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DIST. 6 REGION

W.P. No. 98-87-01

CONT. No. 89-65

W. O. No.

STR. SITE No. 37-1179

HWY. No. 407

LOCATION Weshon Rd. Underpass

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

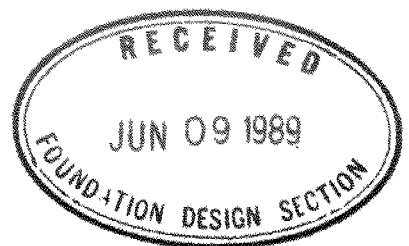
FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-65



Ontario

Ministry of
Transportation and
Communications



I N D E X

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NOTE: For the purposes of this Contract, this report
supersedes all other reports prepared by or for
the Ministry in connection with the above-noted
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 (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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

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

FOUNDATION INVESTIGATION REPORT

For

Hwy. 407 - Weston Rd. Underpass

WP 98-87-01; Site No. 37-1179

District #6, TorontoINTRODUCTION

This report summarizes the foundation investigation for the proposed bridge and underpass at Hwy. 407 and Weston Rd.

The report refers to the area extending from Sta. 9+910 to Sta. 10+075 on Weston Rd. (M.T.C. chainage).

SITE DESCRIPTION

The site is located on Weston Rd. approximately 1 km. north of Steeles Avenue directly north of Metropolitan Toronto, in the Town of Vaughan, Regional Municipality of York.

Topography of the area is generally flat. The land on the east side of the site is wooded and contains a Drive-in Theatre. To the west is the excavation for new Hwy. 407 where cobbles and boulders are visible.

Geologically the site is located on a glacial deposit known as the Peel Plain. The underlying materials are glacial till and clay.

INVESTIGATION PROCEDURES

The field investigation was conducted between 87-10-13 and 87-10-30 with additional work on 87-12-03 and 87-12-04. Equipment consisted of a continuous flight auger machine with 87 mm I.D. hollow stem augers, solid stem augers and BX-casing. Wash boring techniques were used on some boreholes.

The investigation consisted of:

- 5 sampled boreholes with dynamic cone penetration tests.
- 4 supplementary boreholes.

Boreholes were advanced at each abutment and pier location in the right-of-way of Weston Road. All sampling was carried out using a split spoon to obtain disturbed samples of cohesive and non-cohesive materials. Standard Penetration Tests were conducted.

Borehole elevations and locations were obtained from the "E" plan provided by the Structural Section, Central Region.

LABORATORY TESTS

Laboratory testing was carried out on representative samples to determine Atterberg Limits and grain size characteristics of the soil.

The results of the tests are contained on the Record of Borehole sheets.

SUBSURFACE CONDITIONS

Subsoil at the site consists of stiff to hard silty clay with sand and gravel (Glacial Till) of varying thickness from 7 to 13.1 m. In certain locations on the northern portion of the site, this glacial origin deposit is underlain by a 3.4 to 5.4 m thick layer of compact to very dense sand and gravel. These deposits are underlain by an extensive stratum of very stiff to hard silty clay (Lacustrine) ranging in thickness from 21 to 22.7 m. The silty clay is immediately underlain by at least 3.0 m of very dense silt. Groundwater level was found to range between elev. 189.0 to elev. 190.5 about 1 to 1.3 m below the existing ground surface. The locations and elevations of the boreholes together with stratigraphical profiles based on the borehole data are shown on Dwg. #998701-A. **

**** NOTE: Refer to Drawing No. 2 of the Contract Drawings.**

Detailed descriptions of the various deposits encountered are as follows:

Silty Clay, some Sand occasional Gravel (Glacial Till)

This deposit was encountered in all boreholes. The material consists of silty clay generally of low plasticity with traces of sand and gravel. The layer is found at ground level and extends to a maximum depth of 13.1 m. Random layers and pockets of sand are found throughout. Boulders and cobbles are also present.

Properties of the material as determined by field and laboratory tests are summarized as follows:

<u>Atterberg Limits</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)	7.5 - 15.0%	11.4%
Liquid Limit (w_L)	17.0 - 38.0%	24.1%
Plastic Limit (w_p)	10.5 - 17.5%	12.8%

Standard Penetration Tests ("N" values) ranged from 9 to 117 + blows per 0.3 m. The consistency of the deposit may be described as stiff to hard based on this information.

Figure 1, illustrates a typical grain size distribution envelope for the material.

Figure 2, illustrates typical plasticity characteristics of the material.

Sand & Gravel

This material was encountered at the north-east portion of the site (BH, 1, 1A, 1B). The stratum consists of sand and gravel in varying proportions. The deposit is sandwiched between the silty clay (Glacial Till) deposit and

an underlying Lacustrine silty clay stratum. The thickness of the deposit ranges from 3.4 to 5.4 m and decreases to the north and south of BH 1.

Standard Penetration Tests ("N" values) ranged from 18 to 77 blows per 0.3 m. The denseness may be described as compact to very dense based on this information.

Based on a representative sample, the moisture content (w) was 7.5% with the following grain size distribution:

Gravel	42.0%
Sand	44.5%
Silt	13.0%
Clay	0.5%

Silty Clay (Lacustrine)

This material was found in all boreholes directly below the silty clay (Glacial Till) or the sand and gravel deposits. The deposit consists of silty clay of intermediate plasticity with occasional layers of clay of high plasticity and random layers of silt. Thickness of this deposit ranges from 21.0 m to 22.7 m. The lower boundary of the material was penetrated only in certain locations (BH #2, #3, #5).

Properties of the material as determined by field and laboratory tests are summarized as follows:

<u>Atterberg Limits</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)	12.5 - 31.5%	21.5%
Liquid Limit (w_L)	24.0 - 56.0%	38.2%
Plastic Limit (w_p)	14.5 - 22.0%	17.5%

Standard Penetration Tests ("N" values) ranged from 22 to 130 + blows per 0.3 m indicating the consistency of the material to be very stiff to hard.

Figure 3, illustrates a typical grain size envelope for the material.

Figure 4, illustrates typical plasticity characteristics of the material.

Silt

This deposit was encountered below the silty clay deposit in some locations (BH #2, #3, #5) and was not full penetrated. The material is classified as a silt with traces of sand and clay. The deposit was found at depths below the ground surface ranging from 29.3 m to 32.0 m.

The Standard Penetration Tests ("N" values) ranged from 7 to 150 + blows per 0.3 m. The "N" value of 7 resulted from boiling of the silt during sampling and is not considered to be representative of the deposit. Generally the denseness may be described as very dense.

Based on representative samples, the natural moisture content (w) ranged from 16.5% to 34.5% with the following grain size distribution:

Gravel	0 - 1%
Sand	3 - 17%
Silt	80 - 87%
Clay	2 - 10%

Figure 5, illustrates a typical grain size distribution envelope for this material.

Groundwater

Groundwater levels in open boreholes were measured periodically during the investigation. From this information it was determined that stabilized groundwater levels range from 1.0 m to 1.3 m below ground surface.

MISCELLANEOUS

The field work for this investigation was carried out during the period of 87-10-03 and 87-10-30 with additional work on 87-12-03 and 87-12-04, under the supervision of K. D. Zasitko, Foundation Field Technician (acting). The equipment was owned and operated by Malone's Soil Samples of Toronto.

This report was written by K. D. Zasitko and reviewed by M. Devata, Chief Foundation Engineer (East).



D. H. Dundas
D. H. Dundas, P. Eng.
Sr. Foundation Engineer

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

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 898.5; E 301 106.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 13 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
191.5 0.0	Ground Level										
	Silty Clay Some Sand Occasional Gravel (Glacial Till) Stiff to Hard Random Layers or Pockets of Sand		1	SS	13		190				3 22 51 24
			2	SS	16						
			3	SS	20						
			4	SS	18						
			5	SS	41						
			6	SS	63						
			7	SS	83						
			8	SS	49						
183.0 8.5	Sand and Gravel Compact to Very Dense		9	SS	18		182				2 21 60 17
			10	SS	31						
			11	SS	77						
177.6 13.9	Silty Clay Occasional Silt and Clay Layers Hard		12	SS	124	25 cm	178				42 44 13 1
			13	SS	109	25 cm					
174.3 17.2	End of Borehole		14	SS	110	23 cm	176				0 4 50 46

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 1A										METRIC			
W P 98-87-01		LOCATION Co-ords. N 4 848 887.5; E 301 108.0				ORIGINATED BY KZ							
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem Auger				COMPILED BY KZ							
DATUM Geodetic		DATE 1987 12 03				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
191.5 0.0	Ground Level												
	Silty Clay Some Sand Occ. Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)												
181.7 9.8	Sand and Gravel Compact to Very Dense		1	SS	26								
			2	SS	41								
178.3 13.2	Silty Clay, Occ. Silt and Clay Layers												
177.4 14.1	Hard		3	SS	120/25 cm								
	End of Borehole												
	* Note Water Level Not Established												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1B

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 908.0; E 301 104.0
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger
 DATUM Geodetic DATE 1987 12 03

ORIGINATED BY KZ
 COMPILED BY KZ
 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
191.5	Ground Level													
0.0	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)					*								
181.5														
10.0	Sand and Gravel Compact		1	SS	29									
	Silt Dense		2	SS	50									
178.1														
13.4	Silty Clay													
177.3	Occ. Silt & Clay Layers Hard		3	SS	98									
14.2	End of Borehole													
	* Note Water Level Not Established													

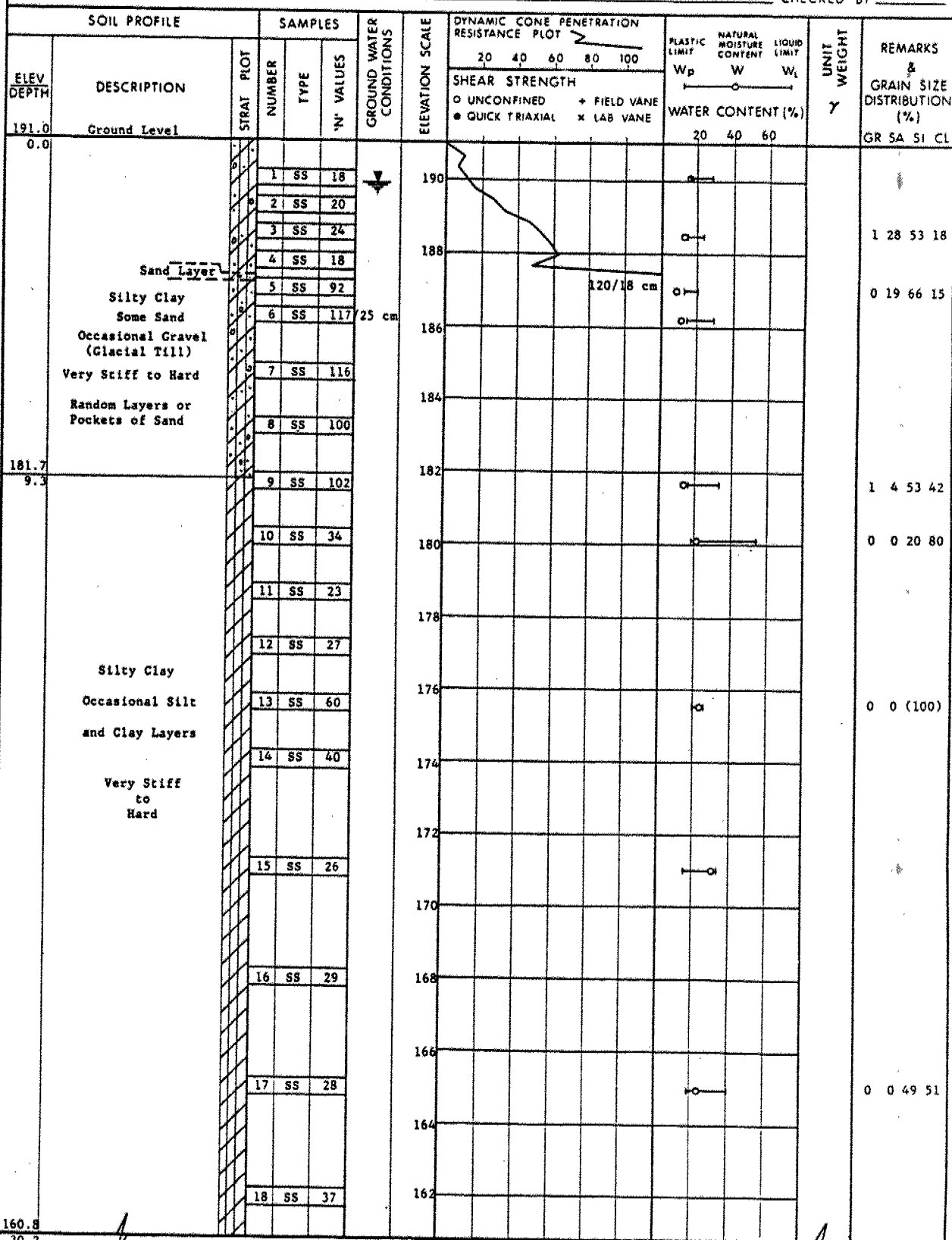
+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 859.5; E 301 089.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem, Wash Boring-N Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 22, 23, 26 CHECKED BY



OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2 Continued METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 859.5; E 301 089.0 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem, Wash Boring-N Casing, Cone Test COMPILED BY KZ
DATUM Geodetic DATE 1987 10 22, 23, 26 CHECKED BY _____

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 2 A

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 879.0; E 301 086.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
 DATUM Geodetic DATE 1987 12 03 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W		
191.5 0.0	Ground Level					*										
	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)															
179.9			1	SS	76											
11.6	Silty Clay															
178.9	Occ. Silt & Clay Layers		2	SS	48											
12.6	End of Borehole															
	* Note Water Level Not Established															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2 B

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 899.0; E 301 083.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
 DATUM Geodetic DATE 1987 12 04 CHECKED BY _____

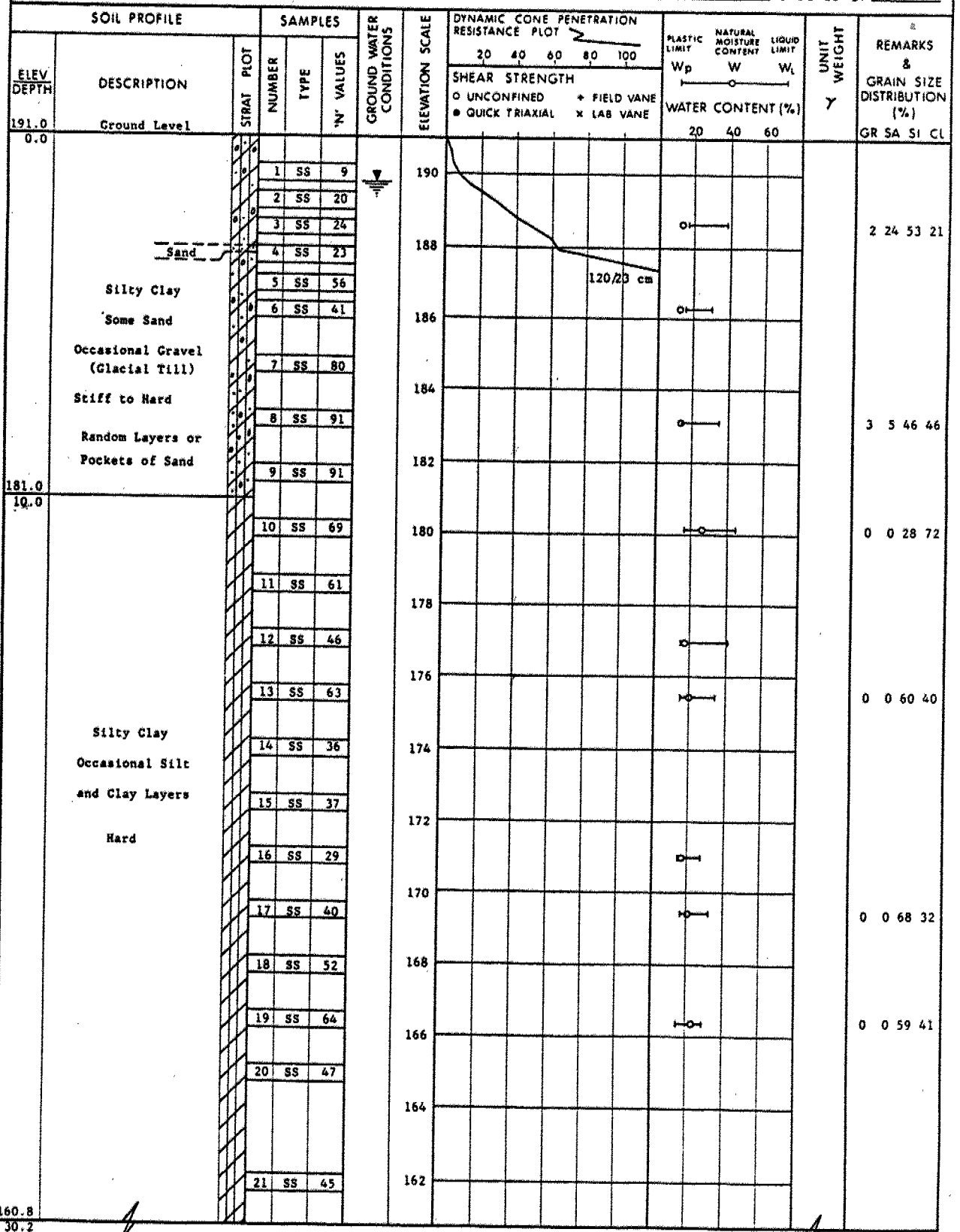
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W		
191.5	Ground Level															
0.0	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)					*										
			1	SS	56											
			2	SS	130											
178.4																
13.1	Silty Clay															
177.3	Occ. Silt & Clay Layers Hard		3	SS	43											
14.2	End of Borehole															
	* Note Water Level Not Established															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 826.3; E 301 117.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem, Wash Boring-B Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 13, 14, 19, 20, 21 CHECKED BY _____



OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5; Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

W P 98-87-01 LOCATION Co-ords. N 4 848 826.3; E 301 117.5 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem, Wash Boring-B Casing, Cone Test COMPILED BY KZ
DATUM Geodetic DATE 1987 10 13, 14, 19, 20 CHECKED BY _____

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 4

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 777.2; E 301 102.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger and Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 28 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
190.5	Ground Level													
0.0			1	SS	26		190							
			2	SS	18		188							13 23 42 22
	Sandy Silt		3	SS	22									
			4	SS	72									
			5	SS	53									
	Silty Clay		6	SS	105									3 25 57 15
	Some Sand													
	Occ. Gravel (Glacial Till)		7	SS	94									4 33 47 16
	Very Stiff to Hard		8	SS	116									3 28 54 15
	Random Layers or Pockets of Sand		9	SS	108									
			10	SS	114									
178.0														
12.5	Silty Clay		11	SS	130		178							2 1 55 42
	Occasional Silt and Clay Layers													
176.3	Hard		12	SS	36									
14.2	End of Borehole													0 0 11 89

*3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 748.5; E 301 129.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 14, 15, 16 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
190.2	Ground Level												
0.0			1	SS	10								
			2	SS	10								
	Sandy Silt		3	SS	22								4 26 54 16
	Silty Clay Some Sand Occasional Gravel (Glacial Till) Stiff to Hard		4	SS	42								1 24 66 9
			5	SS	33								
			6	SS	28								
	Random Layers or Pockets of Sand		7	SS	44								
183.2			8	SS	48								
7.0			9	SS	37								0 4 52 44
			10	SS	27								
	Silty Clay		11	SS	28								0 0 35 65
	Occasional Silt and Clay Layers		12	SS	23								
			13	SS	46								0 0 (100)
	Very Stiff to Hard		14	SS	40								
			15	SS	26								
			16	SS	22								0 0 57 43
			17	SS	25								
160.9													
29.3	Silt												
160.0	Traces of Sand & Clay												
30.2													

OFFICE REPORT ON SOIL EXPLORATION

Continued

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

Continued

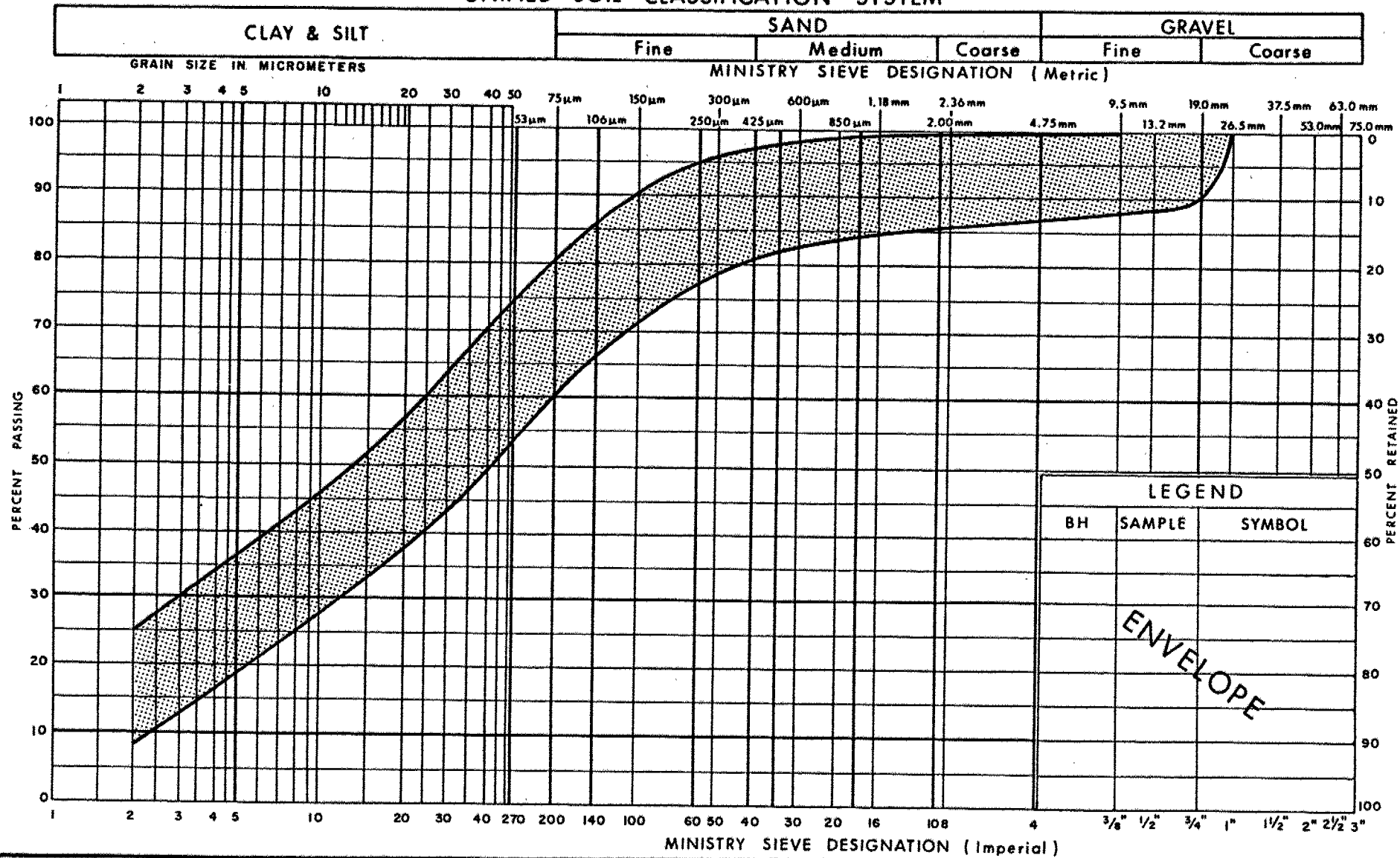
RECORD OF BOREHOLE No 5 Continued METRIC

W P 98-87-01 LOCATION Co-ords. N 4 848 748.5; E 301 129.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 14, 15, 16 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.0	Continued																
30.2	Silt, Traces of Sand and Clay Very Dense		18	SS	7	*											1 14 83 2
157.9			19	SS	120	15 cm	158										0 3 87 10
32.3	End of Borehole																
	Note: * Low N Value caused by Boiling Condition																

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



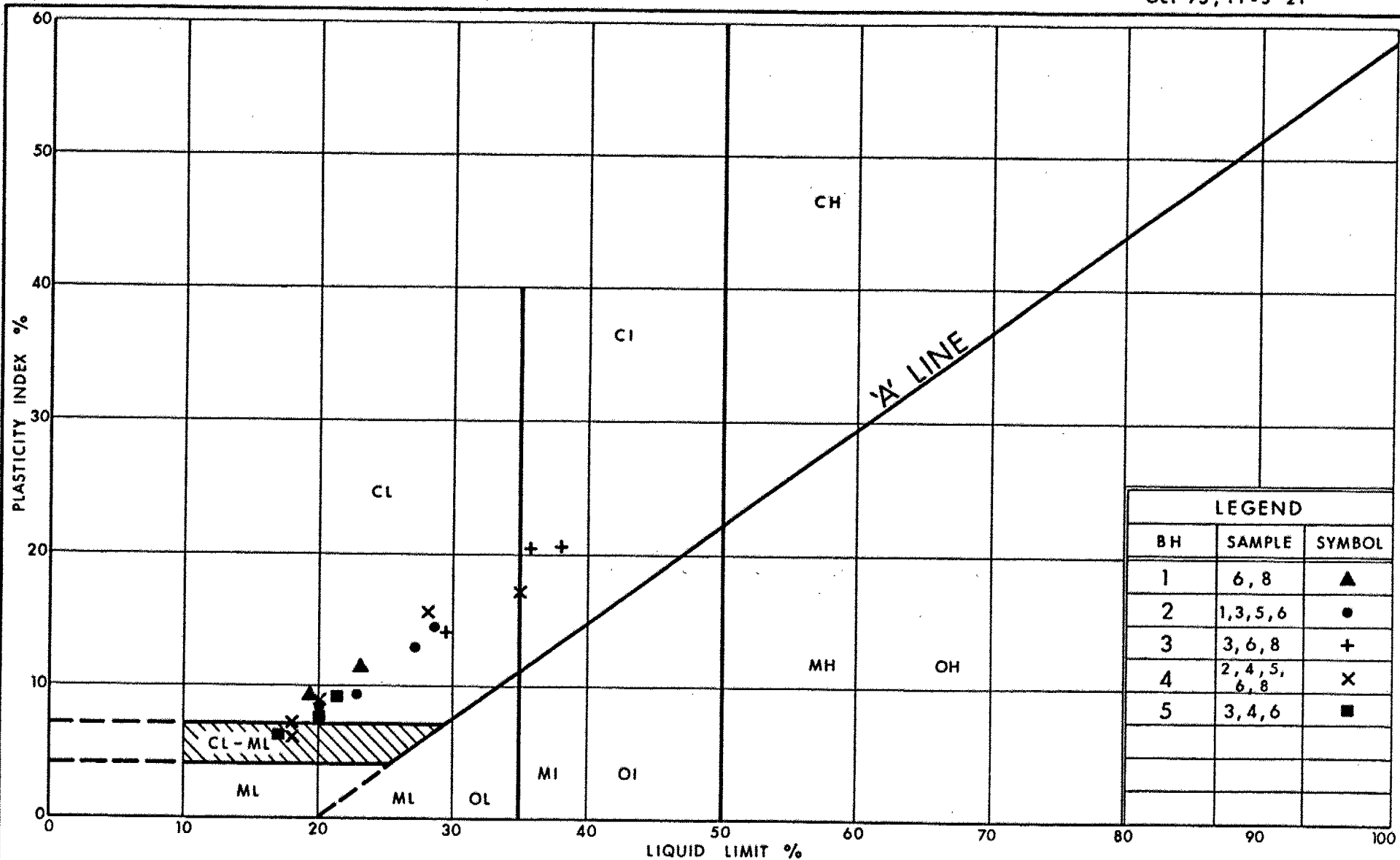
Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY, SOME SAND OCC GRAVEL
(Glacial Till)

FIG No 1

W P 98-87-01



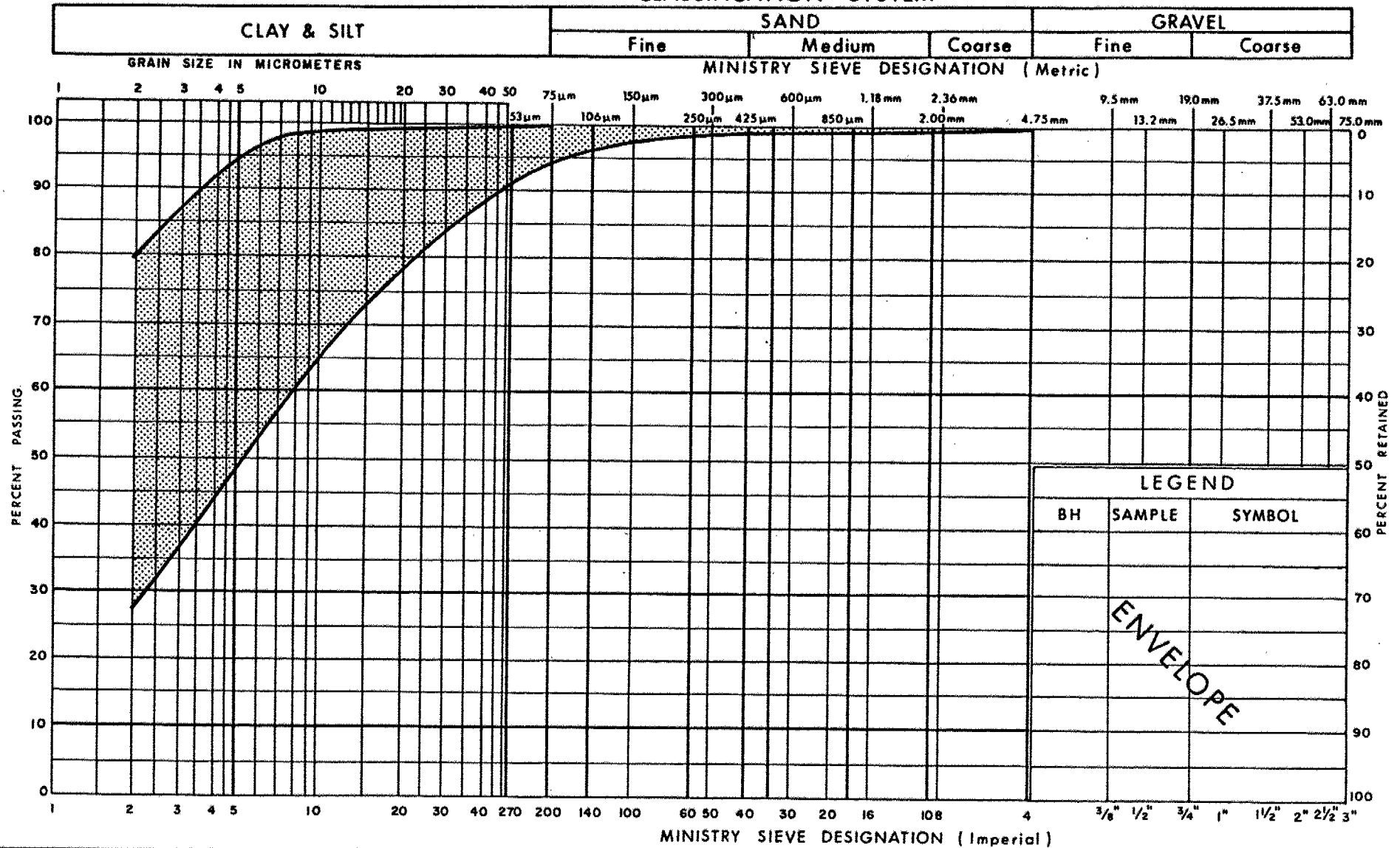
Ministry of
Transportation
Ontario

PLASTICITY CHART
SILTY CLAY, SOME SAND OCC GRAVEL
(Glacial Till)

FIG No 2

W P 98-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM

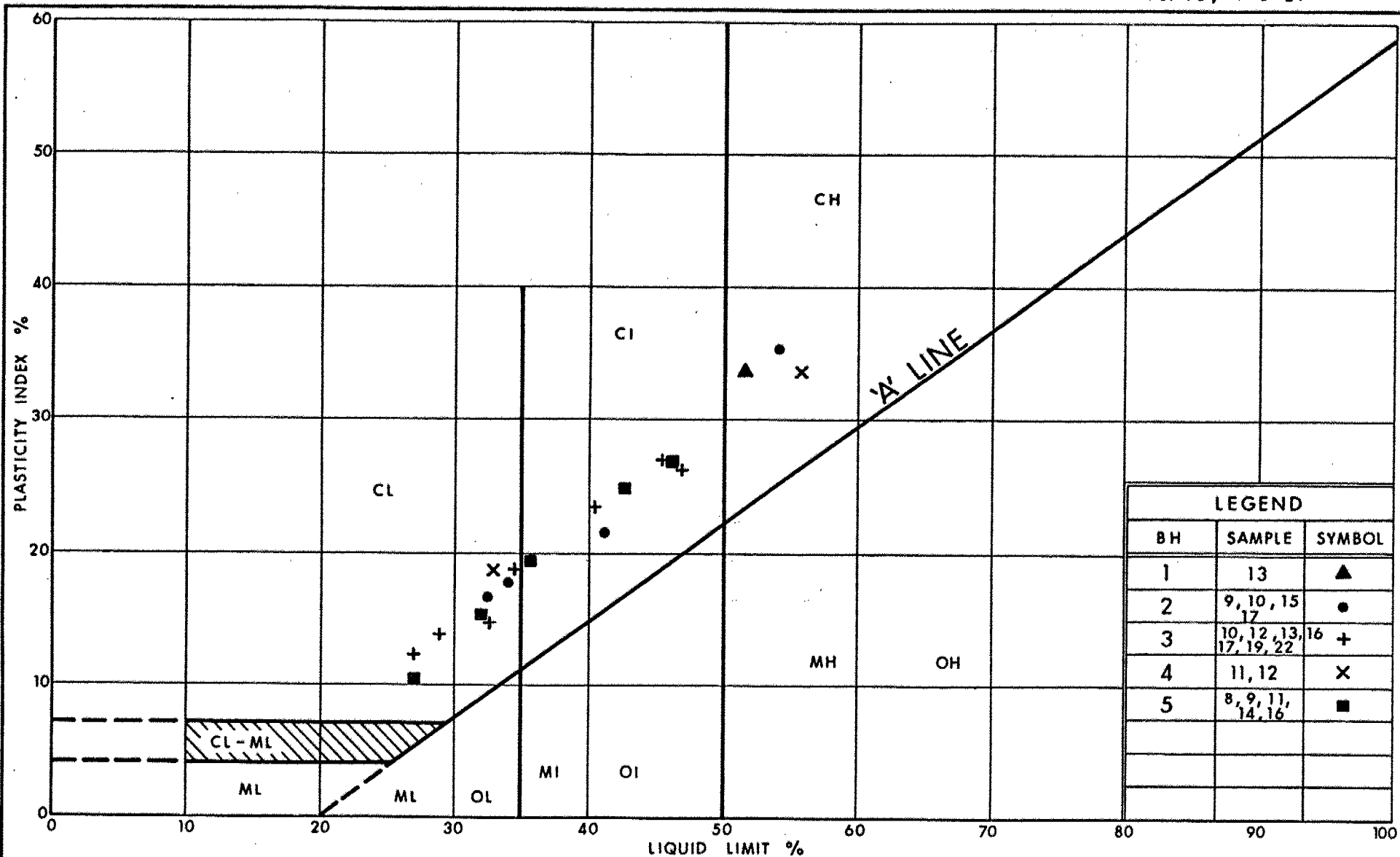


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GRAIN SIZE DISTRIBUTION
SILTY CLAY, OCC SILT AND CLAY LAYERS

FIG No 3

W P 98 - 87 - 01



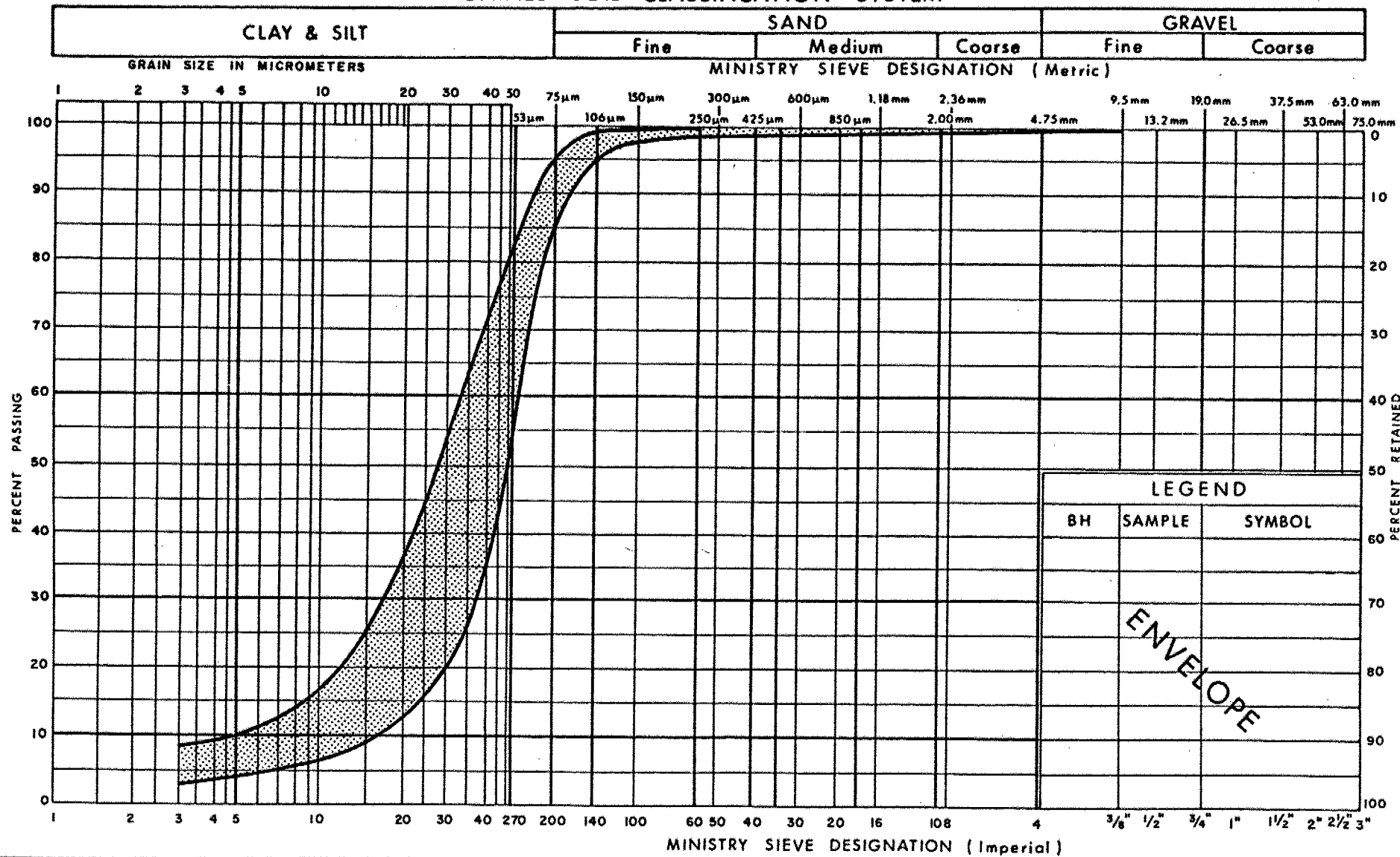
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PLASTICITY CHART SILTY CLAY, OCC SILT AND CLAY LAYERS

FIG No 4

W P 98-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

SILT, TRACES OF SAND AND CLAY

FIG No 5

W P 98-87-01

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

DIST. No. 6

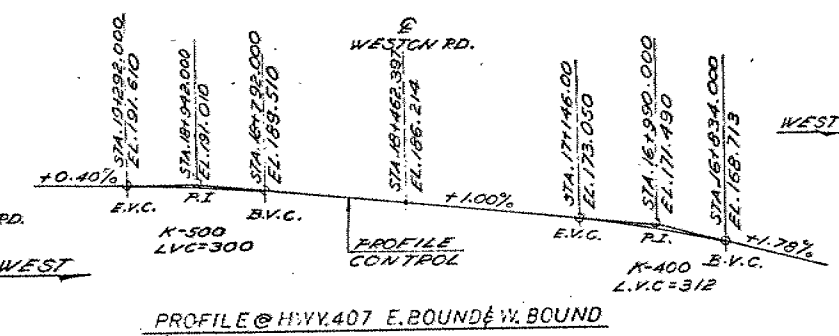
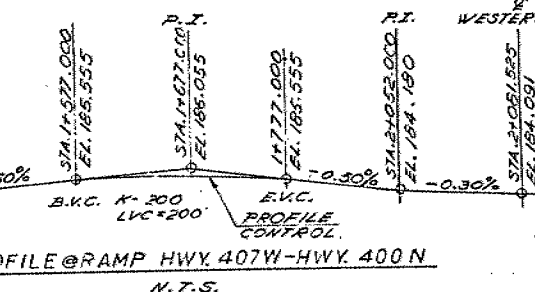
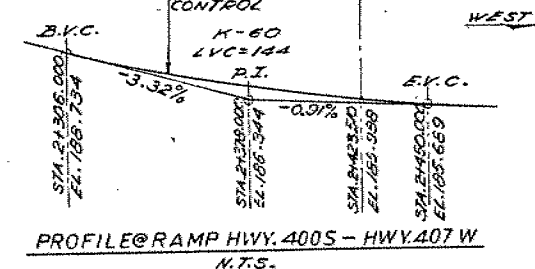
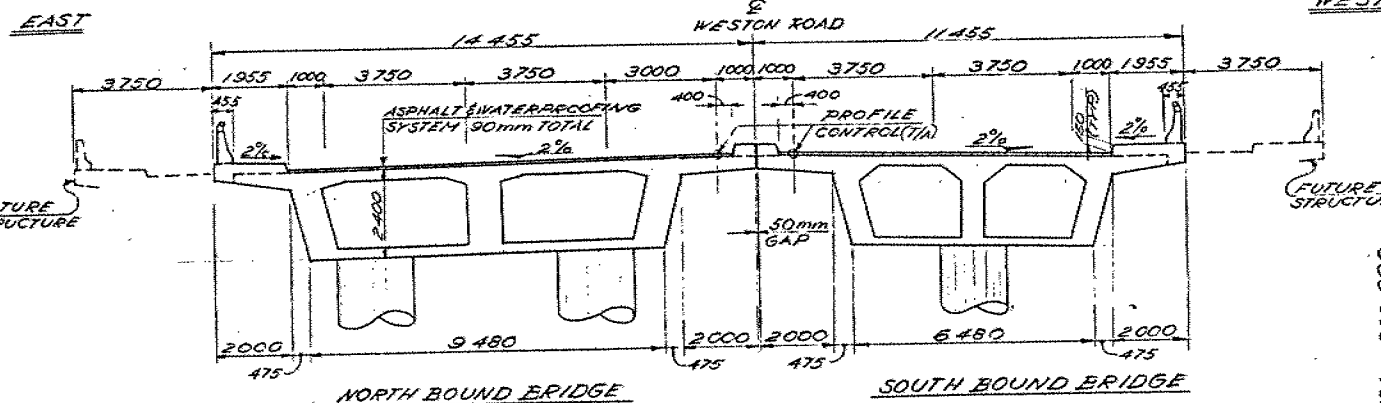
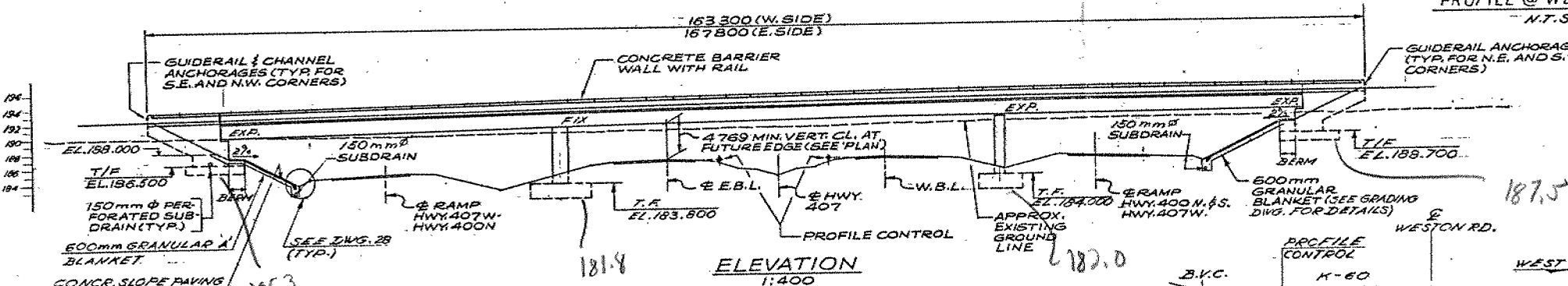
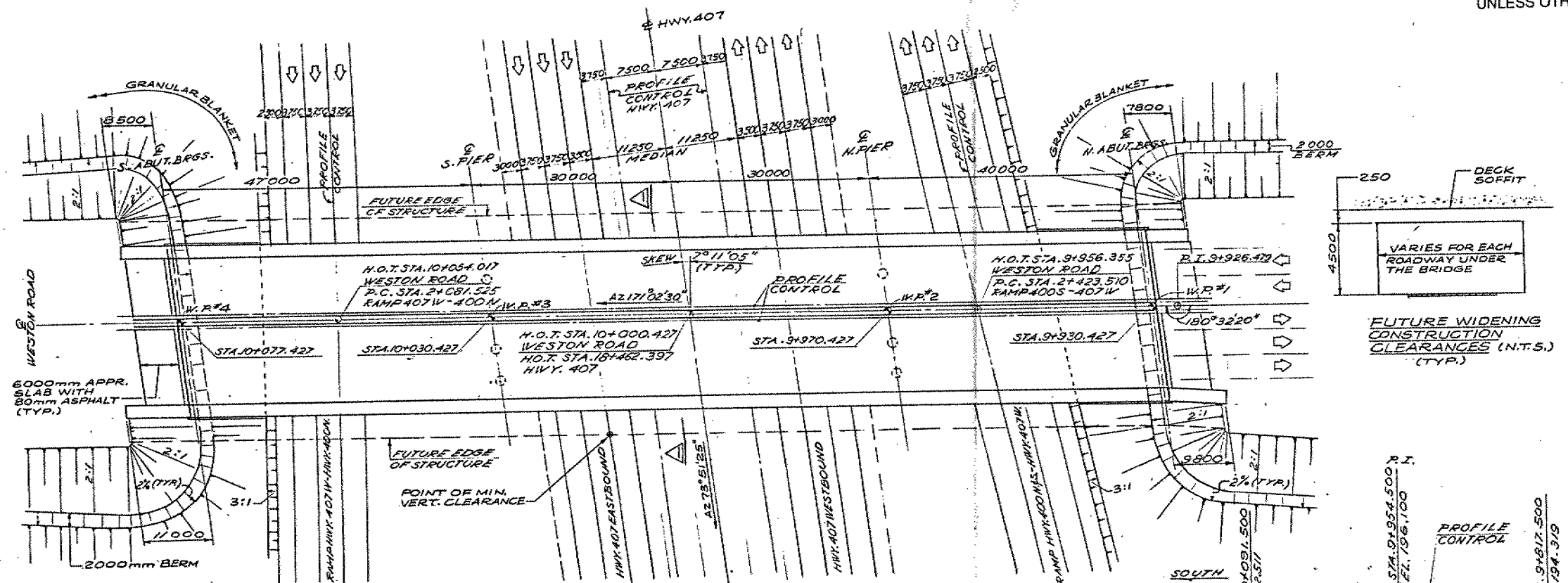
CONT No
WP No 98-87-01

HWY. 407-WESTON RD. UNDERPASS

GENERAL ARRANGEMENT



SHEET



NOTES

CLASS OF CONCRETE

Footings	20 MPa
Pier Columns	35 MPa
Deck	35 MPa
Remainder	30 MPa

CLEAR COVER TO REINFORCING STEEL

Footings	100 + 25mm
Abutments & Wingwalls front face	80 + 20mm
Abutments & Wingwalls back face	70 + 20mm
Pier Columns	80 + 20mm
Deck Top	70 + 20mm
Deck Bottom & sides	50 + 10mm
Deck interior surface of box girder	40 + 10mm
Barrier Walls & Appr. slabs - as per std. dvgs.	70 + 20mm
Remainder	

REINFORCING STEEL

Reinforcing steel shall be grade 400 unless otherwise specified. Bar marks with suffix 'C' denote coated bars.

CONSTRUCTION NOTES

Bearing seats shall be finished level and to the specified elevations.

LIST OF DRAWINGS

- General Arrangement
- Bore Hole Location & Soil Strata
- Footings Layout
- North Pier Footings & North Pier
- South Pier Footings & South Pier
- Abutment Footings
- North Abutment
- N. Abutment Wing walls
- South Abutment
- S. Abutment Wingwalls
- Bearing Details
- Deck Details
- Scord Elevations
- Longitudinal tendon details - N.B. Bridge
- Longitudinal tendon details - S.B. Bridge
- Transverse Tendon Details - N.B. Bridge
- Transverse Tendon Details - S.B. Bridge
- Deck Reinforcement I - N.B. Bridge
- Deck Reinforcement II - N.B. Bridge
- Deck Reinforcement III - S.B. Bridge
- Deck Reinforcement IV - S.B. Bridge
- Anchorage Reinforcement
- Joint Anchorage & Armouring
- Barrier Wall on SideWalk - N.B. Bridge
- Barrier Wall on SideWalk - S.B. Bridge
- Railing for Barrier Wall
- 6000 mm approach, slab - N.B. Bridge
- Detail of Concrete Slope paving
- As Constructed Elev. & Dim.
- Bridge Date & Site Number Data
- Quantities - Structure I

APPLICABLE STANDARD DRAWINGS

OPSD 508.2 - BRIDGE DECK WATERPROOFING
DD350.3 - MIN. GRANULAR BACK-FILL

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AL	CHK	CODE 0480C
DRAWN	P.S.	CHK	SITE 37-1179
			STRUCT
			SCHEME
			DWG

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

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

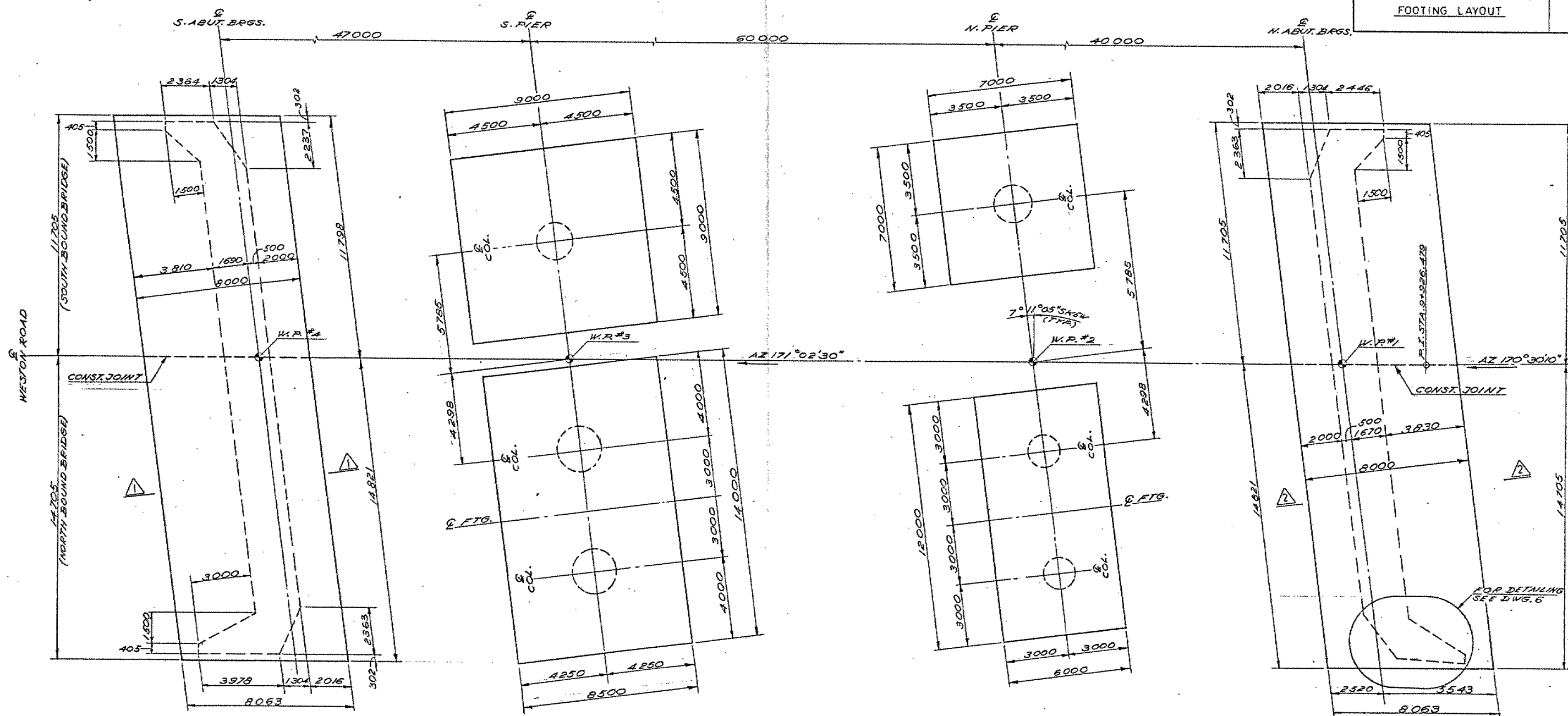
CONT No
WP No 98-87-01

HWY.407-WESTON RD.UNDERPASS

FOOTING LAYOUT

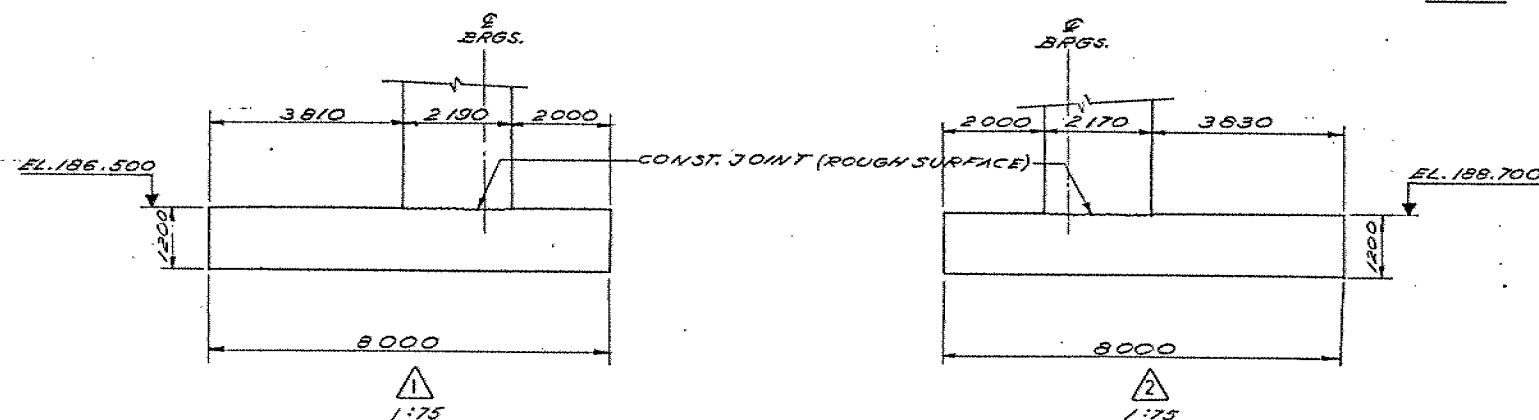


SHEET



FOOTING LAYOUT

1:100



NOTE:
FOR PIER FOOTING DETAILS
SEE DWGS. 4 & 5

W. P. DATA

W.P.	STATION	CO-ORDINATES	
		NORTH	EAST
W.P.#1	9+930.427	4 648 692.686	301 096.603
W.P.#2	9+970.427	4 848 853.174	301 102.631
W.P.#3	10+030.427	4 848 793.906	301 112.174
W.P.#4	10+077.427	4 648 747.479	301 119.493

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN A.L.	CHK	CODE	HRDC
DRAWN P.S.	CHK	SITE 37-1179	STRUCT
		LOAD 31-A	DATE
		SCHEME	DWG.3

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 98-87-01

DIST 6

HWY 407

STR SITE 37-1179

Weston Road Underpass

CONT. 89-65

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FOUNDATION INVESTIGATION REPORT

For

Hwy. 407 - Weston Rd. Underpass

WP 98-87-01; Site No. 37-1179

District #6, Toronto

INTRODUCTION

This report summarizes the foundation investigation for the proposed bridge and underpass at Hwy. 407 and Weston Rd.

The report refers to the area extending from Sta. 9+910 to Sta. 10+075 on Weston Rd. (M.T.C. chainage).

SITE DESCRIPTION

The site is located on Weston Rd. approximately 1 km. north of Steeles Avenue directly north of Metropolitan Toronto, in the Town of Vaughan, Regional Municipality of York.

Topography of the area is generally flat. The land on the east side of the site is wooded and contains a Drive-in Theatre. To the west is the excavation for new Hwy. 407 where cobbles and boulders are visible.

Geologically the site is located on a glacial deposit known as the Peel Plain. The underlying materials are glacial till and clay.

INVESTIGATION PROCEDURES

The field investigation was conducted between 87-10-13 and 87-10-30 with additional work on 87-12-03 and 87-12-04. Equipment consisted of a continuous flight auger machine with 87 mm I.D. hollow stem augers, solid stem augers and BX-casing. Wash boring techniques were used on some boreholes.

The investigation consisted of:

- 5 sampled boreholes with dynamic cone penetration tests.
- 4 supplementary boreholes.

Boreholes were advanced at each abutment and pier location in the right-of-way of Weston Road. All sampling was carried out using a split spoon to obtain disturbed samples of cohesive and non-cohesive materials. Standard Penetration Tests were conducted.

Borehole elevations and locations were obtained from the "E" plan provided by the Structural Section, Central Region.

LABORATORY TESTS

Laboratory testing was carried out on representative samples to determine Atterberg Limits and grain size characteristics of the soil.

The results of the tests are contained on the Record of Borehole sheets.

SUBSURFACE CONDITIONS

Subsoil at the site consists of stiff to hard silty clay with sand and gravel (Glacial Till) of varying thickness from 7 to 13.1 m. In certain locations on the northern portion of the site, this glacial origin deposit is underlain by a 3.4 to 5.4 m thick layer of compact to very dense sand and gravel. These deposits are underlain by an extensive stratum of very stiff to hard silty clay (Lacustrine) ranging in thickness from 21 to 22.7 m. The silty clay is immediately underlain by at least 3.0 m of very dense silt. Groundwater level was found to range between elev. 189.0 to elev. 190.5 about 1 to 1.3 m below the existing ground surface. The locations and elevations of the boreholes together with stratigraphical profiles based on the borehole data are shown on Dwg. #998701-A.

Detailed descriptions of the various deposits encountered are as follows:

Silty Clay, some Sand occasional Gravel (Glacial Till)

This deposit was encountered in all boreholes. The material consists of silty clay generally of low plasticity with traces of sand and gravel. The layer is found at ground level and extends to a maximum depth of 13.1 m. Random layers and pockets of sand are found throughout. Boulders and cobbles are also present.

Properties of the material as determined by field and laboratory tests are summarized as follows:

<u>Atterberg Limits</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)	7.5 - 15.0%	11.4%
Liquid Limit (w_L)	17.0 - 38.0%	24.1%
Plastic Limit (w_p)	10.5 - 17.5%	12.8%

Standard Penetration Tests ("N" values) ranged from 9 to 117 + blows per 0.3 m. The consistency of the deposit may be described as stiff to hard based on this information.

Figure 1, illustrates a typical grain size distribution envelope for the material.

Figure 2, illustrates typical plasticity characteristics of the material.

Sand & Gravel

This material was encountered at the north-east portion of the site (BH, 1, 1A, 1B). The stratum consists of sand and gravel in varying proportions. The deposit is sandwiched between the silty clay (Glacial Till) deposit and

an underlying Lacustrine silty clay stratum. The thickness of the deposit ranges from 3.4 to 5.4 m and decreases to the north and south of BH 1.

Standard Penetration Tests ("N" values) ranged from 18 to 77 blows per 0.3 m. The denseness may be described as compact to very dense based on this information.

Based on a representative sample, the moisture content (w) was 7.5% with the following grain size distribution:

Gravel	42.0%
Sand	44.5%
Silt	13.0%
Clay	0.5%

Silty Clay (Lacustrine)

This material was found in all boreholes directly below the silty clay (Glacial Till) or the sand and gravel deposits. The deposit consists of silty clay of intermediate plasticity with occasional layers of clay of high plasticity and random layers of silt. Thickness of this deposit ranges from 21.0 m to 22.7 m. The lower boundary of the material was penetrated only in certain locations (BH #2, #3, #5).

Properties of the material as determined by field and laboratory tests are summarized as follows:

<u>Atterberg Limits</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)	12.5 - 31.5%	21.5%
Liquid Limit (w_L)	24.0 - 56.0%	38.2%
Plastic Limit (w_p)	14.5 - 22.0%	17.5%

Standard Penetration Tests ("N" values) ranged from 22 to 130 + blows per 0.3 m indicating the consistency of the material to be very stiff to hard.

Figure 3, illustrates a typical grain size envelope for the material.

Figure 4, illustrates typical plasticity characteristics of the material.

Silt

This deposit was encountered below the silty clay deposit in some locations (BH #2, #3, #5) and was not full penetrated. The material is classified as a silt with traces of sand and clay. The deposit was found at depths below the ground surface ranging from 29.3 m to 32.0 m.

The Standard Penetration Tests ("N" values) ranged from 7 to 150 + blows per 0.3 m. The "N" value of 7 resulted from boiling of the silt during sampling and is not considered to be representative of the deposit. Generally the denseness may be described as very dense.

Based on representative samples, the natural moisture content (w) ranged from 16.5% to 34.5% with the following grain size distribution:

Gravel	0 - 1%
Sand	3 - 17%
Silt	80 - 87%
Clay	2 - 10%

Figure 5, illustrates a typical grain size distribution envelope for this material.

Groundwater

Groundwater levels in open boreholes were measured periodically during the investigation. From this information it was determined that stabilized groundwater levels range from 1.0 m to 1.3 m below ground surface.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a twin 4 span (33-40-43-36 m) flyover bridge to carry Weston Road over Hwy. 407. The new structure, according to available information will be some 26 m wide to accommodate future traffic on Weston Road.

The existing ground level at this site ranges from about elevation 190 m to 192 m.

At the structure, the proposed grade of Hwy. 407 will be at the approximate elevation of 186 m, and the proposed grade of new Weston Road centre line will be at elevation +193 m.

Hwy. 407 will be located in a cut some 5 m in depth. Weston Road will be elevated some 1 to 1.5 m above its present level.

Subsurface Conditions

Subsoil at the site consists of stiff to hard silty clay with sand and gravel (Glacial Till) of varying thickness from 7 to 13.1 m. In certain locations on the northern portion of the site, this glacial origin deposit is underlain by a 3.4 to 5.4 m thick layer of compact to very dense sand and gravel. These deposits are underlain by an extensive stratum of very stiff to hard silty clay (Lacustrine) ranging in thickness from 21 to 22.7 m. The silty clay is immediately underlain by at least 3.0 m of very dense silt. Groundwater level was found to range between elev. 189.0 to elev. 190.5 about 1 to 1.3 m below the existing ground surface. The locations and elevations of the boreholes together with stratigraphical profiles based on the borehole data are shown on Dwg. #998701-A.

Structure Foundations

The proposed structure may be supported on spread footings constructed within the stiff to hard silty clay deposit at or below the following elevations:

Abutments 187.50 Piers El. 186.00

All footings must have a minimum earth cover of 1.2 m for frost protection.

For purposes of the O.H.B.D.C. the following design values are recommended.

Abutments:	Factored Bearing Capacity at U.L.S.	525 kPa
	Bearing Capacity at S.L.S. Type II	350 kPa
Piers:	Factored Bearing Capacity at U.L.S.	750 kPa
	Bearing Capacity at S.L.S. Type II	500 kPa

Backfill to abutments and retaining walls should consist of Granular 'A' or Granular 'B' for which the following properties are recommended:

Granular 'A'	$\gamma = 22.8 \text{ kN/m}^3$	$\phi = 35^\circ$	$K_A = 0.27$
Granular 'B'	$\gamma = 21.2 \text{ kN/m}^3$	$\phi = 30^\circ$	$K_A = 0.33$

Lateral pressures should be computed in accordance with Section 6.6.1.2.1 of the code. A yielding foundation condition may be assumed. Sliding resistance may be computed by assuming an adhesion of 75 kPa to apply between the underside of footings and the soil.

Excavations for footings carried out below the water level prevailing at the time of construction will require to be dewatered. Due to the relatively impervious nature of the silty clay subsoil, no major problems are anticipated. However, any minor seepage from the silt and sand seams can be removed by ordinary sump pumping techniques. It is desirable however, that

the excavation for Hwy. 407 be completed prior to construction of the bridge in which case a more favourable groundwater regime will result.

Stability of Approaches

At this location, cuts up to 5 m in depth will be required to achieve the grade of Hwy. 407. In addition, fills of 1.5 to 2.5 m will be needed for the construction of new Weston Road.

Stability Analyses in terms of effective stresses have been carried out for the proposed geometry of the approaches. It is concluded that the stable slopes of 2 horizontal to 1 vertical can be achieved provided the following measures are adopted.

The cut will expose numerous random pockets and layers of fine sand and silt which are susceptible to disturbance. Loosening of this material can be anticipated due to freeze-thaw cycles. Consequently, a toe drain at the base of the cut, and in addition a 0.6 m thick granular blanketing will be required. The blanket should extend from elevation 188 down to the toe of the slope. The sub-drain should be located at least 1.2 m below the finished grade of the ditch. The drains should be wrapped with a suitable geotextile filter fabric, such as Class 1 non-woven geotextile with EOS of 75 to 150 um. The perforated pipes should be 150 mm minimum diameter and should be surrounded by a minimum of 150 mm of granular backfill. The drains should be connected to an appropriate permanent drainage system. In addition, all slopes should be provided with an interceptor ditch at the top of the slope. The granular blanket should consist of a free-draining material such as Granular 'A'.

All slopes should be protected against surficial erosion by grassing.

MISCELLANEOUS

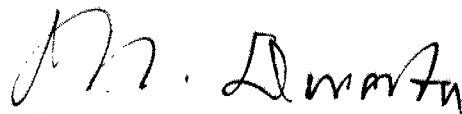
The field work for this investigation was carried out during the period of 87-10-03 and 87-10-30 with additional work on 87-12-03 and 87-12-04, under the supervision of K. D. Zasitko, Foundation Field Technician (acting). The equipment was owned and operated by Malone's Soil Samples of Toronto.

This report was written by K. D. Zasitko and reviewed by M. Devata, Chief Foundation Engineer (East).



K.D. Zasitko, CET

Foundation Field Technician (Acting)

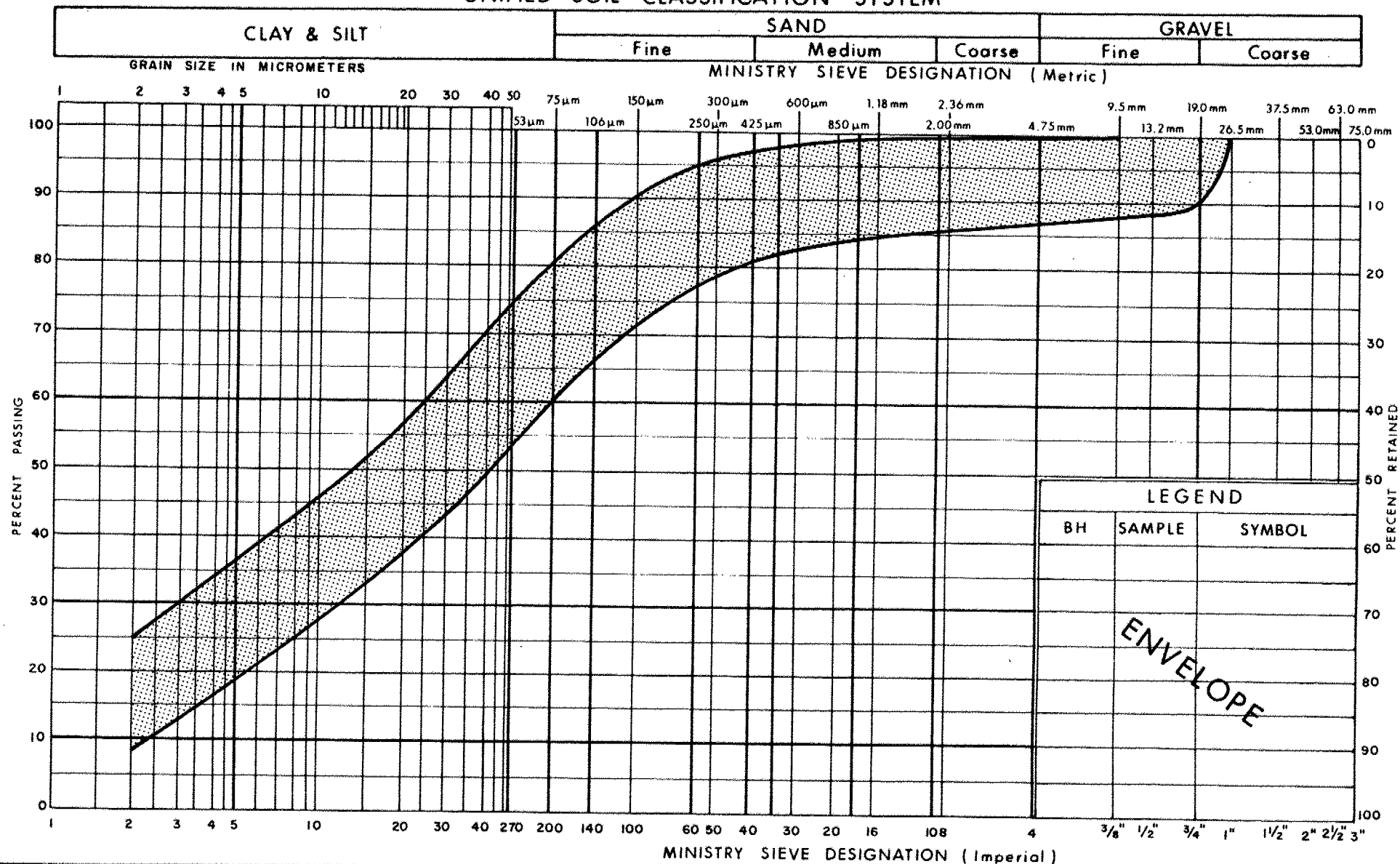


Murty Devata, P.Eng.

Chief Foundations Engineer (East)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

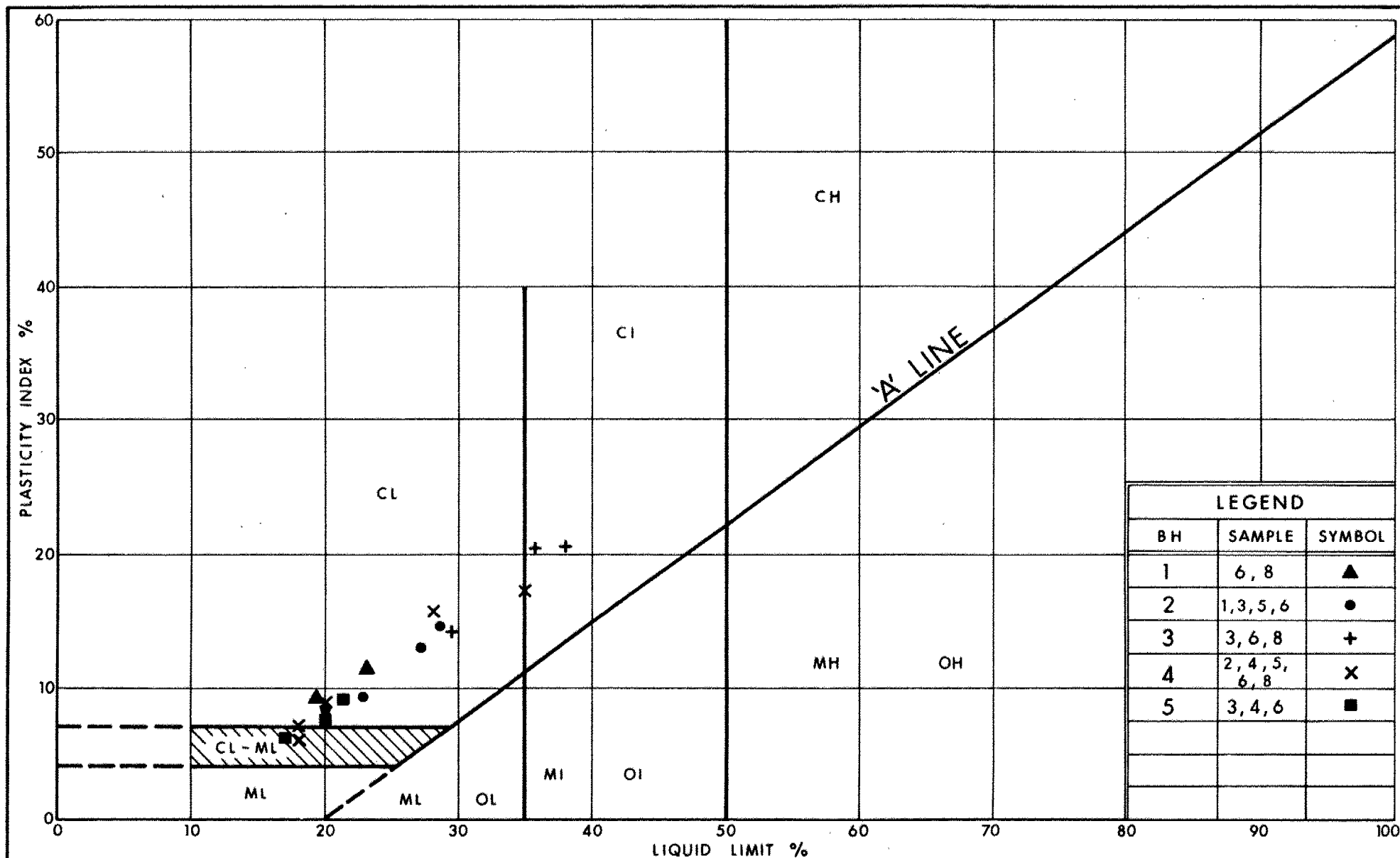


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY, SOME SAND OCC GRAVEL
(Glacial Till)

FIG No 1

W P 99-87-01



Ministry of
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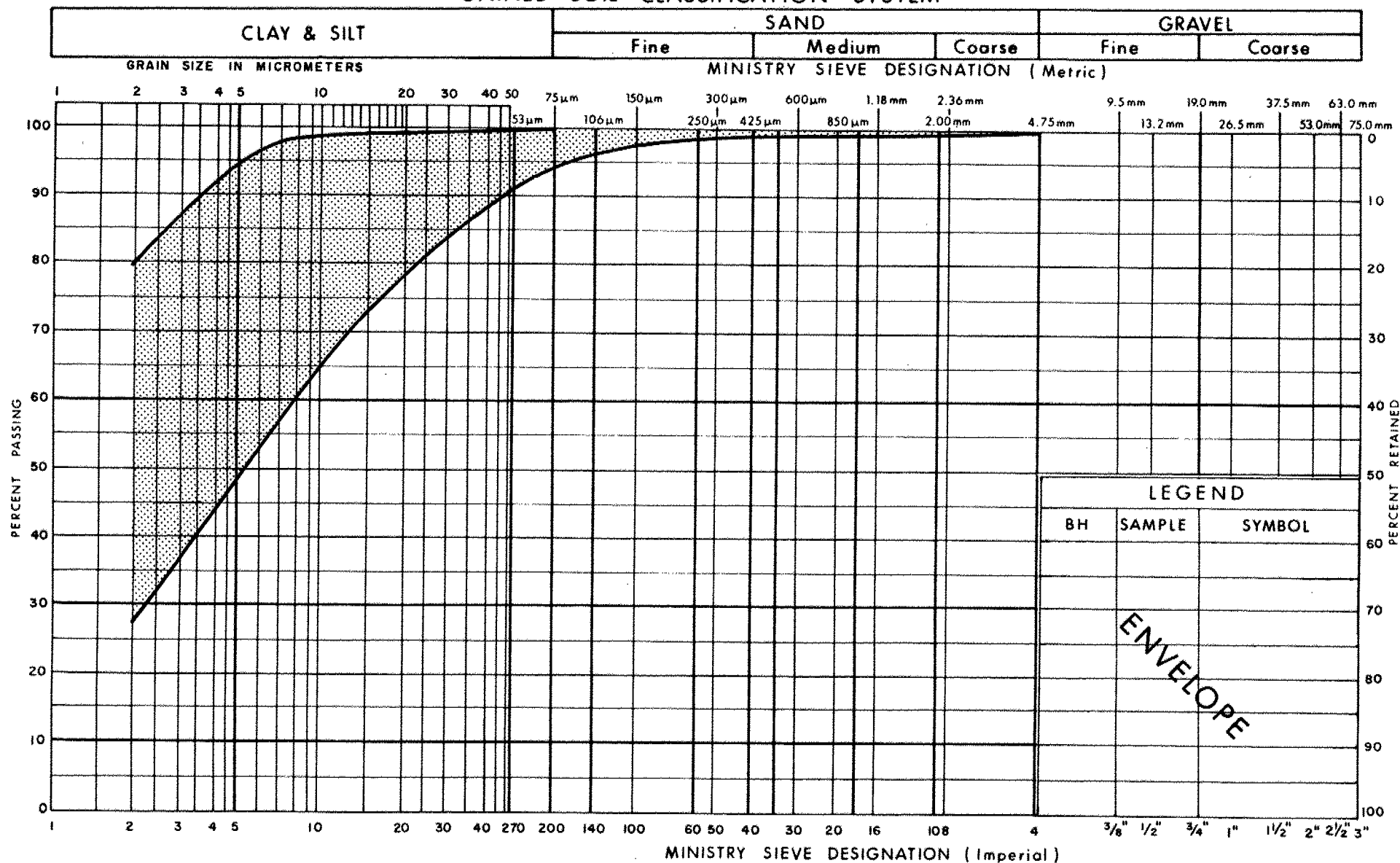
Ontario

PLASTICITY CHART
SILTY CLAY, SOME SAND OCC GRAVEL
(Glacial Till)

FIG No 2

W P 99-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM

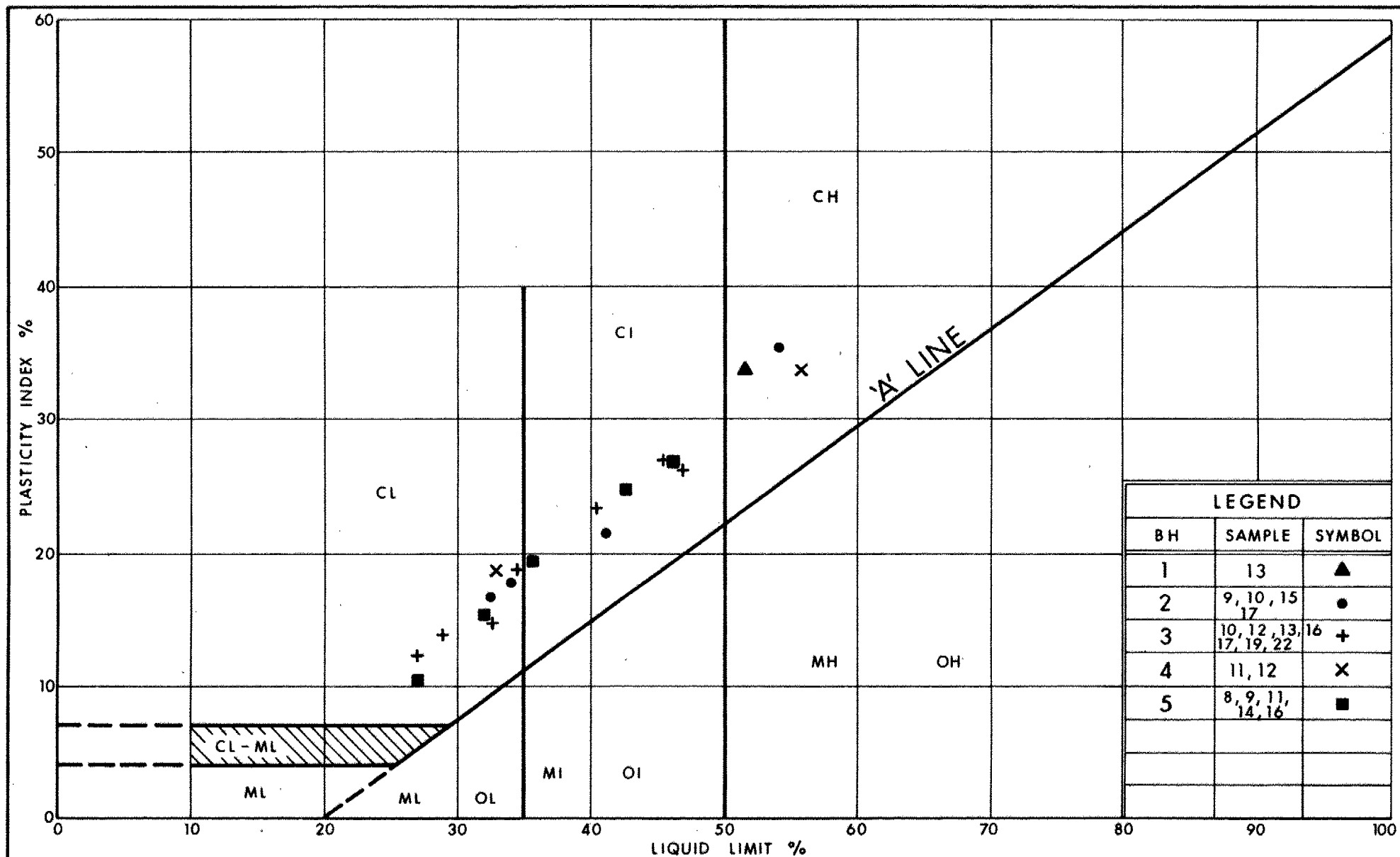


Ministry of
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GRAIN SIZE DISTRIBUTION
SILTY CLAY, OCC SILT AND CLAY LAYERS

FIG No 3

W P 99-87-01



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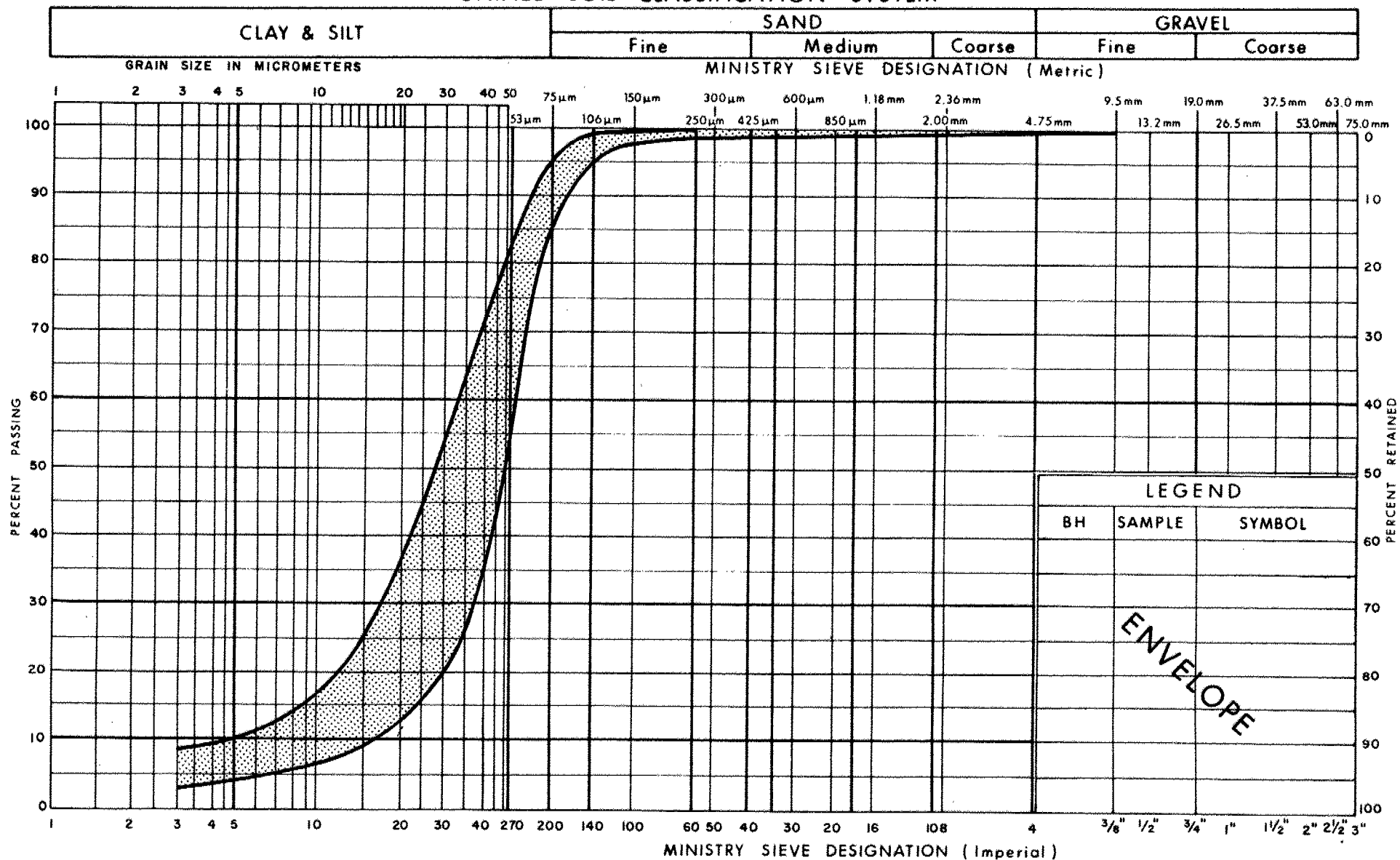
Ontario

PLASTICITY CHART SILTY CLAY, OCC SILT AND CLAY LAYERS

FIG No 4

W P 99-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, TRACES OF SAND AND CLAY

FIG No 5

W P 99-87-01

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:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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'_{v0}	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_f	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_f}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 898.5; E 301 106.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 13 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	WATER CONTENT (%)						
								SHEAR STRENGTH							20	40	60							
							○ UNCONFINED + FIELD VANE																	
							● QUICK TRIAXIAL x LAB VANE																	
191.5	Ground Level													GR SA SI CL										
0.0	Silty Clay Some Sand Occasional Gravel (Glacial Till) Stiff to Hard Random Layers or Pockets of Sand		1	SS	13									3 22 51 24										
			2	SS	16																			
			3	SS	20																			
			4	SS	18																			
			5	SS	41																			
			6	SS	63																			
			7	SS	83																			
183.0	Sand and Gravel Compact to Very Dense		8	SS	49																		2 21 60 17	
8.5			9	SS	18																			
			10	SS	31																			42 44 13 1
			11	SS	77																			
			12	SS	124										25 cm									
177.6	Silty Clay Occasional Silt and Clay Layers Hard		13	SS	109										25 cm								0 4 50 46	
13.9			14	SS	110										23 cm									
174.3	End of Borehole																							
17.2																								

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 1A

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 887.5; E 301 108.0 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
DATUM Geodetic DATE 1987 12 03 CHECKED BY

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
191.5	Ground Level												
0.0	Silty Clay Some Sand Occ. Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)												
181.7													
9.8	Sand and Gravel Compact to Very Dense		1	SS	26								
			2	SS	41								
178.3	Silty Clay, Occ.												
13.2	Silt and Clay Layers												
177.4	Hard		3	SS	120/25 cm								
14.1	End of Borehole												
	* Note Water Level Not Established												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
S (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 1B

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 908.0; E 301 104.0 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
DATUM Geodetic DATE 1987 12 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
191.5	Ground Level															GR SA SI CL
0.0	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)					*										
181.5																
10.0	Sand and Gravel Compact		1	SS	29											
	Silt Dense		2	SS	50											
178.1																
13.4	Silty Clay															
177.3	Occ. Silt & Clay Layers Hard		3	SS	98											
14.2	End of Borehole															
	* Note Water Level Not Established															

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 859.5; E 301 089.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem, Wash Boring-N Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 22, 23, 26 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
191.0	Ground Level											
0.0			1	SS	18		190					
			2	SS	20							1 28 53 18
			3	SS	24							
			4	SS	18							
	Sand Layer		5	SS	92			120/18 cm				0 19 66 15
	Silty Clay		6	SS	117	25 cm						
	Some Sand											
	Occasional Gravel (Glacial Till)		7	SS	116							
	Very Stiff to Hard		8	SS	100							
	Random Layers or Pockets of Sand											
181.7			9	SS	102		182					1 4 53 42
9.3			10	SS	34		180					0 0 20 80
			11	SS	23							
			12	SS	27							
	Silty Clay		13	SS	60							
	Occasional Silt		14	SS	40							0 0 (100)
	and Clay Layers											
	Very Stiff to Hard		15	SS	26							
			16	SS	29							
			17	SS	28							0 0 49 51
			18	SS	37							
160.8							162					
30.2												

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2 Continued METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 859.5; E 301 089.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem, Wash Boring-N Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 22, 23, 26 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 2A

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 879.0; E 301 086.5 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
DATUM Geodetic DATE 1987 12 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
191.5 0.0	Ground Level					*								
	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)													
179.9			1	SS	76									
11.6	Silty Clay													
178.9	Occ. Silt & Clay Layers		2	SS	48									
12.6	End of Borehole													
	* Note Water Level Not Established													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 B

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 899.0; E 301 083.0 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger COMPILED BY KZ
 DATUM Geodetic DATE 1987 12 04 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
191.5 0.0	Ground Level					*					
	Silty Clay Some Sand Occasional Gravel (Glacial Till) Random Layers or Pockets of Sand Boulders & Cobbles (Description Inferred from Adjacent Boreholes)										
			1	SS	56						
			2	SS	130						
178.4	Silty Clay										
13.1	Occ. Silty Clay Layers										
177.3	Hard		3	SS	43						
14.2	End of Borehole										
	* Note Water Level Not Established										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 826.3; E 301 117.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem, Wash Boring-B Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 13, 14, 19, 20, 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	WATER CONTENT (%)			GR	SA	SI	CL
								W _p	W						W _L									
191.0	Ground Level																							
0.0																								
			1	SS	9		190																	
			2	SS	20																			
			3	SS	24																			
			4	SS	23																			
			5	SS	56																			
			6	SS	41																			
			7	SS	80																			
			8	SS	91																			
			9	SS	91																			
			10	SS	69																			
			11	SS	61																			
			12	SS	46																			
			13	SS	63																			
			14	SS	36																			
			15	SS	37																			
			16	SS	29																			
			17	SS	40																			
			18	SS	52																			
			19	SS	64																			
			20	SS	47																			
			21	SS	45																			
		</																						

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3 Continued METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 826.3; E 301 117.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem, Wash Boring-B Casing, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 13, 14, 19, 20 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L		
160.8	Continued													
30.2														
160.0	Silty Clay, Hard		22	SS	38		160							0 0 37 63
31.0														
	Silt		23	SS	60	8 cm								
	Traces of Sand and Clay						158							
	Very Dense		24	SS	120	10 cm								0 13 80 7
155.8			25	SS	120	10 cm	156							
35.2	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 777.2; E 301 102.0
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger and Cone Test
DATUM Geodetic DATE 1987 10 28
ORIGINATED BY KZ
COMPILED BY KZ
CHECKED BY

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

190.5	Ground Level													
0.0			1	SS	26									
			2	SS	18									
			3	SS	22									
	Sandy Silt		4	SS	72									
			5	SS	53									
	Silty Clay		6	SS	105									
	Some Sand													
	Occ. Gravel (Glacial Till)		7	SS	94									
	Very Stiff to Hard		8	SS	116									
	Random Layers or Pockets of Sand		9	SS	108									
			10	SS	114									
178.0			11	SS	130									
12.5	Silty Clay Occasional Silt and Clay Layers													
176.3	Hard		12	SS	36									
14.2	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 99-87-01 LOCATION Co-ords. N 4 848 748.5; E 301 129.5
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem & Cone Test
DATUM Geodetic DATE 1987 10 14, 15, 16
ORIGINATED BY KZ
COMPILED BY KZ
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)		
190.2	Ground Level													GR SA SI CL
0.0			1	SS	10		190							
			2	SS	10									
			3	SS	22		188							4 26 54 16
	Sandy Silt		4	SS	42									1 24 66 9
	Silty Clay		5	SS	33									
	Some Sand		6	SS	28		186							
	Occasional Gravel (Glacial Till)		7	SS	44		184							
	Stiff to Hard													
	Random Layers or Pockets of Sand		8	SS	48		182							0 4 52 44
			9	SS	37									
			10	SS	27		180							
			11	SS	28		178							0 0 35 65
	Silty Clay		12	SS	23									
	Occasional Silt and Clay Layers		13	SS	46		176							0 0 (100)
			14	SS	40		174							
	Very Stiff to Hard		15	SS	26		172							
			16	SS	22		170							0 0 57 43
			17	SS	25		168							
							166							
							164							
							162							
160.9														
29.3	Silt													
160.0	Traces of Sand & Clay													
20.2														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5 Continued METRIC

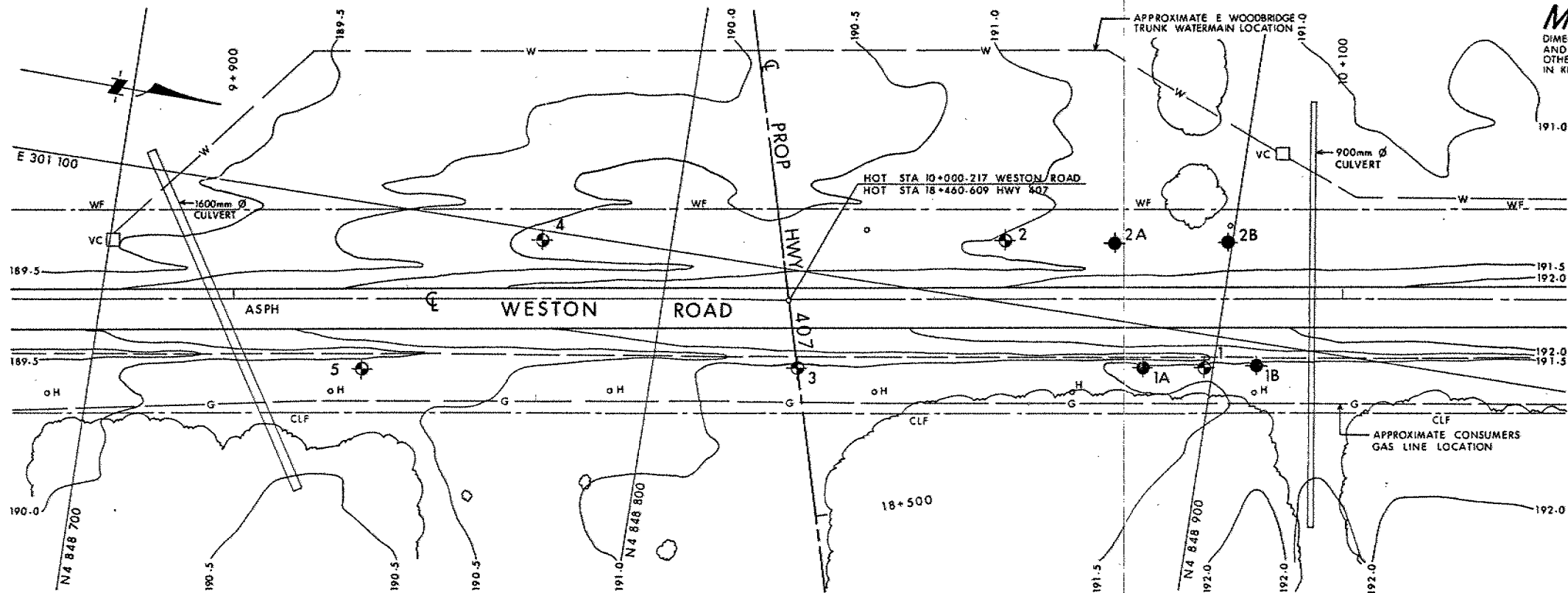
W P 99-87-01 LOCATION Co-ords. N 4 848 748.5; E 301 129.5 ORIGINATED BY KZ
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 1987 10 14, 15, 16 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.0	Continued																
30.2	Silt, Traces of Sand and Clay Very Dense		18	SS	7	*											1 14 83 2
157.9			19	SS	120	15 cm	158										0 3 87 10
32.3	End of Borehole Note: * Low N Value caused by Boiling Condition																

OFFICE REPORT ON SOIL EXPLORATION

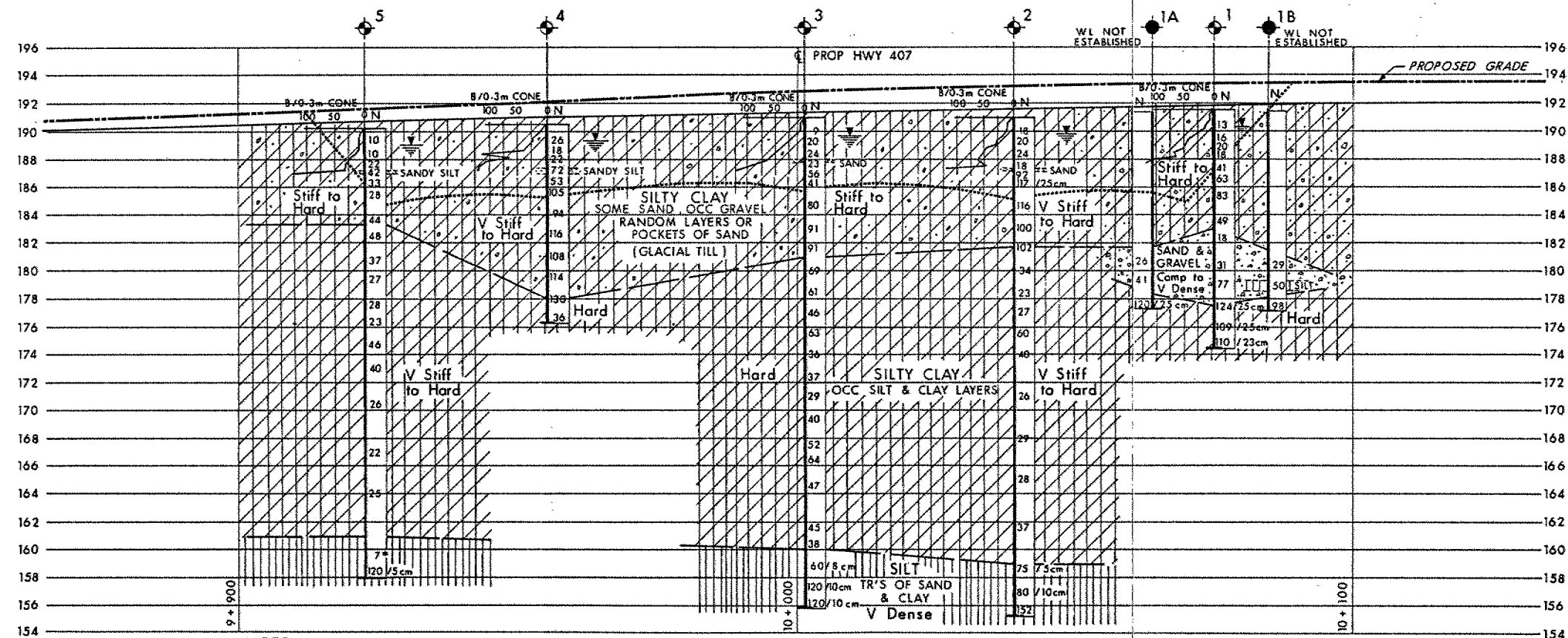
+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



PLAN
SCALE
8m 4 0 8m

NOTE
Subsoil information for BH 2A and 2B
refer to Record of Borehole Sheets



NOTE
* Low N value caused by
boiling condition.

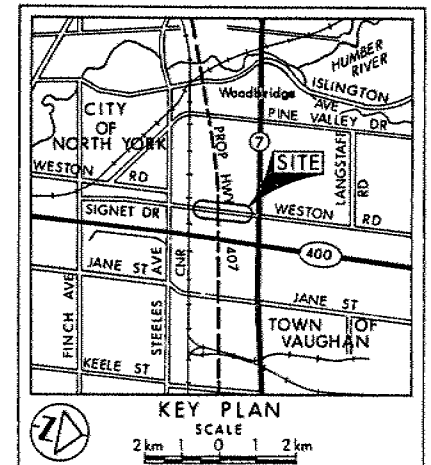
PROFILE WESTON ROAD

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

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

CONT No
WP No 99-87-01
WESTON RD
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)			
W	WL at time of investigation 87 10			
No	ELEVATION	CO-ORDINATES		
		NORTH	EAST	
1	191.5	4 848 898.5	301 106.0	
2	191.0	4 848 859.5	301 089.0	
3	191.0	4 848 826.3	301 117.5	
4	190.5	4 848 777.2	301 102.0	
5	190.2	4 848 748.5	301 129.5	
1A	191.5	4 848 887.5	301 108.0	
1B	191.5	4 848 908.0	301 104.0	
2A	191.5	4 848 879.0	301 086.5	
2B	191.5	4 848 899.0	301 083.0	

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

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

REV	DATE	BY	DESCRIPTION
Geocres No 30M13-68			
HWY No 407			
SUBM'D	DD	CHECKED	DATE 88 01 12
DRAWN	DT	CHECKED	APPROVED
DIST 6			SITE 37-1179
DWG 998701-A			

REF No E-6081-1, 87 10

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-68,69

DIST. 6 REGION

W.P. No. 137-87-00-B

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 400/407 1C

LOCATION CUT SLOPE STABILITY
RAMPS

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

*FILE
Copy*

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 137-87-00(B) DIST 6

HWY 401 / 407 IC STR SITE N/A

Deep Cuts for Ramps - 407W to 400N
407W to 400S
407E to 400S
407E to 400N

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GEOCRES

DATE

FOUNDATION INVESTIGATION REPORT

For

Deep Cuts for Ramps

- 407 W to 400 N
- 407 W to 400 S
- 407 E to 400 S
- 407 E to 400 N

W.P. 137-87-00(B), Site N/A

Hwy. 400/407 IC, District 6, Toronto

INTRODUCTION

At the request of the Central Region Geotechnical Section, the Foundation Design Section initiated a foundation investigation into the slope stability of deep cuts along the above-noted ramps. This report summarizes the results of these investigations related to cuts over 4.5 m deep.

SITE DESCRIPTION

The site is located at the proposed Hwy. 400/407 interchange, approximately 0.9 km south of Hwy. 7.

This area is basically a glacial till plain with low local relief. The till deposits are interbedded with some continuous, and frequent random discontinuous silt to sand pockets. Bedrock was not encountered during the investigation but is reported to be composed of shale with limestone laminations and located below elev. 120± m.

The the east of Hwy. 400, land use is agricultrual; to the west; there is a drive-in theatre and the Toronto Star property.

INVESTIGATION PROCEDURES

The feild work for this investigation was conducted between 88 07 18 and 88 07 25 utilizing continuous-flight auger machines equipped with 82 mm I.D. hollow-stem augers and solid-stem augers.

The investigation consisted of 3 sampled boreholes, 2 of which were accompanied by dynamic cone penetration tests. This information was supplemented by previous subsurface information collected for W.P. 137-87-01 to -06 consisting of 54 boreholes and 28 piezometer installations and for W.P. 98-87-01 consisting of 9 boreholes. A total of 9 boreholes from these 2 previous projects are specifically referenced.

Survey details were provided by the Central Region Surveys and Plans Section.

The sampling program consisted of split spoon samples collected at 0.8 m to 3.0 m intervals. They provided Standard Penetration Test (N) values for assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of shear strengths of cohesive materials. These samples also provided material for identification purposes.

The laboratory testing program for representative samples consisted of:

- grain size analyses
- natural moisture content determinations
- Atterberg Limit determinations

SUBSURFACE CONDITIONS

The Record of Borehole Sheets in the Appendix for Boreholes #7-5, #8-3, #9-6, #9-7, #10-5, #10-6 and #12-5 are representative of the subsurface conditions along the ramps in the vicinity of the Hwy. 400/407 interchange. The locations of these boreholes are indicated on Drawing No. 1378700(B)-A.

At the Hwy. 400/407 interchange the overburden consisted of the following generalized layers, in sequence, from the surface down:

<u>Elevation (m)</u>		<u>Material</u>
<u>From</u>	<u>To</u>	
192.5	190	Clayey Silt (Glacial Till)
190	179	Silt/Clayey Silt with random silt and sand pockets (Glacial Till with Lacustrine Interbeds)
179	157	Silty Clay to Clay with thin silt seams (Lacustrine)
157	undetermined	Sandy Silt to Silty Sand (Lacustrine)

The properties of the glacial till deposits are variable across the site in both the horizontal and vertical dimensions, and the boundaries between the soil strata are transitional.

The groundwater elevation is generally between elev. 190 and 192 m.

For detailed descriptions of the subsurface conditions in the immediate Hwy. 400/407 Interchange area, refer to the Foundation Investigation Reports for W.P. 137-87-01 through -06.

The Record of Borehole Sheets in the Appendix for Borehole #4 and #5 are representative of the subsurface conditions along the ramps in the vicinity of Weston Road. The locations of these boreholes are indicated on Drawing No. 1378700(B)-B.

Subsoil at this location consists of stiff to hard silty clay with sand and gravel (Glacial Till) of varying thickness from 7 to 13.1 m. In certain locations on the northern portion of the site, this glacial origin deposit is underlain by a 3.4 to 5.4 m thick layer of compact to very dense sand and gravel. These deposits are underlain by an extensive stratum of very stiff to

hard silty clay (Lacustrine) ranging in thickness from 21 to 22.7 m. The silty clay is immediately underlain by at least 3.0 m of very dense silt. Groundwater level was found to range between elev. 189.0 to elev. 190.5 about 1 to 1.3 m below the existing ground surface.

For detailed descriptions of the subsurface conditions in the immediate vicinity of Weston Road, refer to the Foundation Investigation Reports for W.P. 98-87-01.

The Record of Borehole Sheets in the Appendix illustrate the subsurface conditions at BH #101, #102 and #103. The approximate locations of these boreholes is illustrated on Drawing No. 1378700(B)-C which also illustrates the approximate ramp locations.

These boreholes, advanced specially to investigate these ramps, have indicated that the subsurface conditions along the ramps are generally similar to those at the Hwy. 400/407 interchange except at the west ends of Ramp 407 W - 400 N and 407 W - 400 S where conditions are similar to those at Weston Road.

Detailed descriptions of the soil strata encountered in these boreholes are presented below.

Clayey Silt (Glacial Till)

This cohesive material has been described as clayey silt containing some sand and some to traces of gravel. It was encountered at the surface at BH #102 and #103, located west of the Hwy. 400/407 interchange, where it extended for thicknesses of 3.0 and 3.4 m respectively.

Based on the results of Standard Penetration Tests (N = 19 to 44), the material can be described as very stiff to hard.

Typical properties of the material, as determined by laboratory tests of 2 representative samples, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	10.0-17.0%	13.5%
Liquid Limit (w_L)	21.5-23.0%	22.3%
Plastic Limit (w_p)	-	12.0%
Plasticity Index (I_p)	9.5-11.0%	10.3%

Figure 1 illustrates a typical grain size distribution for this material.

Silt/Clayey Silt (Glacial Till)

This material has been described as silt/clayey silt containing some sand, traces of gravel, random silt and sand pockets and occasional boulders. The main component of this deposit varies randomly from non-plastic silt (ML), to slightly plastic silt (CL-ML), to clayey silt (CL). Within this deposit there are frequent random discontinuous pockets of silts and sands, typically 1 m thick. This deposit was encountered under the surficial clayey silt layer at both BH #102 and BH #103 where it extended for thicknesses of over 12.7 m and 8.8 m respectively. The full thickness was not explored as both boreholes were terminated within this deposit.

Based on the results of Standard Penetration Test (N values 16 to 100+), the non-cohesive zones of this material can be described as compact to very dense while the cohesive zones can be described as very stiff to hard.

Typical properties of the material, as determined by laboratory tests of representative samples, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	10.0-12.5%	11.2%
Liquid Limit (w_L)	19.0-21.5%	20.2%
Plastic Limit (w_p)	12.0-15.5%	13.3%
Plasticity Index (I_p)	6.0-7.5%	6.8%

Figure 2 illustrates a typical grain size distribution for this material.

Silty Clay to Clayey Silt (Glacial Till)

This cohesive material has been described as silty clay to clayey silt, containing some sand, traces of gravel, occasional boulders and random silt and sand zones. It was encountered as the surficial deposit at BH #101, the most westerly borehole that was advanced specifically for this project. At this location it was 9.1 m thick.

Based on the results of Standard Penetration Test ($N = 20$ to $100+$), the material can be described as very stiff to hard.

Typical properties of the material, as determined by laboratory tests of representative samples, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	8.0-30.0%	18.7%
Liquid Limit (w_L)	22.5-48.5%	35.0%
Plastic Limit (w_p)	10.0-22.0%	15.7%
Plasticity Index (I_p)	12.5-26.5%	19.3%

Figure 3 illustrates a typical grain size distribution for this material.

Silty Clay to Clay (Lacustrine)

This cohesive material has been described as silty clay to clay with thin silt seams. It was encountered below the silty clay to clayey silt layer at BH #101 where it extended for a thickness in excess of 2.6 m. The fill thickness was not explored as the borehole was terminated within this deposit.

Based on the results of Standard Penetration Tests ($N = 100+$), the material can be described as hard.

Groundwater

At the time of the field investigation the groundwater elevation at the location of these boreholes was $190 \pm$ m.

DISCUSSION

As requested by the Central Region Geotechnical Section, this report provides recommendations for cuts deeper than 4.5 m along Ramps 407 W - 400 N, 407 W - 400 S, 407 E - 400 S and 407 E - 400 N.

Ramp 407 W to 400 N

The deep cuts for this ramp extend from approximately 70 m west of the centreline of Weston Road, through the Hwy. 400/407 I.C. to approximately 70 m west of Ramp 400 S - 7 E, W centreline. Reference is made to BH #4, #5, #9-7, #10-6, #12-5, #101 and #102.

Ramp 407 W to 400 S

The deep cuts for this ramp are only in the vicinity of the bull nose to Ramp 407 W to 400 N. Reference is made to BH #101 and #103.

Ramp 407 E to 400 S

The deep cuts for this ramp are only in the immediate vicinity of the Hwy. 400/407 I.C. Reference is made to BH #7-5, #8-3, #9-6, #10-5 and #102.

Ramp 407 E to 400 N

There are no deep cuts along this ramp.

RECOMMENDATIONS

Slope Treatment

Deep cuts will expose numerous random pockets and some distinct zones of fine-grained granular soils that are susceptible to disturbance when the water table is lowered. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. These measures are

required to lower the groundwater table below the frost penetration depth to prevent the softening of material due to freeze-thaw cycles, and to dissipate excess pore water pressures that could contribute to surficial slope failures.

The slope geometry was analyzed utilizing Bishop's effective stress method. An analysis assuming a 2.5H:1V slope treated with a 0.6 m thick granular blanket and a 1.2 m deep toe drain (Figure 4), resulted in an acceptable factor to safety. An analysis assuming a 2H:1V slope with a 2 m wide mid-height bench, a 1.2 m deep bench drain and a 1.2 m deep toe drain, and 0.6 m thick granular blankets on both the upper and lower slopes (Figure 5), resulted in an acceptable factor of safety.

Based on those samples, cut slopes deeper than 4.5 m should be constructed in accordance with either of the alternatives illustrated in Figure 6. The granular blanket should consist of free-draining material such as Ministry of Transportation Granular 'A'. Alternatively, Granular 'B' with appropriate gradation limits would be suitable. If Granular 'B' is proposed, typical gradations of the material should be submitted to this office for assessment. The drain trenches should be lined with a suitable geotextile filter fabric, such as Class 1 non-woven geotextile with EOS of 75 to 150 μ m. The perforated pipes should be 150 mm minimum diameter and should be surrounded by a minimum of 150 mm of granular backfill. The drains should be connected to an appropriate permanent drainage system. In addition all slopes should be provided with an interceptor ditch at the top of the slope.

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

Dewatering

As the groundwater elevation is at 190 \pm m, both a temporary (during construction) dewatering scheme and a permanent drainage system will be required.

The temporary dewatering scheme should lower the prevailing groundwater table a minimum of 0.5 m below excavations and should be designed to prevent disturbance of the soil. The dewatering scheme should also take into consideration the presence of silt and sand pockets within the overburden. These materials are susceptible to disturbance under conditions of unbalanced hydrostatic head.

Consideration should be given to establishing the existing groundwater conditions in the area surrounding the site, and the effects of both temporary dewatering and permanent drainage, particularly in those areas where there is a potential for claims.

MISCELLANEOUS

The field work for this project was carried out under the supervision of M. Schnarr, Engineering Student.

The equipment used was owned and operated by Dominion Soil Investigation Inc. and Longyear Canada Inc.

The report was written by D. Dundas, Senior Foundation Engineer and renewed by M. Devata, Chief Foundation Engineer.



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A P P E N D I X

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:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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 = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	ϕ	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{I_p}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



RECORD OF BOREHOLE No 4

METRIC

W P 137-87-00-B

LOCATION Co-ords. N 4 848 777.2; E 301 102.0

ORIGINATED BY KZ

DIST 6 HWY 407

BOREHOLE TYPE Solid Stem Auger and Cone Test

COMPILED BY KZ

DATUM Geodetic

DATE 1987 10 28

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
190.5	Ground Level												
0.0			1	SS	26		190						
			2	SS	18								
			3	SS	22								
	Sandy Silt		4	SS	72								
			5	SS	53								
	Silty Clay		6	SS	105								
	Some Sand												
	Occ. Gravel (Glacial Till)		7	SS	94								
	Very Stiff to Hard		8	SS	116								
	Random Layers or Pockets of Sand		9	SS	108								
			10	SS	114								
178.0			11	SS	130								
12.5	Silty Clay Occasional Silt and Clay Layers												
176.3	Hard		12	SS	36								
14.2	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
S (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 5

METRIC

W P 137-87-00-8

LOCATION

Co-ords. N 4 848 748.5; E 301 129.5

ORIGINATED BY KZ

DIST 6

HWY 407

BOREHOLE TYPE Hollow Stem & Cone Test

COMPILED BY KZ

DATUM

Geodetic

DATE

1987 10 14, 15, 16

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH O UNCONFINED + FIELD VANE X QUICK TRIAXIAL X LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
190.2	Ground Level													
0.0			1	SS	10		190							
			2	SS	10									
			3	SS	22									
	Sandy Silt		4	SS	42									4 26 54 16
	Silty Clay		5	SS	33									1 24 66 9
	Some Sand		6	SS	28									
	Occasional Gravel (Glacial Till)		7	SS	44									
	Stiff to Hard		8	SS	48									
	Random Layers or Pockets of Sand		9	SS	37									
183.2			10	SS	27									
7.0			11	SS	28									
	Silty Clay		12	SS	23									0 4 52 44
	Occasional Silt and Clay Layers		13	SS	46									
	Very Stiff to Hard		14	SS	40									
			15	SS	26									
			16	SS	22									
			17	SS	25									
160.9														
29.3	Silt													
160.0	Traces of Sand & Clay													
30.2														

Continued

* 3, x 5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued



RECORD OF BOREHOLE No 5 Continued METRIC

W P 137-87-00-B LOCATION Co-ords. N 4 848 748.5; E 301 129.5 ORIGINATED BY KZ
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem & Cone Test COMPILED BY KZ
DATUM Geodetic DATE 1987 10 14, 15, 16 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
160.0	Continued		18	SS	7	*											GR SA SI CL
30.2	Silt, Traces of Sand and Clay Very Dense																1 14 83 2
157.9			19	SS	1.07	15 cm	158										0 3 87 10
32.3	End of Borehole																
	Note: * Low N Value caused by Boiling Condition																

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7-5

METRIC

W P 137-87-00-B LOCATION Co-ords. N 4 849 076.0; E 301 875.5 ORIGINATED BY DD
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY DD
 DATUM Geodetic DATE 87 10 20 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
192.3	Ground Surface											
0.0	Clayey Silt Some Sand Trace Gravel Firm to Very Stiff (Glacial Till)		1	SS	18		192					
189.9			2	SS	31		190					
2.4	Silt, Very Dense (Lacustrine)		3	SS	54		188					
			4	SS	24							
	Silt/Clayey Silt		5	SS	59							
	Some Sand		6	SS	63							
	Trace Gravel		7	SS	62							
	Random Silt and Sand Pockets		8	SS	57							
	Occ. Boulders		9	SS	23							
	Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		10	SS	30							
			11	SS	24							
			12	SS	25							
178.9			13	SS	37							
13.4	Silt Compact (Lacustrine)		14	SS	22							
	Silty Clay to Clay with Thin Silt Seams Hard (Lacustrine)		15	SS	62/	15 cm						
171.6			16	SS	91/	25 cm						
18.7	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8-3

METRIC

W P 137-87-00-B LOCATION Co-ords. N 4 848 995.7; E 301 793.0 ORIGINATED BY KZ
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY KZ
 DATUM Geodetic DATE 1987 11 10 - 13 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
194.6	Ground Surface															
0.0	Sand Compact (Fill)						194									
193.1	With Organics		1	SS	15		192									
1.5	Clayey Silt Some Sand Trace Gravel Stiff to Very Stiff (Glacial Till)		2	SS	13		190									
189.4			3	SS	22		188									5 27 48 20
5.2	Silt to Sandy Silt Very Dense (Lacustrine)		4	SS	86		186									0 21 70 9
			5	SS	85		184									0 13 68 19
			6	SS	230	15 cm	182									2 46 (52)
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Very Dense/Hard (Glacial Till)		7	SS	80	15 cm	180									1 5 67 27
			8	SS	142	20 cm	178									2 17 59 22
			9	SS	101	25 cm	176									
			10	SS	63		174									
			11	SS	62		172									
			12	SS	88	20 cm	170									2 7 57 34
177.4			13	SS	109	28 cm	168									
17.2			14	SS	38		166									
			15	SS	88											
			16	SS	84											
	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		17	SS	55											
			18	SS	46											
			19	SS	50											
			20	SS	34											
164.4																
30.2																

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 8-3 Continued METRIC

W P 137-87-00-8 LOCATION Co-ords. N 4 848 995.7; E 301 793.0 ORIGINATED BY KZ
 DIST 6 HWY. 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY KZ
 DATUM Geodetic DATE 87 11 10-13 CHECKED BY MS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
164.4 30.2	Continued												
	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		21	SS	23								
			22	SS	32								
156.5 38.1	Sandy Silt to Silty Sand Very Dense (Lacustrine)		23	SS	95	15 cm							
153.0 41.6	End of Borehole		24	SS	110								

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
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Communications
Ontario

RECORD OF BOREHOLE No 9-6

METRIC

W P 137-87-00-B LOCATION Co-ords. N 4 848 955.0; E 301 763.1 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 10 26 - 27 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
194.6	Ground Surface															
0.0																
191.2	Sand Compact (Fill)		1	SS	22		194									
3.4			2	SS	31		192									
189.9	Clayey Silt *		3	SS	24		190									
4.7			4	SS	19		188									1 20 70 9
	Silt to Sandy Silt Compact (Lacustrine)		5	SS	90		186									
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		6	SS	100	30 cm	184									1 22 60 17
			7	SS	100	25 cm	182									1 5 30 44
			8	SS	100	25 cm	180									0 6 53 41
181.2			9	SS	116	25 cm	178									1 4 49 46
13.4			10	SS	84		176									0 4 49 47
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		11	SS	112	23 cm	174									0 6 50 44
			12	SS	125	25 cm	172									2 60 20 18
			13	SS	121	23 cm										1 4 49 46
			14	SS	110	23 cm										
			15	SS	100	28 cm										
	Sand		16	SS	101	23 cm										
			17	SS	100	15 cm										
			18	SS	120	13 cm										
171.5			19	SS	141	23 cm										
23.1	End of Borehole															
	* Some Sand Trace Gravel Very Stiff (Glacial Till)															

* 3, x 5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications

RECORD OF BOREHOLE No 9-7

METRIC

W P 137-87-00-B

LOCATION

Co-ords. N 4 848 952.5; E 301 751.0

ORIGINATED BY MS

DIST 6 HWY 400/407

BOREHOLE TYPE

Cone Test, H-S Auger

COMPILED BY MS

DATUM Geodetic

DATE

87 10 30 & 87 11 20

CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
191.9	Ground Surface															
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	18		190									
189.9			2	SS	15		188									
2.0	Silt Compact (Lacustrine)		3	SS	100		186									1 19 69 11
			4	SS	92		184									1 21 65 13
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Stiff to Hard (Glacial Till)		5	SS	52		182									0 6 54 40
			6	SS	97		180									1 4 51 44
180.0			7	SS	69		178									
11.9			8	SS	60		176									
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		9	SS	84		174									0 0 29 71
			10	SS	100											
			11	SS	82											8 20 38 34
173.2			12	SS	100											
18.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10-5

METRIC

W P 137-87-00-B LOCATION Co-ords. N 4 849 023.5; E 301 800.5 ORIGINATED BY MS
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 87 11 16-17 CHECKED BY MS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100						
192.6	Ground Surface												GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	26								
189.9			2	SS	23								3 29 57 11
2.7	Silt Compact (Lacustrine)		3	SS	30								0 8 82 10
			4	SS	20								10 15 65 10
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense Very Stiff to Hard (Glacial Till)		5	SS	89								5 39 49 7
			6	SS	59								
			7	SS	46								
			8	SS	43								0 3 36 61
178.9			9	SS	40								0 3 81 16
13.7	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		10	SS	128	22 cm							1 13 55 31
			11	SS	107	25 cm							
174.3			12	SS	120	27 cm							
18.3	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10-6

METRIC

W P 137-87-00-8 LOCATION Co-ords. N 4 849 084.0; E 301 789.5
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone
 DATUM Geodetic DATE 87 10 19
 ORIGINATED BY MS
 COMPILED BY MS
 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
192.8	Ground Surface												
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	29		192						
190.4			2	SS	47		190						3 37 43 17
2.4	Sandy Silt to Silty Sand		3	SS	13		188						9 64 23 4
			4	SS	80								1 16 62 21
			5	SS	120	23 cm							
			6	SS	120	23 cm	186						2 29 57 12
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense Stiff to Hard (Glacial Till)		7	SS	120	23 cm							
			8	SS	120	23 cm	184						
			9	SS	120	23 cm							4 20 51 25
			10	SS	120	25 cm							1 20 56 23
			11	SS	120	20 cm	182						
			12	SS	120	25 cm	180						
179.1			13	SS	27		178						2 4 43 51
13.7	Sandy Silt		14	SS	81								0 24 72 4
	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		15	SS	120	25 cm	176						
174.2			16	SS	120	27 cm							
18.6	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 12-5

METRIC

W P 137-87-00-8 LOCATION Co-ords. N 4 849 016.0; E 301 771.8
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone
DATUM Geodetic DATE 87 11 02 - 04
ORIGINATED BY MS
COMPILED BY MS
CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
194.6	Ground Surface													
0.0	Asphalt													
193.1	Sand Compact (Fill)													
1.5	With Organics, Clayey Silt Some Sand Trace Gravel Stiff to Very Stiff (Glacial Till)		1	SS	10									
			2	SS	18									
189.7			3	SS	16									
4.9	Silt Dense (Lacustrine)		4	SS	33									0 12 75 13
	Silt/ Clayey Silt		5	SS	81									1 8 78 13
	Some Sand		6	SS	71									
	Trace Gravel		7	SS	120	15 cm								
	Random Silt and Sand Pockets		8	SS	100	23 cm								2 15 56 27
	Occ. Boulders		9	SS	100	13 cm								1 7 68 24
	Dense to Very Dense/ Hard (Glacial Till)		10	SS	100	23 cm								
180.3			11	SS	86									2 10 47 41
14.3			12	SS	100	23 cm								
			13	SS	115	23 cm								
	Silty Sand		14	SS	120	23 cm								0 59 39 2
			15	SS	120	20 cm								
	Very Dense		16	SS	100	8 cm								
			17	SS	100	13 cm								
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		18	SS	70	15 cm								1 6 66 27
			19	SS	100	28 cm								
169.9			20	SS	100	28 cm								
24.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 101

METRIC

W P 137-87-00-B LOCATION Sta 10 + 558.0, 10.2 Rt. (Ramp 407 W - 400 S) ORIGINATED BY MS
 DIST 6 HWY 407 BOREHOLE TYPE H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 88 07 25 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
192.8	Ground Surface															GR 5A SI CL
0.0	Silty Clay to Clayey Silt Some Sand, Trace Gravel, Occasional Boulders, Random Silt and Sand Zones Very Stiff to Hard (Glacial Till) Sandy Silt Compact		1	SS	100/	20 cm										0 16 39 45
			2	SS	33											0 4 29 67
			3	SS	30											2 27 66 5
			4	SS	30											
			5	SS	80											
			6	SS	20											
			7	SS	35											
			8	SS	60 /	15 cm										
			9	SS	60 /	15 cm										1 20 50 29
183.7																
9.1	Silty Clay to Clay with Thin Silt Seams Hard (Lacustrine)		10	SS	100											
			11	SS	100/	23 cm										
181.1			12	SS	60 /	8 cm										
11.7	End of Borehole * Groundwater Elevation Not Determined															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 102

METRIC

W P 137-87-00-B LOCATION Sta. 10 + 400.0, 55.0=Lt. (Ramp 407 E - 400 S) ORIGINATED BY MS
 DIST 6 HWY 407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 88 07 19, 22 CHECKED BY DD

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
193.3	Ground Surface												
0.0	Clayey Silt Some Sand Some Gravel Very Stiff		1	SS	26								16 29 35 20
	(Glacial Till)		2	SS	28								
190.3			3	SS	16								
3.0	Silt to Sand Very Dense		4	SS	64								2 39 53 6
	(Lacustrine)		5	SS	66								
			6	SS	80								
			7	SS	88								
			8	SS	100								1 20 62 17
	Silt / Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occasional Boulders Compact to Very Dense Very Stiff to Hard		9	SS	100/25 cm								
			10	SS	60/15 cm								
	(Glacial Till)		13	SS	100/28 cm								2 23 54 21
			14	SS	70								
177.6			15	SS	100								
15.7	End of Borehole												

RECORD OF BOREHOLE No 103

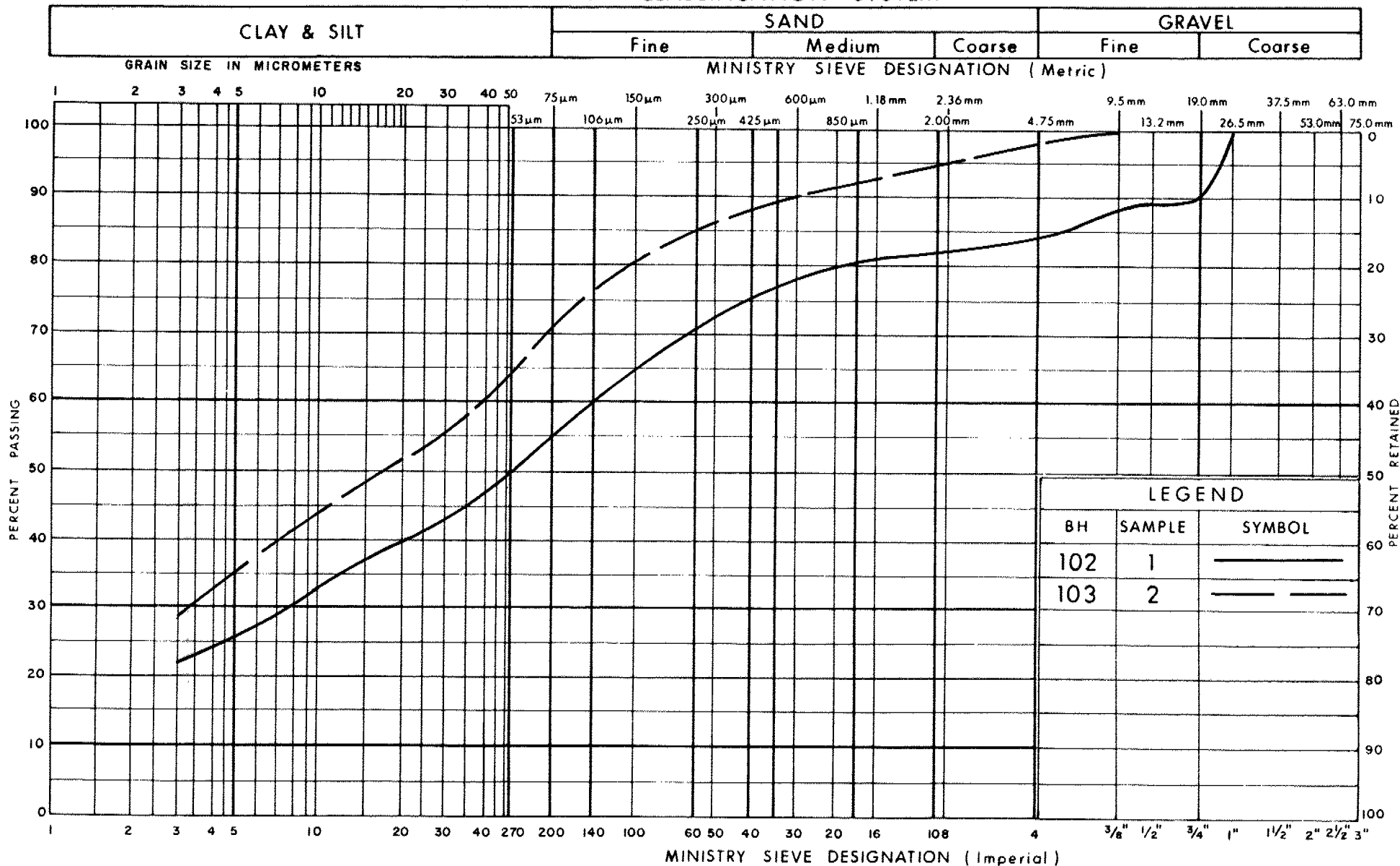
METRIC

W P 137-87-00-B LOCATION Sta. 10 + 325.0, 10.0m Rt. (Ramp 407 W - 400 S) ORIGINATED BY MS
 DIST 6 HWY 407 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY MS
 DATUM Geodetic DATE 88 07 18 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
193.8	Ground Surface															GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff to Hard		1	SS	22											3 27 48 22
			2	SS	19											
			3	SS	44											
190.4	(Glacial Till)		4	SS	33											
3.4			5	SS	100											1 6 82 11
	Silt to Sand Very Dense		6	SS	60 / 15 cm											
	Silt / Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occasional Boulders Very Dense / Hard		7	SS	80 / 8 cm											
			8	SS	60 / 15 cm											
			9	SS	80 / 15 cm											1 70 24 5
	Sand Very Dense		10	SS	75 / 15 cm											
181.6	(Lacustrine)															
12.2	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



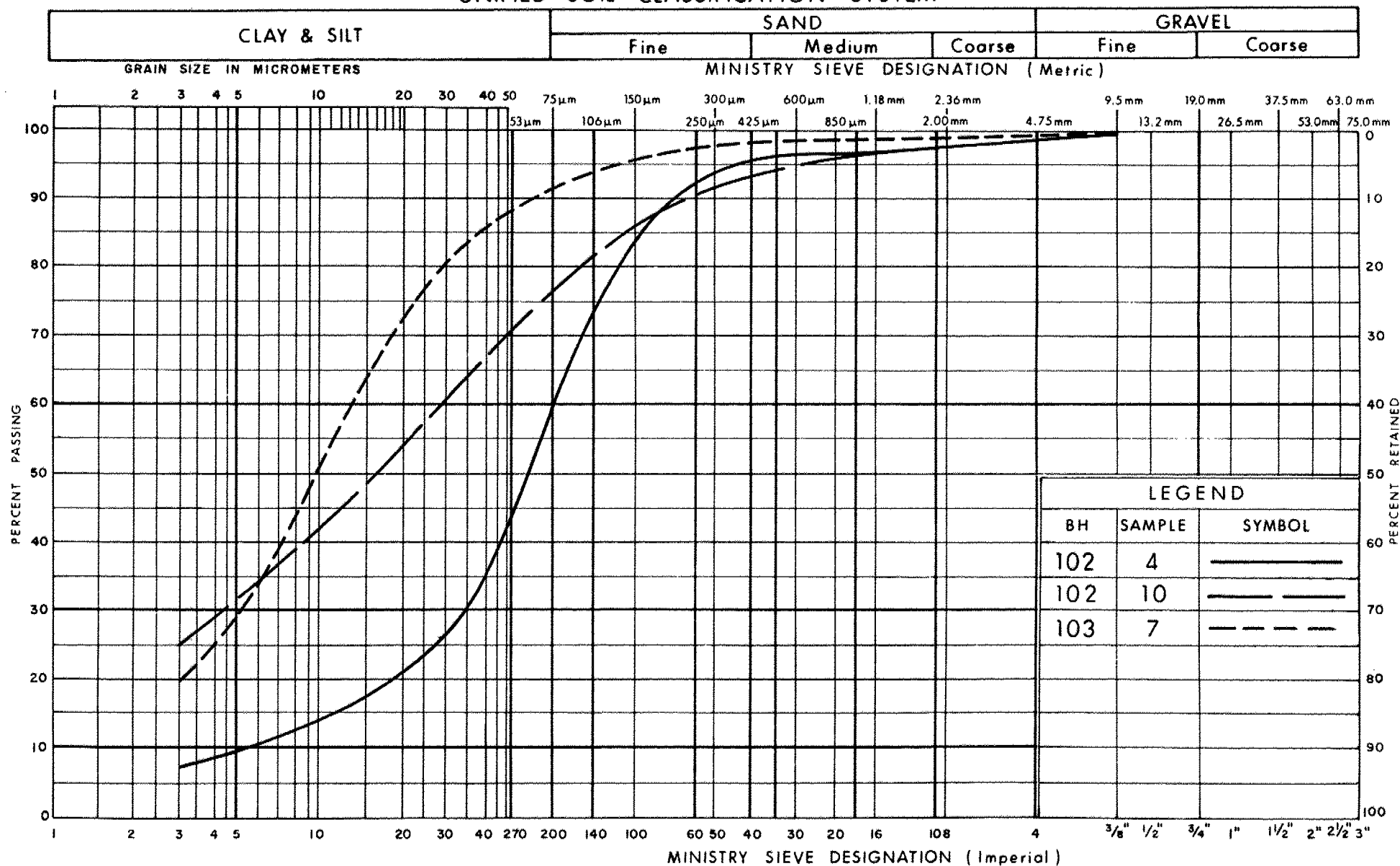
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
(Glacial Till)

FIG No 1

W P 137-87-00-B

UNIFIED SOIL CLASSIFICATION SYSTEM



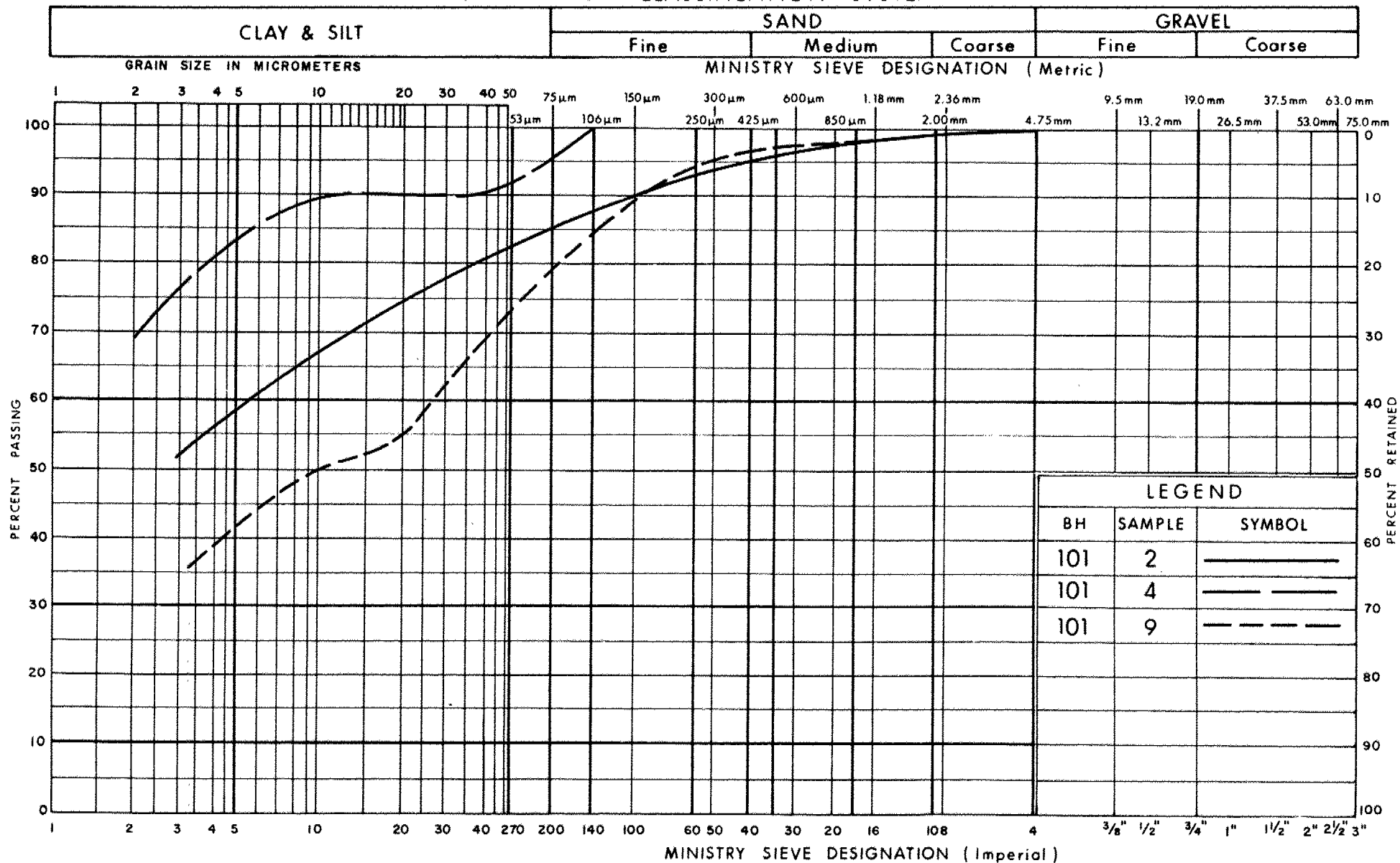
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT / CLAYEY SILT
(Glacial Till)

FIG No 2

W P 137 - 87 - 00 - B

UNIFIED SOIL CLASSIFICATION SYSTEM

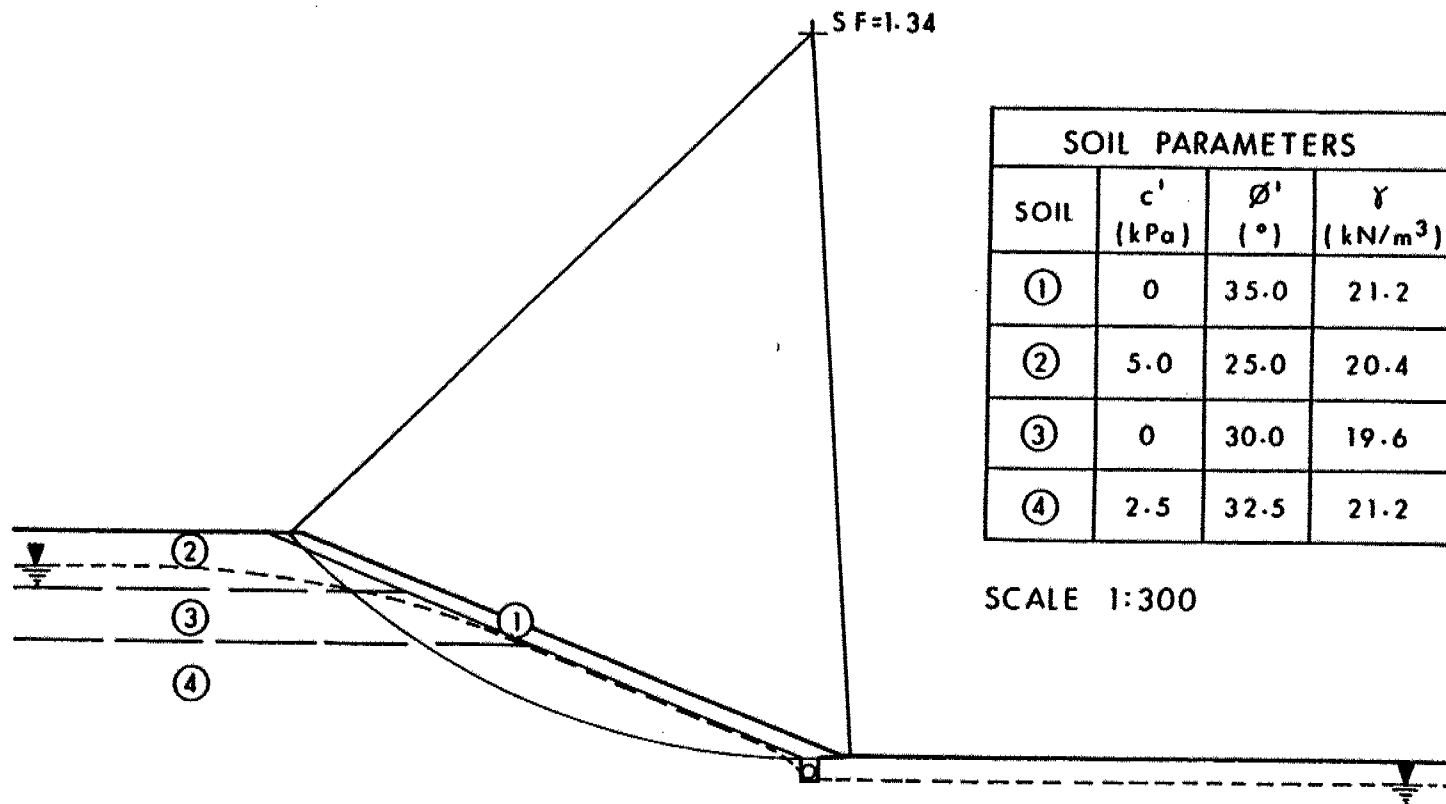


Ministry of
Transportation

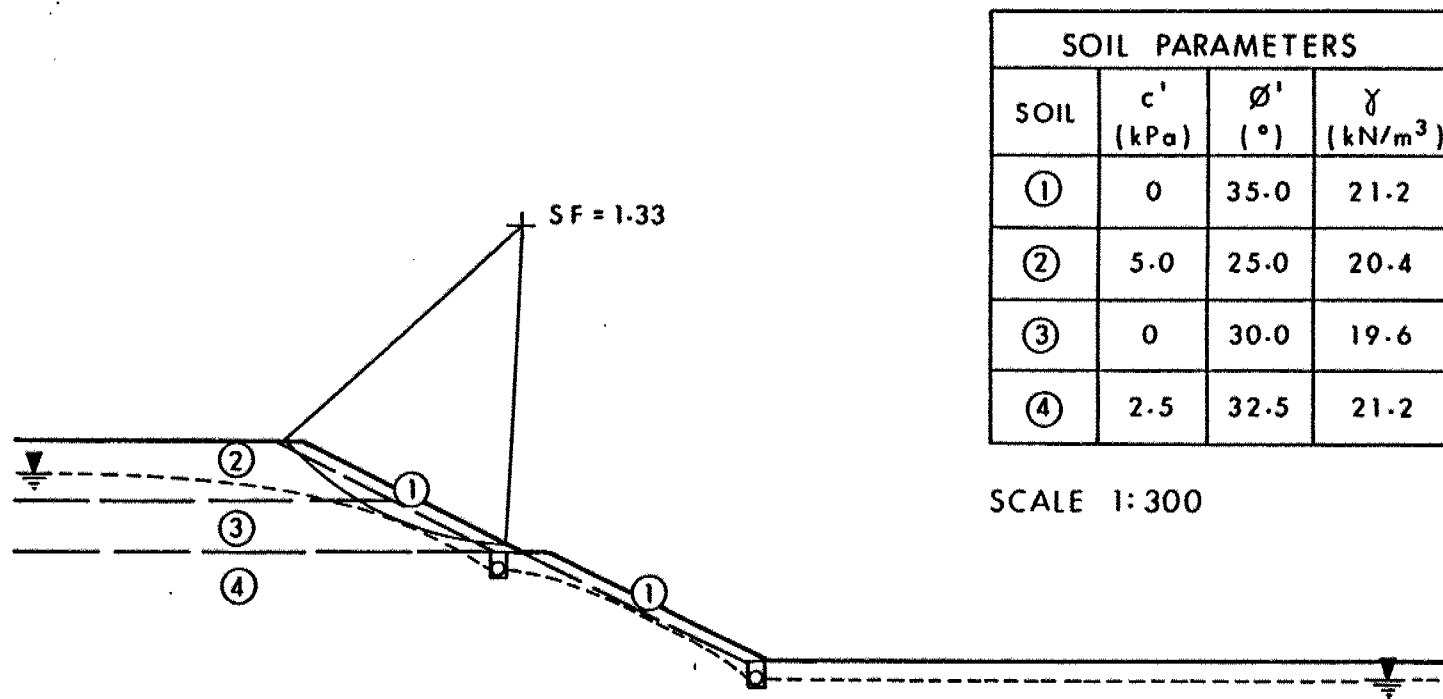
GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

FIG No 3

W P 137-87-00-B



EFFECTIVE STRESS ANALYSIS (2.5H:1V SLOPE)
WITH 0.6m THICK GRANULAR BLANKET AND TOE DRAIN

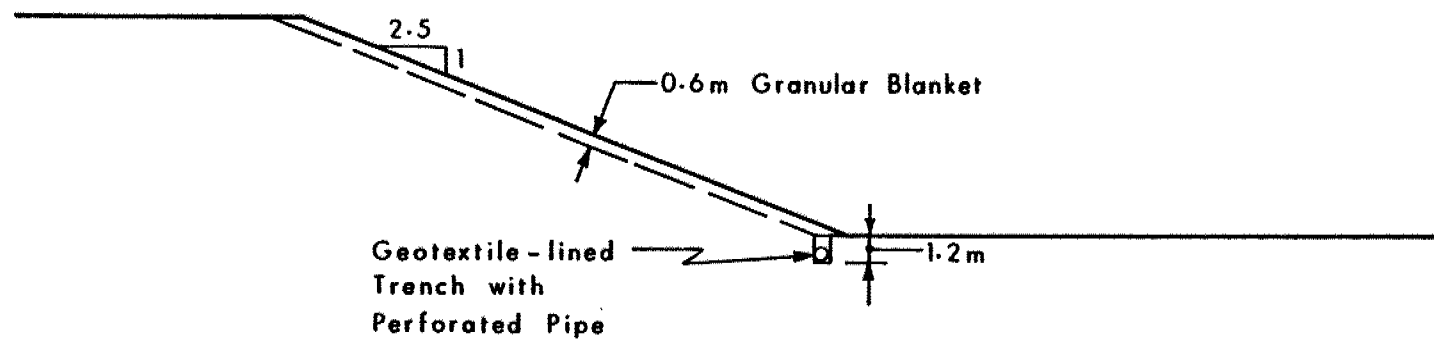


EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)
WITH 0.6m THICK GRANULAR BLANKET AND BENCH AND TOE DRAINS

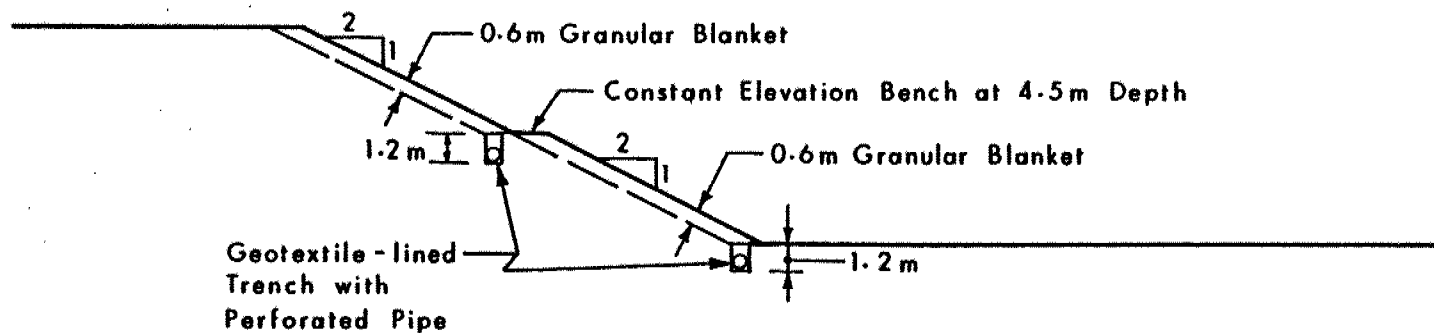
Fig 5

WP 137-87-00B

Alternative No 1



Alternative No 2

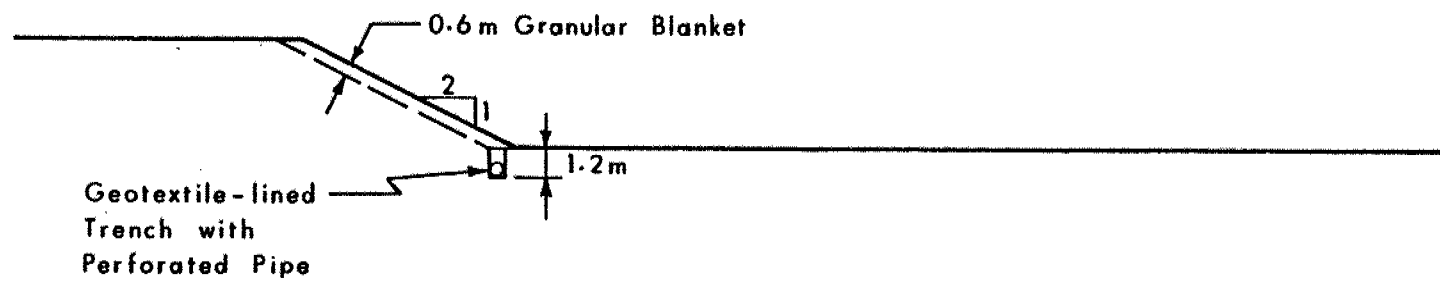


SCALE 1:300

RECOMMENDED CUT SLOPE TREATMENT FOR CUTS OVER 4.5m DEEP

Fig 6

WP 137-87-00B

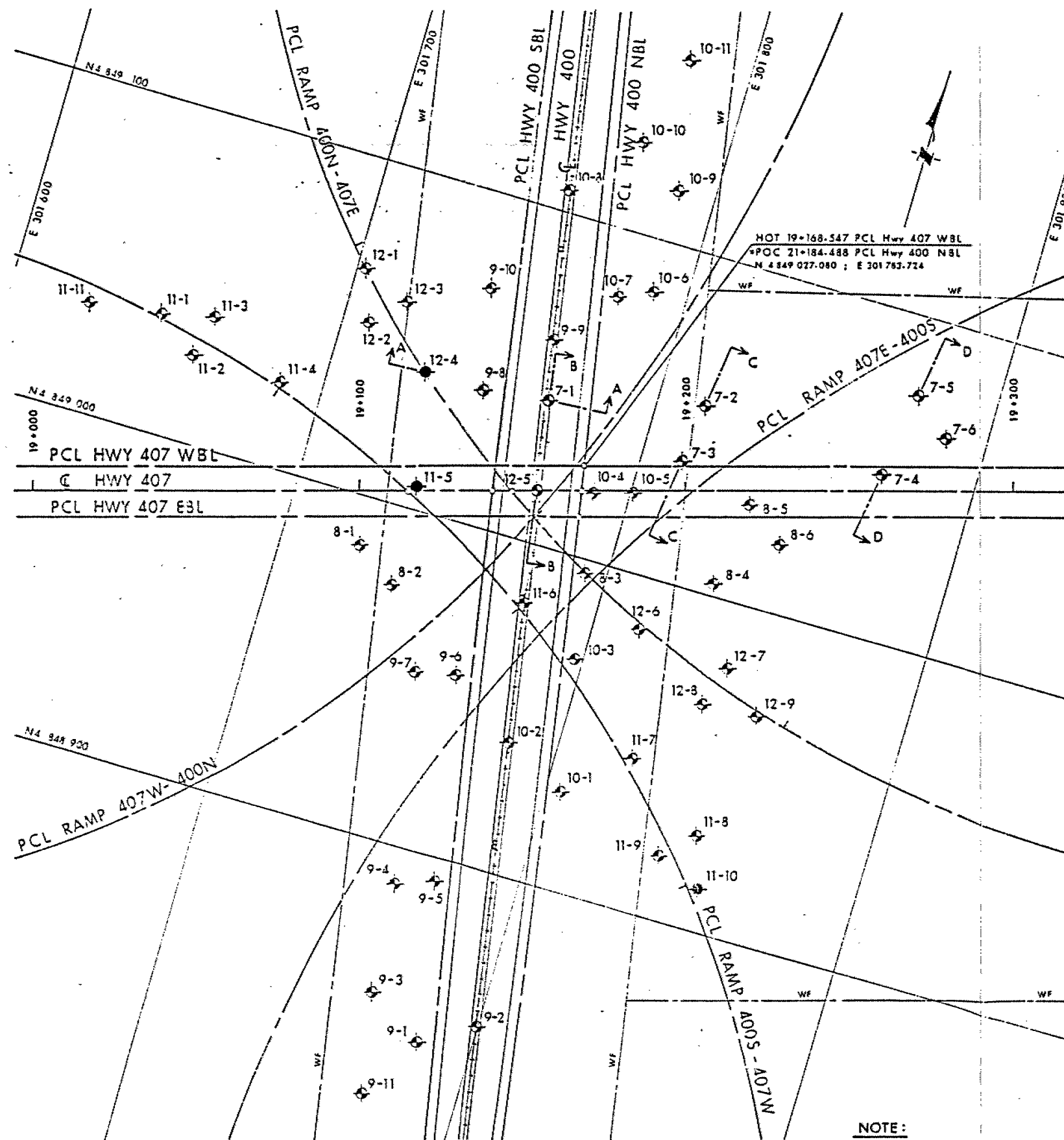


SCALE 1:300

RECOMMENDED CUT SLOPE TREATMENT FOR CUTS UNDER 4.5m DEEP

Fig 7

WP 137-87-00B



PLAN
SCALE
20m 10 0 10 20m

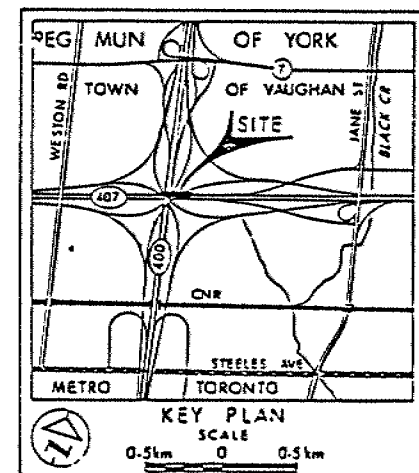
NOTE:
Refer only to bore holes
indicated with *

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

CONT No
WP No 137-87-00-B

HWY 400/407
INTERCHANGE RAMP
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

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

No	ELEVATION	CO-ORDINATES NORTH	EAST
7-1	194.6	4 849 043.3	301 767.3
7-2	192.6	4 849 035.0	301 814.5
7-3	192.6	4 849 037.0	301 812.0
7-4	192.3	4 849 050.0	301 871.5
7-5	192.3	4 849 076.0	301 875.5
7-6	192.3	4 849 066.0	301 887.5
8-1	192.8	4 848 985.0	301 724.0
8-2	192.2	4 848 976.0	301 737.0
8-3	194.6	4 848 995.7	301 793.0
8-4	192.6	4 849 004.0	301 832.0
8-5	192.5	4 849 030.0	301 836.0
8-6	192.4	4 849 021.0	301 848.0
9-1	194.3	4 848 844.3	301 782.9
9-2	194.3	4 848 853.7	301 799.0
9-3	191.6	4 848 855.5	301 765.5
9-4	191.8	4 848 889.0	301 763.0
9-5	194.4	4 848 893.0	301 774.5
9-6	194.6	4 848 955.0	301 763.1
9-7	191.9	4 848 952.5	301 751.0
9-8	194.6	4 849 040.7	301 747.0
9-9	194.6	4 849 061.7	301 764.0
9-10	194.6	4 849 071.3	301 740.9
9-11	191.5	4 848 825.0	301 771.0
10-1	194.0	4 848 929.9	301 804.4
10-2	194.5	4 848 939.9	301 784.6
10-3	194.6	4 848 969.8	301 797.3
10-4	194.6	4 849 020.0	301 788.6
10-5	192.6	4 849 023.5	301 800.5
10-6	192.8	4 849 084.0	301 789.5
10-7	194.5	4 849 079.7	301 779.2
10-8	194.4	4 849 106.9	301 755.8
10-9	192.1	4 849 116.0	301 788.0
10-10	194.3	4 849 127.0	301 773.5
10-11	191.8	4 849 155.0	301 780.5
11-1	192.8	4 849 036.0	301 646.0
11-2	191.8	4 849 026.5	301 659.0
11-3	193.4	4 849 039.5	301 662.0
11-4	193.1	4 849 026.0	301 686.5
11-5	192.0	4 849 007.0	301 735.5
11-6	194.6	4 848 982.0	301 777.5
11-7	192.1	4 848 945.5	301 823.0
11-8	192.4	4 848 928.5	301 848.5
11-9	192.2	4 848 919.5	301 839.0
11-10	192.0	4 848 913.0	301 853.0
11-11	192.9	4 849 033.0	301 623.5
12-1	193.3	4 849 066.5	301 702.5
12-2	193.4	4 849 051.0	301 708.0
12-3	193.5	4 849 060.0	301 717.5
12-4	192.2	4 849 041.0	301 728.5
12-5	194.6	4 849 016.0	301 771.8
12-6	192.4	4 848 984.0	301 814.0
12-7	192.4	4 848 980.0	301 843.5
12-8	192.7	4 848 967.5	301 839.0
12-9	192.3	4 848 968.5	301 856.0

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

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.

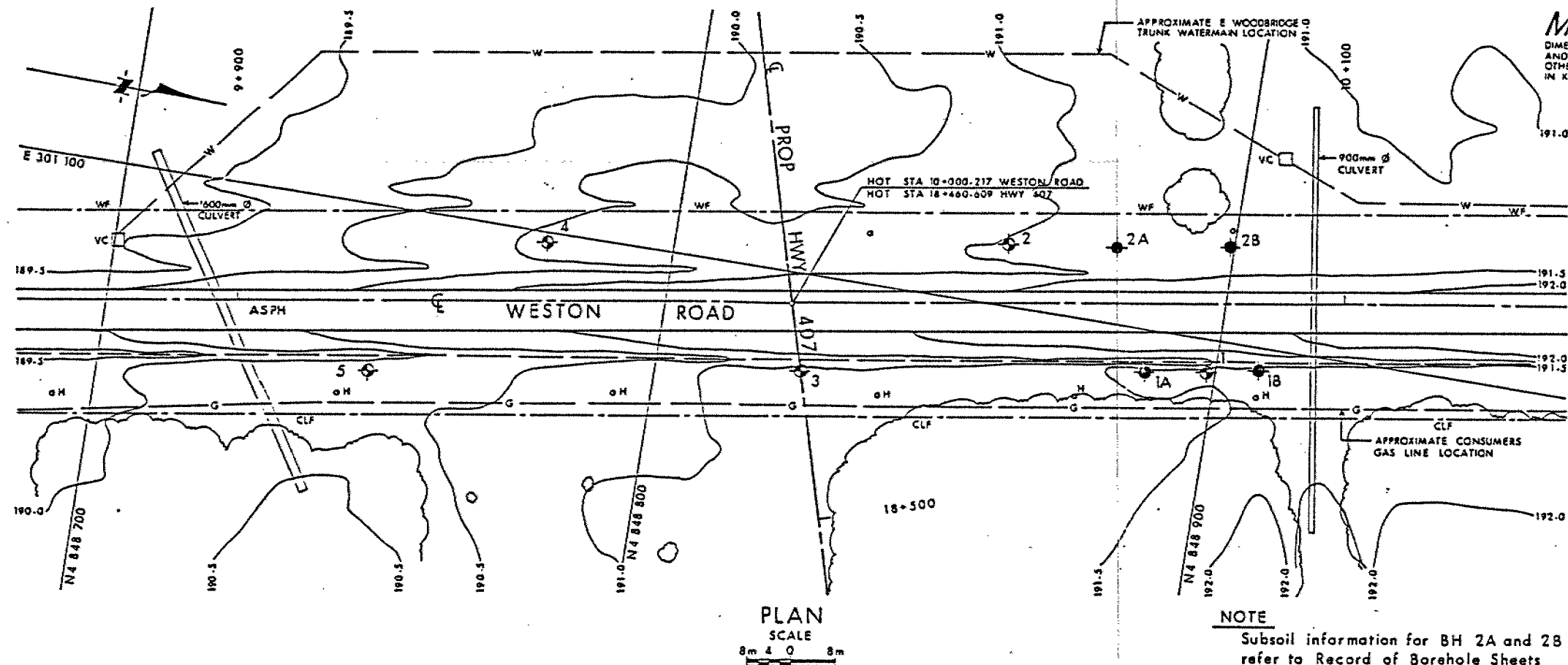
DATE	BY	DESCRIPTION
1988 02 22	137-1171	13787008-A

Geacres No 30M13-69

HWY No 400 & 407 DIST 6

SUBMITTAL CHECKED DATE 1988 02 22 SITE 37-1171

DRAWN BY CHECKED DATE 1988 02 22



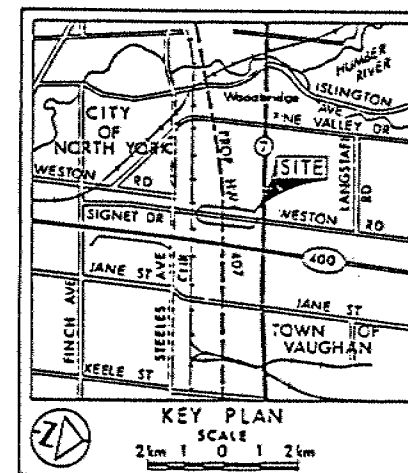
METRIC.
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES = METRES.

CONT No
WP No 137-87-00-B





HWY 400 / 407
INTERCHANGE RAMPS
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 l/blow) |
| CONE | Blows/0.3m (60° Cone, 475 l/blow) |
|  | WL at time of investigation 87 10 |

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	191.5	4 848 898.5	301 106.0
2	191.0	4 848 859.5	301 089.0
3	191.0	4 848 826.3	301 117.5
* 4	190.5	4 848 777.2	301 102.0
* 5	190.2	4 848 748.5	301 129.5
1A	191.5	4 848 887.5	301 108.0
1B	191.5	4 848 908.0	301 104.0
2A	191.5	4 848 879.0	301 086.5
2B	191.5	4 848 899.0	301 083.0

NOTE

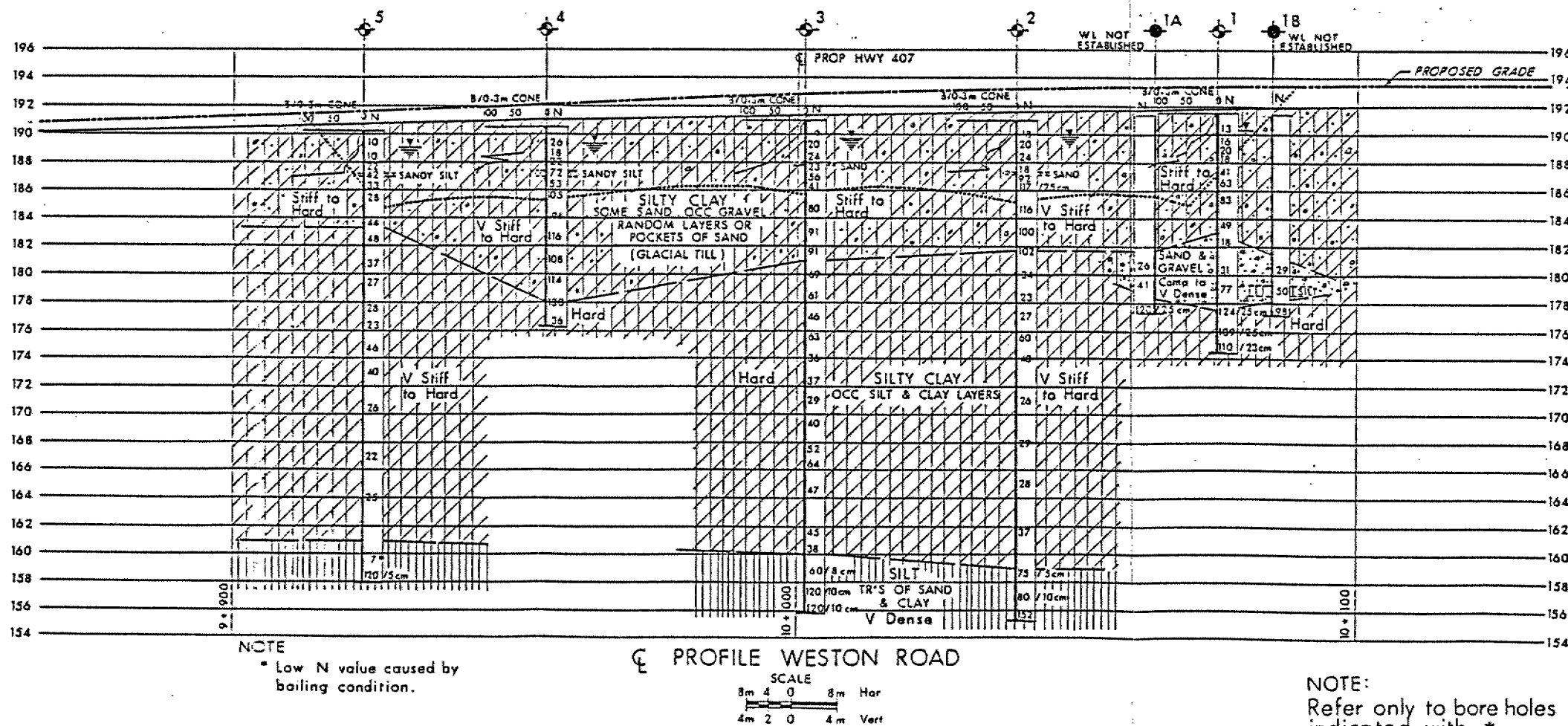
The boundaries between soil strata have been established only at Bare Hole locations. Between Bare Holes the boundaries are assumed from geological evidence.

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
Geocore No 10M13-68			
HWY No 407			LOIST 0
SUSMD DD	CHECKED	DATE 38 01 2	SITE 37-1170
DRAWN OF	CHECKED	TO APPROVED	LOWG 13787008-8

NOTE:
Refer only to bore holes
indicated with *

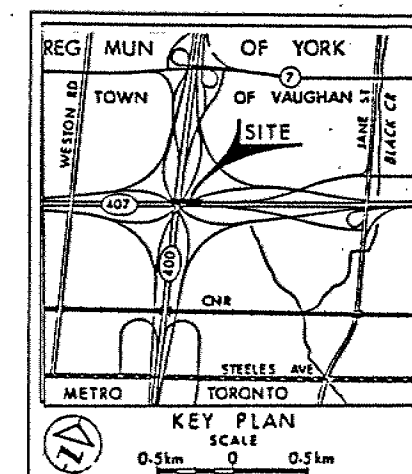
REF No E-6081-1, 87 10







CONT No
WP No 137-87-00-B

HWY 400/407
INTERCHANGE RAMPS
BORE HOLE LOCATIONS & SOIL STRAT.

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 |

No	ELEVATION	STATION	OFFSET
101	192.8	10+558.0	10.2m R RAMP 402 400 S
102	193.3	10+400.0	55.0m L RAMP 402 400 S
103	193.8	10+325.0	10.0m R RAMP 402 400 S

==NOTE==

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	

Geocross No

MWY No	400 & 407	DIST	0
SUBMD	DD	CHECKED	DATE 88 03 07
DRAWN	DT	CHECKED	DATE 88 03 07
		APPROVED	
			1DWG1378700B-C

