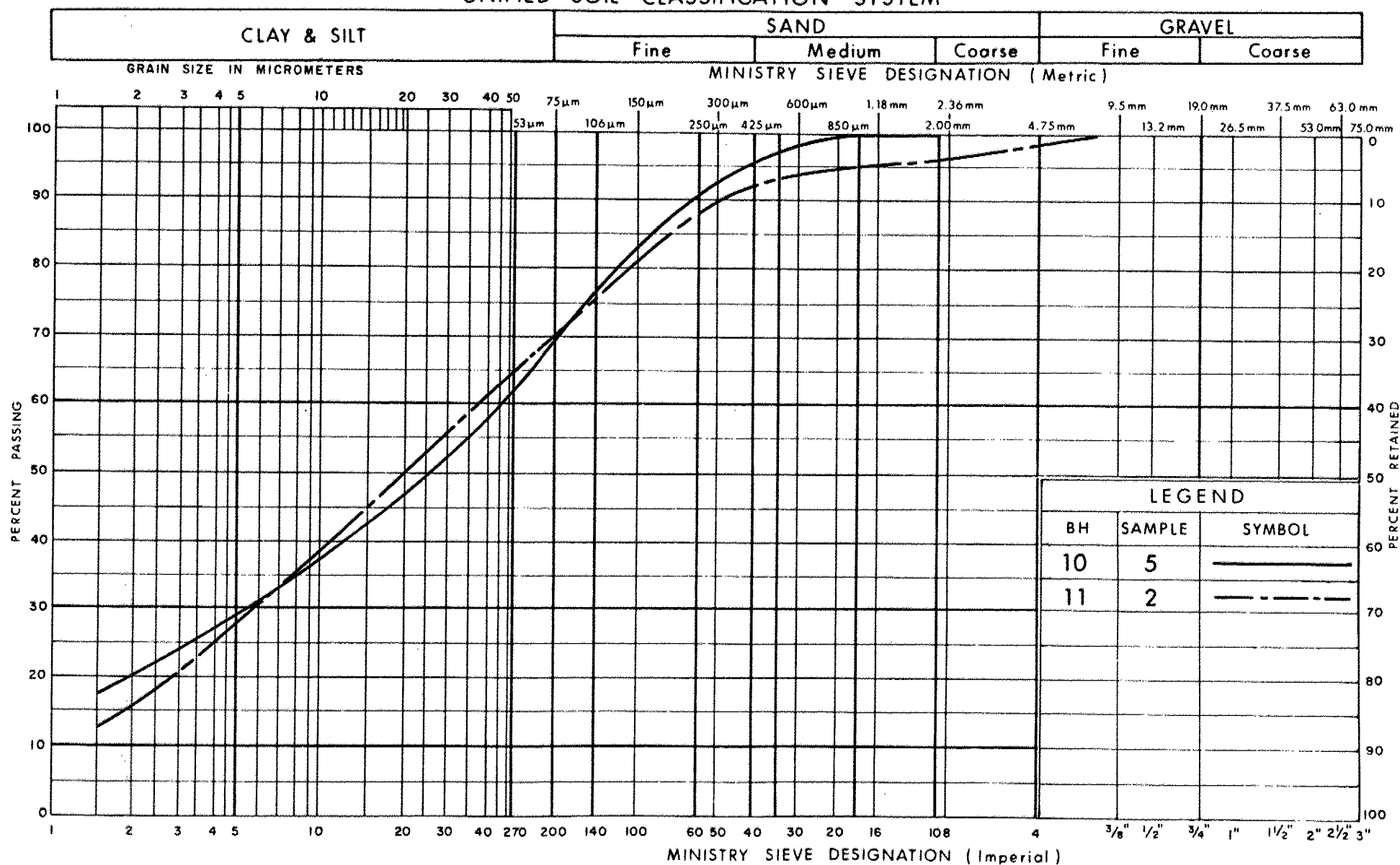
  
Balu Iyer, P. Eng.  
Sr. Foundation Engineer

  
M. Devata, P. Eng.  
Chief Foundation Engineer



**APPENDIX**

## UNIFIED SOIL CLASSIFICATION SYSTEM



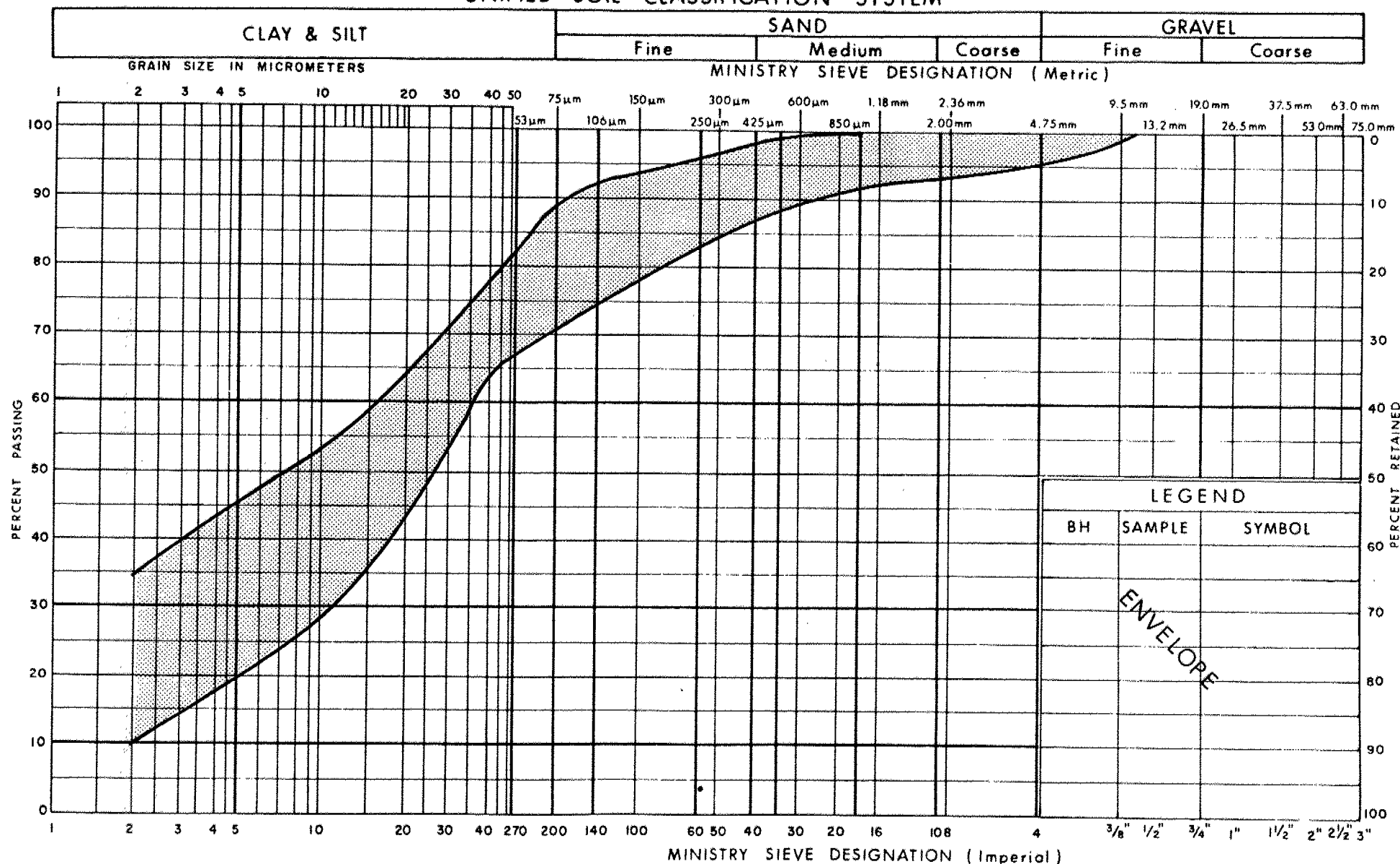
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# GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SANDY SILT

FIG No 1

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION**  
**CLAYEY SILT TO SILTY CLAY SOME SAND, TR GRAVEL**  
 (GLACIAL TILL) UPPER

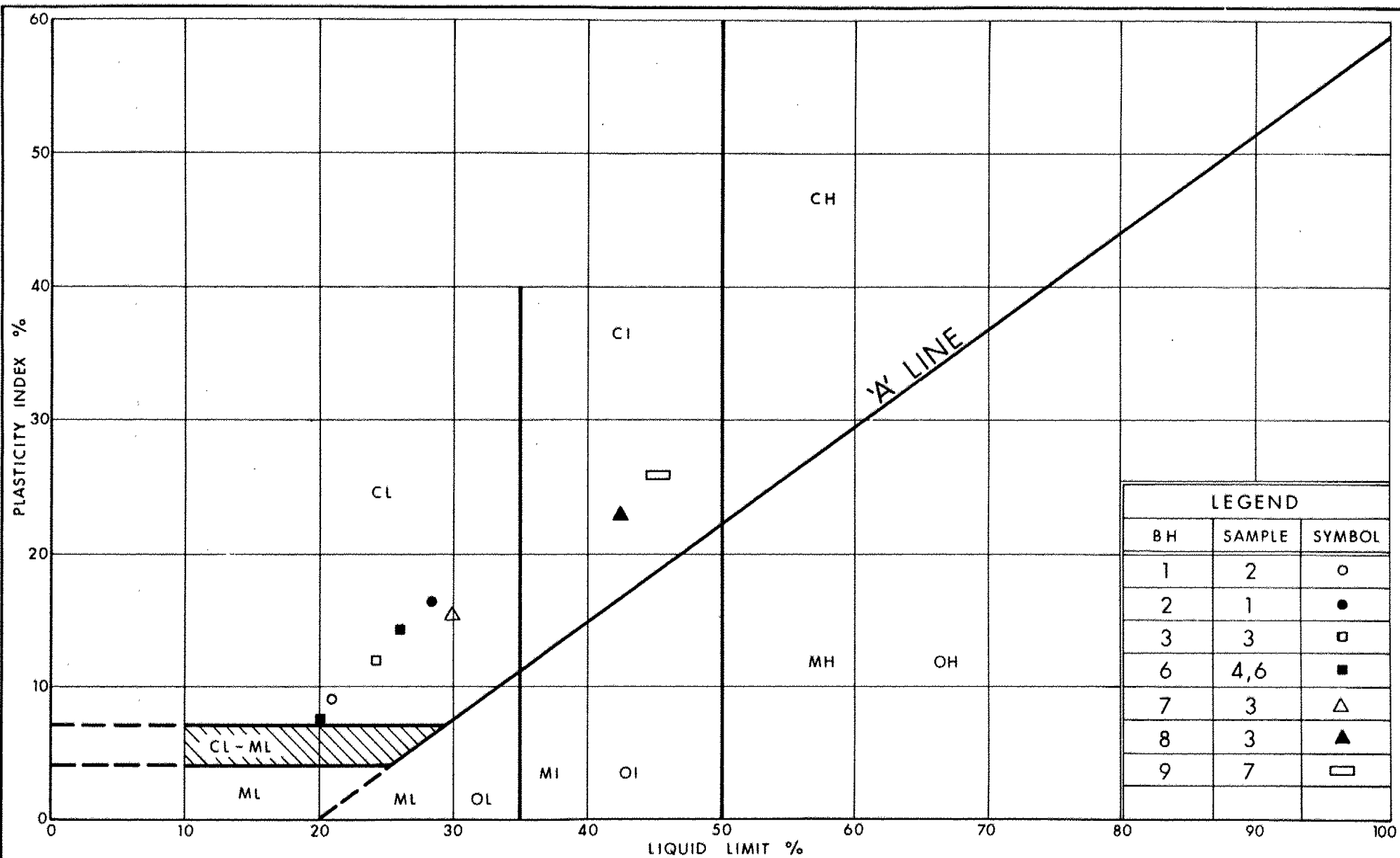
FIG No 2

W P 632-89-01



Ontario

Ministry of  
Transportation



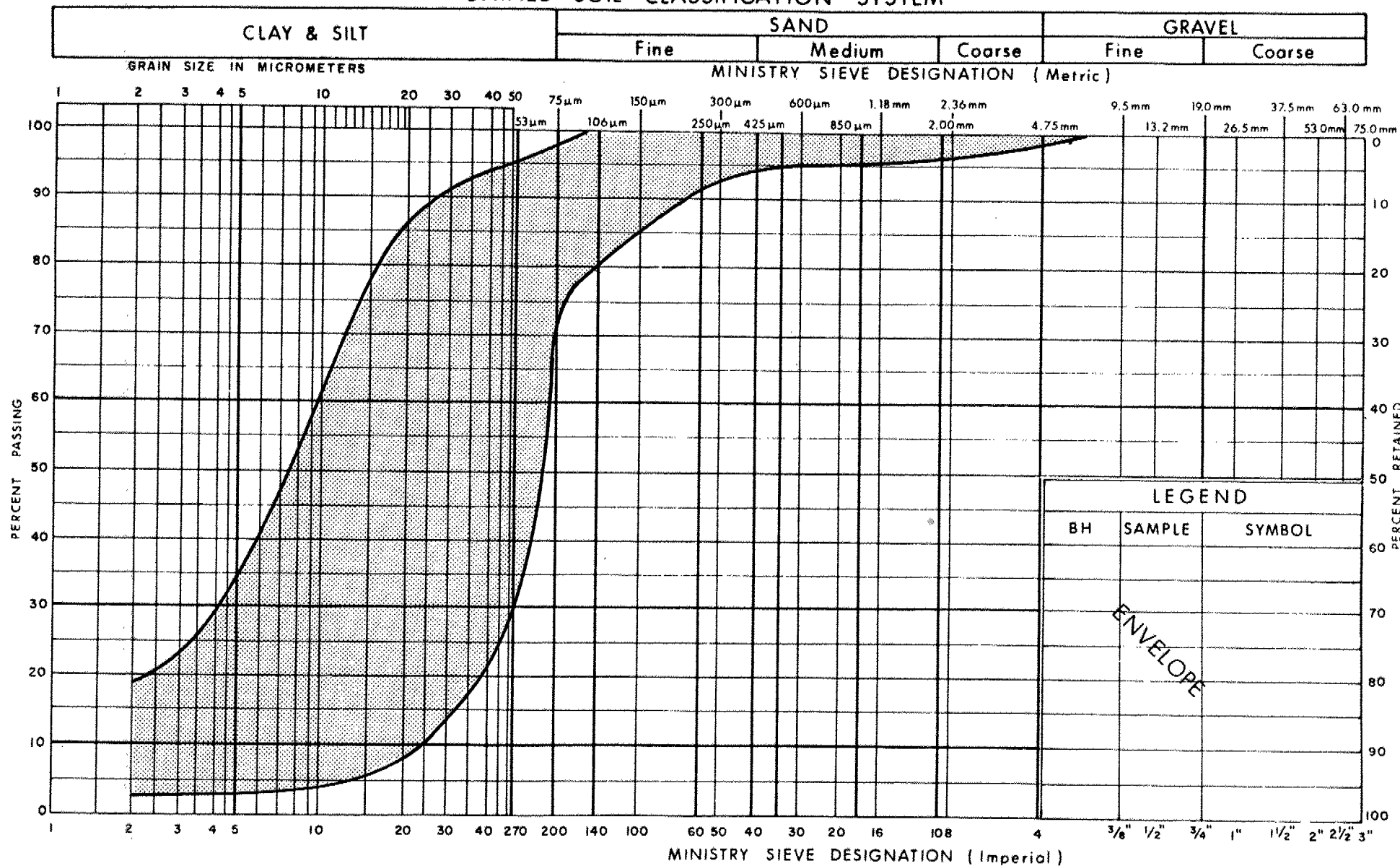
Ministry of  
Transportation

PLASTICITY CHART  
CLAYEY SILT, SOME SAND, TR GRAVEL  
(GLACIAL TILL) UPPER

FIG No 3

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM

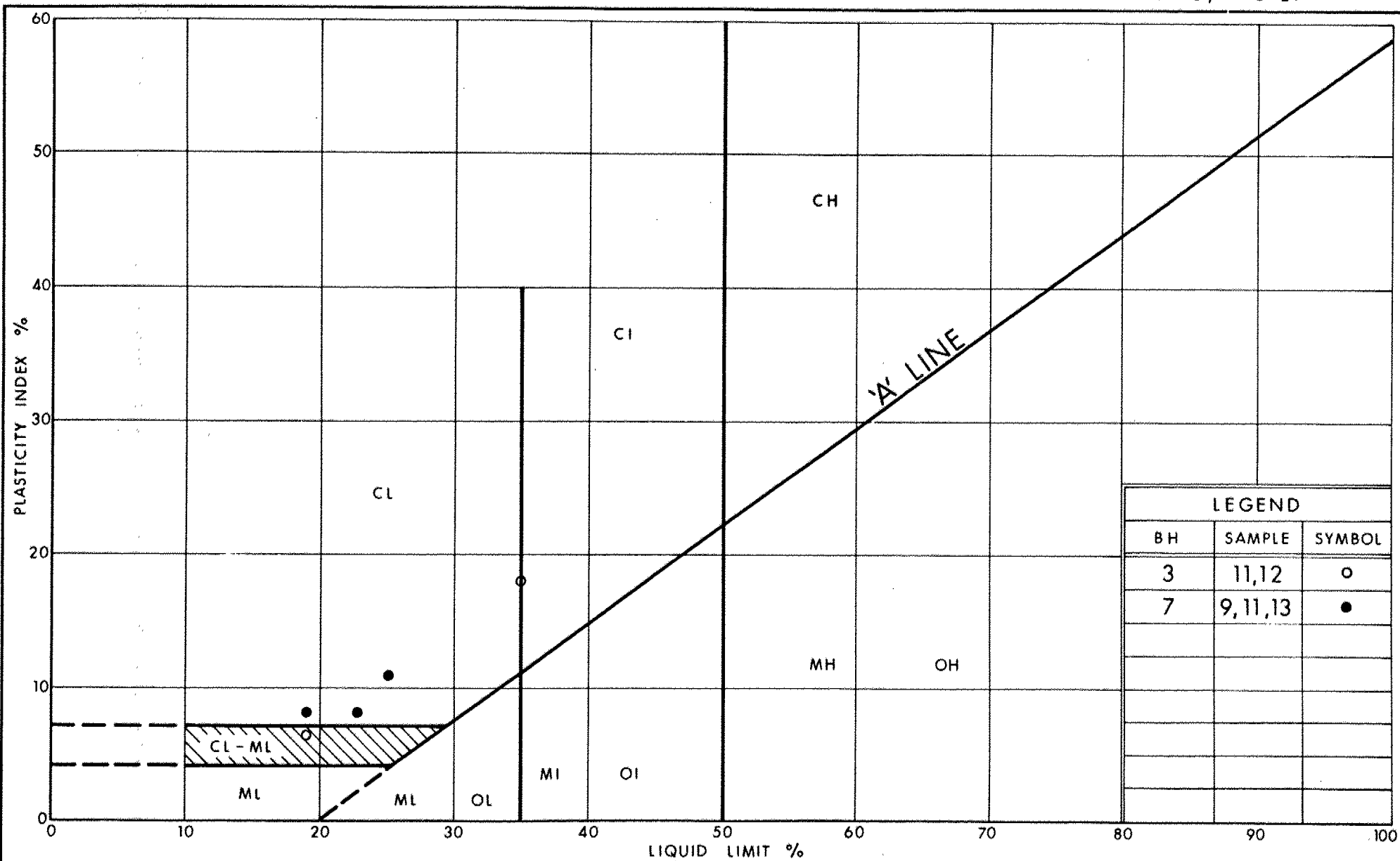


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Transportation

GRAIN SIZE DISTRIBUTION  
SILT, TRACE / SOME SAND

FIG No 4

W P 632-89-01



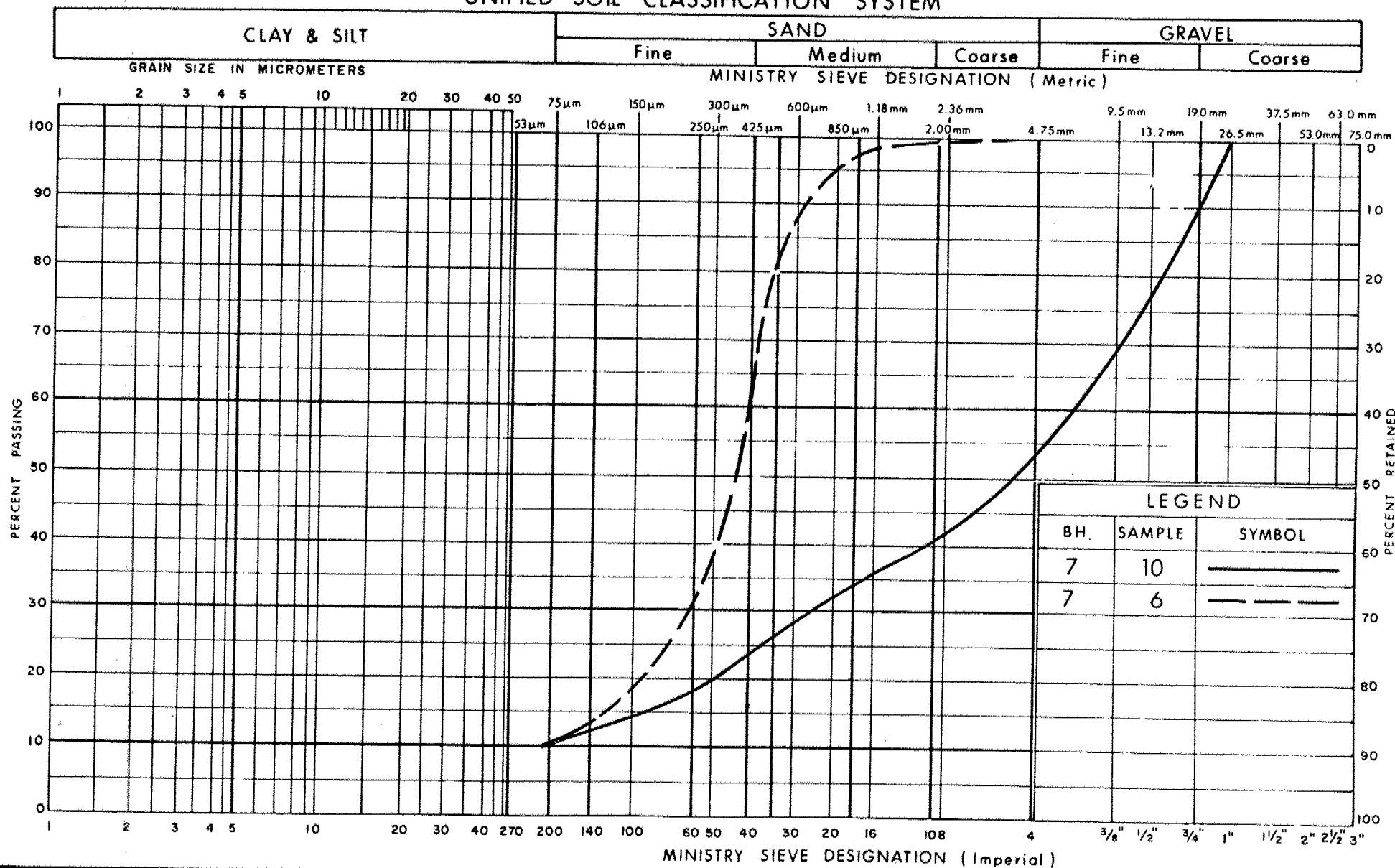
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PLASTICITY CHART  
CLAYEY SILT, SOME SAND, TR GRAVEL  
(GLACIAL TILL)

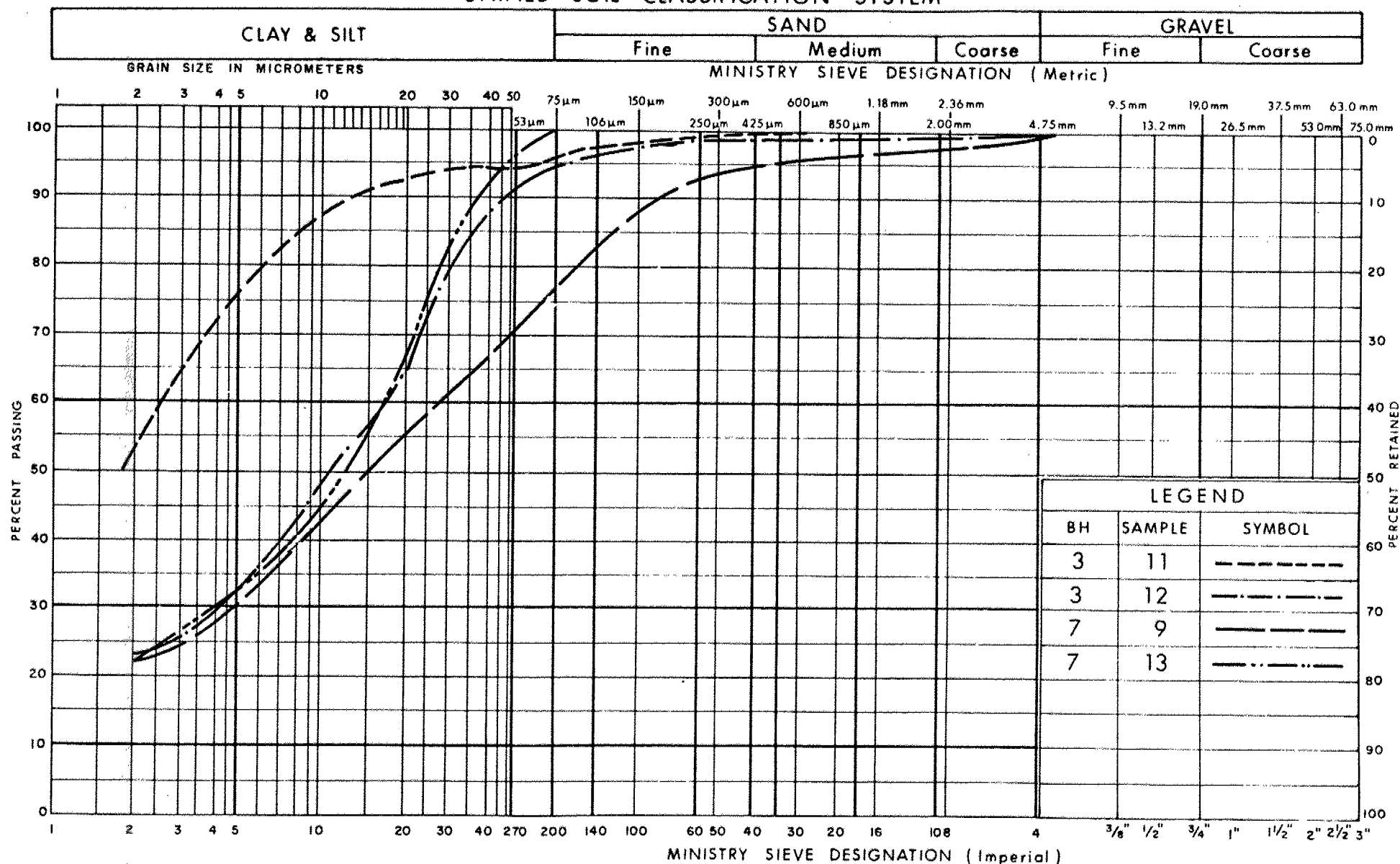
FIG No 5

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



## UNIFIED SOIL CLASSIFICATION SYSTEM



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**GRAIN SIZE DISTRIBUTION**  
CLAYEY SILT, SOME SAND, TR GRAVEL  
(GLACIAL TILL) (LOWER)

FIG No 7

W P 632-89-01



RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 048.5 ; E 301 100 ORIGINATED BY FLR  
DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
DATUM Geodetic DATE 90 03 27 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ 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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
223.7	Ground Surface													
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	11									
221.4	Brown, Stiff to Hard		2	SS	26									
2.3			3	SS	36									
			4	SS	36									
			5	SS	29									
			6	SS	22									
	Silt, Trace/ Some Sand Compact to Very Dense		7	SS	17									
			8	SS	108									
			9	SS	66									
			10	SS	14									
211.1			11	SS	15									
12.6	End of Borehole													

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords N 4 854 047.5 ; E 301 132 ORIGINATED BY FLR

DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR

DATUM Geodetic DATE 90 03 27-28 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					
223.5	Ground Surface																
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	21		222										0 15 55 30
221.3	Brown, Very Stiff		2	SS	28												
2.3	Brown		3	SS	28											21.0	0 10 80 10
	Grey		4	SS	37		220										
			5	SS	22												
	Silt, Trace Sand Compact to Very Dense		6	SS	33												0 3 82 15
			7	SS	22		218										
			8	SS	21		216										
			9	SS	60		214										
			10	SS	39												
210.9			11	SS	18		212										
12.6	End of Borehole																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 036 ; E 301 020.5 ORIGINATED BY FLR  
DIST 5 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
DATUM Gedodetic DATE 90 03 29 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
223.2	Ground Surface													
0.0	Cloey Silt, Some Sand, Trace Gravel (Glacial Till) Brown, Firm to Very Stiff		1	SS	27	*	222							4 25 40 31
			2	SS	27									
			3	SS	16									
219.4			4	SS	24		220							
3.8			5	SS	6									
			6	SS	19									2 22 56 20
	Silt, Some Sand Grey, Loose to Compact		7	SS	9		218							
			8	SS	10		216							
213.3			9	SS	17		214							
9.9	Cloey Silt (LAC) Very Soft		10	SS	2		212							
	Cloey Silt, Trace Sand (Glacial Till)		11	SS	9									0 4 44 52
209.0	Grey, Firm to Hard		12	SS	74		210							0 4 79 17
14.2	End of Borehole													
	* GWL - Dry upon completion													

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 016 ; E 300 987 ORIGINATED BY TS  
 DIST 5 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY TS  
 DATUM Geodetic DATE 90 04 11 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					
223.4	Ground Surface																
0.0	Sand to Silty Sand Brown, Loose to Compact	[Pattern]	1	SS	8	•	222										
			2	SS	10												
			3	SS	20		220										
			4	SS	15												
			5	SS	14												
			6	SS	28		218										
216.8	Clayey Silt, Some Sand, Trace of Gravel (Glacial Till) Grey, Very Stiff to Hard	[Pattern]	7	SS	21												
6.6			8	SS	30		216										
			9	SS	18		214										
			10	SS	39												
							212										
210.8			11	SS	32												
12.6	End of Borehole																
	• GWL - Dry upon completion																

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 025 : E 301 061 ORIGINATED BY FLR  
DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
DATUM Gedodetic DATE 90 03 29 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  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							w <sub>p</sub> w      w <sub>L</sub>		
225.2	Ground Surface																
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)  Brown, Stiff to Hard		1	SS	11	*	224							20.9	2   25   45   28		
			2	SS	15												
			3	SS	16												
			4	SS	25												
			5	SS	27												
			6	SS	52												
218.6	Silt, Some Sand Compact to Dense, Grey		7	SS	19		220								28   15   46   11		
6.6			8	SS	25		218										
			9	SS	26		216										
			10	SS	44		214										
212.5			11	SS	43												
12.6	End of Borehole																
	• GWL - Dry upon completion																

# RECORD OF BOREHOLE No 7

1 OF 2

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 013.5 ; E 301 027 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE HS Auger, NW Casing, Washboring COMPILED BY TS  
 DATUM Geodetic DATE 90 04 02 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	20 40 60 80 100					
223.5														
0.0	Trace Organics		1	SS	8		222						21.5	2 24 39 35
	Clayey Silt, Some Sand, Trace Gravel (Glacial Till) Brown, Firm to Hard		2	SS	40		220							
			3	SS	28									
			4	SS	28									
218.8			5	SS	25									
4.7			6	SS	48		218							
	Silt, Some Sand Brown, Compact		7	SS	25									0 17 79 4
			8	SS	25		216							
215.1			9	SS	28		214							1 22 56 21
8.4			10	SS	27		212							
	Clayey Silt, Some Sand, Trace Gravel (Glacial Till) Grey, Firm to Hard		11	SS	13		210						20.7	
			12	SS	55									
			13	SS	25		208							0 0 78 22
			14	SS	58		206							
204.5			15	SS	60									
19.1			16	SS	75		204							0 89 (11)
			17	SS	50		202							
			18	SS	50		200							
	Sand and Gravel Grey, Very Dense		19	SS	52		198							
			20	SS	60		196							46 42 (12)
			21	SS	54									
			22	SS	55		194							

Continued

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

RECORD OF BOREHOLE No 7

2 OF 2

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 013.5 ; E 301 027 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE HS Auger, NW Casing, Washboring COMPILED BY TS  
DATUM Geodetic DATE 90 04 02 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		
30.5	<b>Continued</b>													
	Sand and Gravel													
	Grey Very Dense		23	SS	34		192							
190.0														
33.5							190							
	Clayey Silt		24	SS	95									
	Grey, Hard		25	SS	70		188							
185.4														
38.1			26	SS	165		186							
	Silt, Some Sand													
	Grey, Very Dense		27	SS	120	/25cm	184							2 13 80 5
181.8														
41.6	End of Borehole		28	SS	100	/15cm	182							

RECORD OF BOREHOLE No 7A

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 024.5 ; E 301 024.5 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY FLR  
DATUM Geodetic DATE 90 04 11 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					
223.5	Ground Surface																
0.0	Clayey Silt, Trace Sand, Trace Gravel (Glacial Till)		1	SS	28		222										
			2	SS	74												
220.5	Brown, Very Stiff to Hard		3	SS	29												
3.0	Silt, Trace Sand Brown, Compact		4	SS	32		220										
			5	SS	23												
218.2			6	SS	16												
5.3			7	SS	15		218										
	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		8	SS	33		216										
	Grey, Stiff to Hard		9	SS	18		214										
			10	SS	41		212										
210.9	Clayey Silt (LAC)		11	SS	11												
12.6	End of Borehole																
	* Cave-in at El. 216 m																



# RECORD OF BOREHOLE No 8 (96-78-02) 1 OF 1 METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 004 : E 301 019 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE November 24, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
223.4													
0.0	Topsoil - Organics, 150 mm												
			1	SS	32							21.4	
			2	SS	25							21.5	
			3	SS	28							19.8	
	Silty Clay, Traces of Sand and Gravel, Sand layers Brown, Very Stiff to Hard		4	SS	31								
			5	SS	20								
217.3													
6.1 216.9	*		6	SS	70							22.9	1 25 56 18
6.5	End of Borehole												
	* Sandy Silt to Clayey Silt, Traces of Gravel Very Dense												
	Water level at 6.0 m depth and borehole open to 6.1 m depth upon completion.												

RECORD OF BOREHOLE No 9(96-78-02) 1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 853 986 ; E 301 020 ORIGINATED BY  
DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY  
DATUM Geodetic DATE November 28, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
230.8																	
0.0	Gravel - 150 mm		1	SS	20											21.9	
			2	SS	11		229									21.2	
	Fill - Sandy Silt, Trace to Some Clay		3	SS	12		228									21.1	
	Brown, Compact		4	SS	14		227										
			5	SS	26		226										
							225										
	Occasional Organic Materials at 7.6 m depth. (Possible Original Topsoil)		6	SS	12		224										
223.0							223										
7.6			7	SS	19		222										
	Silty Clay Trace to Some Sand Stiff to Very Stiff, Brown, Moist,		8	SS	12		221										
219.9							220										
10.7	Sand		9	SS	59		219										
	Very Dense, Fine Grained, Traces of Silt, Silty Layers, Wet at 12.2 m depth		10	SS	56		218										
217.9																	
12.7	End of Borehole Borehole dry and open to 11.6 m depth upon completion.																

# RECORD OF BOREHOLE No 10(96-78-02) OF 1 METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 853 979 ; E 301 027 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE November 24, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT 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					
230.6	Gravel - Some Sand, 150 mm																
0.0			1	SS	22												
	Fill - Sandy Silt to Clayey Silt, Traces of Gravel, Occasional Shale Fragments, Some Sand		2	SS	32		229										
	Compact to Dense, Brown, Moist, Slightly Cohesive		3	SS	27		228										
			4	SS	26		227										
							226										
			5	SS	26		225										
							224										
	Organic Materials at 8.0 m depth (Possible Original Topsoil)		6	SS	25		223										
222.6			7	SS	43		222									21.3	
8.0							221										
	Clayey Silt, Some Sand, Traces of Gravel (Glacial Till) Brown, Very Stiff		8	SS	30		220										
			9	SS	30		219										
							218										
217.9			10	SS	23												
12.7	End of Borehole Borehole dry and open to 11.6 m depth upon completion.																

# RECORD OF BOREHOLE No 11(96-78-02) 1 OF 1 METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 006 ; E 301 088 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE December 4, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
231.0																	
0.0	Gravel - Some Sand, 150 mm																
			1	SS	16		230									22.1	
			2	SS	7		229										2 27 53 18
			3	SS	8		228										
			4	SS	8		227										
			5	SS	22		226										
			6	SS	26		225									22.1	
							224										
223.4							223										
7.6	Topsoil - Silty Sand, Black, Organics		7	SS	26		222										
222.9							221										
8.1			8	SS	35		220									21.9	4 23 44 29
			9	SS	27		219										
			10	SS	57												
218.4																	
12.6	End of Borehole																
	Borehole Dry and open to 8.2 m depth upon completion.																



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## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*CONT 92-78*

WP 632-89-00 DIST 6

HWY 400 STR SITE

Proposed High Mast Lighting  
Highway 400/Rutherford Road Interchange

DISTRIBUTION

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

FOUNDATION INVESTIGATION REPORT  
For  
Proposed High Mast Lighting  
Highway 400/Rutherford Road Interchange  
W.P. 632-89-00 Site No. N/A  
District 6, Toronto

INTRODUCTION

A foundation investigation was carried out at the above-mentioned site for proposed high mast lighting of the reconstructed Highway 400/Rutherford Road Interchange.

During this investigation, boreholes were drilled at two of the proposed locations for the high mast lights. Subsurface information for three other locations was obtained from two previous borehole investigations (W.P. 96-78-02 and W.P. 632-89-00).

This report contains the factual information obtained from this and selected boreholes from the two previous investigations, which pertain to the structural foundations for the proposed five high mast lights, at the locations shown on Dwg. No. 6328900-A.

SITE DESCRIPTION AND GEOLOGY

The site is located in the area immediately surrounding (i.e. within 600 m) the existing Highway 400/Rutherford Road Overpass, in the Town of Vaughan, Regional Municipality of York.

There are two existing reinforced rigid frame concrete structures at the site. The first one consists of a 29 m span overpass which carries Rutherford Road over the existing Highway 400. The second is a smaller, more westerly structure with a span of 8.2 m, which carries Rutherford Road over the existing EW-S Ramp.

The site is located in the Bolton Area, which lies adjacent to the northwestern corner of Metropolitan Toronto. The Bolton physiographic area is characterized by drumlins, till plains, moraines and numerous other features associated with Wisconsin glacialiation (approximately 50,000 years ago) and its subsequent retreat (some 15,000 years ago).

Geological maps indicate that the overburden at the site consists of clayey silt morainic tills (Halton Till) underlain by stratified silt, clayey silt and/or silty clay sediments which were deposited in a ponded body of water known as Lake Peel. These soils are underlain by Paleozoic bedrock consisting of thinly bedded shales interbedded with limestone (Dundas/Meaford Formation) which, according to bedrock topography maps, lies at depths of about 70 to 80 m beneath the existing ground surface.

### PROCEDURES

The field work, for this project, which was carried out by this office on May 5 and 6, 1991, consisted of two sampled boreholes advanced to depths of 11.1 and 13.7 m by means of continuous flight, hollow stem augers driven by a bombardier-mounted drilling rig equipped with standard soil sampling equipment. Additional information was obtained from dynamic cone penetration testing adjacent to the two boreholes and at the base of one of them.

Groundwater levels were measured in the open boreholes immediately upon completion of sampling and then the augers were withdrawn and the boreholes backfilled.

The locations of the boreholes were staked in the field and their elevations determined by the Central Region Surveys and Plans Office.

The soil samples obtained in the field were examined in the laboratory by visual and tactile methods.

### SUBSURFACE CONDITIONS

BH's HM4 and HM5 were drilled at the proposed locations for high mast pole no.'s 4 and 5, respectively. Subsurface information for the remaining high mast poles was obtained from BH's 1, 2, 4 and 7 from Project No. W.P. 632-89-01, dated July 30, 1990 (and henceforth referred to as the 1990 investigation) as well as BH's MTC8 and MTC11 from Project No. 96-78-02, dated February 15, 1979 (and henceforth referred to as the 1979 investigation). The relevant borehole logs



and laboratory testing from these previous investigations are included in the Appendix at the back of this report.

The subsurface conditions appear to be fairly consistent at the proposed locations for the high mast lights. Topsoil, approximately 0.3 m thick, is underlain by a heterogeneous mixture of generally very stiff, silty clay to clayey silt (Glacial Till) (or sand to silty sand at one of the boreholes) which is, in turn, underlain by deposits of stiff to very stiff silty clay to clayey silt and compact to very dense, sandy silt to sand and gravel. The groundwater table is expected to be found at elevations varying from about 217 m to 218.5 m.

Detailed descriptions of the various soil and groundwater conditions encountered in the two boreholes, drilled during this investigation, as well as additional information obtained from previous investigations are given in the following sections.

#### Topsoil

A surficial layer of topsoil, approximately 300 mm thick, was contacted at BH HM5.

#### Clayey Silt (Fill)

A layer of clayey silt containing traces of topsoil enclosures was contacted at the ground surface at BH HM4. Since it appears that the clayey silt has been disturbed due to past farming activity, this material has been referred to as fill. It should be noted that such surficial disturbance is likely to be found at other high mast light locations as well.

In any case, it should be noted that, in our experience at many sites, the thickness of topsoil and/or soils disturbed by farming activity can vary significantly between boreholes.

#### Sand to Silty Sand

A cohesionless deposit of brown sand to silty sand was contacted at the ground surface at BH 4 during the 1990 investigation. This deposit extended to a depth of approximately 6.6 m (or an elevation of about 216.8 m). 'N' values, measured during Standard Penetration Testing (SPT), ranged from 8 to 28 blows/0.3 m, indicating loose to compact conditions.

#### Heterogeneous Mixture of Clayey Silt to Silty Clay, some Sand, Trace of Gravel (Glacial Till) (Upper)

Beneath the topsoil and/or disturbed soils, BH's HM4 and HM5 contacted a heterogeneous mixture of clayey silt to silty clay with some sand and a trace of gravel, which extended to depths of 2.1 m and 3.7 m (or elevations of about 216.9 m and 216.3 m, respectively). One of the boreholes, drilled during the 1990 investigation, indicated that the till extended to depths of at least 6.1 m. Visual examination of the fabric of the soil indicates that this soil is likely to be of glacial origin and therefore, may be considered a glacial till.

Atterberg Limits Tests carried out on several samples of the till obtained during the 1990 investigation, (and shown as Figure 3 in the Appendix), indicate that these soils range from low plasticity clayey silts to silty clays of intermediate plasticity. Grain Size Distribution Tests also presented in the Appendix (Figure 2) reveal a fairly well-graded mixture of 71 to 91 percent silt and clay-sized particles and from 10 to 25 percent sand.

Measured 'N' values from 6 blows/0.3 m to 88 blows/0.3 m indicate that the till is of firm to hard consistency. However, since, 'N' values generally range from 25 to 30+ blows/0.3 m, this deposit can be considered very stiff to hard.

#### Silt, trace/some Sand

Some of the boreholes drilled during the 1990 investigation contacted a cohesionless deposit of silt with a trace to some sand at depths of 2.3 m to 6.6 m which extended to depths of 5.3 m (BH 7A) to the maximum depth explored in BH's 1 and 2.

The results of a Grain Size Distribution Test carried out on a sample of soil obtained from this deposit (and shown on Figure 4 of the Appendix) indicate soils ranging from silts (occasionally with up to 18 percent clay and 3 percent sand) to soils with about 67 percent silt, 26 percent sand and 2 percent gravel.

'N' values, carried out in this deposit, ranged from 9 to 108 blows/0.3 m indicating loose to very dense compactness conditions. However, since 'N' values generally ranged from 20 to 40 blows/0.3 m, the deposit can be considered compact to dense.

#### Silty Clay to Clayey Silt, some Sand

A deposit of silty clay to clayey silt with some sand, was encountered in BH's HM4 and HM5 at depths of 2.1 m and 3.7 m (elevations of 216.9 m and 216.3 m), respectively. This deposit extended to a depth of about 10.1 m in both boreholes.

Some of the soil in this deposit was found to be quite sandy and often contained partings and thin layers of sandy silt to fine sand indicating soils of glacio-lacustrine origin.

It is likely that this deposit represents the fringes of a similar deposit comprised of a heterogeneous mixture of clayey silt containing some sand and a trace of gravel which was encountered in a few of the boreholes (3, 7 and 7A) drilled during the 1990 investigation. Although this material was referred to as the 'Lower Glacial Till' in the 1990 report, random interbeds of layered clayey silt of possible glacio-lacustrine origin were found within it as well. The results of Atterberg Limits and Grain Size Distribution Tests carried out on samples of this deposit obtained during the 1990 investigation are shown (Figures 5 and 7) of the Appendix.

'N' values, measured in this deposit at BH's HM4 and HM5, ranged from 5 to 59 blows/0.3 m indicating soils of firm to hard consistency. However, in general, 'N' values ranged from 15 to 30 blows/0.3 m indicating soils of very stiff consistency.

### Sandy Silt to Silty Sand

A layer of sandy silt to silty sand was encountered in BH's HM4 and HM5 at depths of about 10.1 m (elevation 208.9 m to 209.9 m). This deposit appears to be an extension of the sand and gravel deposit encountered at much greater depth (19.1 m or elevation 204.5 m) in BH 7, which was drilled during the 1990 investigation (see the Grain Size Distribution Tests results shown on Figure 6 of the Appendix).

In both cases, these deposits were found to be water bearing and consequently, when the boreholes penetrated into them, sand and silt-sized particles quickly moved up into the augers due to the unbalanced hydrostatic head.

'N' values measured during this investigation ranged from 5 to 51 blows/0.3 m indicating loose to very dense compactness conditions in this deposit. It should be noted, however, that the 5 blows/0.3 m recorded at BH HM4 was likely to be unrepresentative, due to the unbalanced hydrostatic head and resulting disturbance of the sand beneath the augers. 'N' values of 34 to 75 blows/0.3 m were consistently recorded in the coarser deposits encountered in BH 7 which is more in line with the measured results obtained at BH HM5. Therefore, the soil can generally be considered dense to very dense.

### GROUNDWATER CONDITIONS

The groundwater levels, measured in BH's HM4 and HM5, immediately upon completion of sampling, were found to be at depths of 6.5 m and 9.5 m (or elevations of 212.5 m and 210.5 m), respectively.

Similar observations were made during the two previous investigations (W.P. 96-78-02 and W.P. 632-89-01) which also indicated that several of the boreholes were either dry or the water levels were relatively close to the bottom of the boreholes upon completion of sampling.

It should be noted, however, that, where the very permeable cohesionless sand and gravel layer was encountered in BH 7, (during Project No. 632-89-01), a much higher water level was recorded (elevation 217.4 m). Although the water levels

recorded in our observations were much lower than this, it was observed that the water levels continued to rise in both BH's HM4 and HM5 until the augers were withdrawn and the surrounding soil collapsed into the boreholes.

Such observations indicate that these permeable soils had simply allowed the groundwater level to stabilize more quickly and the low groundwater levels observed in most of the boreholes, probably reflects the relatively impervious nature of the clayey soils above these layers rather than the existence of a very low groundwater table.

Based on moisture contents and colour changes in the soil, as well as groundwater observations during this and previous investigations, it appears that the long term groundwater table is likely to be at the highest levels recorded or at elevations of about 215.6 m to 218 m.

In any case, it should be noted that the groundwater table is always subject to seasonal fluctuations and is expected to rise during the spring freshet and during and immediately following any periods of prolonged heavy rainfall.

## DISCUSSION AND RECOMMENDATIONS

### RECOMMENDATIONS

It is proposed to construct the 5 high mast lighting poles, shown on Dwg. No. 6328900-A, at the following locations.

<u>Pole #</u>	<u>Northing</u>	<u>Easting</u>	<u>Existing G.S. (m)</u>
1	4 854 092	301 172	222.6±
2	4 853 977	301 150	223.3±
3	4 854 055	300 950	224.1±
4	4 853 890	300 811	219±
5	4 854 560	300 985	220±

### Design

The loads from the high mast lights may be transferred to the subsoil by means of a single bored, cast-in-place concrete caisson.

Caissons should be founded at the maximum elevation needed to provide the required lateral resistance. The design of the caissons should be in accordance with the method outlined in the following papers for both cohesive and cohesionless soils:

Brohms, B. B. Lateral Resistance of Piles in Cohesive Soil Journal of the Soil Mechanics and Foundation Division, ASCE Vol. 90, No. SM2, Paper 3285, March 1964.

Brohms, B. B. Lateral Resistance of Piles in Cohesionless Soil Journal of the Soil Mechanics and Foundation Division, ASCE Vol. 90, No. SM3, Paper 3909, May 1964.

Based on the boreholes drilled during this and the previous investigations, the calculated parameters to be used for the design are outlined in the attached Table 1. These parameters include:

For Cohesionless Soils: The Angle of Internal Friction  $\phi$  (degrees)

For Cohesive Soils: The Unconfined Compressive Strength  $q_u$  (kPa)

Bulk Unit Weight  $\gamma$  (kN/m<sup>3</sup>)

### Construction Considerations

Our investigations have noted the presence of a sandy silty to sand and gravel deposit in BH's HM4, HM5 and HM7, well below the groundwater table. If it is necessary to extend the caissons into this layer, special construction methods (i.e. maintaining a positive head of drilling mud, dewatering, etc.) may be required in order to prevent excessive disturbance of the basal soils due to unbalanced hydrostatic head (i.e. blow out).

It should be noted, however, that boreholes were drilled at only two of the five proposed locations (HM4 and HM5) for the high mast lights. The stratigraphy at the other three locations has been based on stratigraphical projections from surrounding boreholes. Therefore, at these locations, it is possible that the sandy silt to sand and gravel layer (or other similar layers) may be intersected at much higher elevations than the surrounding boreholes indicate. To prevent 'blow out' should such a layer be intersected, it may be necessary to maintain a positive head of drilling mud at these locations. In addition, the foundation concrete would have to be tremied-in from the base of the caisson. In any case, such methods will be required, if, in order to attain the required lateral capacity, the caissons must be extended in cohesionless layers below the groundwater table.

Caissons must be cased during their installation to seal off any saturated sand zones that may possibly be encountered prior to reaching their lowest elevations. If, however, the ingress of water becomes intolerable, then, once again, measures such as drilling mud etc. may be required.

It should also be noted that caissons will extend through at least one deposit of glacial till. Although no large cobbles or boulders appeared when drilling the boreholes for this investigation, such inclusions should be expected and prepared for (i.e. chopping bits, core barrel) when augering through any till deposit.

Should it become necessary to investigate the possibility of extending the caissons into the underlying cohesionless soils, we would be pleased to provide you with additional recommendations for their design.

MISCELLANEOUS

The field investigation was supervised by Messrs. J. Blair, D. Tari and M. Iampietro, using equipment owned and operated by Malone's Soil Samples Inc.

This report was written by Mr. J. Blair, Project Foundation Engineer, reviewed by Dr. B. Iyer, Senior Foundation Engineer and approved by Mr. M. Devata, Chief Foundation Engineer.



*John A. Blair*

John A. Blair, P.Eng.  
Project Foundation Engineer

*Murty Devata*

Murty Devata, P.Eng.  
Chief Foundation Engineer



Table I

Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Design Parameters			Assumed Water Level (m)	Borehole No.
	Original (m)	Finished Grade (m)	Upper (m)	Lower (m)	Cohesive (C) Non-Cohesive (NC)	$\phi$ Degrees	qu kPa	$\gamma$ kN/m <sup>3</sup>		
1	222.6	223	221.8	221.4	Cohesive		400	22.4	220.5	1,2
			221.4	218.0	Non-Cohesive	36		21.0		
			218.0	215.0	Non-Cohesive	33		21.0		
			215.0	213.0	Non-Cohesive	40		21.5		
			213.0	211.0	Non-Cohesive	31		21.0		
2	223.3	223.0	S A M E A S A B O V E							2, MTC11
3	224.1	224.0	222.8	222.0	Non-Cohesive	28		18.0	217.5	4
			222.0	217.0	Non-Cohesive	33		20.5		
			217.0	215.0	Cohesive		400	21.0		
			215.0	213.0	Cohesive		300	20.7		
			213.0	211.0	Cohesive		600	21.8		
4	219.0	220.0	218.8	218.3	Cohesive		300	20.7	216.0	HM4
			218.3	216.9	Cohesive		400	21.0		
			216.9	216.0	Cohesive		350	20.7		
			216.0	214.5	Cohesive		150	20.3		
			214.5	211.5	Cohesive		350	20.8		
			211.5	208.8	Cohesive		400	21.0		
			208.8	207.0	Non-Cohesive	31		20.5		
5	220.0	220.0	218.8	217.1	Cohesive		500	22.5	215.6	HM5
			217.1	216.3	Cohesive		400	22.0		
			216.3	214.4	Cohesive		400	21.0		
			214.4	212.8	Cohesive		300	20.7		
			212.8	211.2	Cohesive		200	20.7		
			211.2	209.9	Cohesive		400	21.0		
			209.9	208.9	Non-Cohesive	40		21.5		

# RECORD OF BOREHOLE No HM4

1 OF 1

METRIC

W.P. 532-89-00 LOCATION Co-ords. N 4 853 890; E 300 811 ORIGINATED BY JB  
DIST 6 HWY 400 BOREHOLE TYPE H.S. Auger COMPILED BY JB  
DATUM Geodetic DATE 91 06 06 CHECKED BY BI

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	20 40 60 80 100					
219.0														
0.0	300 mm Topsoil Heterogeneous Mixture of Clayey Silt, some Sand, tr. of Gravel (Upper Glacial Till)		1	SS	10		218							
216.9	Stiff to Hard Brown		2	SS	32									
2.1	Brownish Grey		3	SS	28									
			4	SS	17		216							
	Silty Clay to Clayey Silt, some Sand		5	SS	5									
	Contains Numerous Thin Partings and Layers of Sandy Silt to Silty Fine Sand		6	SS	9		214							
	(Occasionally 'Till-Like')		7	SS	16									
	Stiff to Hard		8	SS	17		212							
			9	SS	14									
			10	SS	15		210							
			11	SS	27									
208.9			12	SS	30		208							
10.1	Sandy Silt to Silty Sand		13	SS	14		206							
	Compact to Very Dense		14	SS	5 **									**Soil probably disturbed due to unbalanced hydrostatic head.
205.3														
13.7	End of Borehole						204							
202.2														
16.8	End of Cone Test													
	Note: The water level in the open borehole was at a depth of 6.5 m immediately upon com- pletion of sampling. However, it is unlikely that the water level has had sufficient time to stabilize.													

# RECORD OF BOREHOLE No HM5

1 OF 1

METRIC

W.P. 632-89-00 LOCATION Co-ords. N 4 854 560; E 300 985 ORIGINATED BY JB  
DIST 6 HWY 400 BOREHOLE TYPE H.S. Auger COMPILED BY JB  
DATUM Geodetic DATE 91.06.07 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub>	WATER CONTENT (%) 10 20 30	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							
220.0												
0.0	300 mm Topsoil Heterogeneous Mixture of Clayey Silt, Some Sand, Trace of Gravel (Upper Glacial Till)  Very Stiff to Hard	Brown	1	SS	3							
			2	SS	32							
			3	SS	88							
			4	SS	88							
216.3		Grey	5	SS	27							
3.7	Silty Clay to Clayey Silt, Trace Sand  Contains Occasional Thin Layers and Partings of Sand  Stiff to Hard		6	SS	71							
			7	SS	58							
			8	SS	28							
			9	SS	10							
209.9			10	SS	42							
10.1	Sandy Silt to Silty Sand Very Dense		11	SS	51							
208.9												
11.1	End of Borehole  *Note: The water level in the open borehole was at a depth of 9.5 m immediately upon com- pletion of sampling. However, it is unlikely that the water level has had sufficient time to stabilize.											

DATE OF PRINTING  
FEB 18 1961  
U. S. GOVERNMENT PRINTING OFFICE

**M.T.O.**

## 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

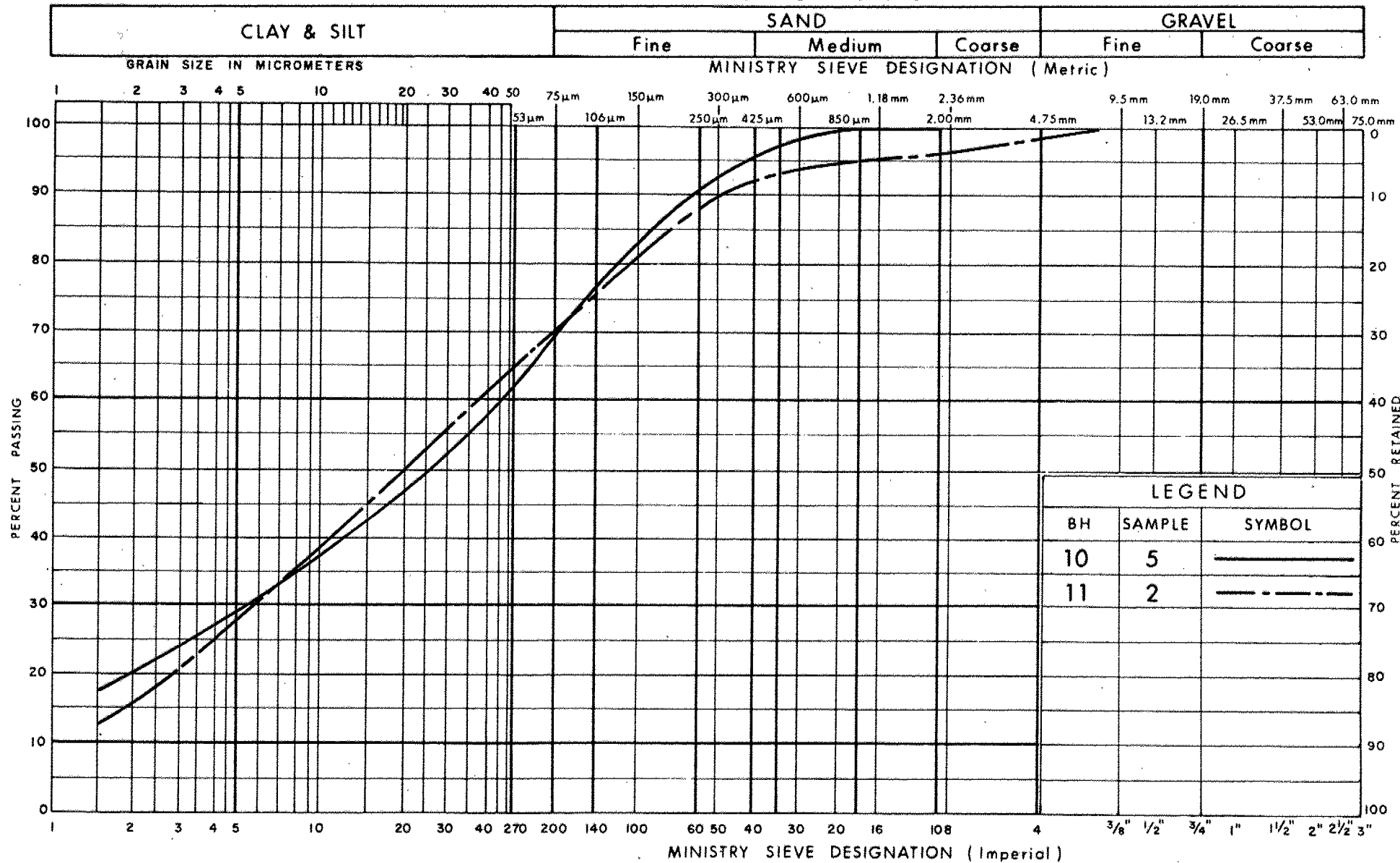
$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN 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						

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



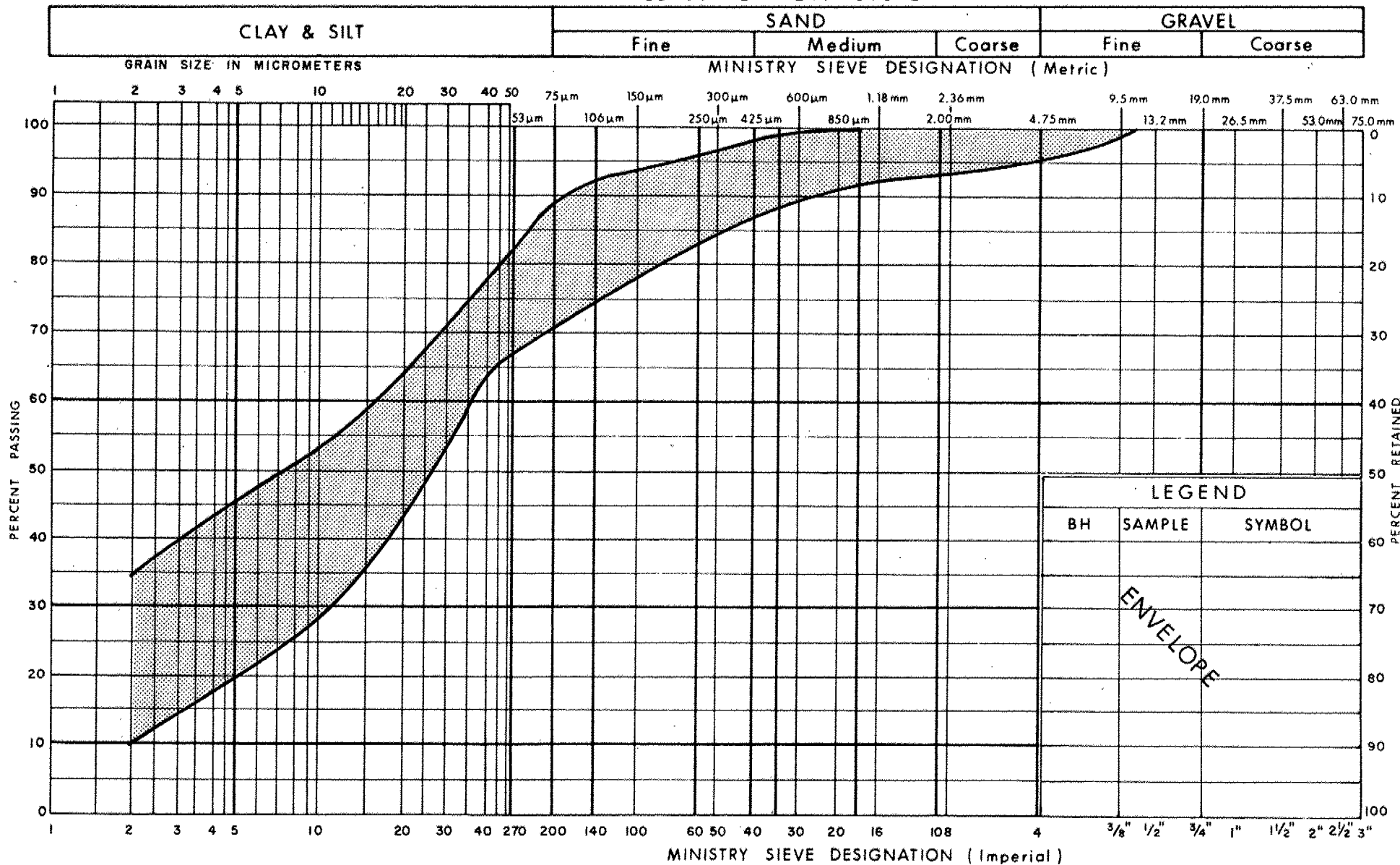
Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SANDY SILT

FIG No 1

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



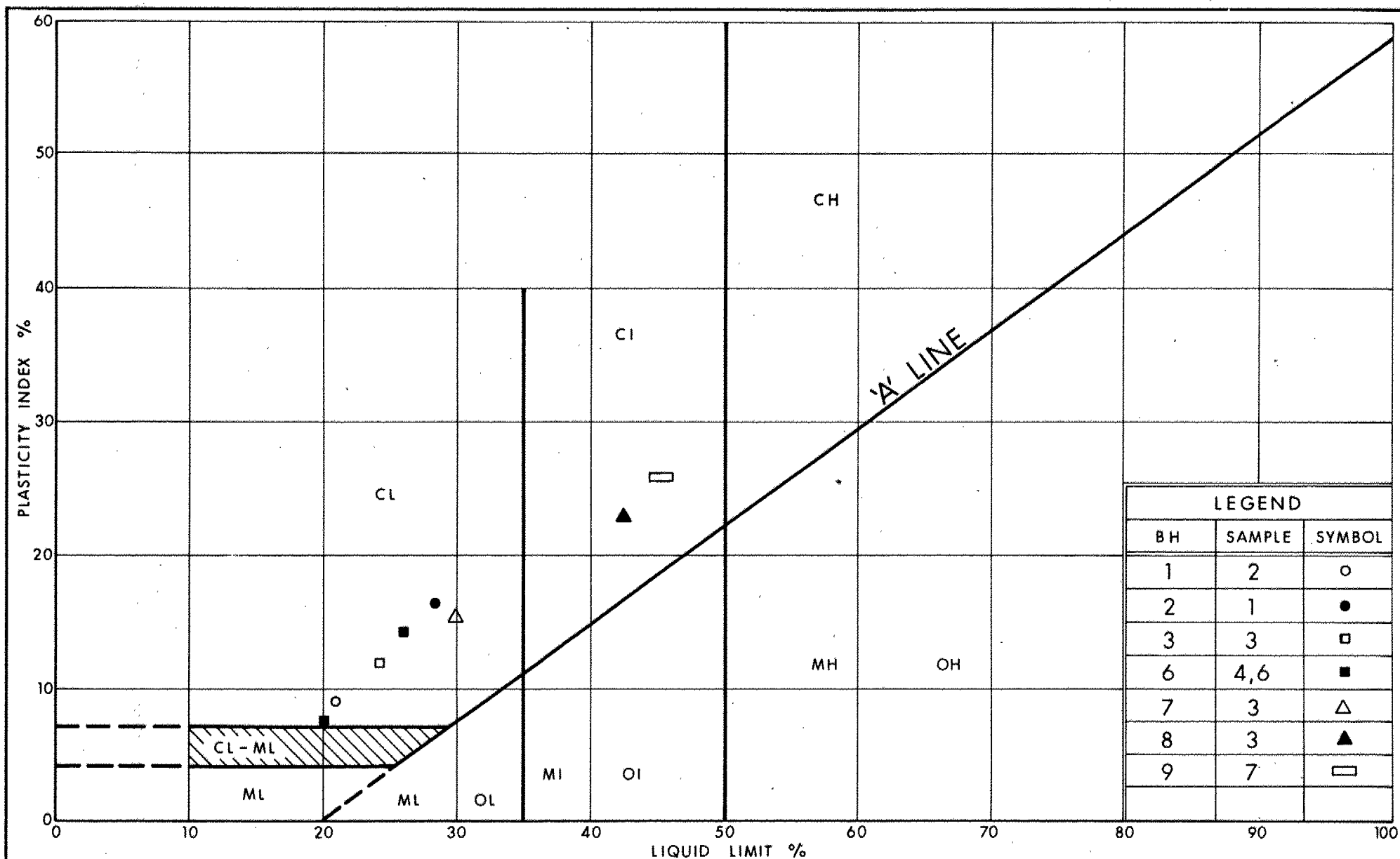
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**CLAYEY SILT TO SILTY CLAY SOME SAND, TR GRAVEL**  
 (GLACIAL TILL) UPPER

FIG No 2

W P 632-89-01





Ministry of  
Transportation

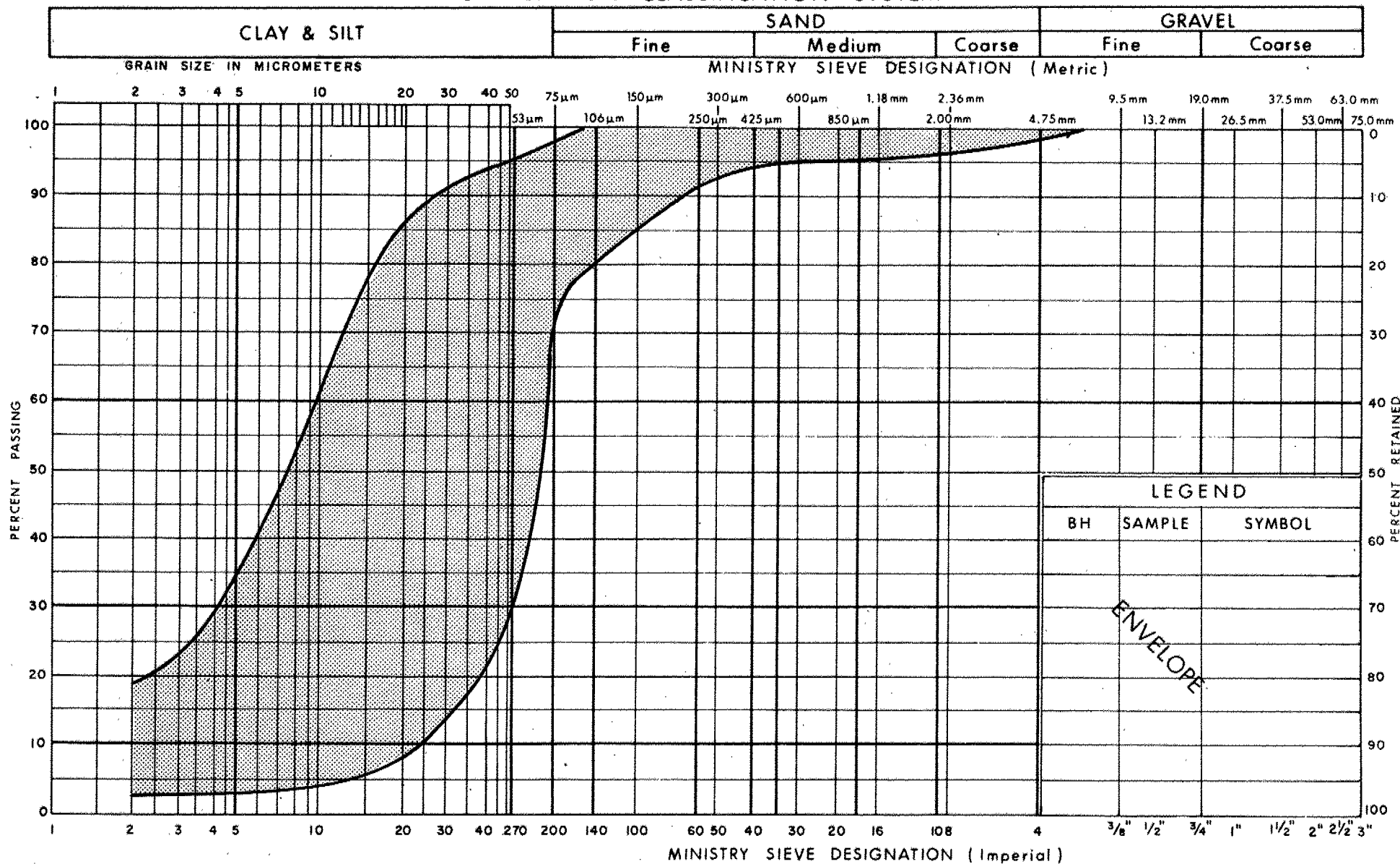
Ontario

# PLASTICITY CHART CLAYEY SILT, SOME SAND, TR GRAVEL (GLACIAL TILL) UPPER

FIG No 3

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



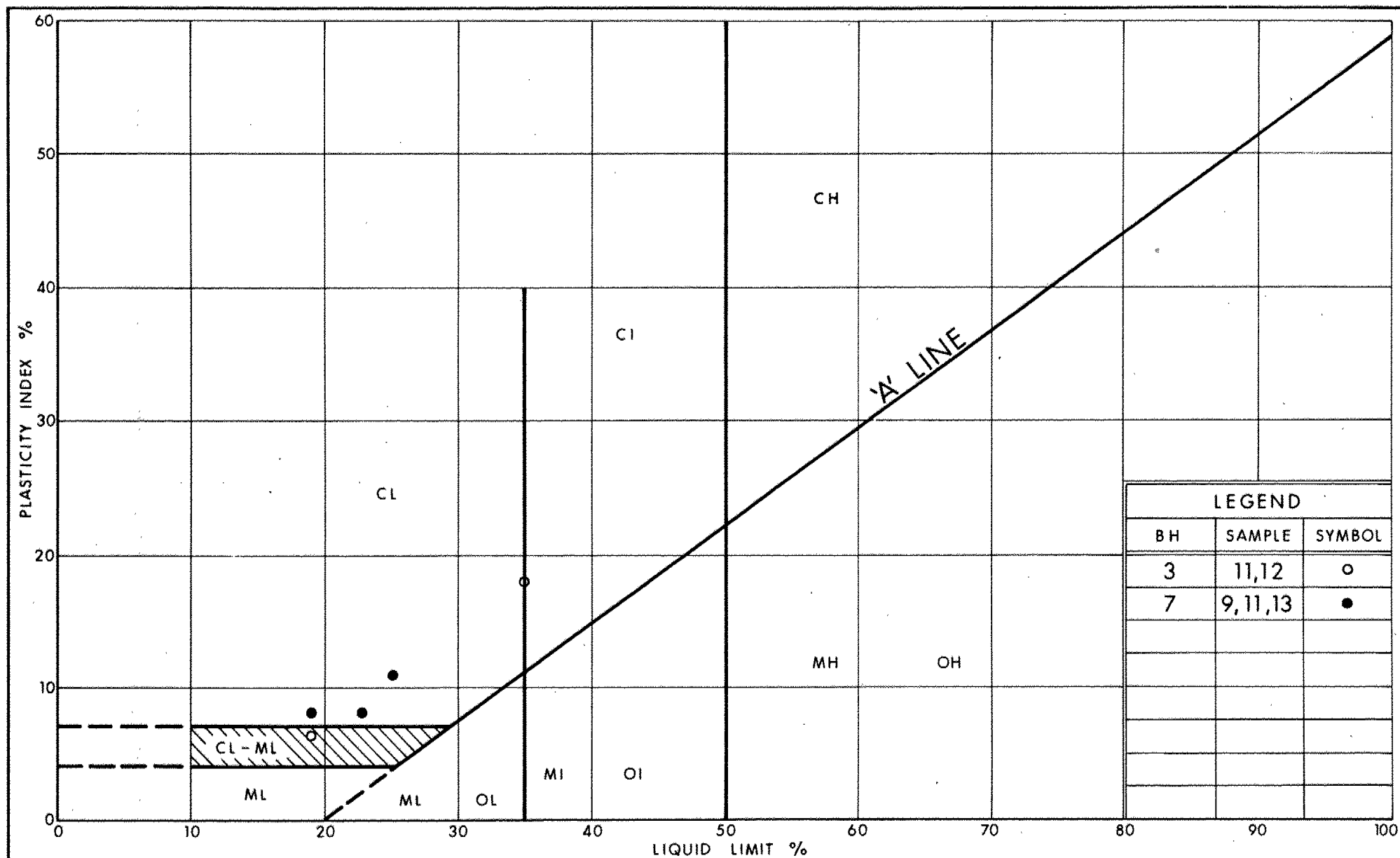
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## GRAIN SIZE DISTRIBUTION

SILT, TRACE / SOME SAND

FIG No 4

W P 632-89-01



Ministry of  
Transportation

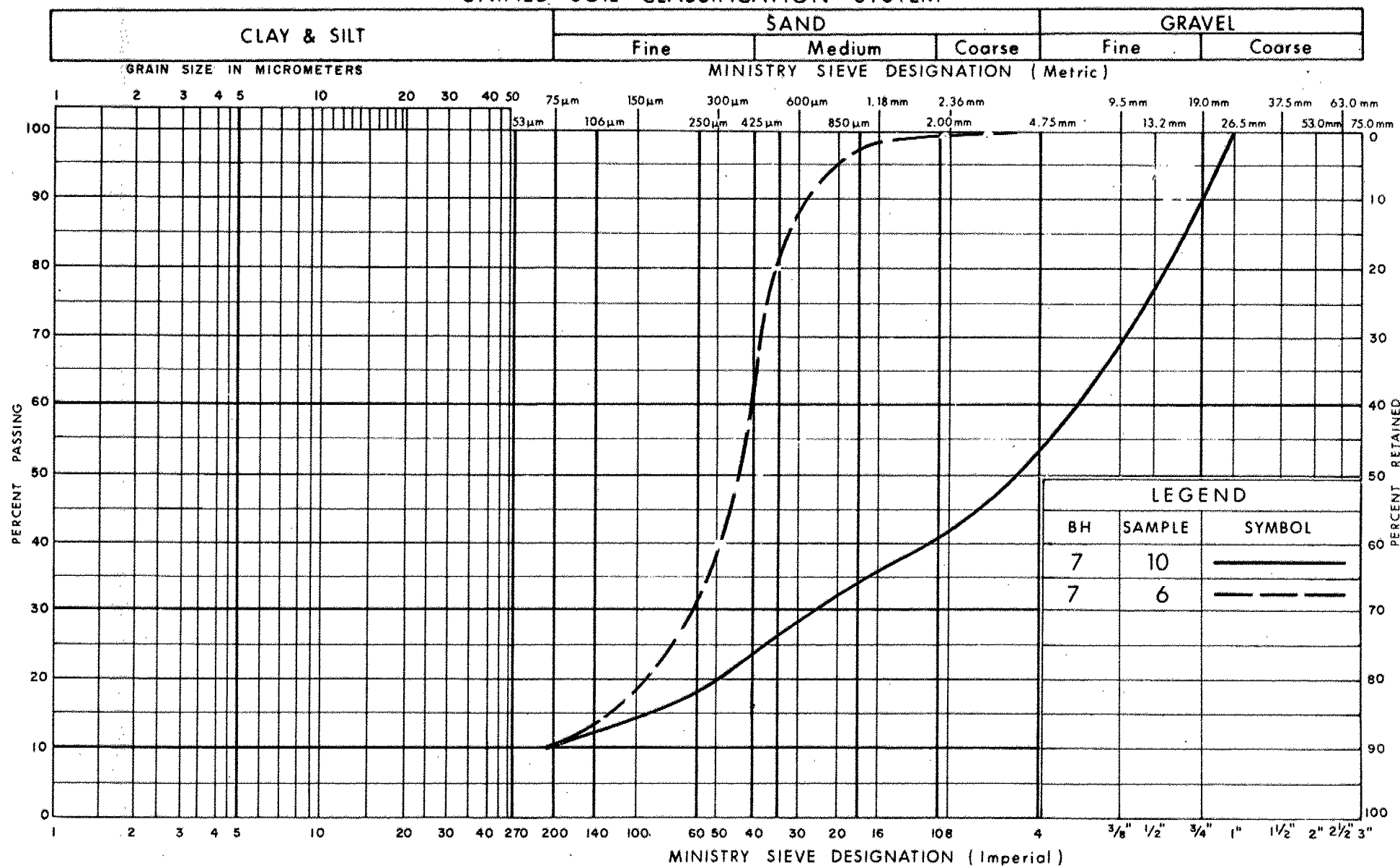
Ontario

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

FIG No 5

W P 632-89-01

## UNIFIED SOIL CLASSIFICATION SYSTEM



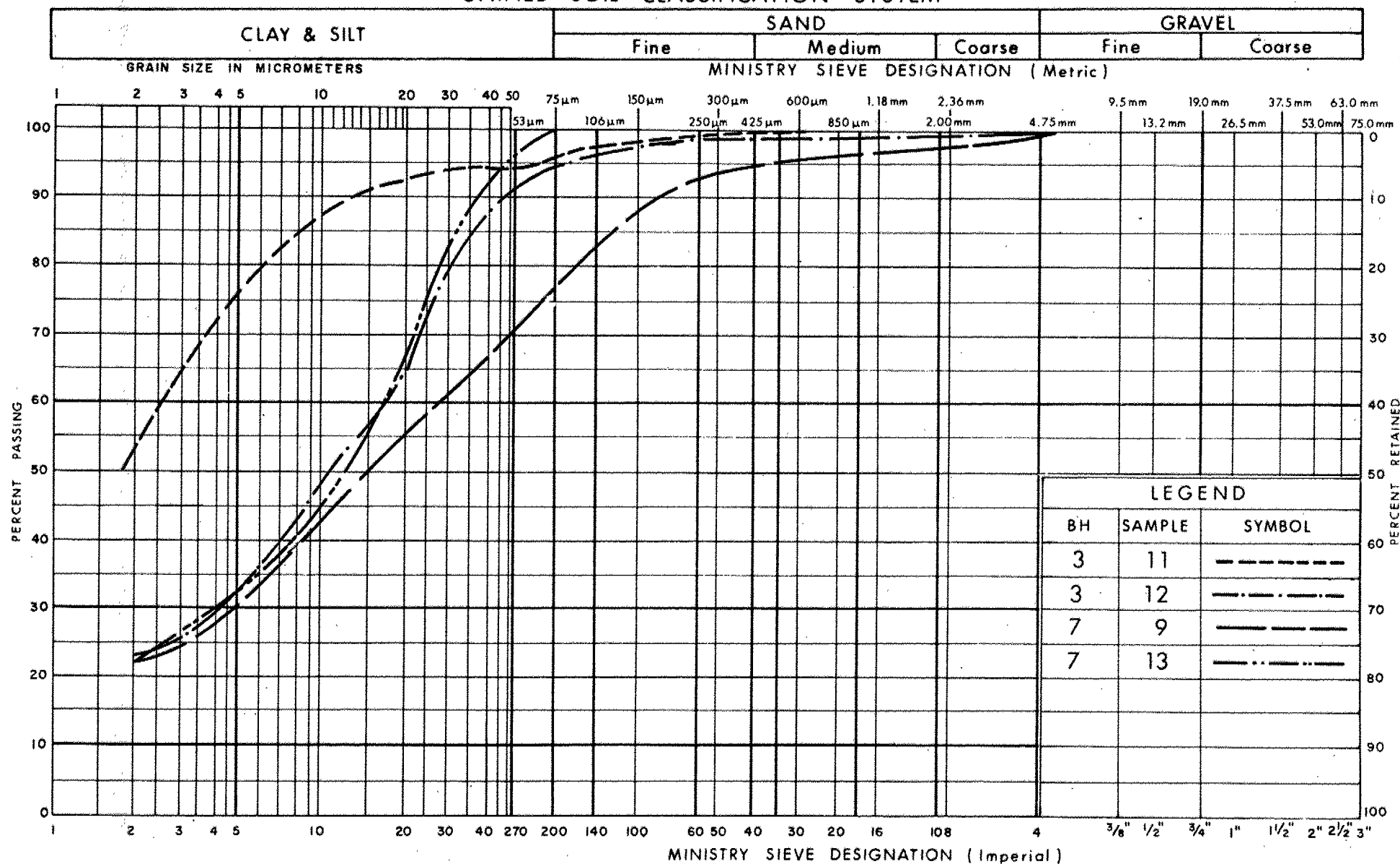
Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SAND & GRAVEL

FIG No 6

W P 632 - 89 - 01

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**CLAYEY SILT, SOME SAND, TR GRAVEL**  
 (GLACIAL TILL) (LOWER)

FIG No 7

W P 632-89-01

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 832-89-01 LOCATION Co-ords: N 4 854 048.5 ; E 301 100 ORIGINATED BY FLR  
 DIST 6 HWY 400 BOREHOLE TYPE H5 Auger COMPILED BY FLR  
 DATUM Geodetic DATE 90 03 27 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		
223.7	Ground Surface													
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	11									
221.4	Brown, Stiff to Hard		2	SS	26									
2.3			3	SS	36									
			4	SS	36									
			5	SS	28									
			6	SS	22									
	Silt, Trace/ Some Sand Compact to Very Dense		7	SS	17									
			8	SS	108									
			9	SS	66									
			10	SS	14									
211.1			11	SS	15									
12.6	End of Borehole													

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 632-89-01 LOCATION Co-ords N 4 854 047.5 ; E 301 132 ORIGINATED BY FLR  
 DIST 5 HWY 400 BOREHOLE TYPE H5 Auger COMPILED BY FLR  
 DATUM Geodetic DATE 90 03 27-28 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			20	40	60	80	100					
223.5	Ground Surface															
0.0	Clayey Silt, Some Sand, Trace Gravel (Glacial Till)		1	SS	21	222									21.0	0 15 55 30
221.3	Brown, Very Stiff		2	SS	28											
2.3	Brown		3	SS	28	220										0 10 80 10
	Grey		4	SS	37											
			5	SS	22	218										0 3 82 15
	Silt, Trace Sand Compact to Very Dense		6	SS	33											
			7	SS	22	216										
			8	SS	21											
			9	SS	60	214										
			10	SS	39	212										
210.8			11	SS	18											
12.6	End of Borehole															

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 832-89-01 LOCATION Co-ords: N 4 854 016 ; E 300 987 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE HS Auger COMPILED BY TS  
 DATUM Geodetic DATE 90 04 11 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>		
223.4	Ground Surface																
0.0	Sand to Silty Sand Brown, Loose to Compact	•••••	1	SS	8												
			2	SS	10												
			3	SS	20												
			4	SS	15												
			5	SS	14												
			6	SS	28												
216.8	Clayey Silt, Some Sand, Trace of Gravel (Glacial Till) Gray, Very Stiff to Hard		7	SS	21												
6.6			8	SS	30												
			9	SS	19												
			10	SS	39												
			11	SS	32												
210.8	End of Borehole																
12.6	• GWL - Dry upon completion																



## METRIC

ORIGINATED BY TS

COMPILED BY TS

**CHECKED BY** TS

Continued

**+3, x5: Numbers refer to Sensitivity**

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

# RECORD OF BOREHOLE No 7

2 OF 2

METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 013.5 ; E 301 027 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE HS Auger, NW Casing, Washboring COMPILED BY TS  
 DATUM Geodetic DATE 90 04 02 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			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>		
30.5	Continued																
	Sand and Gravel Grey Very Dense		23	SS	34												
190.0																	
33.5																	
	Clayey Silt Grey, Hard		24	SS	65												
			25	SS	70												
185.4																	
38.1			26	SS	165												
	Silt, Some Sand Grey, Very Dense		27	SS	120	/25cm											
181.8			28	SS	100	/15cm											
41.8	End of Borehole																

# RECORD OF BOREHOLE No MTC 8 (96-78-02) METRIC

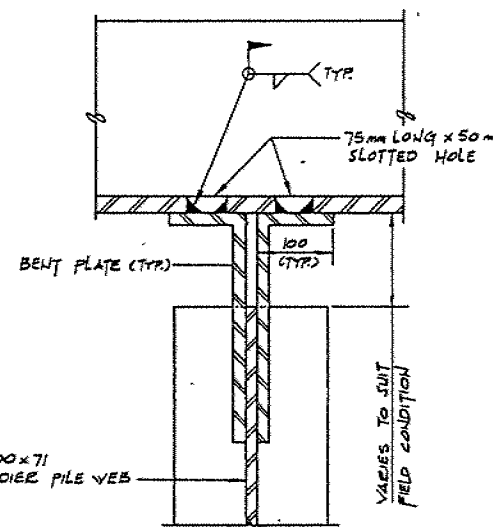
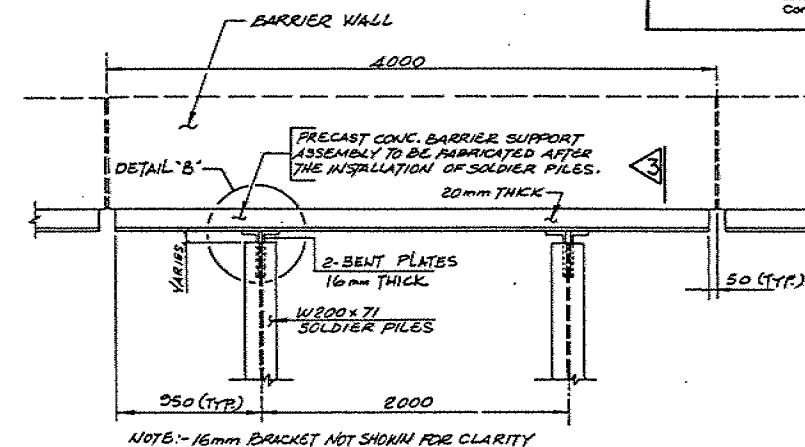
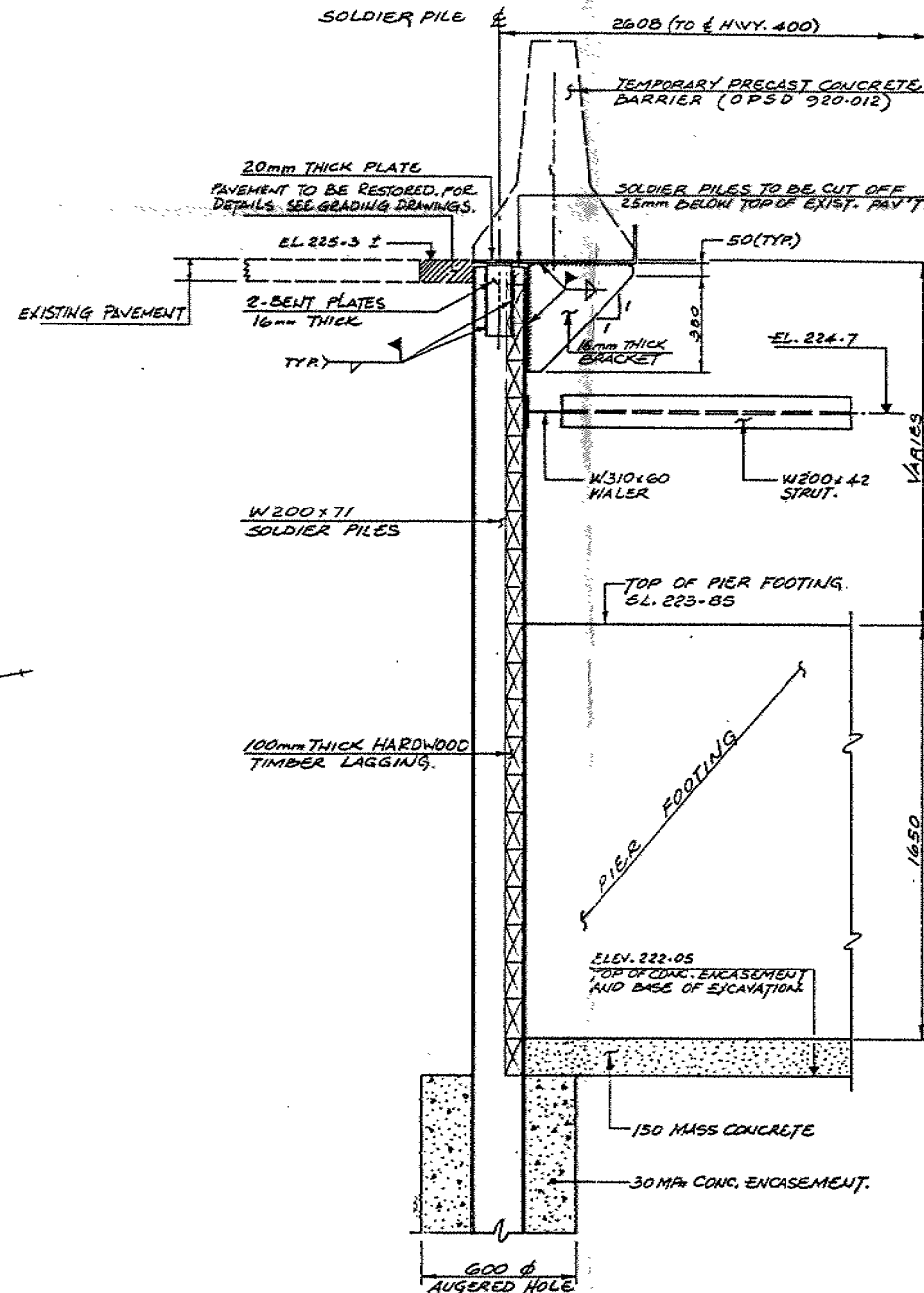
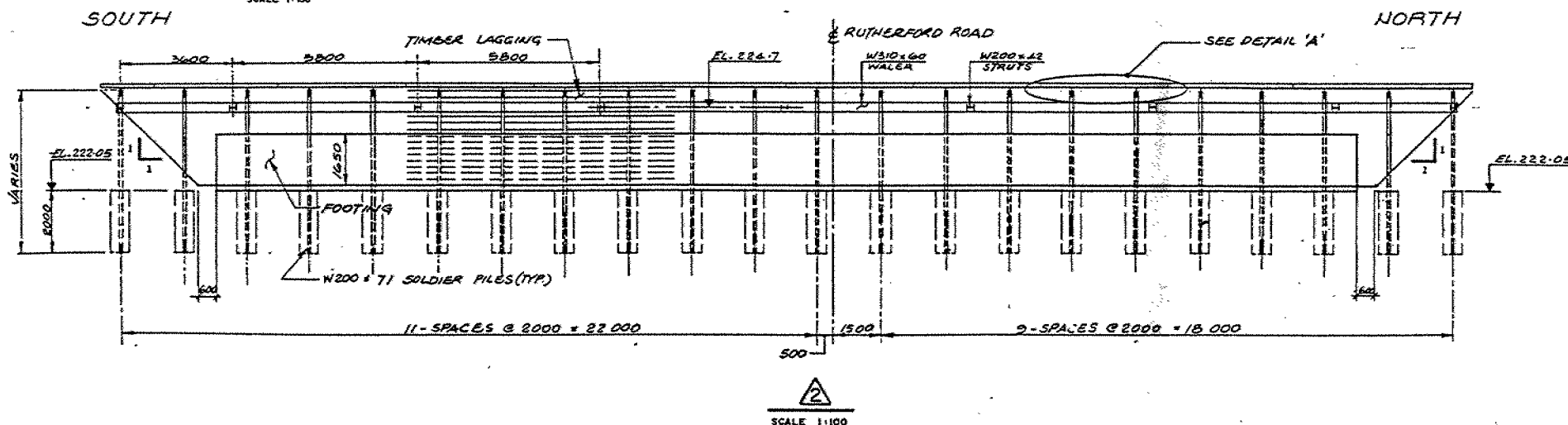
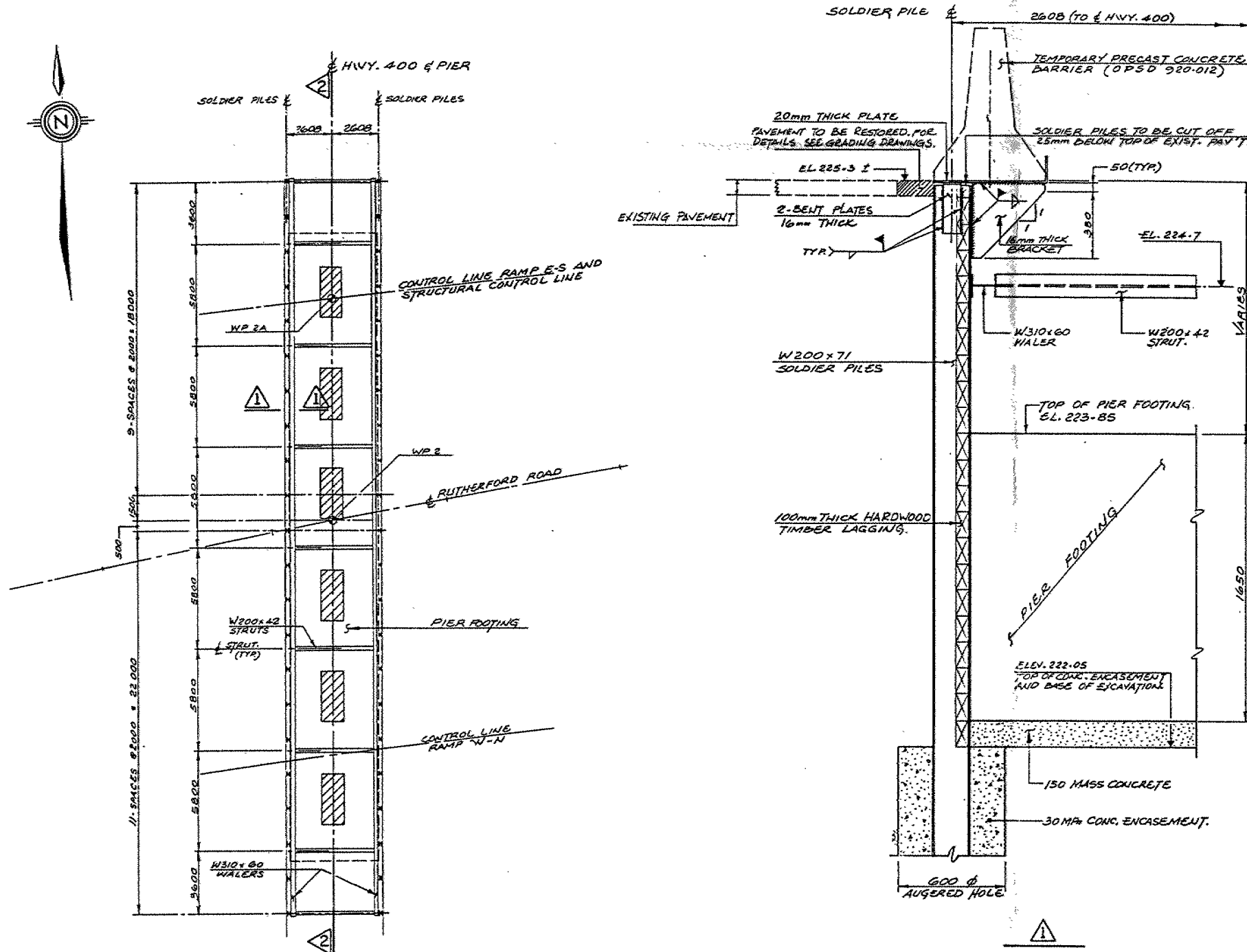
W.P. 632-89-01 LOCATION Co-ords: N 4 354 004 ; E 301 019 ORIGINATED BY \_\_\_\_\_  
 DIST 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE November 24, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
223.4																
0.0	Topsoil - Organics, 150 mm															
			1	SS	32								o			21.4
			2	SS	25								o			21.5
			3	SS	28											
	Silty Clay, Traces of Sand and Gravel, Sand layers Brown, Very Stiff to Hard		4	SS	31								o			19.8
			5	SS	20								o			
217.3																
6.1			6	SS	70								o			22.9
216.9																
6.5	End of Borehole															
	Sandy Silt to Clayey Silt, Traces of Gravel Very Dense															
	Water level at 6.0 m depth and borehole open to 6.1 m depth upon completion.															

# RECORD OF BOREHOLE No MTC 11(96-78-02) METRIC

W.P. 632-89-01 LOCATION Co-ords: N 4 854 006 : E 301 088 ORIGINATED BY \_\_\_\_\_  
 DIST. 6 HWY RUTHERFORD RD. BOREHOLE TYPE Solid Stem Auger COMPILED BY \_\_\_\_\_  
 DATUM Caselle DATE December 4, 1978 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
231.0																	
0.0	Gravel - Some Sand, 150 mm																
			1	SS	16		230									22.1	
			2	SS	7		229										2 27 53 18
			3	SS	8		228										
			4	SS	8		227										
			5	SS	22		226										
			6	SS	26		225									22.1	
							224										
223.4																	
7.8 222.9	Topsoil - Silty Sand, Black, Organics		7	SS	26		223										
8.1							222										
			8	SS	35		221									21.9	4 23 44 29
			9	SS	27		220										
							219										
218.4			10	SS	57												
12.6	End of Borehole																
	Borehole Dry and open to 8.2 m depth upon completion.																



DETAIL 'B'

# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No 92-78  
WP - No 632-89-01

HIGHWAY 400  
RUTHERFORD RD. UNDERPASS  
ROADWAY PROTECTION - I



SHEET  
238

**DILLON**  
Consulting Engineers - Planners  
Environmental Scientists

## CENTRAL PIER CONSTRUCTION SEQUENCE

1. INSTALL SOLDIER PILES.
2. LOCALLY EXCAVATE AROUND SOLDIER PILES, INSTALL BARRIER SUPPORT ASSEMBLY, BACKFILL AS REQUIRED.
3. INSTALL TEMPORARY CONCRETE BARRIER.
4. INSTALL TIMBER LAGGING AS EXCAVATION PROCEEDS TO ELEVATION 224.1 (APPROX. 1.2 m BELOW EXISTING GROUND).
5. INSTALL STRUT AND WALER.
6. EXCAVATE TO ELEV. 222.05.
7. PLACE CONCRETE FOOTING.
8. CONSTRUCT PIER.
9. REMOVE SHORING 1000 mm BELOW FINISHED GRADE.

## NOTES

1. ALTERNATE ROADWAY PROTECTION SCHEMES WILL BE CONSIDERED SUBJECT TO THE ENGINEER'S APPROVAL. ALTERNATE SCHEMES WILL NOT BE ALLOWED TO ENCRoACH ON THE PAVED PORTIONS OF HWY. 400, BEYOND THE LIMITS SHOWN ON THIS DRAWING. THE CONTRACTOR SHALL SUBMIT DETAILED CONSTRUCTION DRAWINGS FOR ANY ROADWAY PROTECTION SEALED AND SIGNED BY A PROFESSIONAL ENGINEER.
2. STRUCTURAL STEEL FOR ROADWAY PROTECTION: CAN/CSA - G40.21 - M87, GRADE 300W
3. WELDING OF STRUCTURAL STEEL: CSA W59
4. CONTRACTOR TO VERIFY EXISTING GRADE ELEVATIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK.
5. UNLESS OTHERWISE NOTED WELD SIZES FOR STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH STRUCTURAL STEEL NOTES ON DWG. No. 15



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No 92-78  
WP No 632-89-01



HIGHWAY 400  
RUTHERFORD RD. UNDERPASS  
ROADWAY PROTECTION-II

SHEET  
239

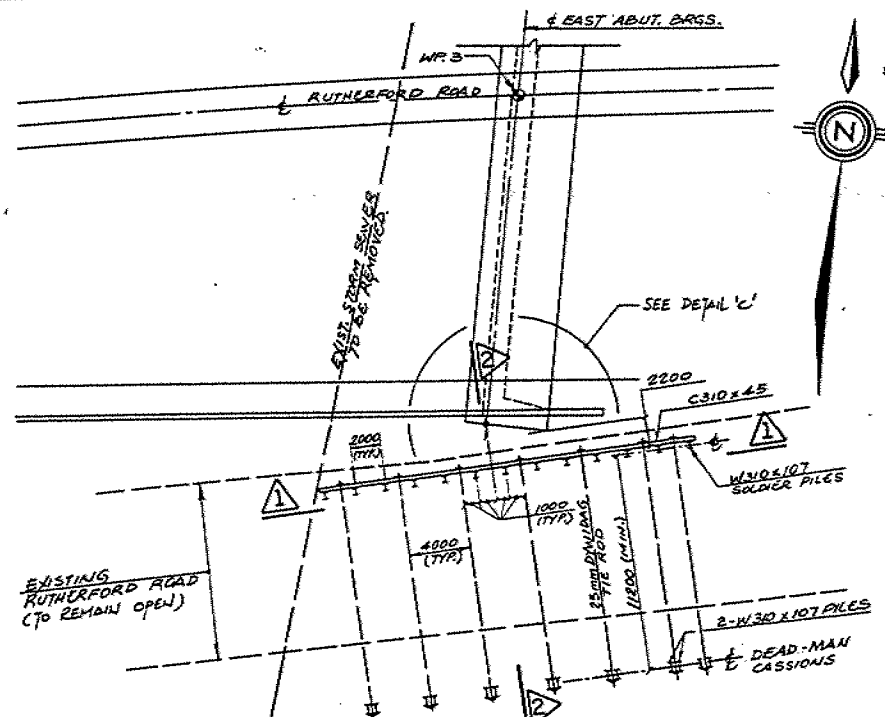
**DILLON**  
Consulting Engineers - Planners  
Environmental Scientists

## EAST ABUTMENT ROAD PROTECTION CONSTRUCTION SEQUENCE

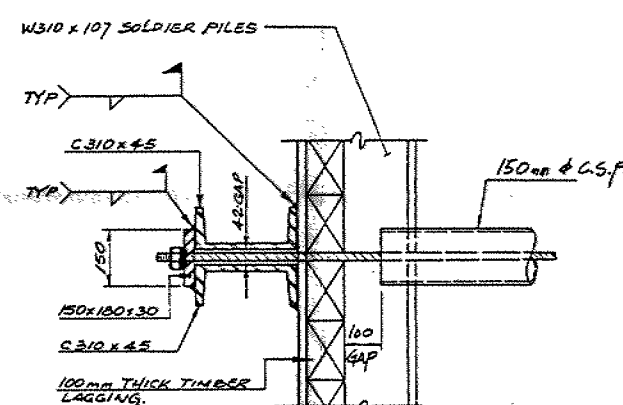
1. INSTALL SOLDIER PILES
2. INSTALL TIMBER LAGGING TO ELEVATION 227.0 m.
3. TRENCH FOR TIE RODS AND INSTALL 150mm DIAMETER C.S.P.
4. INSTALL HALERS AND TIE RODS.
5. DRILL DEAD-MAN CASSIONS AND INSTALL DOUBLE PILE SECTION.
6. PLACE DEAD-MAN CONCRETE, WITH TIE ROD ENGAGED.
7. PROOF TEST TIE RODS TO 475 KN. AND REDUCE TO WORKING LOAD AS NOTED.
8. EXCAVATE TO ELEVATION 225.0 m
9. PLACE AND COMPACT GRANULAR FILL TO 227.0 m
10. PLACE EAST ABUTMENT FOOTING AND ABUTMENT WALL.
11. REMOVE SHORING TO 1.0 m MIN. BELOW FINISHED GRADE. SHORING MAY BE REMOVED TO LOWER ELEVATION BUT MUST NOT BE REMOVED BELOW ELEVATION 227.30.

## NOTES:

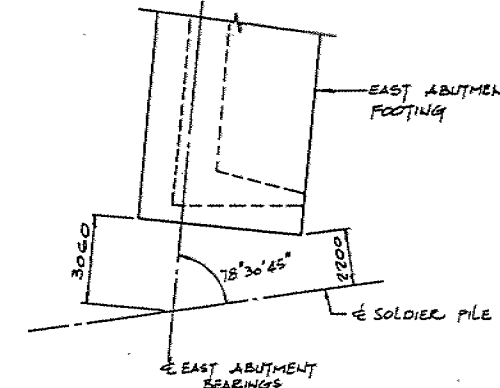
1. ALTERNATE ROADWAY PROTECTION SCHEMES WILL BE CONSIDERED SUBJECT TO THE ENGINEER'S APPROVAL. ALTERNATE SCHEMES WILL NOT BE ALLOWED TO ENCROACH INTO THE GRANULAR FILL SUPPORTING THE EAST ABUTMENT. THE CONTRACTOR SHALL SUBMIT DETAILED CONSTRUCTION DRAWINGS FOR ANY ROADWAY PROTECTION SEALED AND SIGNED BY A PROFESSIONAL ENGINEER.
2. STRUCTURAL STEEL FOR ROADWAY PROTECTION CAN/CSA - G40.21 - M 87, GRADE 300W.
3. WELDING OF STRUCTURAL STEEL: C.S.A. W59
4. CONTRACTOR TO VERIFY EXISTING GRADE ELEVATIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK.
5. UNLESS OTHERWISE NOTED WELD SIZES SHALL BE IN ACCORDANCE WITH STRUCTURAL STEEL NOTES ON DWG. No 15
6. TIE RODS SHALL BE DYWIDAG THREADBARS, GRADE 1030 MPa, CONFORMING TO THE REQUIREMENTS OF ASTM DESIGNATION A722.
7. TIE RODS TO BE INSTALLED BY TRENCHING ACROSS ROADWAY OR BY HORIZONTALLY BORING ACROSS ROADWAY.



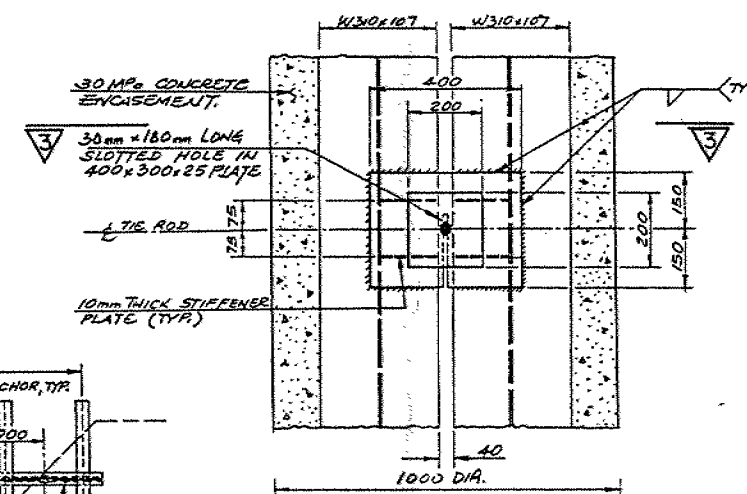
PLAN  
SCALE 1:250



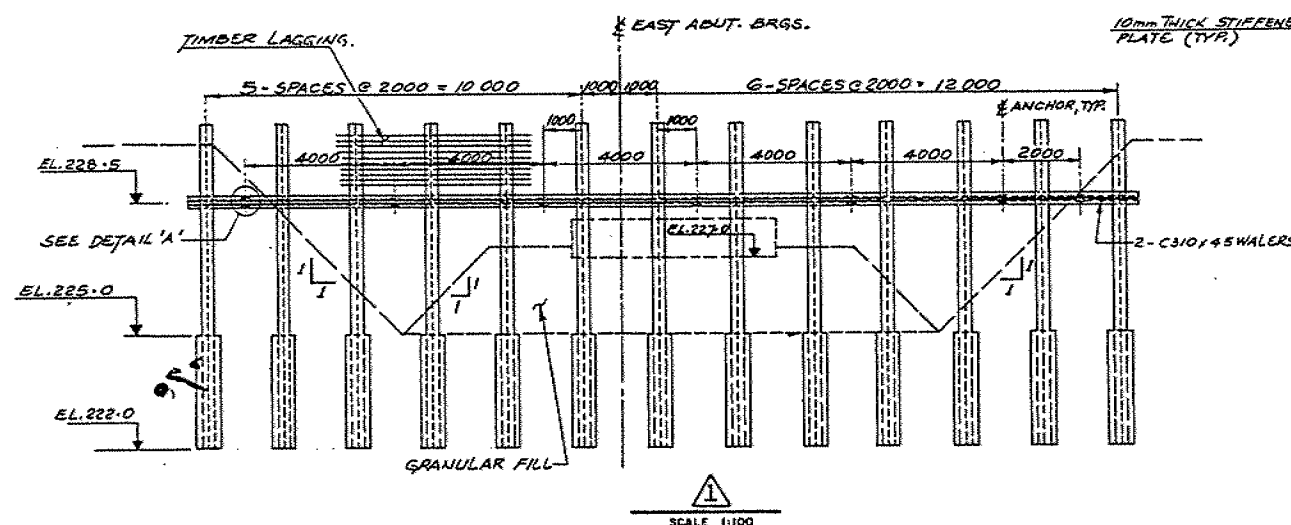
DETAIL 'A'  
SCALE 1:10



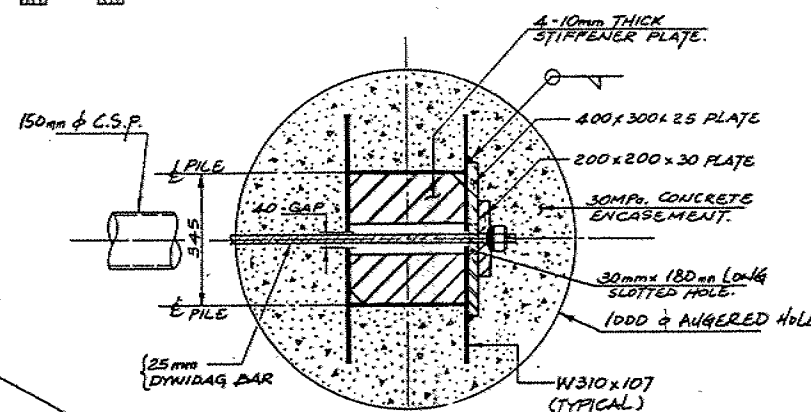
DETAIL 'C'  
N.T.S.



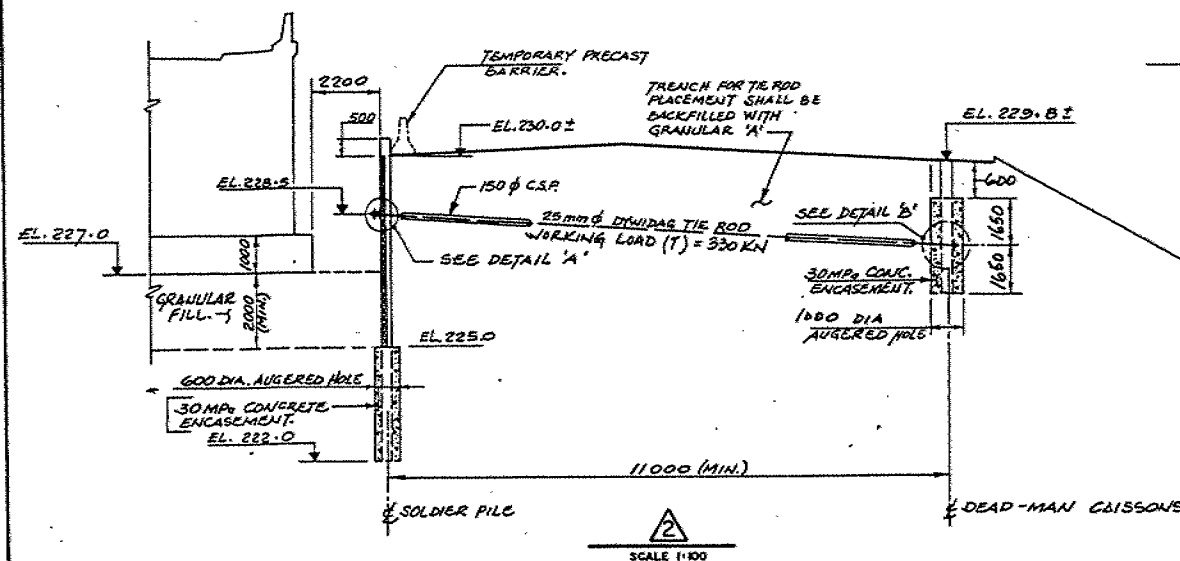
DETAIL 'B'  
SCALE 1:10



SCALE 1:100



DETAIL '3'  
SCALE 1:10



SCALE 1:100



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
1	41-04-29	D.C.	DESIGN
2	41-04-29	C.H.K.	CHK
3	41-04-29	R.T.	R.T.
4	41-04-29	C.H.K.	CHK
5	41-04-29	D.C.	DESIGN
6	41-04-29	SITE	37-127
7	41-04-29	STRUCT	SCHEME
8	41-04-29	DWG	4

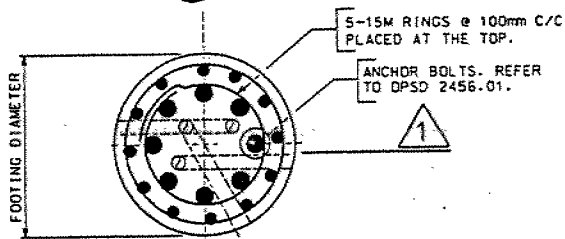
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT 92-78  
WP NO 632-89-00

HWY 400/RUTHERFORD RD.  
HIGH MAST LIGHTING  
POLE FOOTINGS



SHEET  
188



TOP VIEW  
N.T.S.

### FOOTING DATA

FTG. No.	POLE LENGTH (m)	FOOTING DIA. (m)	FOOTING DEPTH (m)	REINF. BARS "A"			SPIRAL		No. OF BOLTS	TOTAL MASS OF STEEL (t)	VOLUME OF CONCRETE (m <sup>3</sup> )	T/FTG ELEVATION
				LENGTH (m)	SIZE (M)	No. REQ'D	HEIGHT (m)	O.D. (m)				
F4	30	1.22	8.750	8.375	25	12	8.275	1.080	8	0.61	10.23	223.15
F3	30	1.22	10.150	9.775	25	12	9.675	1.080	8	0.71	11.87	224.15

### QUANTITIES:

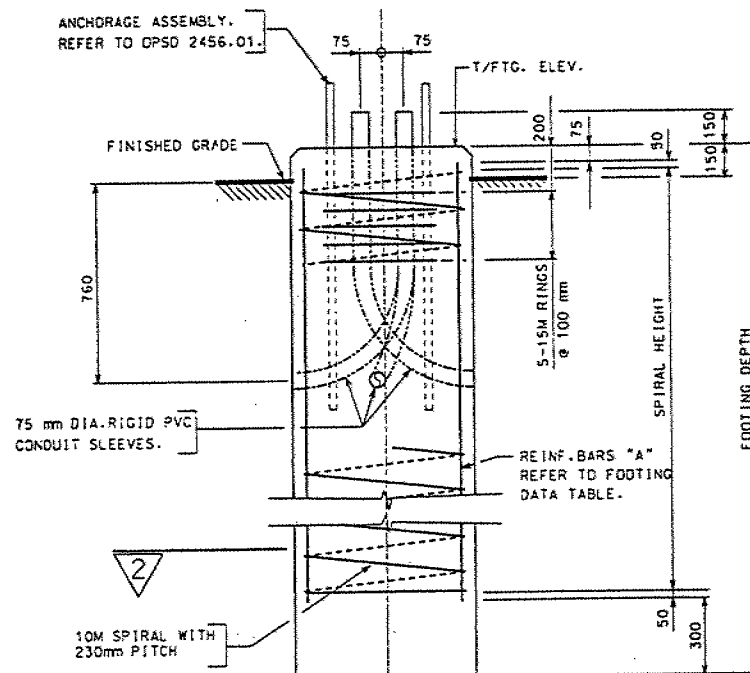
TOTAL MASS OF REINF. STEEL = 1.67 (tonne)  
TOTAL VOLUME OF CONCRETE = 22.1 (m<sup>3</sup>)

212-216

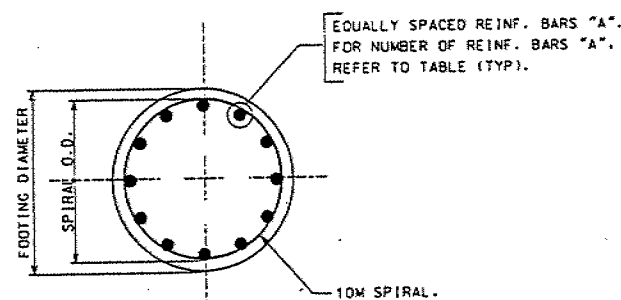
F3 224  
10  
214

F4 223  
9  
214

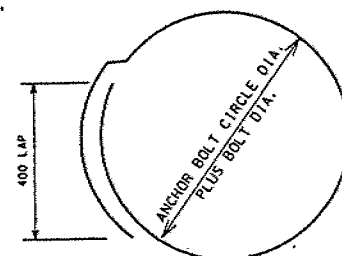
May hit water



SECTION 1  
N.T.S.



SECTION 2  
N.T.S.



DETAIL OF 15M RINGS  
PLACED AT THE TOP.



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS		DESCRIPTION			
DESIGN	N.C. CHK	CODE	OHBC 83	LOAD	DATE NOV. '92
DRAWN	G.Y. CHK	SITE	37-127	STRUCT	SCHEME DWG 1

