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DIST. 6 REGION

W.P. No. 369-87-04/05

CONT. No. 93-102

W. O. No.

STR. SITE No.

HWY. No. 407

LOCATION Eighth line Overpass
EBL & WBL

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 369-87-04/05 DIST 6

HWY 407 STR SITE 24-654

CONT. 93-102

8th Line (Gorewood Drive)
Hwy. 407 EBL/WBL Overpass

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GEOCRES 30M12-214

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FOUNDATION INVESTIGATION REPORT
For
8th Line (Gorewood Drive)
Hwy. 407 EBL/WBL Overpass
W.P. 369-87-04/05, Site No. 24-654
District 6, Toronto

INTRODUCTION

This report summarizes the results of a Foundation Investigation conducted at the aforementioned site. Two single span bridge structures have been proposed to carry the east and west bound lanes of Highway 407 over Gorewood Drive. This report contains factual information obtained from this investigation pertaining to structural foundations and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located ¼ km north of Steeles Avenue along 8th Line (Gorewood Drive) in the City of Brampton, Region of Peel. The area is partially residential with private homes on the west side and a conservation area that contains a single storey building to the east.

8th Line (Gorewood Drive) is a narrow paved two lane road with drainage ditches on both shoulders. The terrain surrounding the site is generally flat to gently rolling. The vegetation on the conservation property consists of deciduous trees along the side of the road and short wild grasslands.

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

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

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

INVESTIGATION PROCEDURES.

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

Field Investigation

The fieldwork for this investigation was carried out between 90 06 27 and 90 07 07 and consisted of a total of 10 sampled boreholes. Six of these boreholes were located at the various structure locations. These boreholes were advanced to a maximum depth of 30.9 m below existing grade. The four remaining boreholes were located at the approach embankments and were advanced to depths of 13.0 to 5.7 m below existing grade. The boreholes were advanced using a track mounted CME55 drill rig employing hollow stem augering and wash boring techniques.

In general, subsoil samples were retrieved at 0.7 m intervals from the top 6 m depth and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved using a shelby tube sampler in accordance with Standard Practice (ASTM D1587). In situ vane shear tests were conducted between the aforementioned sampling intervals to determine the undisturbed and remolded undrained shear strength of soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

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

Water levels were monitored throughout the duration of the investigation in open boreholes. All boreholes were backfilled upon completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Giffels Engineering Consultants under contract with Central Region surveys and plans.

Laboratory Analysis

The following laboratory tests were carried on select soil samples?

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

Laboratory Test Results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

General

The generalized subsurface soil stratigraphy at this site consits of a surficial layer of a heterogeneous mixture of clayey silt, sand and gravel (Glacial Till) underlain by a clayey silt to silty clay (Lacustrine) deposit followed by a second layer of heterogeneous mixture of clayey silt, sand, and gravel (Glacial Till) and then a silty sand. A layer of silty sand was encountered between the lacustrine deposit and the underlying Glacial Till deposit in BH 1. This deposit was not encountered in the remaining boreholes.

The plan and location of borings and the stratigraphical profile are shown on Drawing No. 369870405-A in the attached Appendix. The results of all field and laboratory tests are plotted on the Record of Borehole sheets, also included in the appendix of this report. A brief description of the different soil strata is given below.

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

The surficial deposit at the site consists of 5.3 m to 8.4 m of a heterogeneous mixture of clayey silt, sand and gravel (Glacial Till) at all boreholes.

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in an envelope form. The deposit is comprised primarily of 0-7% Gravel, 5-31% sand, 31-59% silt and 2-60% clay.

The results from the Atterberg Limit Tests performed on the fine fraction of this report is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	8.5-24.5	10
Liquid Limit (w_L)	19-51	10
Plastic Limit (w_P)	12-18	10
Plastic Index (I_P)	8-33	10

From the plasticity chart (Figure 2), this deposit can be classified as a clayey silt of low plasticity. Unit weight measurements carried out on samples from this stratum yield dry unit weights of 18.7 to 23.1 kN/m^3.

In this stratum the Standard Penetration resistance, 'N' values ranged from 3 blows/0.3 m to 47 blows/0.3 m indicating that the consistency ranged from firm to hard, but generally from stiff to hard.

Clayey Silt to Silty Clay (Lacustrine)

Underlying the above surficial layer a 6.1 m - 11.5 m thick moist clayey silt to silty clay, lacustrine deposit, was encountered.

Results of Grain Size Distribution tests on this deposit are shown on Figure 3 in the Appendix, in an envelope form. Based on these test data, this deposit is comprised of 0-13% gravel, 1-25% sand, 36-57% silt and 22-53% clay.

The results from the Atterberg Limit Tests performed on this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	16-29	9
Liquid Limit (w_L)	28-44	9
Plastic Limit (wp)	14-20	9
Plastic Index (Ip)	13-25	9

From the Plasticity Chart (Figure 4) the layer can be classified as a clayey silt to silty caly of low to medium plasticity. Unit weight measurements carried out on samples from this stratum yielded dry unit weights of 18.2 to 20.67 kN/m^3.

Undrained Shear Strength (Cu) measurements of the soil were obtained by conducting in situ vane shear tests and laboratory unconfined compression tests. Based on the undrained Shear Strength values of 30 to >130 kPa, this stratum can be classified as firm to very stiff.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state of the undrained strength, at the same water content, in the remolded state was determined by the field vane tests. Sensitivity values ranged from 1.3 to 3.2 indicating that the soil has low sensitivity.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 4 blows/0.3 m to 14 blows/0.3 m. Based on these 'N' values, the material can be descibed as having a firm to stiff consistency.

Silty Sand, trace Clay

This layer was encountered only in BH 1, underlying the above mentioned lacustrine deposit at El. 158 m. The encountered thickness of this layer was 5.3 m.

Based on Standard Penetration resistance 'N' values of 22 and 43 blows/0.3 m, this stratum exists in a compact to dense state of relativity density.

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

Underlying the lacustrine deposit in every borehole, excluding BH 1 where it underlies a silty sand, trace clay is another deposit of heterogeneous mixture of clayey silt, sand and gravel (Glacial Till). This layer was encountered at depths ranging from 16.8 m - 28.2 m.

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in an envelope form based on these test data, this deposit is comprised of 0-25% gravel, 1-32% sand, 31-42% silt and 13-57% clay.

The results from the Atterberg Limit tests performed on the fine fraction of this report is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	9-29	5
Liquid Limit (w_L)	17-36	5
Plastic Limit (w_P)	11-18	5
Plastic Index (I_P)	6-18	5

From the plasticity chart (Figure 2), this deposit can be classified as a clayey silt of low plasticity. Unit weight measurements carried out on samples from this stratum yielded dry unit weights of 18.8 and 23.2 kN/m^3. In this stratum the Standard Penetration resistance, 'N' values ranged from 8 blows/0.3 m to 51 blows/0.3 m indicating that the consistency ranged from firm to hard, but generally stiff to hard.

Sandy Silt to Silty Sand, some Clay, trace Gravel

Underlying the above mentioned Glacial Till deposit, a deposit of sandy silt to silty sand was encountered in all boreholes at about elevation 147 to 151 m, at depths of 22.8 to 28.2 m below existing grade.

Results of Grain Size Distribution tests carried out on select samples from this layer are shown on Figure 5 in the Appendix, in an envelope form. Based on these test data, this deposit is comprised of 1-51% gravel, 27-40% sand, 12-55% silt and 3-12% clay.

The results from the Atterberg Limit tests performed on the fine fraction of this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	8.5-8.0	2
Liquid Limit (w_L)	17	1
Plastic Limit (w_P)	13	1
Plastic Index (I_P)	5	1

Standard Penetration resistance 'N' values range from 14 blows/0.30 m to >130/0.30, indicating a compact to very dense state of relative density, in general, however, the deposit can be characterized as dense to very dense.

GROUNDWATER CONDITIONS

Observations of the groundwater level were carried out by measuring the water level in open boreholes. Groundwater levels determined at the time of the investigation were approximately 1.5 (elevation 171.8 m) to 4.5 m (elevation 168.8 m). It is considered that the water levels observed in BH's 2 (163.2 m) and 6 (164.8 m) do not reflect stabilized groundwater levels.

Soil cave-in was encountered in the boreholes upon penetration of the cohesionless sandy silt material below the prevailing groundwater due to unbalanced hydrostatic head. Wash boring techniques were employed to advance the boreholes thereafter.

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

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct two single span bridge structures (rigid frame or girder) with closed abutments to carry the east and westbound lanes of the proposed Hwy. 407 over 8th Line (Gorewood Drive). The proposed structure would consist of a reinforced earth wall rising to about 2.75 m above grade, with the pile supported bridge abutments rising from elevation 176 m to the design grade of Highway 407. Approach fills, approximately 6 m in height will be required for the 3 lane east and westbound lanes with adjoining shoulders. A plan illustrating the proposed structure is shown on Drawing No. 369870405-A in the Appendix of this report.

Abutments for the single span structures have been proposed immediately east and west of the existing 8th Line (Gorewood Drive).

The natural ground surface at abutment locations was fairly uniform with elevations of 172.5 to 173.2 m. The elevation at the centreline of Highway 407 and existing 8th Line (Gorewood Drive) are 178 m and 171.6 m respectively.

To facilitate the design and construction of the proposed structure foundations and related earthworks for the approach ramps over 8th Line, the following foundation and geotechnical recommendations are provided in the scope of this report.

1) Structure Foundation
2) Lateral Earth Pressure
3) Slope Stability
4) Construction Considerations

1) Structure Foundation

A) Abutment Pile Foundation

The structure foundation shall be supported on steel H-piles driven to the lower very dense sandy silt to silty sand deposit encountered at about 22.8 to 25.9 m depth below existing grade.

For purposes of the O.H.B.D.C., the design axial capacity for vertical piles are summarized in table form below:

Table 1 - Axial Capacities - Driven Steel H-Piles

Pile Type	Bearing Capacity at S.L.S. Type II (kN)	Factored Capacity at U.L.S. (kN)	Estimated Pile Tip Elevation (m) EBL	WBL
HP 310x110	1150	1600	144±	143±
HP 310x79	890	1150	144±	143±

The installations of the piles shall be controlled and monitored employing the Hiley Dynamic driving formula, driven in accordance with MTO Standards. Assuming an ultimate capacity as tabulated in Table 2 below.

Table 2 - Ultimate Capacity Employing Hiley Dynamic Formula

Pile Type	Ultimate Capacity (kN)
HP 310x110	3450
HP 310x79	2670

Pile spacing shall conform with section 6.8.3.10 of the O.H.B.D.C. adjacent piles should be checked for heaving during pile installation. Lateral loads shall be supported by batter piles. All sides should be provided with the standard MTO pile tip reinforcement.

B) Reinforced Earth Walls

Vertical loads from reinforced earth walls shall be supported on shallow spread foundations located within the surficial heterogeneous mixture of clayey silt, sand and gravel (Glacial Till) deposit. Bearing pressures from the design of shallow spread foundations are given in the following table:

Table 3 - Bearing Capacities

Bearing Capacity at S.L.S. Type II (kPa)	Factored Capacity at U.L.S. (kPa)	Elevation (m)
200	300	176 m±

2) Lateral Earth Pressures on Structure

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments and reinforced earth walls to prevent hydrostatic pressure build-up design parameters of the soil are given below:

Table 4 - Backfill Properties

		Granular 'A'	Granular 'B'
Angle of Internal Friction (0)		35°	30°
Unit Weight (kN/m^3)		22.8	21.2
*Coefficient of Active Earth Pressure (Ka)	- S.L.S.	0.27	0.33
	- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure At Rest (Ko)	- S.L.S.	0.43	0.5
	- U.L.S.	0.5	0.58

*Horizontal surface backfill only. Appropriate consideration must be given to sloping surface backfill.

The earth pressure coefficient At Rest is to be used in design if the abutment/ retaining walls are rigid and unyielding. The tabulated earth pressure coefficients are applicable to horizontal surfaces only. The valves must be modified to represent sloping surfaces. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

3) Slope Stability

The approach fills rising to a maximum height of 7 m shall be constructed using 2H:1V slopes. The fill material should consist of well compacted acceptable material.

It is anticipated that approximately 70 mm of total settlement can be realized as a result of elastic settlements induced within the fill itself and the elastic recompression of the native subsoil. It is expected that the majority of these settlements will be realized during or immediately following construction.

4) Construction Considerations

All pile caps and shallow spread foundations shall be protected against frost by providing a minimum 1.2 m of earth cover.

Within the limits of the approach fills, if soft soil is encountered, this should be excavated and replaced by compacted granular fill. Excavations to about 2 m depth will be involved in the area of the 8th Line (Gorewood Drive). Such excavations and any temporary construction excavation may be carried out at 1.5H:1V slopes.

Due to the relatively impervious nature of the surficial soils and generally deep groundwater level, no problems are anticipated driving the excavation.

The excavated base is susceptible to disturbance due to construction traffic and ponded water. It is therefore recommended that the excavated base should be protected using compacted granular fill or lean concrete.

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

Even though boulders were not encountered in the boreholes carried out at this site, based on geological evidence cobbles and boulders should be expected in the upper and lower glacial till deposits.

MISCELLANEOUS

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

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

M. Michalek
Junior Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

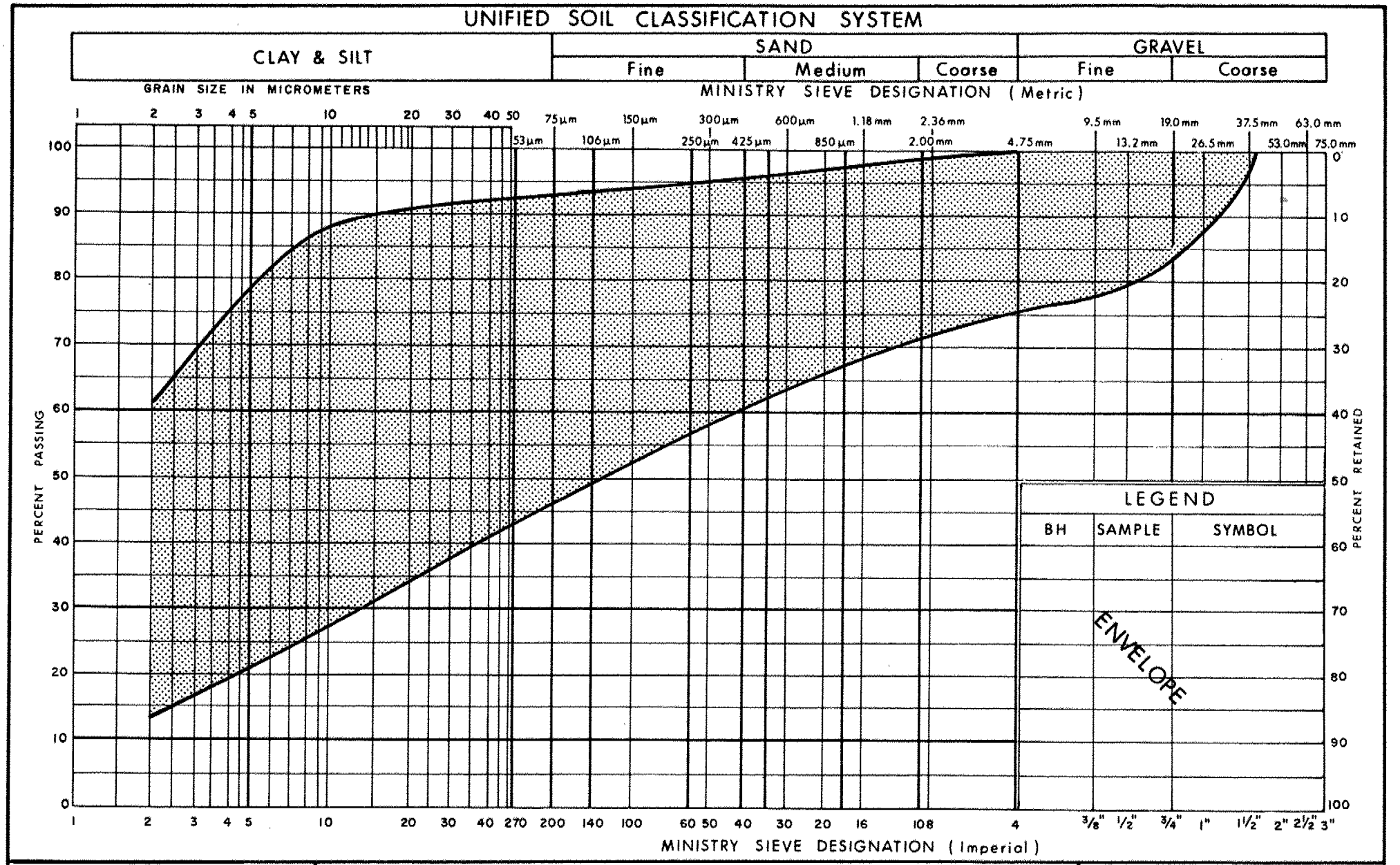
MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE



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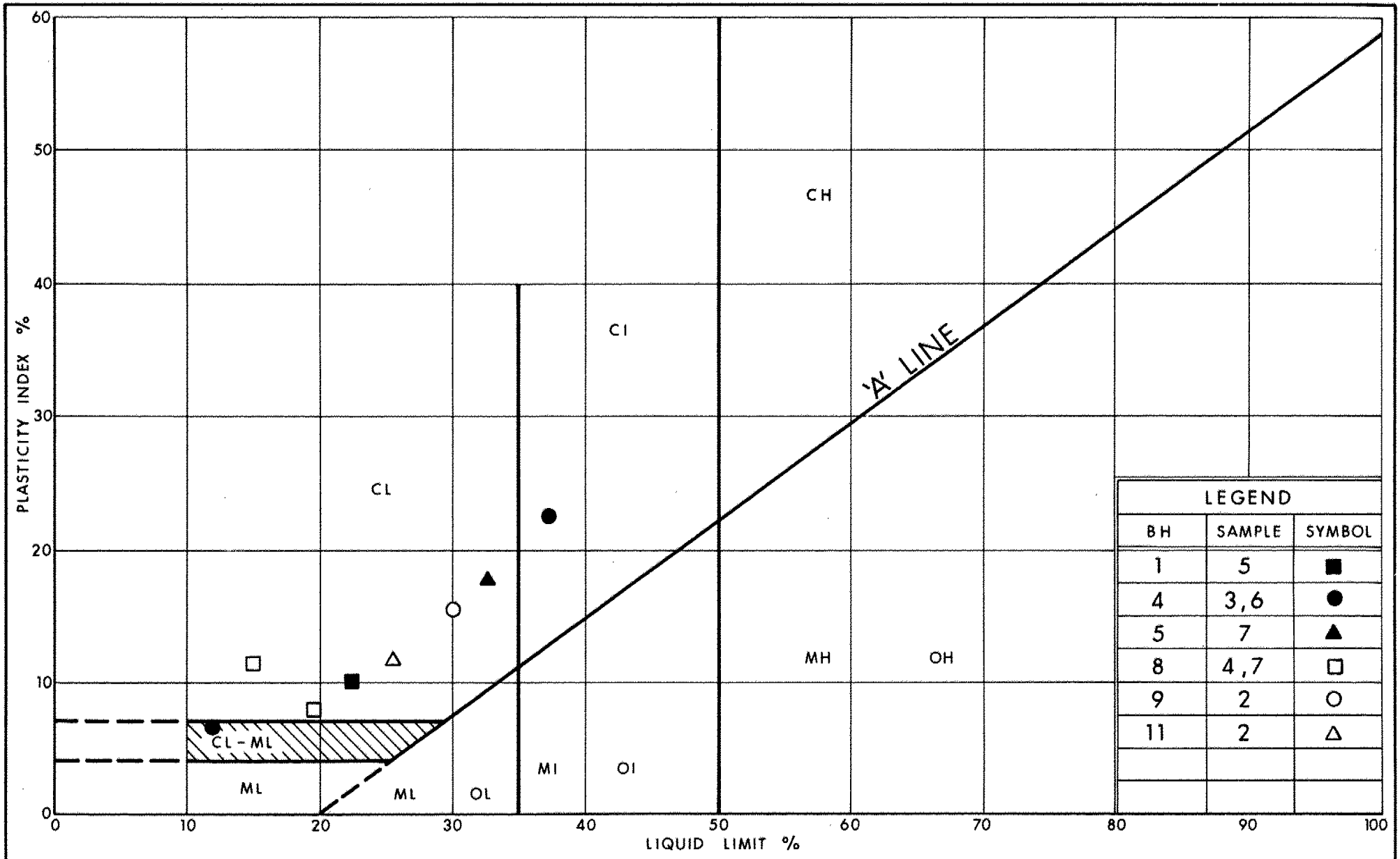
GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(GLACIAL TILL)

FIG No 1

W P 369-87-04/05



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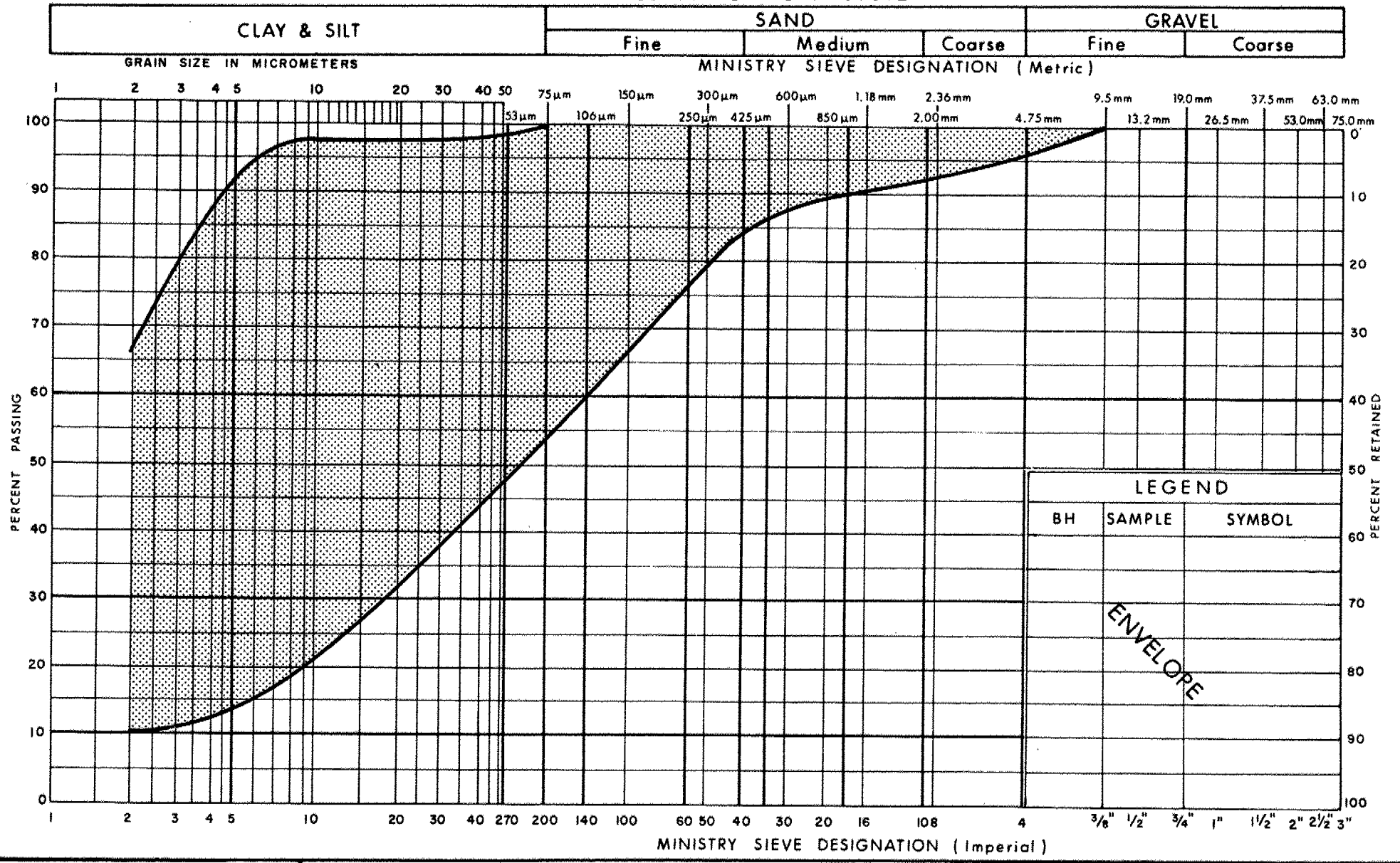
PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(GLACIAL TILL)

FIG No 2

W P 369-87-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



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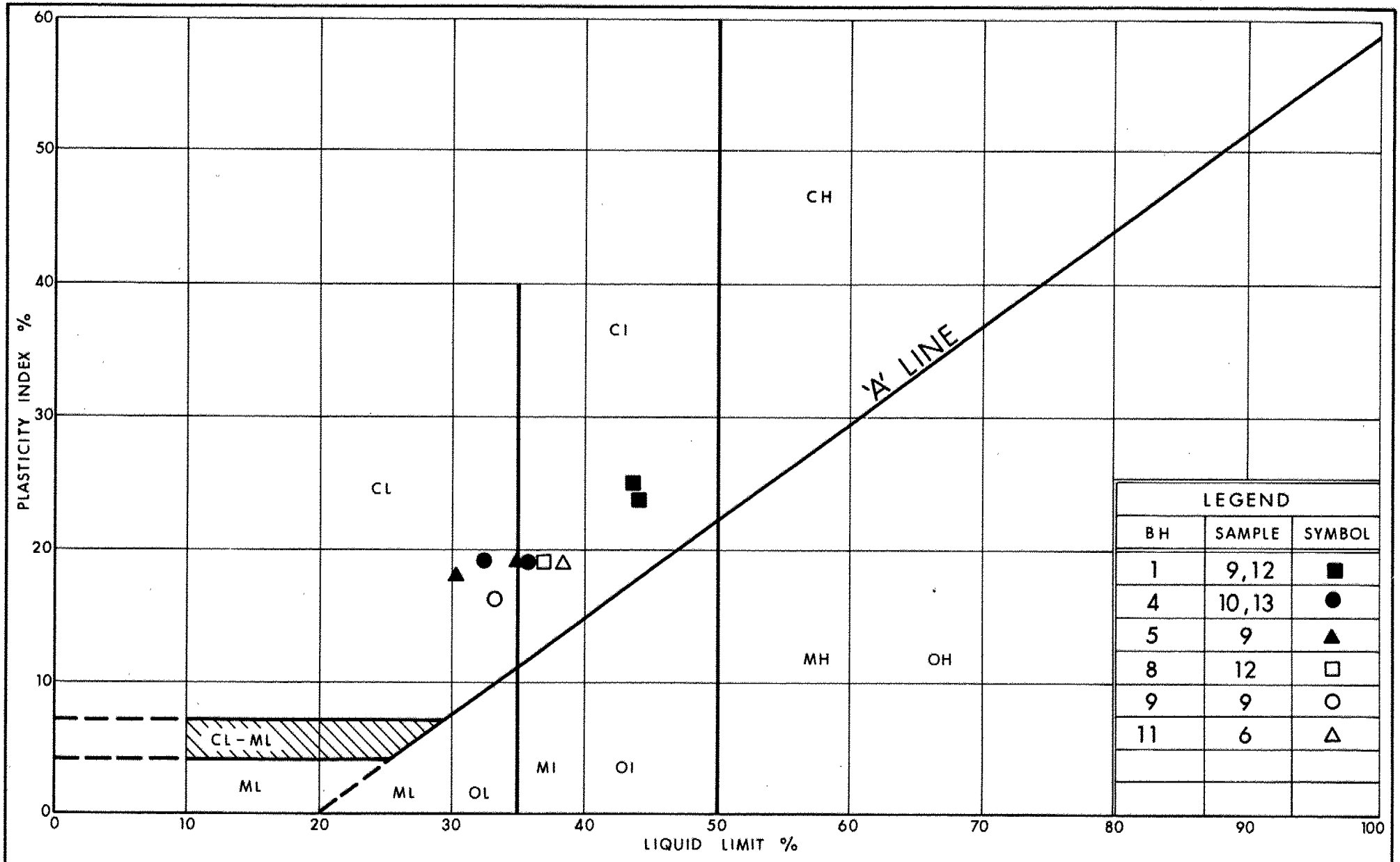
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
(LACUSTRINE)

FIG No 3

W P 369-87-04/05

Oct 75, FF-S-21



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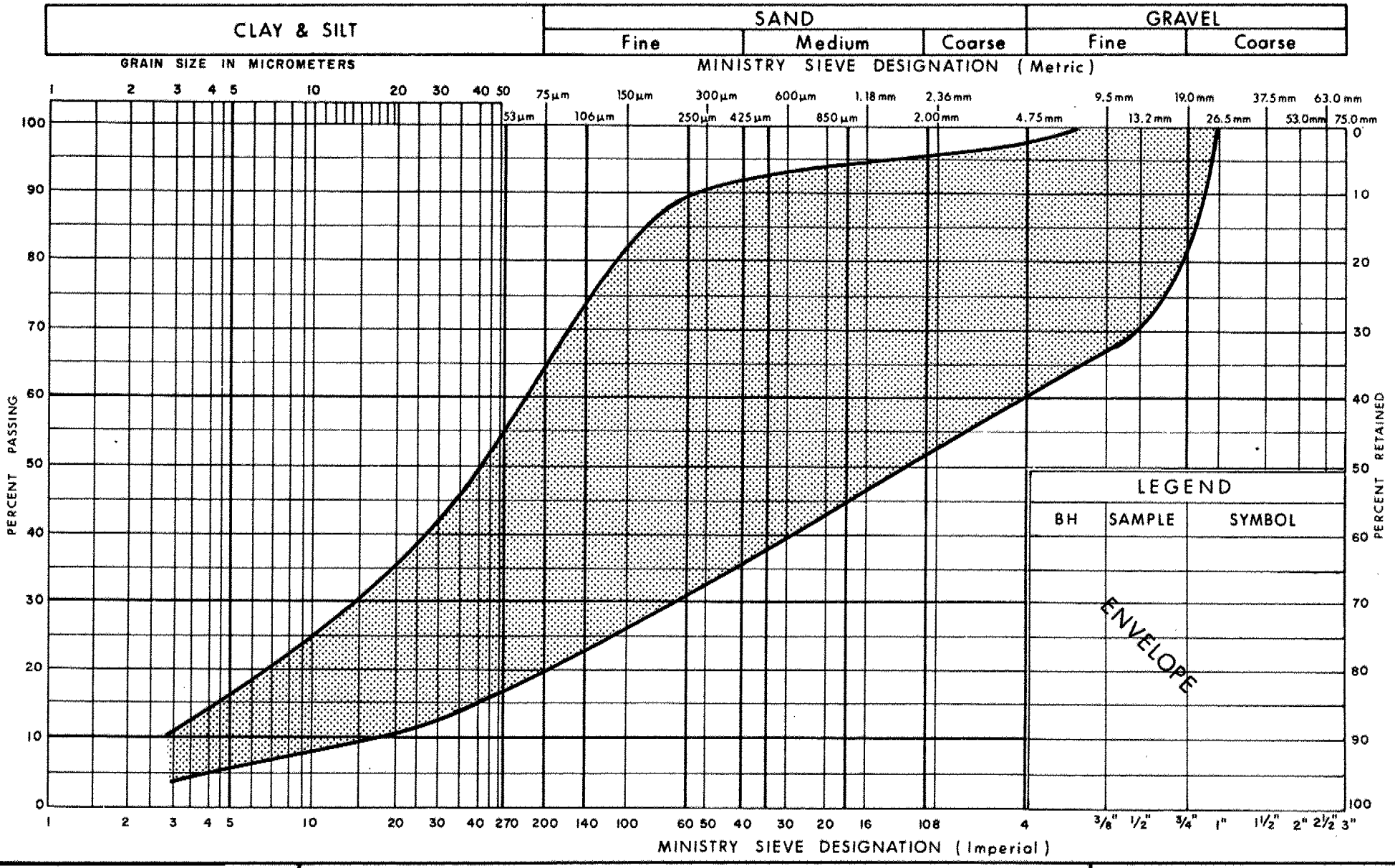
PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
(LACUSTRINE)

FIG No 4
W P 369-87-04/05

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND

FIG No 5

W P 369-87-04/05

RECORD OF BOREHOLE No 1 1 OF 2 METRIC

W.P. 369-87-04/05 LOCATION CO-ORD'S: N 4 844 689, E 292 795.2 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.5	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	8	*					
			2	SS	12					18.7	1 5 39 55
	Brown		3	SS	19		170				
	Grey		4	SS	21						
	Stiff to Very Stiff		5	SS	18					23.1	2 28 46 24
			6	SS	16		168				
165.6			7	SS	17		166				
6.9			8	SS	9			+2			
	Clayey Silt to Silty Clay (Lacustrine)						164				
	Stiff		9	SS	10			+2		19.7	2 8 37 53
			10	SS	12		162				
			11	SS	9		160				
158.0			12	SS	9			+2		18.1	0 2 53 45
14.5			13	SS	22		158				
	Silty Sand, trace Clay										
	Compact to Dense						156				
			14	SS	43		154				
152.7											
19.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)						152				
			15	SS	35					23.2	16 31 40 13
	Hard						150				
149.6											
22.9	Sandy Silt to Silty Sand some Clay trace Gravel						148				
			16	SS	49						
	Very Dense						146				
			17	SS	130	/15cm					1 23 62 14
							144				
142.0			18	SS	120	/15cm					
30.5	Continued										Continued

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1 2 OF 2 METRIC

W.P. 369-87-04/05 LOCATION CO-ORD'S: N 4 844 689, E 292 795.2 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
142.0	Continued										
141.6			19	SS	120	/8cm			oH		
30.9	End of Borehole										

• -Water table not established

+³, x⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 1 OF 2 METRIC

W.P. 369-87-04/05 LOCATION CO-ORDS: N 4 844 673, E 292 814 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.2	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	30		172				
			2	SS	22						
			3	SS	23						
	Brown		4	SS	23		170				
	Grey		5	SS	18						
	Stiff to Very Stiff		6	SS	14		168				
167.9											
5.3	Clayey Silt to Silty Clay (Lacustrine)		7	SS	13			>+			
			8	SS	6		166	>+			
	Firm to Stiff		9	SS	9	▼	164				
			10	SS	6		162	>+			
			11	SS	4			+2			
			12	SS	4		160	+1			
			13	SS	6		158	+2			
156.4											
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	17		156				
	Stiff to Very Stiff		15	SS	14		154				
			16	SS	22		152				
148.1							150				
25.1	Sandy Silt to Silty Sand Trace Clay		17	SS	124		148				
	Very Dense		18	SS	88		146				
142.7							144				
30.5	Continued										

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2 2 OF 2 METRIC

W.P. 389-87-04/05 LOCATION CO-ORDS: N 4 844 673, E 292 814 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
	Continued										
142.3 / 30.9	End of Borehole		19	SS	197						

+³, ×⁵: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 1 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 653.8, E 292 830.4 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
173.0	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	28		172				
			2	SS	21						
			2	SS	28		170			19.9	0 13 34 53
	Brown / Grey		4	SS	38						
			5	SS	23						
	Stiff to Hard		6	SS	31		168			21.4	2 19 59 20
			7	SS	16		166				
164.6			8	SS	15						
8.4	Clayey Silt to Silty Clay (Lacustrine) Firm to Stiff		9	SS	10		164				
			10	SS	11		162			20.7	1 10 37 52
	seams of silt trace gravel very dense		11	SS	53		160				
			12	SS	4						
			13	SS	4		158			19.3	0 1 55 44
155.5			14	SS	6		156				
17.5	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		15	SS	14						
			16	SS	8		154				
			17	SS	11		152				
150.1											
22.9	Sandy Silt to Silty Sand Trace Clay Very Loose to Very Dense		18	SS	13		150				43 36 18 3
			19	SS	32		148				
			20	SS	120	/25cm	146				
			21	SS	120	/25cm	144				3 30 55 12
142.5											
30.5	Continued										Continued

+³, ×⁵: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 2 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 653.8, E 292 830.4 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
	Continued										
142.1			22	SS	120	/8cm					
30.9	End of Borehole * -Water level not established										

+^{3}, x^5 : Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 1 OF 2 METRIC

W.P. 389-87-04/05 LOCATION Co-ords: N 4 844 676.8, E 292 783.7 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.5	Ground Surface									
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	17	▼				0 9 31 60
			2	SS	31					
	Brown		3	SS	35		170			
	Grey		4	SS	24					
	Very Stiff to Hard		5	SS	21		168			
			6	SS	19					
165.6			7	SS	21		166			7 16 39 38
6.9	Clayey Silt to Silty Clay (Lacustrine)		8	SS	14					0 11 36 53
			9	SS	10		164			
	Stiff		10	SS	11		162			
			11	SS	9		160			
			12	SS	9		158			
155.7			13	SS	10					0 15 45 40
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	25		156			
	Very Stiff						154			
			15	SS	24		152			25 29 32 14
							150			
146.6			16	SS	23		148			
25.9	Sandy Silt to Silty Sand and Gravel Trace Clay						146			
	Very Dense		17	SS	120	/25cm	144			51 27 12 10
142.0										
30.5	Continued									Continued

+³, ×⁵: Numbers refer to Sensitivity

20
15◇5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 2 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 676.8, E 292 783.7 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
141.6	Continued		19	SS	210	/25cm					
30.9	End of Borehole										

+^{3}, ×^{3}: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6 1 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 661.5, E 292 799.3 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.7	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	5						
			2	SS	3						
			3	SS	17		170				
	Brown		4	SS	20						
	Grey		5	SS	14						
	Firm to Very Stiff		6	SS	12		168				
167.4											
5.3	seam of silt		7	SS	10						
	Clayey Silt to Silty Clay (Lacustrine)		8	SS	5	▼	166	>+			
	Firm to Stiff		9	TW			164	>+			
			10	SS	4		162	+2			
			11	TW			160	+3			
			12	SS	4			+2			
			13	SS	3		158	+3			
155.9											
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	22		156				
	Stiff to Very Stiff						154				
			15	SS	15		152				
							150				
			16	SS	10		148				
144.5			17	SS	103						
28.2	Sandy Silt to Silty Sand Trace Clay, Trace Gravel Very Dense		8	SS	130		146				
142.2							144				
30.5	Continued										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 6 2 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 661.5, E 292 799.3 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

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_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
141.8	Continued		19	SS	137		142				
30.9	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8 1 OF 2 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 641, E 292 818 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.8	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown / Grey Very Stiff to Hard		1	SS	24		170				
			2	SS	27						
			3	SS	40						
			4	SS	40						7 31 42 20
			5	SS	41	▼	168				
			6	SS	47						
			7	SS	19		166				2 19 44 35
164.4			8	SS	17						
8.4	Clayey Silt to Silty Clay (Lacustrine) Stiff to very Stiff		9	SS	18		164				
			10	SS	13		162				
			11	SS	13		160	+2			
			12	TW				+2		18.8	0 1 42 57
156.0			13	TW			158				
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		14	SS	29		156				
							154				
			15	SS	35		152				17 31 32 20
							150				
146.9			16	SS	51		148				
25.9	Sandy Silt to Silty Sand Some Clay										
			17	SS	130	/28cm	146				1 40 47 12
			18	SS	130	/28cm	144				
142.3											
30.5	Continued										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 8 2 OF 2 METRIC

W.P. 389-87-04/05 LOCATION Co-ords: N 4 844 641, E 292 818 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
141.9	Continued		19	SS	130						
30.9	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9 1 OF 1 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 702.7, E 292 822.3 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.2	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		1	SS	30		172				
			2	SS	16		170				
			3	SS	67	▼	168				
	Brown / Grey										
166.5	seam of sand		4	SS	42						
6.7	Clayey Silt to Silty Clay (Lacustrine) Stiff to Very Stiff		5	SS	20		166				
			6	SS	13		164				
			7	SS	9		162	+2			
			8	SS	8		160	+2			
158.0			9	TW				>+ o	⊢○		0 1 56 43
15.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15◇5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10 1 OF 1 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 681.5, E 292 842.8 ORIGINATED BY M.M.

DIST 5 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.9	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff		1	SS	16		172				
			2	SS	24	▼	170				
	Brown / Grey		3	SS	17		168				
166.0			4	SS	16						
6.9	Clayey Silt to Silty Clay (Lacustrine) Trace Gravel Very Stiff		5	SS	15		166				
			6	SS	13		164				
			7	SS	17		162				
			8	SS	10		160				
			9	TW							
157.2			10	SS	10		158	$+^2$			
15.7	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11 1 OF 1 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 651.1, E 292 772.5 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.6	Ground Surface										
0.0	Heterogeneous mixture of Clay Silt, Sand and Gravel (Glacial Till)		1	SS	27	DRY	172				
			2	SS	26		170		o		
	Brown / Grey										
			3	SS	15		168				
	Stiff to Very Stiff										
165.7			4	SS	10		166				
6.9	Clayey Silt to Silty Clay (Lacustrine) Firm		5	SS	5			+2			
			6	TW			164	+3		17.3	0 1 57 42
			7	SS	6		162	>+			
159.6			8	SS	6			+2			
13.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 12 1 OF 1 METRIC

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 568.5, E 292 782.5 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

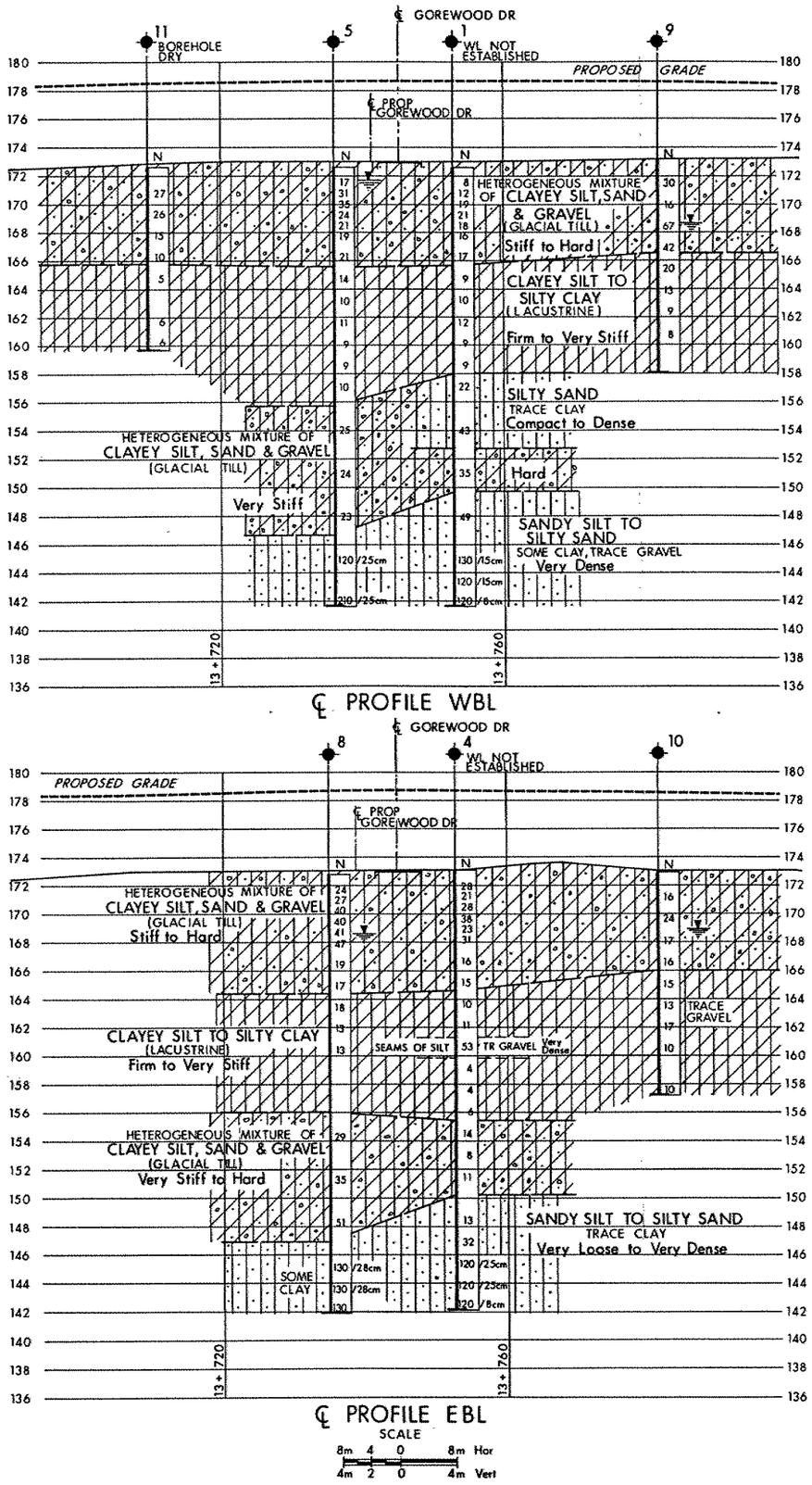
DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.8	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown		1	SS	14		172				
	Grey		2	SS	23		170				
	Stiff to Very Stiff		3	SS	20		168				
167.5											
5.3	Clayey Silt to Silty Clay (Lacustrine) Firm to Stiff		4	SS	13		166				
			5	SS	13						
			6	TW		▼	164	+2			
	seams of gravel and sand		7	SS	16		162				
			8	SS	7		160	+5			
159.8											
13.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

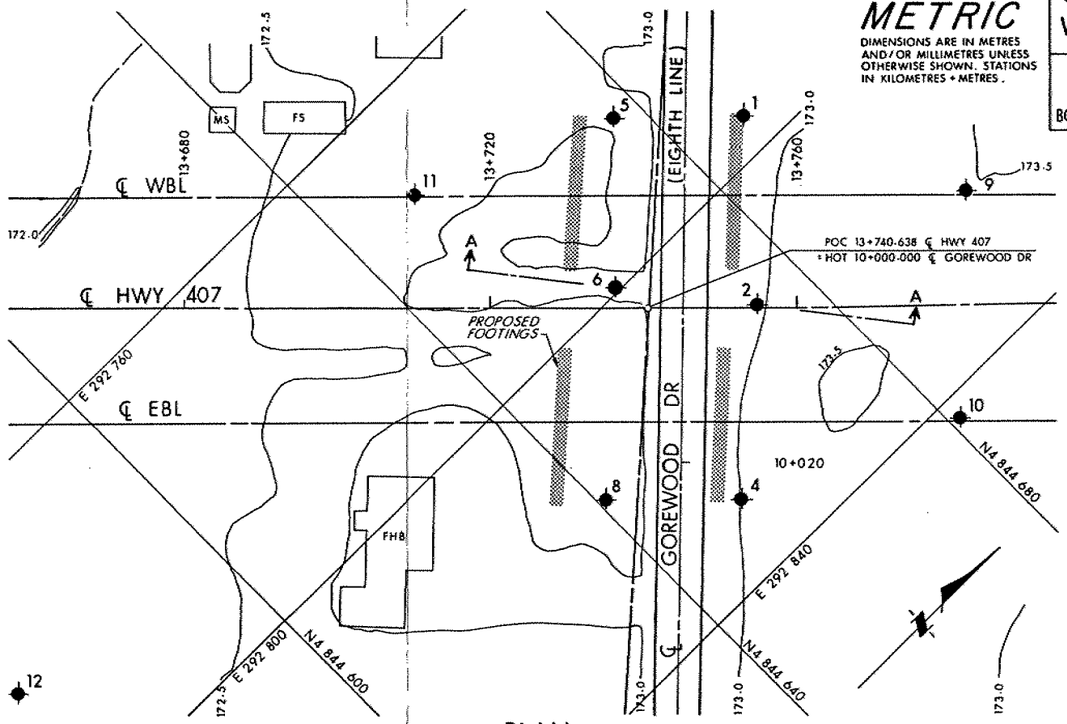
MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10



℄ PROFILE WBL

℄ PROFILE EBL

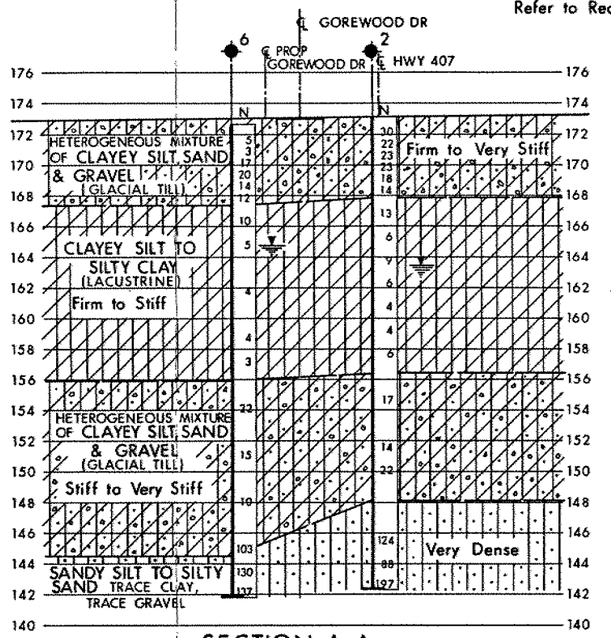
SCALE
8m 4 0 8m Hor
4m 2 0 4m Vert



PLAN

SCALE
8m 4 0 8m

NOTE:
Subsoil Information for BH 12
Refer to Record of Borehole



SECTION A-A

SCALE
8m 4 0 8m Hor
4m 2 0 4m Vert

REF No E-199-407-4, 90 05

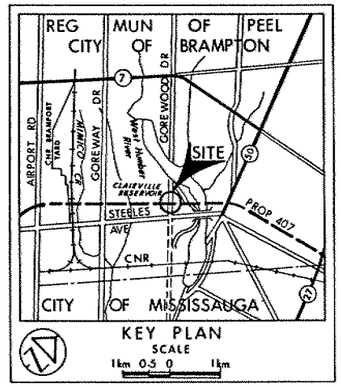
METRIC

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

CONT No
WP No 369-87-04/05

GOREWOOD DR
(EIGHTH LINE EAST)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 90 07

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	172.5	4 844 689.0	292 795.2
2	173.2	4 844 673.0	292 814.0
4	173.0	4 844 653.8	292 830.4
5	172.5	4 844 676.8	292 783.7
6	172.7	4 844 661.5	292 799.3
8	172.8	4 844 641.0	292 818.0
9	173.2	4 844 702.7	292 822.3
10	172.9	4 844 681.5	292 842.8
11	172.6	4 844 651.1	292 772.5
12	172.8	4 844 568.5	292 782.5

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 30M12-214

HWY No 407			DIST 6
SUBM'D MM	CHECKED	DATE 90 02 19	SITE 24-654
DRAWN DT	CHECKED	APPROVED	DWG 369870405-A

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 93-102

Ontario

Ministry of
Transportation

INDEX

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

EXPLANATION OF TERMS USED IN REPORT

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 (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT
For
8th Line (Gorewood Drive)
Hwy. 407 EBL/WBL Overpass
W.P. 369-87-04/05, Site No. 24-654
District 6, Toronto

INTRODUCTION

This report summarizes the results of a Foundation Investigation conducted at the aforementioned site. Two single span bridge structures have been proposed to carry the east and west bound lanes of Highway 407 over Gorewood Drive. This report contains factual information obtained from this investigation.

SITE DESCRIPTION AND GEOLOGY

The site is located ¼ km north of Steeles Avenue along 8th Line (Gorewood Drive) in the City of Brampton, Region of Peel. The area is partially residential with private homes on the west side and a conservation area that contains a single storey building to the east.

8th Line (Gorewood Drive) is a narrow paved two lane road with drainage ditches on both shoulders. The terrain surrounding the site is generally flat to gently rolling. The vegetation on the conservation property consists of deciduous trees along the side of the road and short wild grasslands.

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

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

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

INVESTIGATION PROCEDURES.

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

Field Investigation

The fieldwork for this investigation was carried out between 90 06 27 and 90 07 07 and consisted of a total of 10 sampled boreholes. Six of these boreholes were located at the various structure locations. These boreholes were advanced to a maximum depth of 30.9 m below existing grade. The four remaining boreholes were located at the approach embankments and were advanced to depths of 13.0 to 5.7 m below existing grade. The boreholes were advanced using a track mounted CME55 drill rig employing hollow stem augering and wash boring techniques.

In general, subsoil samples were retrieved at 0.7 m intervals from the top 6 m depth and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved using a shelby tube sampler in accordance with Standard Practice (ASTM D1587). In situ vane shear tests were conducted between the aforementioned sampling intervals to determine the undisturbed and remolded undrained shear strength of soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

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

Water levels were monitored throughout the duration of the investigation in open boreholes. All boreholes were backfilled upon completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Giffels Engineering Consultants under contract with Central Region surveys and plans.

Laboratory Analysis

The following laboratory tests were carried on select soil samples?

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

Laboratory Test Results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

General

The generalized subsurface soil stratigraphy at this site consits of a surficial layer of a heterogeneous mixture of clayey silt, sand and gravel (Glacial Till) underlain by a clayey silt to silty clay (Lacustrine) deposit followed by a second layer of heterogeneous mixture of clayey silt, sand, and gravel (Glacial Till) and then a silty sand. A layer of silty sand was encountered between the lacustrine deposit and the underlying Glacial Till deposit in BH 1. This deposit was not encountered in the remaining boreholes.

The plan and location of borings and the stratigraphical profile are shown on Drawing No. 369870405-A* in the attached Appendix. The results of all field and laboratory tests are plotted on the Record of Borehole sheets, also included in the appendix of this report. A brief description of the different soil strata is given below.

* DWG NO 2 OF THE CONTRACT DWG'S

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

The surficial deposit at the site consists of 5.3 m to 8.4 m of a heterogeneous mixture of clayey silt, sand and gravel (Glacial Till) at all boreholes.

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in an envelope form. The deposit is comprised primarily of 0-7% Gravel, 5-31% sand, 31-59% silt and 2-60% clay.

The results from the Atterberg Limit Tests performed on the fine fraction of this report is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	8.5-24.5	10
Liquid Limit (w_L)	19-51	10
Plastic Limit (w_P)	12-18	10
Plastic Index (I_P)	8-33	10

From the plasticity chart (Figure 2), this deposit can be classified as a clayey silt of low plasticity. Unit weight measurements carried out on samples from this stratum yield dry unit weights of 18.7 to 23.1 kN/m^3.

In this stratum the Standard Penetration resistance, 'N' values ranged from 3 blows/0.3 m to 47 blows/0.3 m indicating that the consistency ranged from firm to hard, but generally from stiff to hard.

Clayey Silt to Silty Clay (Lacustrine)

Underlying the above surficial layer a 6.1 m - 11.5 m thick moist clayey silt to silty clay, lacustrine deposit, was encountered.

Results of Grain Size Distribution tests on this deposit are shown on Figure 3 in the Appendix, in an envelope form. Based on these test data, this deposit is comprised of 0-13% gravel, 1-25% sand, 36-57% silt and 22-53% clay.

The results from the Atterberg Limit Tests performed on this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	16-29	9
Liquid Limit (w_L)	28-44	9
Plastic Limit (wp)	14-20	9
Plastic Index (Ip)	13-25	9

From the Plasticity Chart (Figure 4) the layer can be classified as a clayey silt to silty caly of low to medium plasticity. Unit weight measurements carried out on samples from this stratum yielded dry unit weights of 18.2 to 20.67 kN/m^3.

Undrained Shear Strength (Cu) measurements of the soil were obtained by conducting in situ vane shear tests and laboratory unconfined compression tests. Based on the undrained Shear Strength values of 30 to >130 kPa, this stratum can be classified as firm to very stiff.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state of the undrained strength, at the same water content, in the remolded state was determined by the field vane tests. Sensitivity values ranged from 1.3 to 3.2 indicating that the soil has low sensitivity.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 4 blows/0.3 m to 14 blows/0.3 m. Based on these 'N' values, the material can be descibed as having a firm to stiff consistency.

Silty Sand, trace Clay

This layer was encountered only in BH 1, underlying the above mentioned lacustrine deposit at El. 158 m. The encountered thickness of this layer was 5.3 m.

Based on Standard Penetration resistance 'N' values of 22 and 43 blows/0.3 m, this stratum exists in a compact to dense state of relativity density.

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

Underlying the lacustrine deposit in every borehole, excluding BH 1 where it underlies a silty sand, trace clay is another deposit of heterogeneous mixture of clayey silt, sand and gravel (Glacial Till). This layer was encountered at depths ranging from 16.8 m - 28.2 m.

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in an envelope form based on these test data, this deposit is comprised of 0-25% gravel, 1-32% sand, 31-42% silt and 13-57% clay.

The results from the Atterberg Limit tests performed on the fine fraction of this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	9-29	5
Liquid Limit (w_L)	17-36	5
Plastic Limit (w_P)	11-18	5
Plastic Index (I_P)	6-18	5

From the plasticity chart (Figure 2), this deposit can be classified as a clayey silt of low plasticity. Unit weight measurements carried out on samples from this stratum yielded dry unit weights of 18.8 and 23.2 kN/m^3. In this stratum the Standard Penetration resistance, 'N' values ranged from 8 blows/0.3 m to 51 blows/0.3 m indicating that the consistency ranged from firm to hard, but generally stiff to hard.

Sandy Silt to Silty Sand, some Clay, trace Gravel

Underlying the above mentioned Glacial Till deposit, a deposit of sandy silt to silty sand was encountered in all boreholes at about elevation 147 to 151 m, at depths of 22.8 to 28.2 m below existing grade.

Results of Grain Size Distribution tests carried out on select samples from this layer are shown on Figure 5 in the Appendix, in an envelope form. Based on these test data, this deposit is comprised of 1-51% gravel, 27-40% sand, 12-55% silt and 3-12% clay.

The results from the Atterberg Limit tests performed on the fine fraction of this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	8.5-8.0	2
Liquid Limit (w_L)	17	1
Plastic Limit (w_P)	13	1
Plastic Index (I_P)	5	1

Standard Penetration resistance 'N' values range from 14 blows/0.30 m to >130/0.30, indicating a compact to very dense state of relative density, in general, however, the deposit can be characterized as dense to very dense.

GROUNDWATER CONDITIONS

Observations of the groundwater level were carried out by measuring the water level in open boreholes. Groundwater levels determined at the time of the investigation were approximately 1.5 (elevation 171.8 m) to 4.5 m (elevation 168.8 m). It is considered that the water levels observed in BH's 2 (163.2 m) and 6 (164.8 m) do not reflect stabilized groundwater levels.

Soil cave-in was encountered in the boreholes upon penetration of the cohesionless sandy silt material below the prevailing groundwater due to unbalanced hydrostatic head. Wash boring techniques were employed to advance the boreholes thereafter.

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, M. Michalek, Junior Foundation Engineer, and M. Impietro, Student Engineer, utilizing equipment owned and operated by Master Soil Investigation and Malone's Soil Samples.

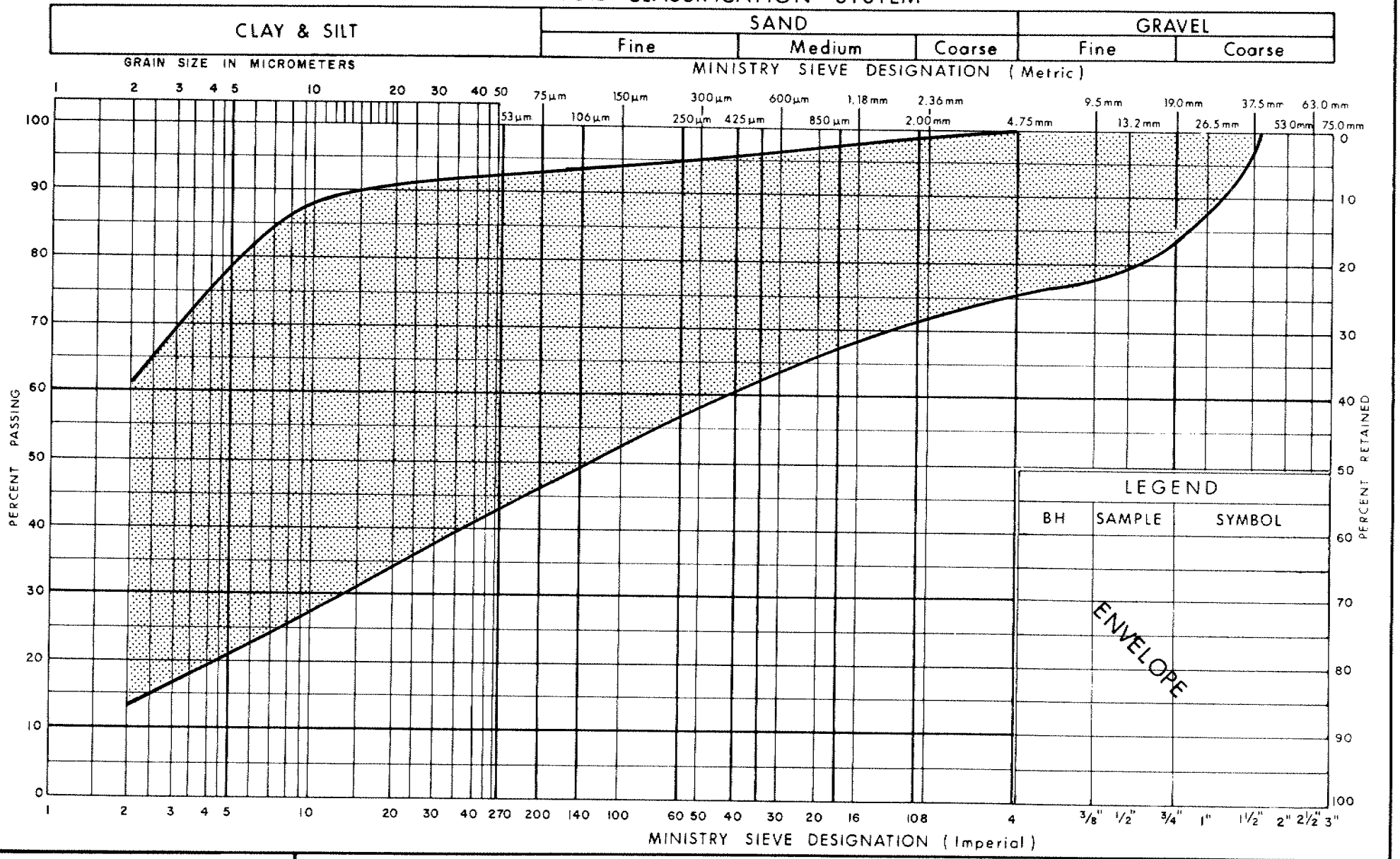
The project was carried out under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by M. Michalek, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

B. Iyer, P. Eng.
Senior Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



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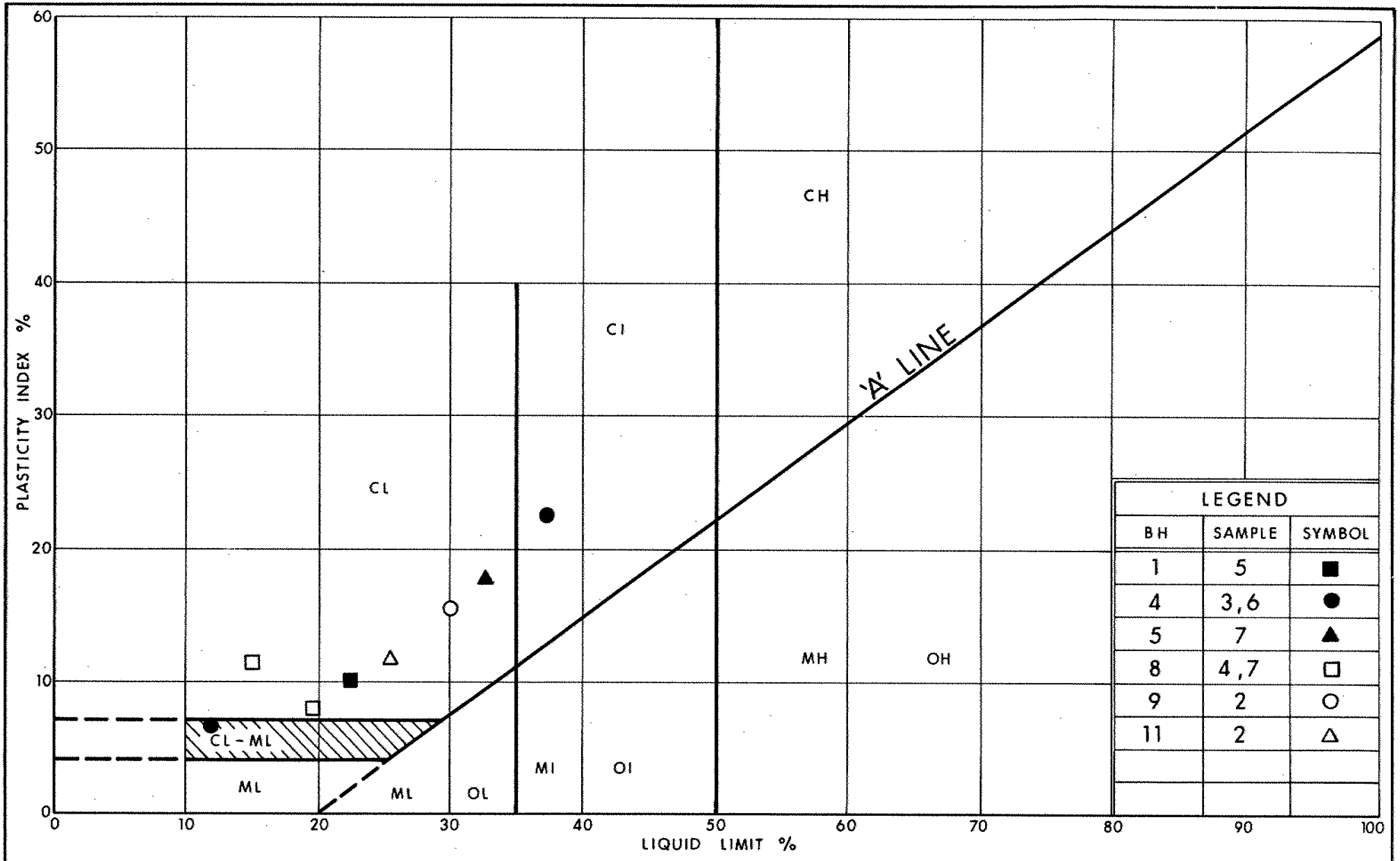
GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(GLACIAL TILL)

FIG No 1

W P 369-87-04/05

12



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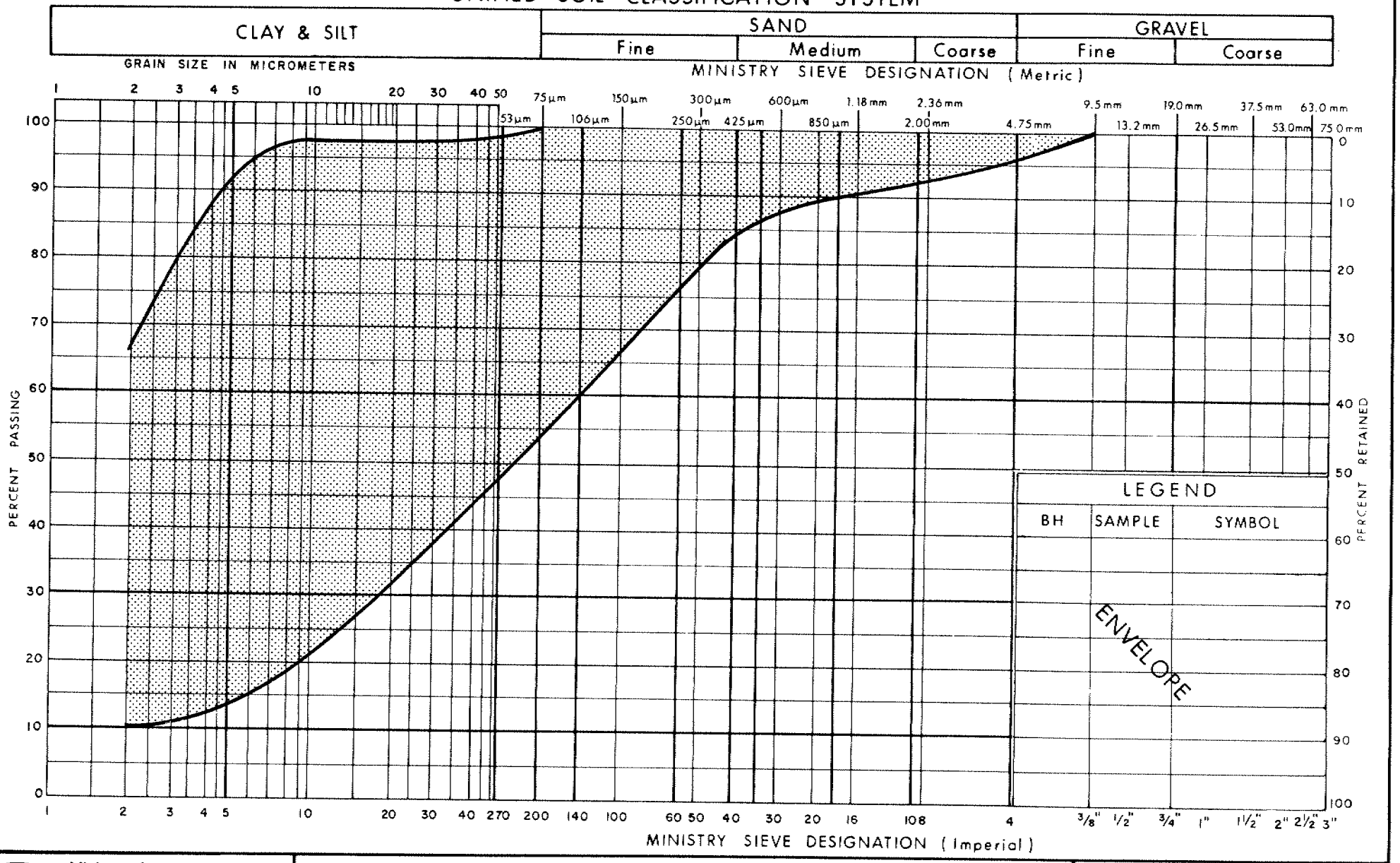
PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL (GLACIAL TILL)

FIG No 2

W P 369-87-04/05 13

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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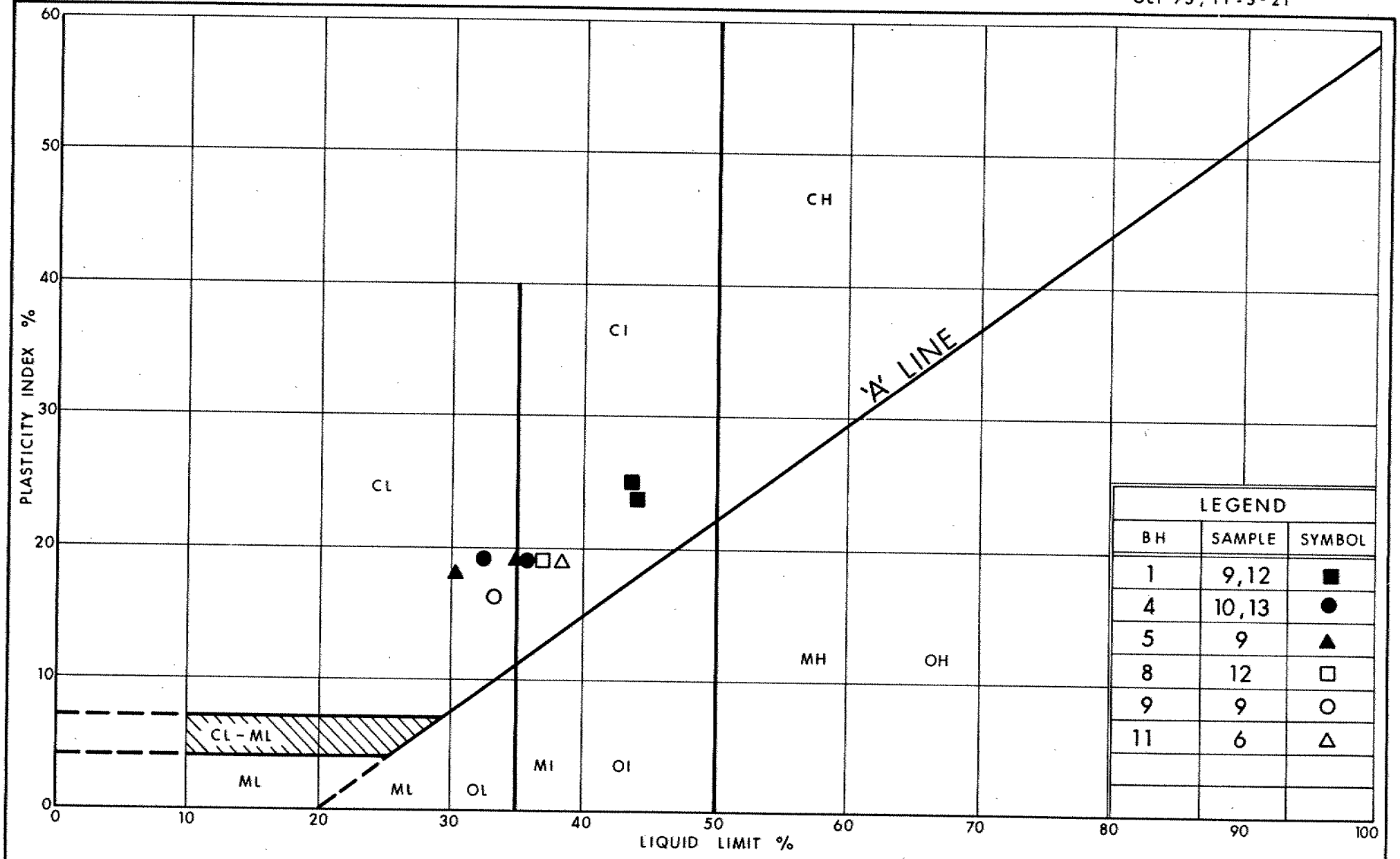
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
(LACUSTRINE)

FIG No 3

W P 369-87-04/05 14

Oct 75, FF-S-21



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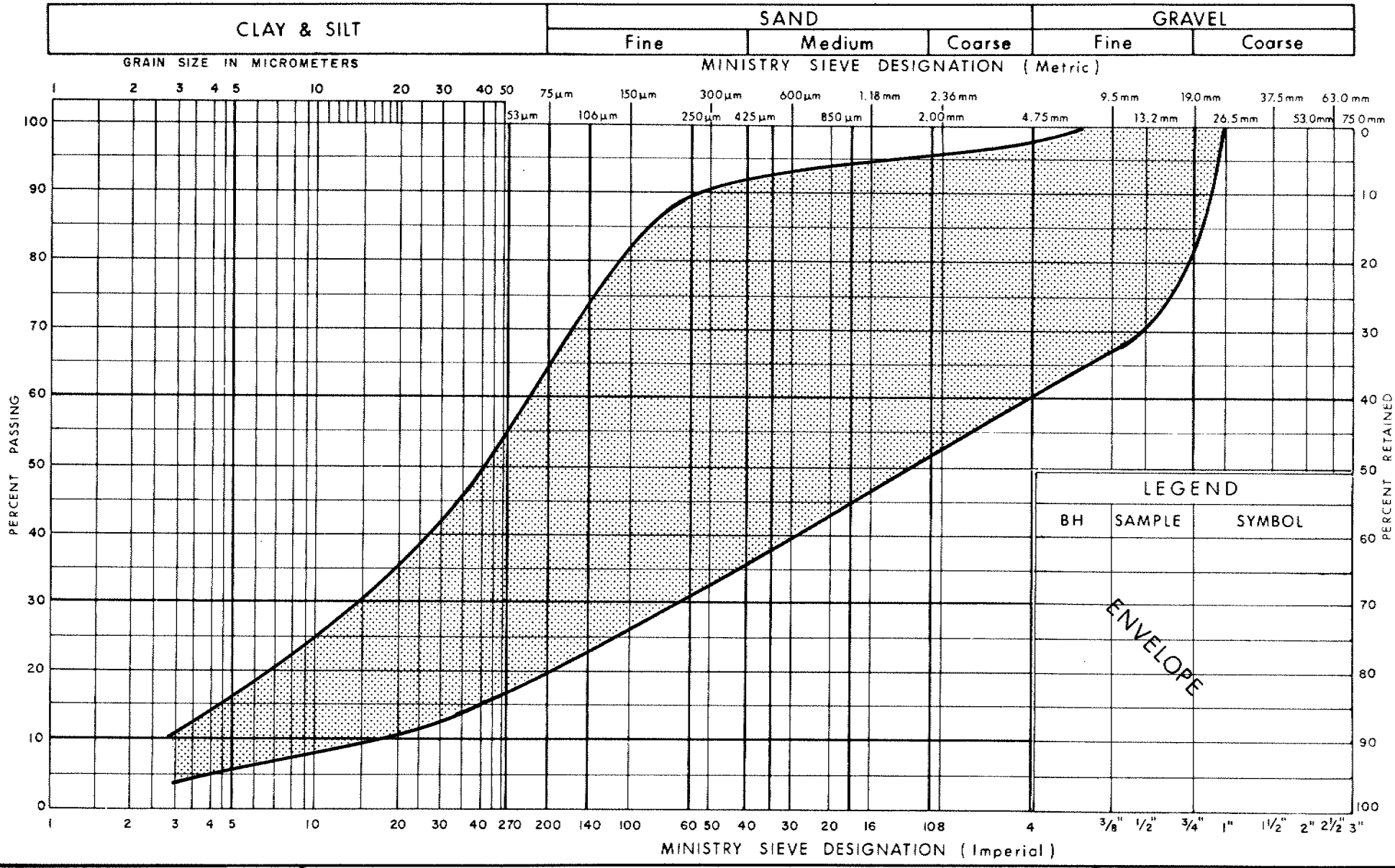
PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
(LACUSTRINE)

FIG No 4
W P 369-87-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND

FIG No 5

W P 369-87-04/05 16

RECORD OF BOREHOLE No 1 — 1 OF 2 — METRIC — 17

W.P. 369-87-04/05 LOCATION CO-ORD'S: N 4 844 689, E 292 795.2 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.5	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown / Grey; Stiff to Very Stiff		1	SS	8	*					
			2	SS	12					18.7	1 5 39 55
			3	SS	19		170				
			4	SS	21						
			5	SS	18		168			23.1	2 28 46 24
			6	SS	16						
165.6			7	SS	17		166				
6.9	Clayey Silt to Silty Clay (Lacustrine) Stiff		8	SS	9			+2			
			9	SS	10		164	+2		19.7	2 8 37 53
			10	SS	12		162				
			11	SS	9		160				
158.0			12	SS	9			+2		18.1	0 2 53 45
14.5	Silty Sand, trace Clay Compact to Dense		13	SS	22		158				
			14	SS	43		156				
152.7							154				
19.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Hard		15	SS	35		152			23.2	16 31 40 13
149.6							150				
22.9	Sandy Silt to Silty Sand some Clay trace Gravel Very Dense		16	SS	49		148				
			17	SS	130	/15cm	146				1 23 62 14
			18	SS	120	/15cm	144				
142.0											
30.5	Continued										Continued

+³, ×⁵: Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1 2 OF 2 METRIC 18

W.P. 369-87-04/05 LOCATION CO-ORD'S: N 4 844 689, E 292 795.2 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
142.0	Continued										
141.6			19	SS	120	/8cm			oH		
30.9	End of Borehole										

* -Water table not established

+³, ×⁵ ; Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 — 1 OF 2 — METRIC — 19

W.P. 369-87-04/05 LOCATION CO-ORDS: N 4 844 673, E 292 814 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
173.2	Ground Surface						
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	30		172
			2	SS	22		
			3	SS	23		170
	Brown		4	SS	23		
	Grey		5	SS	18		
	Stiff to Very Stiff		6	SS	14		168
167.9							
5.3	Clayey Silt to Silty Clay (Lacustrine)		7	SS	13		
			8	SS	6		166
	Firm to Stiff		9	SS	9	▼	164
			10	SS	6		
			11	SS	4		162
			12	SS	4		160
			13	SS	6		
156.4							158
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	17		156
	Stiff to Very Stiff		15	SS	14		154
			16	SS	22		152
148.1							150
25.1	Sandy Silt to Silty Sand Trace Clay		17	SS	124		148
	Very Dense		18	SS	88		146
142.7							144
30.5	Continued						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+2 +2 +1 +2 >+ >+ >+

Continued

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2 — 2 OF 2 — METRIC — 20

W.P. 369-87-04/05 — LOCATION CO-ORDS: N 4 844 673, E 292 814 — ORIGINATED BY M.M.

DIST 6 — HWY 407 — BOREHOLE TYPE HS AUGER — COMPILED BY M.M.

DATUM GEODETIC — DATE JULY 16, 1990 — CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
	Continued										
142.3			19	SS	197						
30.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 — 1 OF 2 — METRIC — 21

W.P. 389-87-04/05 — LOCATION Co-ords: N 4 844 653.8, E 292 830.4 — ORIGINATED BY M.M.

DIST 6 — HWY 407 — BOREHOLE TYPE HS AUGER — COMPILED BY M.M.

DATUM GEODETIC — DATE JULY 16, 1990 — CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.0	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	28	*	172				
			2	SS	21						
			2	SS	28		170			19.9	0 13 34 53
	Brown		4	SS	38						
	Grey		5	SS	23						
	Stiff to Hard		6	SS	31		168			21.4	2 19 59 20
			7	SS	16						
164.6			8	SS	15		166				
8.4	Clayey Silt to Silty Clay (Lacustrine) Firm to Stiff		9	SS	10		164				
			10	SS	11		162			20.7	1 10 37 52
	seams of silt trace gravel very dense		11	SS	53						
			12	SS	4		160				
			13	SS	4		158			19.3	0 1 55 44
155.5			14	SS	6		156				
17.5	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		15	SS	14		154				
			16	SS	8						
			17	SS	11		152				
150.1							150				
22.9	Sandy Silt to Silty Sand Trace Clay Very Loose to Very Dense		18	SS	13		148				43 36 18 3
			19	SS	32						
			20	SS	120	/25cm	146				
			21	SS	120	/25cm	144				3 30 55 12
142.5											
30.5	Continued										Continued

+³, ×⁵ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 2 OF 2 METRIC 22

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 653.8, E 292 830.4 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
	Continued										
142.1			22	SS	120	/8cm					
30.9	End of Borehole * —Water level not established										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 — 1 OF 2 — METRIC 23

W.P. 369-87-04/05 — LOCATION Co-ords: N 4 844 676.8, E 292 783.7 — ORIGINATED BY M.M.

DIST 6 — HWY 407 — BOREHOLE TYPE HS AUGER — COMPILED BY M.M.

DATUM GEODETIC — DATE JULY 16, 1990 — CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.5	Ground Surface					
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)	1	SS	17	▼	0 9 31 60
		2	SS	31		
	Brown	3	SS	35		
	Grey	4	SS	24		
	Very Stiff to Hard	5	SS	21		
		6	SS	19		
165.6		7	SS	21		7 16 39 38
6.9	Clayey Silt to Silty Clay (Lacustrine)	8	SS	14		0 11 36 53
	Stiff	9	SS	10		
		10	SS	11		
		11	SS	9		
		12	SS	9		
155.7		13	SS	10		0 15 45 40
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)	14	SS	25		
	Very Stiff	15	SS	24		25 29 32 14
146.6		16	SS	23		
25.9	Sandy Silt to Silty Sand and Gravel Trace Clay	17	SS	120	/25cm	51 27 12 10
	Very Dense					
142.0						
30.5	Continued					Continued

ELEVATION SCALE: 170, 168, 166, 164, 162, 160, 158, 156, 154, 152, 150, 148, 146, 144

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
• QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 2 OF 2 METRIC 24

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 676.8, E 292 783.7 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

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_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
141.6	Continued		19	SS	210	/25cm					
30.9	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6 — 1 OF 2 — METRIC — 25

W.P. 369-87-04/05 — LOCATION Co-ords: N 4 844 661.5, E 292 799.3 — ORIGINATED BY M.M.

DIST 6 — HWY 407 — BOREHOLE TYPE HS AUGER — COMPILED BY M.M.

DATUM GEODETIC — DATE JULY 16, 1990 — CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
172.7	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	5						
			2	SS	3						
			3	SS	17						
	Brown		4	SS	20						
	Grey		5	SS	14						
	Firm to Very Stiff		6	SS	12						
167.4											
5.3	seam of silt		7	SS	10						
	Clayey Silt to Silty Clay (Lacustrine)		8	SS	5	▼		>+			
	Firm to Stiff		9	TW				>+			
			10	SS	4			+2			
			11	TW				+3			
			12	SS	4			+2			
			13	SS	3			+3			
155.9											
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	22						
	Stiff to Very Stiff		15	SS	15						
			16	SS	10						
144.5			17	SS	103						
28.2	Sandy Silt to Silty Sand Trace Clay, Trace Gravel Very Dense		8	SS	130						
142.2											
30.5											

Continued

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 6 2 OF 2 METRIC 26

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 661.5, E 292 799.3 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
141.8	Continued		19	SS	137		142				
30.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8 1 OF 2 METRIC 27

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 641, E 292 818 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
172.8	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown / Grey Very Stiff to Hard		1	SS	24						
			2	SS	27						
			3	SS	40						
			4	SS	40						7 31 42 20
			5	SS	41	▼					
			6	SS	47						
			7	SS	19						2 19 44 35
164.4			8	SS	17						
8.4	Clayey Silt to Silty Clay (Lacustrine) Stiff to very Stiff		9	SS	18						
			10	SS	13						
			11	SS	13			+2			
			12	TW				+2		18.8	0 1 42 57
			13	TW							
156.0											
16.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		14	SS	29						
			15	SS	35						17 31 32 20
			16	SS	51						
146.9											
25.9	Sandy Silt to Silty Sand Some Clay		17	SS	130	/28cm					1 40 47 12
			18	SS	130	/28cm					
142.3											
30.5	Continued										Continued

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8 2 OF 2 METRIC 28

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 641, E 292 818 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
141.9	Continued		19	SS	130						
30.9	End of Borehole										

$+^{3}$, $\times^{5}$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

RECORD OF BOREHOLE No 9 1 OF 1 METRIC 29

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 702.7, E 292 822.3 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.2	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		1	SS	30		172				
			2	SS	16		170				
			3	SS	67	▼	168				
	Brown / Grey										
166.5	seam of sand		4	SS	42						
6.7	Clayey Silt to Silty Clay (Lacustrine) Stiff to Very Stiff		5	SS	20		166				
			6	SS	13		164	+2			
			7	SS	9		162				
			8	SS	8			+2			
			9	TW			160	+ o			0 1 56 43
158.0											
15.2	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10 1 OF 1 METRIC 30

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 681.5, E 292 842.8 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	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_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.9	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff Brown / Grey		1	SS	16	▼	172				
			2	SS	24		170				
			3	SS	17		168				
166.0			4	SS	16						
6.9	Clayey Silt to Silty Clay (Lacustrine) Trace Gravel Very Stiff		5	SS	15		166				
			6	SS	13		164				
			7	SS	17		162				
			8	SS	10		160				
			9	TW							
157.2			10	SS	10		158	+2			
15.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11 — 1 OF 1 — METRIC 31

W.P. 389-87-04/05 — LOCATION Co-ords: N 4 844 651.1, E 292 772.5 — ORIGINATED BY M.M.

DIST 6 — HWY 407 — BOREHOLE TYPE HS AUGER — COMPILED BY M.M.

DATUM GEODETIC — DATE JULY 16, 1990 — CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
172.6	Ground Surface										
0.0	Heterogeneous mixture of Clay Silt, Sand and Gravel (Glacial Till)					DRY	172				
			1	SS	27						
							170				
			2	SS	26						
	Brown / Grey										
			3	SS	15		168				
	Stiff to Very Stiff										
165.7			4	SS	10		166				
6.9	Clayey Silt to Silty Clay (Lacustrine) Firm							+2			
			5	SS	5		164				
								+3			
			6	TW						17.3	0 1 57 42
			7	SS	6		162	>+			
159.6			8	SS	6			+2			
13.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 12 1 OF 1 METRIC 32

W.P. 369-87-04/05 LOCATION Co-ords: N 4 844 568.5, E 292 782.5 ORIGINATED BY M.M.

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY M.M.

DATUM GEODETIC DATE JULY 16, 1990 CHECKED BY B.I.

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_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
172.8	Ground Surface										
0.0	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown		1	SS	14		172				
	Grey		2	SS	23		170				
	Stiff to Very Stiff										
167.5			3	SS	20		168				
5.3	Clayey Silt to Silty Clay (Lacustrine) Firm to Stiff		4	SS	13		166				
			5	SS	13						
			6	TW		▼	164	+2			
	seams of gravel and sand		7	SS	16		162				
			8	SS	7			+5			
159.8							160				
13.0	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Cumming Cockburn Limited
Consulting Engineers and Planners

May 7, 1991

4619-1

Ministry of Transportation
Central Region
Structures Section
4th Floor, Atrium Tower
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

c.c. G. ALBazi - Structural Office
R. Jagla - Wyllie & Ufnal
K. G. Bassi - Structural Office
T. Sanguinetti - Foundation Design
B. I.

Note: Revised G.A. for your review & comment
91-05-08

Attention: Mr. J. Lam, P. Eng.
Project Manager

Dear Sir:

Re: Highway 407 and Eighth Line Bridge Structures
WP-369-04 (E.B.L.) and - 05 (W.B.L.)
General Arrangement Drawing

Please find enclosed, as requested, eight (8) copies of the general arrangement drawing for the above noted project. The general arrangement drawing has been revised to account for the comments which were received from yourself through telephone conversations held with myself on March 28, 1991 and April 2, 1991, and by fax on April 5, 1991. The comments received by telephone are as follows.

Comments received on March 28, 1991:

1) Only one general arrangement drawing is required for both the E.B.L. and W.B.L. structures. Only the south elevation is required.

2) Under the notes section, the concrete strength of the prestressed girders should be 40 MPa, "Remainder ..... 30 MPa" concrete strength note should be added. The bearing seat note is incorrect and should be changed to reflect that as described in the Structural Manual.

3) In the lower right hand title block all revisions should be eliminated and '83' should be noted beside 'O.H.B.D.C.', as well as 'CLASS A' beside 'LOAD'.

4) The Structural office thinks that 8 CPCI 1200 girders can be used instead of 10 CPCI 1200 girders on each structure. This should be checked to see if this is the case, and is so, the general arrangement drawing should be revised to suit the change in the number of girders.

.../2

memorandum

Ontario

To: V.F. BOEHNKE
Head, Structural Section
4 th Floor, Atrium Tower

Date: 91 04 18

Att: J.K. LAM

From: Foundation Design Section
Room 315, Central Building

Re: Eight line overpass EBL and WBL
WP 369-87-04/05, Site 24-654
District 6, Toronto

Comments concerning the preliminary General arrangement drawing are as follows:

1. Final foundation investigation report specifies piles should be driven down further than indicated on this drawing. See table below:

Pile Type	Bearing Capacity at SLS TY.II(kN)	Factored Capacity at ULS (kN)	Estimated Pile Tip Elevation (M) EBL	WBL
HP310x110	1150	1600	144+/-	143+/-

Also note, the installations of piles shall be controlled and monitored employing the Hiley Dynamic Driving Formula driven in accordance with MTO standards, assuming an ultimate capacity of 3450 kN.

We apologize for the delay in sending our comments on the General Arrangement Drawing.

If you have any questions, please do not hesitate to contact this office.

MARTIN MICHALEK

M. Michalek
Jr. Foundation Engineer
For
Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer