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DIST. 6 REGION

W.P. No. 142-87-02 (B)

CONT. No. 92-66

W. O. No.

STR. SITE No. 37-1178

HWY. No. 400/407

LOCATION Ramp 400S to 7EW
Over Ramp 407 E,W to 400N

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 92-66



Ministry of
Transportation

INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 27	Foundation Investigation Report for Hwy. 400 & 407 Interchange (Structure No. 14) W.P. 142-87-02, Site 37-1178 Hwy. 400 & 407, District 6 Toronto

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

EXPLANATION OF TERMS USED IN REPORT

2

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

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
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						

GEOTECHNICAL INVESTIGATION
HIGHWAY 400 AND 407 INTERCHANGE
DISTRICT 6 (TORONTO) CENTRAL REGION
FOR
MINISTRY OF TRANSPORTATION ONTARIO
W.P. 142-87-02
SITE 37-1178 (STRUCTURE 14)

1. INTRODUCTION

Peto MacCallum Ltd. was authorized by The Ministry of Transportation Ontario, Agreement Number 4238-9087-185 dated November 30, 1987, to carry out a geotechnical investigation at the site of structure 14 at the proposed Highway 400 and 407 interchange in the Town of Vaughan, Ontario.

The purpose of the investigation was to determine the subsurface soil and ground water conditions at the site.

2. FIELD WORK

The field work for the investigation was carried out during the period January 25 to February 8, 1988, and comprised eight (8) boreholes, put down to depths of 24.8 m below existing grade.

The boreholes were advanced using a CME 55 track mounted drillrig equipped with continuous flight hollow stem augers supplied and operated by a specialist drilling contractor.

Representative samples of the overburden were secured at regular intervals throughout the depth explored. Standard penetration resistance tests were carried out during sampling operations using conventional split spoon equipment.

The ground water conditions in the open boreholes were monitored during and on completion of drilling. Piezometers were installed in each borehole and monitored to determine the stabilized ground water conditions.

The field work was supervised throughout by a member of our engineering staff who directed the drilling and sampling operations, documented the soil stratigraphy encountered, monitored ground water conditions and processed the recovered samples.

The location and ground surface elevation of the boreholes at the time of drilling were established in the field by a survey crew from The Ministry of Transportation Ontario. It is understood all elevations were referenced to geodetic datum.

3. LABORATORY TESTING PROGRAM

All recovered samples were brought to our laboratory for detailed visual examination and testing to confirm field classification. The following tests were carried out:

- i) Natural moisture content determinations on all recovered samples, with results shown on the appended Record of Borehole sheets;
- ii) Thirteen (13) grain size analyses with results illustrated on Figures 1 to 4 and the appended Record of Borehole sheets;
- iii) Nine (9) Atterberg Limits with results presented on Table I, Figures 5 to 7 and the appended Record of Borehole sheets;
- iv) Four (4) "Quick" triaxial compression tests on relatively undisturbed split spoon samples with results summarized on Table II and shown on the appended Record of Borehole sheets.

4. SITE DESCRIPTION

Based on available geological mapping, the surficial material at the site comprises Lacustrine - Wildfield Till complex. Overburden deposits are about 50 to 55 m thick. Bedrock comprises shale, siltstone and limestone belonging to the Georgian Bay Formation.

The natural ground surface at the site is relatively flat, ranging from elevation 190.89 to 193.99 at the borehole locations and generally dropping from north to south. Major construction activities were underway in the immediate vicinity of the site at the time of the field work. A large fill stockpile was located at the north end.

5. SUMMARIZED SUBSURFACE CONDITIONS

5.1 General

Reference is made to the appended Record of Borehole sheets for details of the field work, including soil classifications, inferred stratigraphy, standard penetration 'N' values, the results of laboratory undrained shear strength testing, moisture content determinations and Atterberg Limit test results, together with ground water observations in the open boreholes and installed piezometers.

The summarized subsurface conditions are presented on profiles.

The stratigraphy at the site generally comprises surficial topsoil over glacial till units underlain by a major deposit of silty clay.

5.2 Overburden

5.2.1 Topsoil

Surficial topsoil, described as dark brown or black clayey silt with relatively low organic content, was found in each borehole to depths of 300 to 460 mm.

5.2.2 Sandy Clayey Silt (Glacial Till)

A glacial till unit was encountered beneath the topsoil at each borehole, and extended to depths of 2.1 to 3.7 m below ground surface, about elevation 187.5 to 190.6. This stratum typically comprised a heterogeneous mixture of clay, silt and sand with trace gravel. Grain size distribution curves for four (4) representative samples of the material are shown on Figure 1.

Atterberg limit tests were carried out on four (4) representative samples of the stratum. Test results are summarized on Table I and illustrated on Figure 5. Liquid limits ranged from 20 to 37%, plastic limits from 12 to 20% and plasticity indices from 6 to 17%. The material may be classified as a clayey silt ranging locally to a silty clay or borderline clayey silt to silt. Moisture contents varied between 12 and 25%, ranging from drier than to wetter than the plastic limit.

The results of four (4) "Quick" triaxial compression tests on relatively undisturbed split spoon samples of this material are shown on Table II and on Records of Borehole 1, 3, 4 and 7, and indicated shear strengths of 92 to 209 kPa. Based on these results, and standard penetration resistance 'N' values, the consistency of the stratum ranges from firm to very stiff. Wet unit weights of the triaxial test specimens ranged from 21.41 to 22.18 kN/m³.

5.2.3 Clayey Silt (Glacial Till)

Clayey silt glacial till was encountered in all the boreholes beneath the clay, silt and sand glacial till, and extended to depths of 8.6 to 10.5 m elevation 180.4 to 185.4. The material typically comprised brown to grey clayey silt with sand and trace gravel. Scattered boulders and layers of sand or silt were contacted within the deposit. Grain size distribution curves for four (4) representative samples of the material are presented in Figure 2.

One (1) Atterberg limit test was carried out on a sample of the stratum. Test results are presented on Table I and Figure 6 and are typical of a borderline clayey silt to silt material. Natural moisture contents ranged from 7 to 19%.

Based on standard penetration resistance 'N' values, the consistency ranged from stiff to hard.

5.2.4 Sandy Gravel

At borehole 5, a layer of sandy gravel was encountered beneath the clayey silt glacial till to 10.2 m depth. The material comprised grey sandy gravel with silt. A grain size distribution curve for a representative sample of the material is presented in Figure 3.

5.2.5 Sandy Silt (Glacial Till)

Sandy silt glacial till was encountered beneath the clayey silt glacial till or sandy gravel, at boreholes 1 and 3 to 8, and extended to depths of 10.0 to 13.4 m, elevation 179.2 to 184.0. The material comprised grey sandy silt with gravel. The relative density was compact to very dense, with standard penetration resistance 'N' values typically

exceeding 100 blows per 0.3 m. Moisture contents typically ranged between 8 and 11%.

5.2.6 Silty Clay

All boreholes encountered a major glacio-lacustrine deposit at depths of 10.0 to 13.4 m (elevation 179.2 to 184.0) and terminated within the unit at 24.8 m depth. The material comprised grey silty clay with trace sand, and was stratified with layers of clayey silt and silt. Grain size distribution curves for four (4) representative samples of the material are presented in Figure 4.

Atterberg limit tests were carried out on four (4) samples of the stratum. Test results are summarized on Table I and illustrated on Figure 7. Liquid limits ranged from 20 to 38%, plastic limits from 13 to 24%, and plasticity indices from 7 to 20%. The material may be classified as a silty clay with layers of clayey silt or silt. Moisture contents ranged from 15 to 31% and were typically wetter than the plastic limit.

The consistency of the deposit was very stiff to hard, based on standard penetration resistance 'N' values.

5.3 Ground Water

The ground water conditions observed in the boreholes during and on completion of drilling, and the piezometer readings afterward, are shown on the individual Record of Borehole sheets. On completion of drilling, the water level inside the hollow stem augers was at depths of 1.2 to 4.0 m, elevation 188.3 to 189.7 at boreholes 1 to 4, and at depths of 3.1 to 22.9 m, elevation 169.6 to 190.9 at boreholes 5 to 8. These levels likely reflect varying quantities of seepage occurring as surface water infiltration at shallow depth and from sandy layers in the glacial till units.

Subsequent readings in the piezometers at boreholes 1 to 5, 7 and 8, indicated water levels at depths of 10.2 to 12.5 m, elevation 180.6 to 181.5. These represent the stabilized piezometric levels at the site.

Note: The preceding report is a copy of the factual information from the Foundation Report prepared by PETO MacCALLUM LTD (consulting geotechnical engineers for this project), under the technical supervision of the M.T.O. Foundation Design Section.



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Chief Foundation Engineer

I N D E X

Job No. 87 F 600
MAY, 1988

TABLE I
ATTERBERG LIMIT TEST RESULTS

STRUCTURES 14 AND 22
HIGHWAY 400 AND 407 INTERCHANGE

<u>BOREHOLE No.</u>	<u>SAMPLE No.</u>	<u>DEPTH (m)</u>	<u>NATURAL WATER CONTENT (W) %</u>	<u>LIQUID LIMIT (^WL) %</u>	<u>PLASTIC LIMIT (^WP) %</u>	<u>PLASTICITY INDEX (^IP)</u>	<u>REMARKS</u>
<u>Sandy Clayey Silt (Glacial Till)</u>							
1	2	1.52- 1.98	17.8	24	12	12	Clayey silt
2	2	1.52- 1.98	13.7	37	20	17	Silty clay
4	2	1.52- 1.98	19.3	20	14	6	Clayey silt to silt
7	2	1.52- 1.98	11.8	23	16	7	Clayey silt
<u>Clayey Silt (Glacial Till)</u>							
2	8	7.62- 8.08	12.3	22	17	5	Clayey silt to silt
<u>Silty Clay</u>							
2	11	12.19-12.65	24.6	38	18	20	Silty clay
2	14	16.76-17.22	23.4	20	13	7	Clayey silt to silt
2	19	24.38-24.84	25.9	28	16	12	Clayey silt
6	12	13.71-14.17	31.1	36	24	12	Silty clay

TABLE II
"QUICK" TRIAXIAL COMPRESSION TEST RESULTS

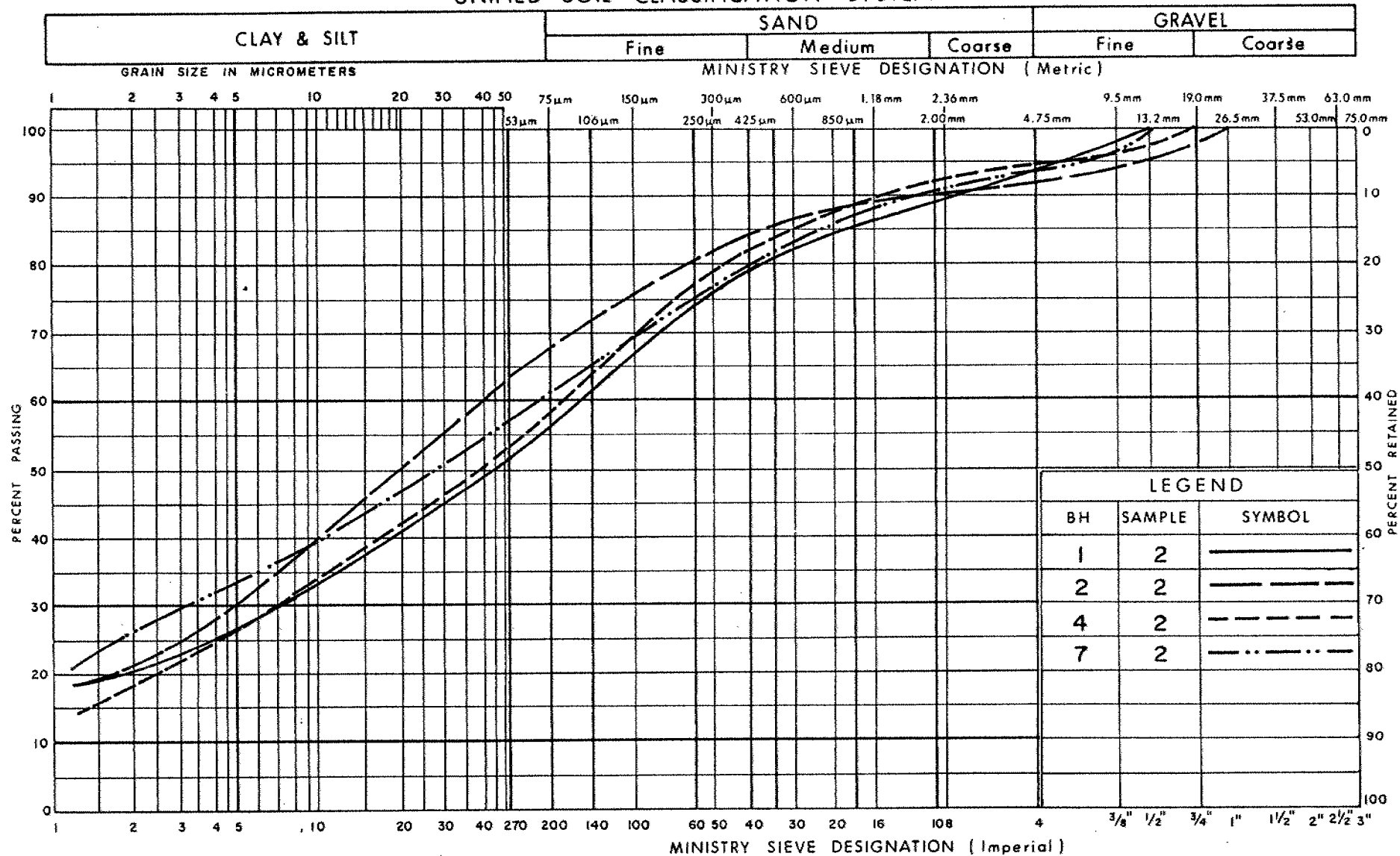
STRUCTURES 14 AND 22
HIGHWAY 400 AND 407 INTERCHANGE

BOREHOLE	SAMPLE	ELEV. DEPTH (m)	NATURAL WATER CONTENT (w) (%)	UNIT WEIGHT		VOID RATIO (e)	DEGREE OF SATURATION S _r (%)	CELL PRESSURE (σ ₃) (kPa)	FAILURE STRAIN (ε _f) (%)	SHEAR STRENGTH (τ _f) (kPa)
				WET (γ) (kN/m ³)	DRY (γ _d) (kN/m ³)					
1	2	1.52-1.98	14.9	21.41	18.63	0.42	95	37.3	20	125
3	3	2.29-2.74	15.7	22.15	19.15	0.38	100	55.9	10	108
4	2	1.52-1.98	14.2	22.15	19.40	0.36	100	38.7	17	92
7	2	1.52-1.98	10.4	22.18	20.09	0.31	88	38.7	20	209

Note:

Tests were carried out on split spoon samples. Based on previous experience, Peto MacCallum Ltd. have found relatively little disturbance for split spoon samples in some glacial till deposits, however, the reported shear strength values are considered to be conservative.

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

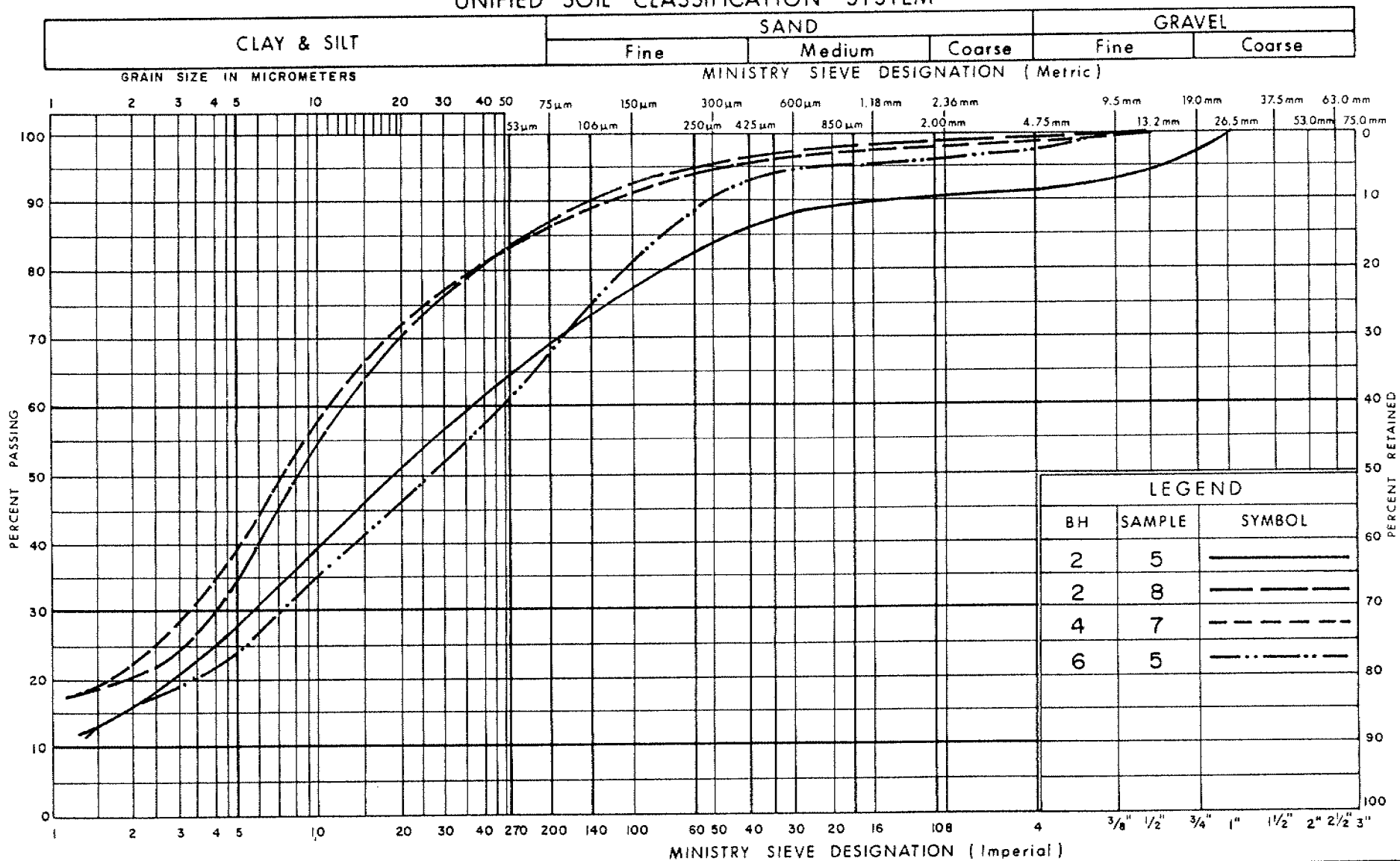
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SANDY CLAYEY SILT (GLACIAL TILL)
TRACE GRAVEL

FIG No 1

W P 142-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM



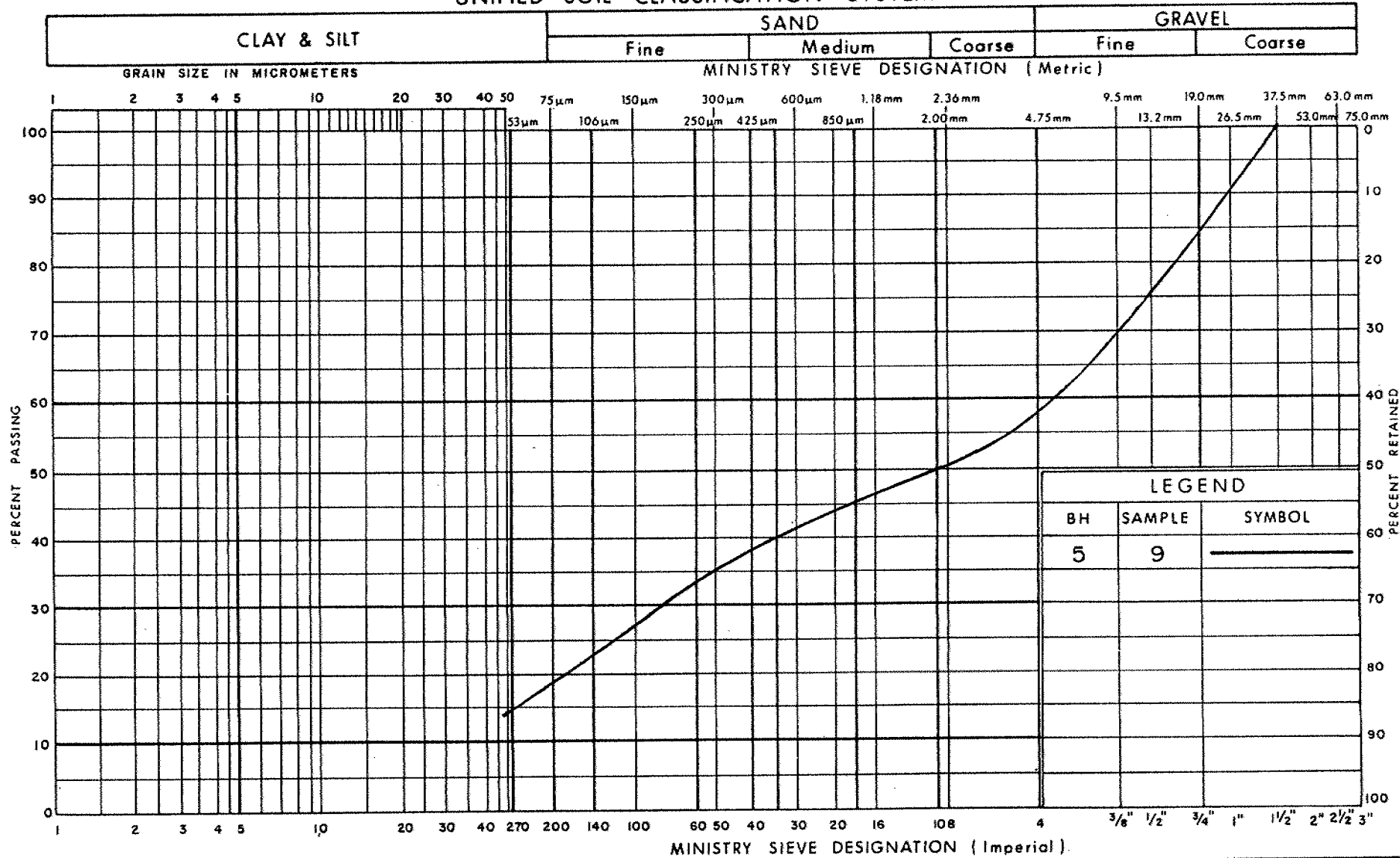
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (GLACIAL TILL)
WITH SAND, TRACE GRAVEL

FIG No 2

W P 142-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

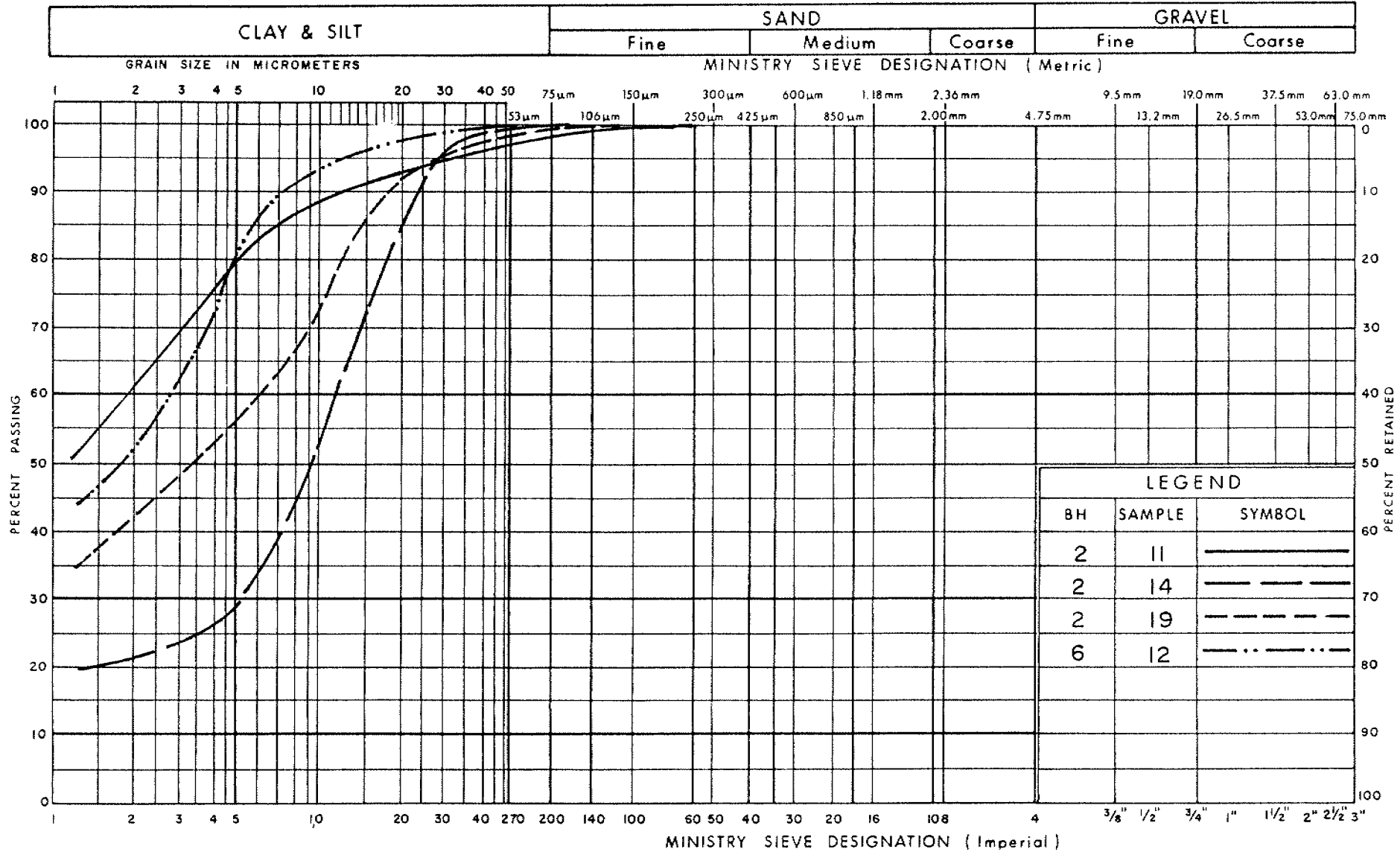
Ontario

**GRAIN SIZE DISTRIBUTION
SANDY GRAVEL
WITH SILT**

FIG No 3

W P 142-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM



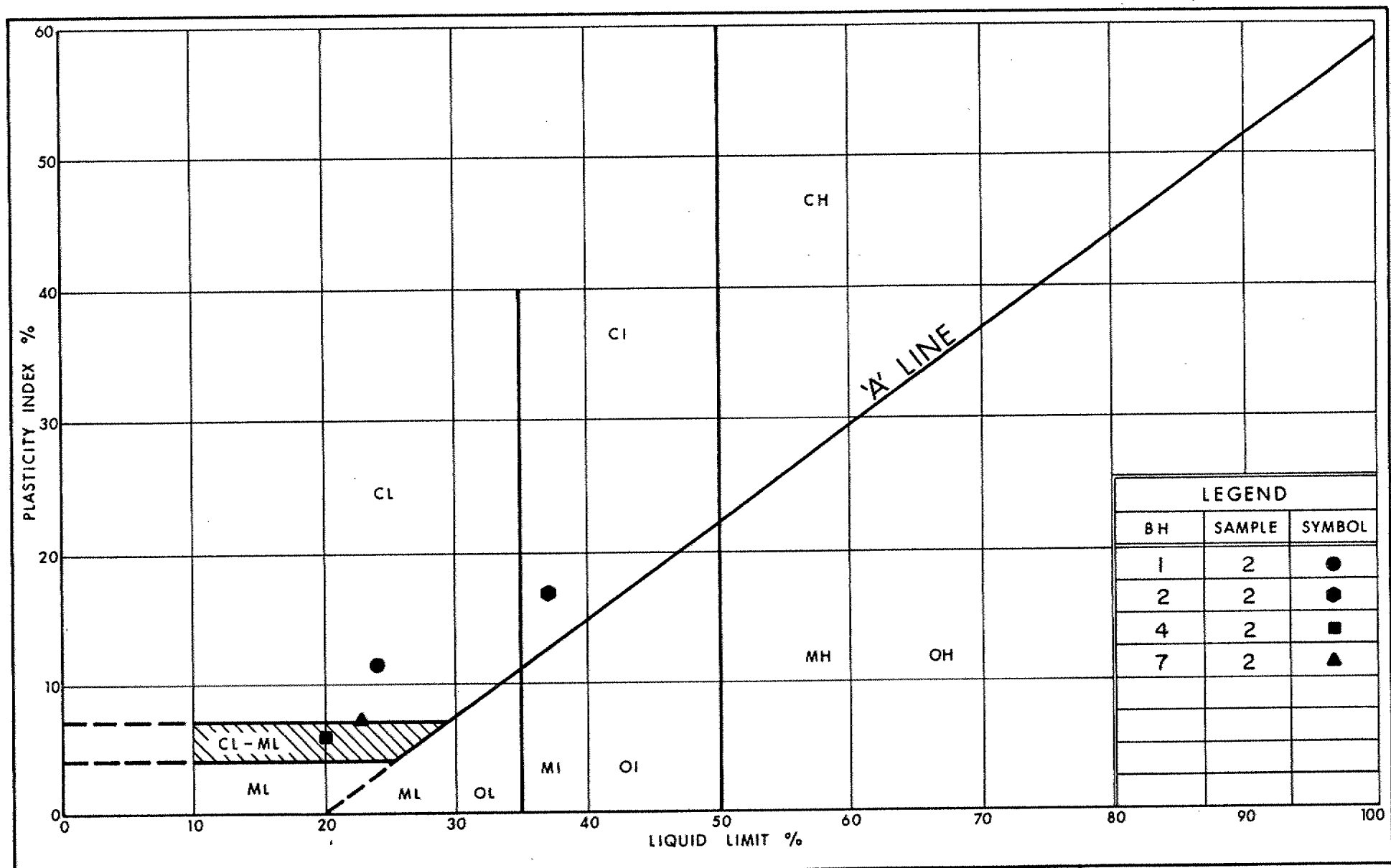
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SILTY CLAY

TRACE SAND, WITH LAYERS OF CLAYEY SILT AND SILT

FIG No 4

W P 142 - 87 - 02



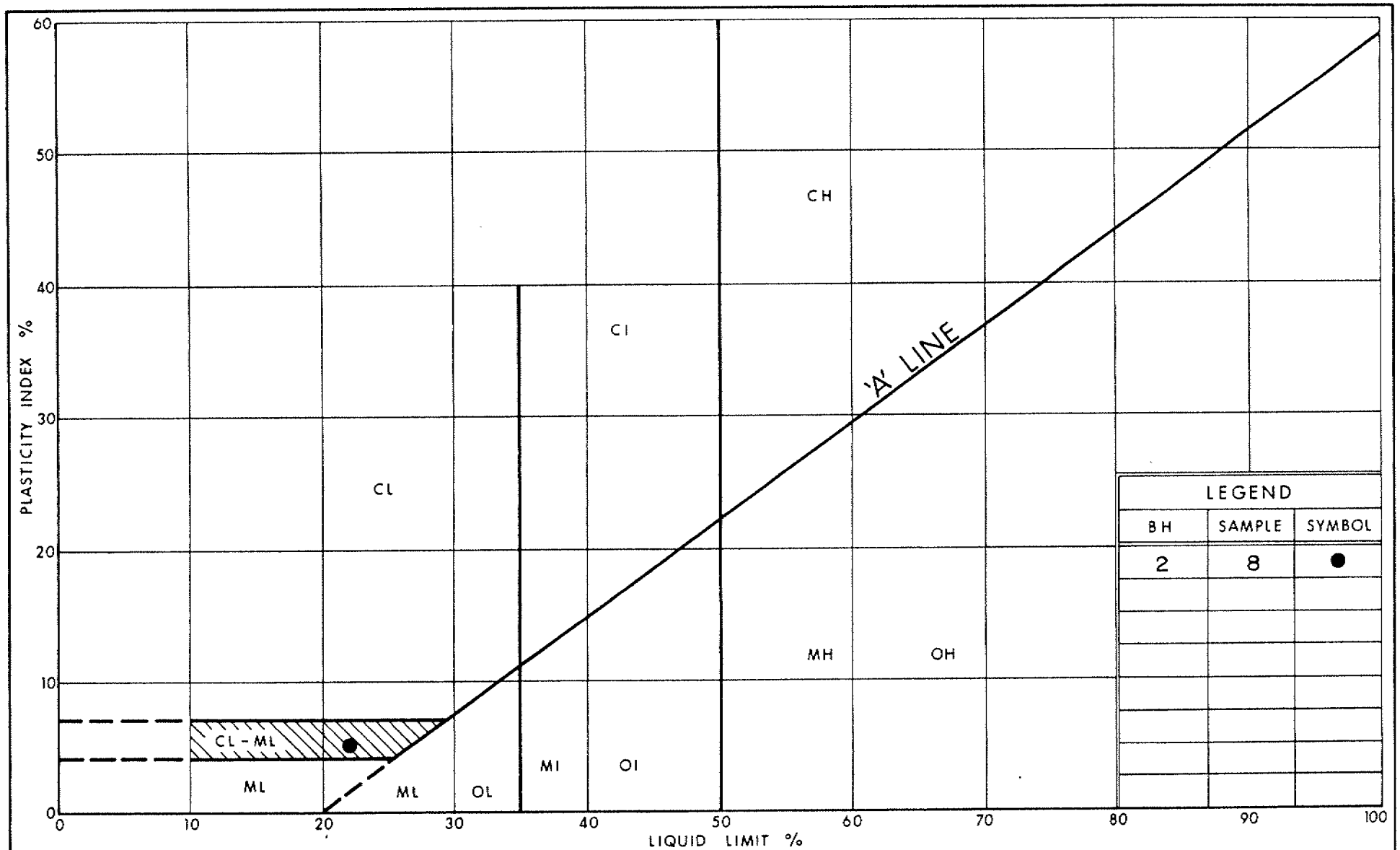
Ministry of
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Ontario

PLASTICITY CHART
SANDY CLAYEY SILT (GLACIAL TILL)
TRACE GRAVEL

FIG No 5

W P 142-87-02

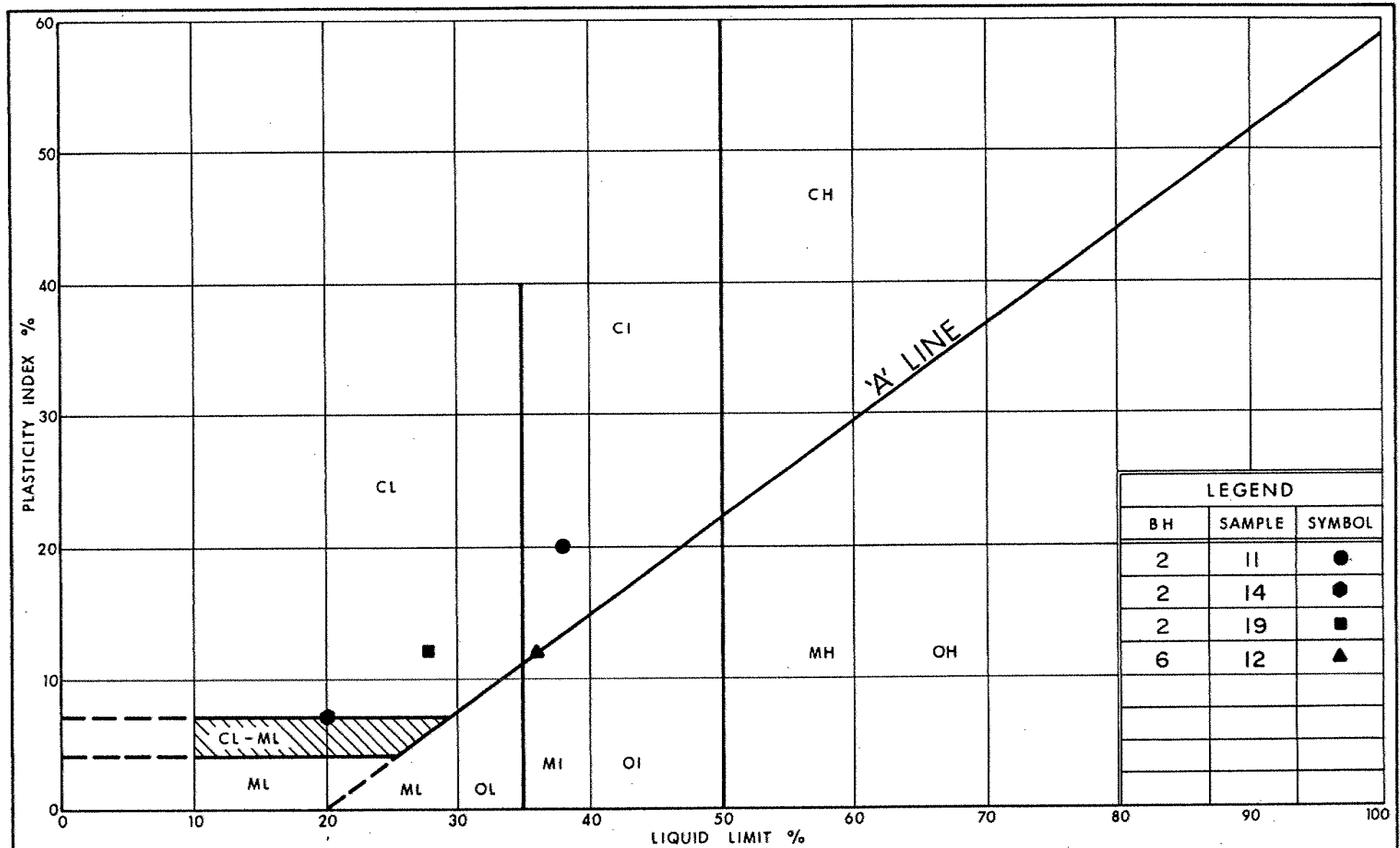


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PLASTICITY CHART
CLAYEY SILT (GLACIAL TILL)
WITH SAND, TRACE GRAVEL

FIG No 6

W P 142 - 87 - 02



Ministry of
Transportation

**PLASTICITY CHART
SILTY CLAY**
TRACE SAND, WITH LAYERS OF CLAYEY SILT AND SILT

FIG No 7

W P 142 - 87 - 02

RECORD OF BOREHOLE No 1

METRIC

W P 142-87-03 LOCATION N 4849458 E 321772
 DIST 2 HWY 400 BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY RB
 DATUM Geodetic DATE January 26, 27, 1988 COMPILED BY JFW
 CHECKED BY JFW

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						
190.89	Ground Level												
190.54	Topsoil, clayey silt, low organic, black												
0.35	Sandy Clayey silt, trace gravel (Glacial Till)		1	SS	8								
			2	SS	12								
187.54	Brown Stiff		3	SS	12								
3.35	Clayey Silt, with sand, trace gravel (Glacial Till)		4	SS	19								
			5	SS	22								
			6	SS	28								
	Grey Very Stiff Hard		7	SS	56								
			8	SS	32								
			9	SS	39								
180.39			10	SS	60								
10.50	Sandy Silt, with gravel (Glacial Till)		11	SS	60								
179.39	Grey Very Dense		12	SS	70								
11.50	Silty Clay, trace sand, with layers of clayey silt and silt		13	SS	55								
			14	SS	53								
	Grey Hard		15	SS	78								
			16	SS	49								
			17	SS	45								
			18	SS	40								
			19	SS	37								
166.05													
24.84	End of Borehole												
Note: Upon completion of augering, water at elevation 189.67 inside augers Piezometer installed at elevation 166.71 with seal at elevation 169.55 Water Date Elevation Jan. 27/88 172.04 Jan. 29/88 180.52 Feb. 5/88 180.60 Feb. 8/88 180.66													

▽ water level in open borehole
 ▼ piezometric level

+3, x5: Numbers refer to
 Sensitivity

20
 15 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 2

METRIC

W P 142-87-02 LOCATION N 4849502 E 301767 ORIGINATED BY RB
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
 DATUM Geodetic DATE January 25, 1988 CHECKED BY JFW

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	WATER CONTENT (%)					
191.66	Ground Level													
191.31	Topsoil, clayey silt, low organic, black		1	SS	15									
0.35	Sandy Clayey Silt, silty clay, trace gravel, random cobbles (Glacial Till)		2	SS	19									
			3	SS	28									
188.00	Brown Very Stiff		4	SS	17									
3.66	Clayey Silt to silt with sand, trace gravel (Glacial Till)		5	SS	35									
			6	SS	49									
	Grey Hard		7	SS	70									
			8	SS	93									
			9	SS	74									
181.56	Silty Clay, trace sand, with layers of clayey silt and silt		10	SS	66									
10.10			11	SS	45									
	Grey Hard		12	SS	50									
			13	SS	45									
			14	SS	67									
			15	SS	57									
	Very Stiff		16	SS	28									
	Hard		17	SS	60									
			18	SS	60									
			19	SS	78									
166.82	End of Borehole													
24.84	Note: Upon completion of augering, water at elevation 188.61 inside augers. Piezometer installed at elevation 167.40 with seal at elevation 169.41													
	Date	Water Elevation												
	Jan. 25/88	170.32												
	Jan. 27/88	178.19												
	Jan. 29/88	179.36												
	Feb. 5/88	180.48												
	Feb. 8/88	180.58												

▽ Water level in open borehole

▽ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 142-87-00 LOCATION N 4849529 E 301771 ORIGINATED BY RB
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
 DATUM Geodetic DATE January 27/28, 1988 CHECKED BY JFW

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	100 200 300	500					
192.25	Ground Level														
191.79	Topsoil, clayey silt, low organic, dark brown														
0.46															
	Sandy Clayey Silt, trace gravel (Glacial Till)		1	SS	9										
			2	SS	11										
189.35			3	SS	26										
2.90	Brown Stiff Very Stiff		4	SS	18										
	Clayey Silt, with sand, trace gravel (Glacial Till) with layers of sand		5	SS	26										
			6	SS	44										
	Grey Very Stiff Hard		7	SS	32										
			8	SS	44										
183.65															
8.60	Sandy Silt, with gravel (Glacial Till) Grey Very Dense		9	SS	65	50 mm									
182.19															
10.10	Silty Clay, trace sand with layers of clayey silt and silt		10	SS	50										
			11	SS	63										
	Grey Hard Very Stiff		12	SS	58										
			13	SS	24										
			14	SS	23										
			15	SS	24										
			16	SS	27										
	Hard		17	SS	44										
			18	SS	46										
	Very Stiff		19	SS	24										
167.41															
24.84	End of Borehole														
Note: Upon completion of augering water at elevation 188.29 inside augers. Piezometer installed at elevation 167.55 with seal at elevation 169.09															
Date	Water Elevation														
Jan. 28/88	170.53														
Feb. 5/88	181.20														
Feb. 8/88	181.22														

▽ Water level in open borehole
 ▼ Piezometric level

+3, x5: Numbers refer to Sensitivity

20
 15 ϕ 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 4

METRIC

W P 142-87-02 LOCATION N 4849556 E 301759
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger
 DATUM Geodetic DATE February 1/2, 1988
 ORIGINATED BY RB
 COMPILED BY TEW
 CHECKED BY JTW

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					
191.95	Ground Level																
191.35	Topsoil, clayey silt, low organic, dark brown																
189.82	Sandy Clayey Silt to silt, trace gravel (Glacial Till)		1	SS	11												
189.82			2	SS	15												
189.82			3	SS	29												
189.82	Brown Stiff		4	SS	25												
189.82	Clayey Silt, with sand, trace gravel (Glacial Till)		5	SS	58												
189.82			6	SS	70												
189.82	Brown Very Stiff		7	SS	71												
189.82	Hard		8	SS	56												
183.35			9	SS	100												
183.35	Sandy Silt, with gravel (Glacial Till)		10	SS	100												
183.35	Grey Very Dense		11	SS	100												
178.95			12	SS	73												
178.95			13	SS	28												
178.95	Grey Hard		14	SS	25												
178.95	Very Stiff		15	SS	45												
178.95			16	SS	29												
178.95	Hard		17	SS	45												
178.95	Very Stiff		18	SS	42												
178.95			19	SS	39												
167.11	End of Borehole																
167.11	Note: Upon completion of augering water at elevation 188.29 inside augers. Piezometer installed at elevation 167.32 with seal at elevation 171.07.																
167.11	Date																
167.11	Water Elevation																
167.11	Feb. 2/88																
167.11	Feb. 5/88																
167.11	Feb. 8/88																

▽ Water level in open borehole

▼ Piezometric level

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 142-87-02 LOCATION N 4849580 E 301746 ORIGINATED BY RS
 DIST 6 HWY 420 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
 DATUM Geodetic DATE February 2/3, 1988 CHECKED BY JFW

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				
192.55	Ground Level															
187.25	Topsoil, clayey silt, low organic, dark brown															
0.36																
	Sandy Clayey Silt, trace gravel (Glacial Till)		1	SS	14		192									
			2	SS	19											
			3	SS	20		190									
188.85	Brown		4	SS	23											
3.70	Very Stiff		5	SS	27											
	Clayey Silt, with sand, trace gravel (Glacial Till)		6	SS	50	150 mm	188									
			7	SS	84		186									
	Grey Hard		8	SS	79											
183.55							184									
9.00	Sandy Gravel, with silt		9	SS	*											
182.39	Grey															
10.16	Sandy silt, with gravel (Glacial Till)		10	SS	100	130 mm	182									
	Grey Very Dense		11	SS	100	150 mm	180									
179.15																
13.40	Silty Clay, trace sand with layers of clayey silt, and silt		12	SS	62		178									
	Grey Hard		13	SS	36		176									
	Very Stiff		14	SS	26											
	Hard		15	SS	39		174									
			16	SS	32		172									
			17	SS	42											
	Very Stiff		18	SS	24		170									
	Hard		19	SS	36											
167.71																
24.84	End of Borehole															
Note: * Sampler penetrated 0.36 m under weight of rods. Before sample 10, water at elevation 184.32 inside augers. Upon completion of augering water at elevation 184.32 inside augers. Piezometer installed at elevation 168.09 with seal at elevation 169.39. Water Date Elevation Feb. 3/88 171.06 Feb. 5/88 178.91 Feb. 8/88 181.29																

▽ Water level in open borehole

▼ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 142-87-02 LOCATION N 4849597 E 301787
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger
 DATUM Geodetic DATE February 5/8, 1986
 ORIGINATED BY RB
 COMPILED BY JFW
 CHECKED BY JFW

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					
193.45	Ground Level																
193.11	Topsoil, clayey silt, low organic, dark brown																
0.30	Sandy Clayey Silt, trace gravel (Glacial Till)		1	SS	6		192										
	Brown Firm to Stiff Very Stiff		2	SS	10												
190.55			3	SS	20												
2.90	Clayey Silt, with sand to sandy, trace gravel (Glacial Till)		4	SS	12		190										
	Grey Stiff		5	SS	83												
	Hard		6	SS	65												
			7	SS	58		188										
			8	SS	35		186										
184.45			9	SS	28		184										
9.00	Sandy Silt with gravel (Glacial Till)		10	SS	60/250 mm												
	Grey Compact Very Dense		11	SS	45		182										
181.85			12	SS	57		180										
11.60	Silty Clay, trace sand with layers of clayey silt, and silt		13	SS	62		178										
	Grey Hard		14	SS	45		176										
			15	SS	85												
			16	SS	50		174										
			17	SS	32		172										
	Very Stiff		18	SS	25		170										
			19	SS	47												
168.61																	
24.84	End of Borehole Note: Upon completion of augering water at elevation 170.74 in open borehole. Piezometer installed to elevation 169.07 with seal at elevation 173.69 Water Date Feb. 8/88 Elevation 171.41 Water level had not stabilized at completion of field work.																

▽ Water level in open borehole

▼ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7

METRIC

W P 142-87-02 LOCATION N 4849619 E 301782
 DIST 5 HWY 400 BOREHOLE TYPE Hollow Stem Auger
 DATUM Geodetic DATE February 3/4, 1988
 ORIGINATED BY RR
 COMPILED BY JFW
 CHECKED BY JFW

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				
193.99	Ground Level															
193.69	Topsoil, clayey silt, low organic, dark brown															
0.30			1	SS	22											
	Sandy Clayey Silt, trace gravel (Glacial Till)		2	SS	23											
191.09			3	SS	21											
2.90	Brown Very Stiff		4	SS	80											
	Clayey Silt, with sand, trace gravel, random boulders (Glacial Till)		5	SS	62											
	Grey Hard		6	SS	69											
			7	SS	46											
			8	SS	44											
185.39																
8.60	Sandy Silt, with gravel (Glacial Till)															
183.99	Grey Very Dense															
10.00	Silty Clay, trace sand with layers of clayey silt and silt		10	SS	33											
	Grey Hard		11	SS	31											
			12	SS	59											
			13	SS	34											
			14	SS	34											
			15	SS	36											
			16	SS	48											
			17	SS	36											
			18	SS	38											
			19	SS	32											
169.15	End of Borehole															
24.84	Note: Upon completion of augering water at elevation 190.94 inside augers. Piezometer installed at elevation 169.61 with seal at elevation 175.09															
	Date Elevation															
	Feb. 5/88 181.62															
	Feb. 8/88 181.52															

▽ Water level in open borehole
 ▼ Piezometric level

+3, x5; Numbers refer to
 Sensitivity

20
 15 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 8

METRIC

W P 142-87-02 LOCATION N 4849555 E 301786 ORIGINATED BY RB
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
 DATUM Geodetic DATE January 27/28, 1988 CHECKED BY JFW

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			VALUES	20 40 60 80 100					
192.49	Ground Level												
192.19	Topsoil, clayey silt, low organic, dark brown		1	SS	6								
190.39	Sandy Clayey Silt, trace gravel (Glacial Till)		2	SS	9								
2.10	Brown Firm to Stiff		3	SS	28								
	Clayey Silt, with sand, trace gravel (Glacial Till)		4	SS	92								
	Brown Very Stiff		5	SS	60	150 mm							
	Grey Hard		6	SS	60	150 mm							
			7	SS	61								
			8	SS	54								
183.89	Sandy Silt, with gravel (Glacial Till)		9	SS	90								
8.60	Grey Very Dense		10	SS	54	150 mm							
180.99	Silty Clay, trace sand with layers of clayey silt and silt		11	SS	46								
11.50	Grey Hard		12	SS	41								
	Very Stiff		13	SS	27								
			14	SS	23								
	Hard		15	SS	40								
			16	SS	50								
			17	SS	40								
			18	SS	35								
167.65	Piezometer Tip		19	SS	38								
24.84	End of Borehole												
Note: Upon completion of augering water at elevation 169.63 inside augers. Piezometer installed at elevation 167.65 with seal at elevation 175.12 Water Date Elevation Jan. 28/88 170.62 Feb. 5/88 180.98 Feb. 8/88 180.93													

▽ Water level in open borehole
 ▼ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

GEOTECHNICAL INVESTIGATION
HIGHWAY 400 AND 407 INTERCHANGE
DISTRICT 6 (TORONTO) CENTRAL REGION
FOR
MINISTRY OF TRANSPORTATION ONTARIO
W.P. 142-87-02
SITE 37-1178 (STRUCTURE 14)
SITE 37-1184 (STRUCTURE 22)

CONT 92-66

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Job No. 87 F 600

May, 1988

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Job No. 87 F 600

May 5, 1988

Mr. M. S. Devata, P.Eng.
Chief Foundations Engineer (East)
Ministry of Transportation Ontario
Foundation Design Section
Room 315, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Dear Mr. Devata

Geotechnical Investigation
Site 37-1178 (Structure 14)
Site 37-1184 (Structure 22)
Highway 400 and 407 Interchange
District 6 (Toronto) Central Region

We are pleased to present our report for the geotechnical investigation carried out for above noted structures as authorized in Agreement Number 4238-9087-185.

The stratigraphy encountered at the site generally comprises surficial topsoil over glacial till units underlain at depths of 10.0 to 13.4 m by a major deposit of silty clay.

Subsurface conditions are favourable for the use of spread footings to support the proposed bridge structures and associated retaining walls. Alternate foundation schemes for supporting the abutments include shallow footings on Granular 'A' compacted fill or driven piles.

The report presents parameters for design of abutment and retaining walls and approach embankments and discusses situations that will be encountered during construction including excavation slopes and ground water control.

We believe this report has been completed within our terms of reference and trust the information presented herein is sufficient for your present requirements.

...2

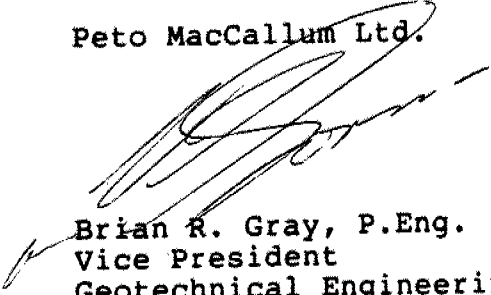
Mr. M. S. Devata, May 5, 1988, P2

87 F 600

Should you have any questions, or when we may be of further assistance to you during the construction phase of the project, please do not hesitate to contact our office. We appreciate this opportunity to be of service to the Ministry of Transportation Ontario.

Sincerely

Peto MacCallum Ltd.



Brian R. Gray, P.Eng.
Vice President
Geotechnical Engineering

BRG:lm

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
2. FIELD WORK	1
3. LABORATORY TESTING PROGRAM	2
4. SITE DESCRIPTION	3
5. SUMMARIZED SUBSURFACE CONDITIONS	3
5.1 General	3
5.2 Overburden	4
5.2.1 Topsoil	4
5.2.2 Sandy Clayey Silt (Glacial Till)	4
5.2.3 Clayey Silt (Glacial Till)	5
5.2.4 Sandy Gravel	5
5.2.5 Sandy Silt (Glacial Till)	5
5.2.6 Silty Clay	6
5.3 Ground Water	6
6. ENGINEERING CONSIDERATIONS	7
6.1 Structure 14	7
6.1.1 Spread Footings	7
6.1.2 Driven Piles	8
6.1.3 Abutments on Compacted Fill	10
6.1.4 Lateral Earth Pressures	10
6.2 Structure 22	11
6.2.1 Spread Footings	11
6.2.2 Driven Piles	12
6.2.3 Abutments on Compacted Fill	12
6.2.4 Lateral Earth Pressures	12
6.3 Retaining Walls	12
6.3.1 Spread Footings	13
6.3.2 Lateral Earth Pressures	14
6.4 Approach Embankments	14
6.5 Excavation and Ground Water Control	14

TABLE I Atterberg Limit Test Results

TABLE II "Quick" Triaxial Compression Test Results

Figures 1 to 4 Grain Size Distribution Sheets

Figures 5 to 7 Plasticity Charts

Figure 8 Abutment on Compacted Fill Showing Granular 'A' Core

Record of Borehole Sheets

Drawing 1428702-A

1. INTRODUCTION

Peto MacCallum Ltd. was authorized by The Ministry of Transportation Ontario, Agreement Number 4238-9087-185 dated November 30, 1987, to carry out a geotechnical investigation at the site of structures 14 and 22 at the proposed Highway 400 and 407 interchange in the Town of Vaughan, Ontario.

The proposed structures will carry the ramp 400S to 7EW above the ramps 407W to 400N and 407E to 400N. It is understood both structures will be single span rigid frame. Structure 14 will be 61.0 m long by 10.9 m wide while structure 22 will be 40.0 m long by 10.9 m wide. Construction of four (4) retaining walls will be required in association with the approach embankments to the structures.

The purpose of the investigation was to determine the subsurface soil and ground water conditions at the site and based on this information to provide geotechnical recommendations pertaining to the design and construction of the proposed structures, retaining walls and approach embankments.

2. FIELD WORK

The field work for the investigation was carried out during the period January 25 to February 8, 1988, and comprised eight (8) boreholes, put down to depths of 24.8 m below existing grade at the locations shown on the appended plan.

The boreholes were advanced using a CME 55 track mounted drillrig equipped with continuous flight hollow stem augers supplied and operated by a specialist drilling contractor.

Representative samples of the overburden were secured at regular intervals throughout the depth explored. Standard penetration resistance tests were carried out during sampling operations using conventional split spoon equipment.

The ground water conditions in the open boreholes were monitored during and on completion of drilling. Piezometers were installed in each borehole and monitored to determine the stabilized ground water conditions.

The field work was supervised throughout by a member of our engineering staff who directed the drilling and sampling operations, documented the soil stratigraphy encountered, monitored ground water conditions and processed the recovered samples.

The location and ground surface elevation of the boreholes at the time of drilling were established in the field by a survey crew from The Ministry of Transportation Ontario. It is understood all elevations were referenced to geodetic datum.

3. LABORATORY TESTING PROGRAM

All recovered samples were brought to our laboratory for detailed visual examination and testing to confirm field classification. The following tests were carried out:

- i) Natural moisture content determinations on all recovered samples, with results shown on the appended Record of Borehole sheets;
- ii) Thirteen (13) grain size analyses with results illustrated on Figures 1 to 4 and the appended Record of Borehole sheets;
- iii) Nine (9) Atterberg Limits with results presented on Table I, Figures 5 to 7 and the appended Record of Borehole sheets;
- iv) Four (4) "Quick" triaxial compression tests on relatively undisturbed split spoon samples with results summarized on Table II and shown on the appended Record of Borehole sheets.

4. SITE DESCRIPTION

Based on available geological mapping, the surficial material at the site comprises Lacustrine - Wildfield Till complex. Overburden deposits are about 50 to 55 m thick. Bedrock comprises shale, siltstone and limestone belonging to the Georgian Bay Formation.

The natural ground surface at the site is relatively flat, ranging from elevation 190.89 to 193.99 at the borehole locations and generally dropping from north to south. Major construction activities were underway in the immediate vicinity of the site at the time of the field work. A large fill stockpile was located at the north end of proposed structure 22.

5. SUMMARIZED SUBSURFACE CONDITIONS

5.1 General

Reference is made to the appended Record of Borehole sheets for details of the field work, including soil classifications, inferred stratigraphy, standard penetration 'N' values, the results of laboratory undrained shear strength testing, moisture content determinations and Atterberg Limit test results, together with ground water observations in the open boreholes and installed piezometers.

The summarized subsurface conditions are presented on profiles included on the appended plan.

The stratigraphy at the site generally comprises surficial topsoil over glacial till units underlain by a major deposit of silty clay.

clayey silt

5.2 Overburden

5.2.1 Topsoil

Surficial topsoil, described as dark brown or black clayey silt with relatively low organic content, was found in each borehole to depths of 300 to 460 mm.

5.2.2 Sandy Clayey Silt (Glacial Till)

A glacial till unit was encountered beneath the topsoil at each borehole, and extended to depths of 2.1 to 3.7 m below ground surface, about elevation 187.5 to 190.6. This stratum typically comprised a heterogeneous mixture of clay, silt and sand with trace gravel. Grain size distribution curves for four (4) representative samples of the material are shown on Figure 1.

Atterberg limit tests were carried out on four (4) representative samples of the stratum. Test results are summarized on Table I and illustrated on Figure 5. Liquid limits ranged from 20 to 37%, plastic limits from 12 to 20% and plasticity indices from 6 to 17%. The material may be classified as a clayey silt ranging locally to a silty clay or borderline clayey silt to silt. Moisture contents varied between 12 and 25%, ranging from drier than to wetter than the plastic limit.

The results of four (4) "Quick" triaxial compression tests on relatively undisturbed split spoon samples of this material are shown on Table II and on Records of Borehole 1, 3, 4 and 7, and indicated shear strengths of 92 to 209 kPa. Based on these results, and standard penetration resistance 'N' values, the consistency of the stratum ranges from firm to very stiff. Wet unit weights of the triaxial test specimens ranged from 21.41 to 22.18 kN/m³.

5.2.3 Clayey Silt (Glacial Till)

Clayey silt glacial till was encountered in all the boreholes beneath the clay, silt and sand glacial till, and extended to depths of 8.6 to 10.5 m elevation 180.4 to 185.4. The material typically comprised brown to grey clayey silt with sand and trace gravel. Scattered boulders and layers of sand or silt were contacted within the deposit. Grain size distribution curves for four (4) representative samples of the material are presented in Figure 2.

One (1) Atterberg limit test was carried out on a sample of the stratum. Test results are presented on Table I and Figure 6 and are typical of a borderline clayey silt to silt material. Natural moisture contents ranged from 7 to 19%.

Based on standard penetration resistance 'N' values, the consistency ranged from stiff to hard.

5.2.4 Sandy Gravel

At borehole 5, a layer of sandy gravel was encountered beneath the clayey silt glacial till to 10.2 m depth. The material comprised grey sandy gravel with silt. A grain size distribution curve for a representative sample of the material is presented in Figure 3.

5.2.5 Sandy Silt (Glacial Till)

Sandy silt glacial till was encountered beneath the clayey silt glacial till or sandy gravel, at boreholes 1 and 3 to 8, and extended to depths of 10.0 to 13.4 m, elevation 179.2 to 184.0. The material comprised grey sandy silt with gravel. The relative density was compact to very dense, with standard penetration resistance 'N' values typically

exceeding 100 blows per 0.3 m. Moisture contents typically ranged between 8 and 11%.

5.2.6 Silty Clay

All boreholes encountered a major glacio-lacustrine deposit at depths of 10.0 to 13.4 m (elevation 179.2 to 184.0) and terminated within the unit at 24.8 m depth. The material comprised grey silty clay with trace sand, and was stratified with layers of clayey silt and silt. Grain size distribution curves for four (4) representative samples of the material are presented in Figure 4.

Atterberg limit tests were carried out on four (4) samples of the stratum. Test results are summarized on Table I and illustrated on Figure 7. Liquid limits ranged from 20 to 38%, plastic limits from 13 to 24%, and plasticity indices from 7 to 20%. The material may be classified as a silty clay with layers of clayey silt or silt. Moisture contents ranged from 15 to 31% and were typically wetter than the plastic limit.

The consistency of the deposit was very stiff to hard, based on standard penetration resistance 'N' values.

5.3 Ground Water

The ground water conditions observed in the boreholes during and on completion of drilling, and the piezometer readings afterward, are shown on the individual Record of Borehole sheets. On completion of drilling, the water level inside the hollow stem augers was at depths of 1.2 to 4.0 m, elevation 188.3 to 189.7 at boreholes 1 to 4, and at depths of 3.1 to 22.9 m, elevation 169.6 to 190.9 at boreholes 5 to 8. These levels likely reflect varying quantities of seepage occurring as surface water infiltration at shallow depth and from sandy layers in the glacial till units.

Subsequent readings in the piezometers at boreholes 1 to 5, 7 and 8, indicated water levels at depths of 10.2 to 12.5 m, elevation 180.6 to 181.5. These represent the stabilized piezometric levels at the site.

6. ENGINEERING CONSIDERATIONS

6.1 Structure 14

The proposed structure will carry the ramp 400S to 7EW above the ramp 407W to 400N. It is understood the structure will be single span rigid frame approximately 61.0 m long by 10.9 m wide.

The soil and ground water conditions at the site are suitable for the use of shallow spread footing foundations. However, alternate foundation systems are described, and because of structural or economic considerations, may be selected.

6.1.1 Spread Footings

The west and east abutments for the proposed structure may be supported on shallow spread footings placed on the very stiff glacial till at or below elevation 189.8. The factored bearing capacity at Ultimate Limit States (ULS) is 450 kPa. It is estimated that settlement will be less than 25 mm for a bearing capacity at Serviceability Limit States Type II (SLS) of 300 kPa.

If higher spread footing bearing capacities are required, the foundations may be placed on the hard clayey silt till at or below elevation 188.0. The factored bearing capacity at ULS is 800 kPa. The bearing capacity at SLS is estimated at 500 kPa.

All foundations must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate protection against possible frost damage.

6.1.2 Driven Piles

While the soil conditions are generally competent for shallow spread footings, there may be structural or economic reasons for utilization of deep foundations. In this regard, driven piles may be used to support the bridge structure.

Based on the subsurface stratification, it appears that a non-displacement type, such as steel H-pile would provide an acceptable type of deep foundation. In general, piles may be driven to practical refusal in the hard clayey silt till or very dense sandy silt till.

For estimating purposes, an HP310X79 (HP12X53) steel H-pile driven to about 8 to 10 m below existing grade should have a factored capacity at ULS of 890 kN (100T). The capacity at SLS is estimated at 580 kN (65T).

Particular care must be given to the founding level of each pile and overdriving should be avoided. Piles which inadvertently penetrate the base of the glacial till deposits and terminate within the silty clay stratum will encounter only medium driving resistance and will have a substantial reduction in bearing capacity. For estimating purposes, an HP310x79 steel H-pile terminating within the silty clay stratum would have a factored capacity at ULS of 540 kN (60T) at a depth of about 10 to 12 m. The capacity at SLS is estimated at 360 kN (40T).

type II

Cognizant of this potential reduction in capacity, it appears that a displacement type, such as steel tube pile may also merit consideration.

For estimating purposes, a 324 mm diameter steel tube pile driven to practical refusal in the hard clayey silt till or very dense sandy silt at depths of 8 to 10 m below existing grade should have a factored capacity at ULS of 890 kN (100T). This capacity at SLS is estimated at 580 kN (65T).

In the event the pile penetrates the base of the glacial till deposit, a modest reduction in bearing capacity is anticipated.

Alternatively, if a more modest pile capacity is acceptable, the piles may be terminated at more shallow depth. For estimating purposes, a 324 mm diameter steel tube pile terminating at depths of 5 to 6 m below existing grade should have a factored capacity at ULS of 670 kN (75T). The capacity at SLS is estimated at 450 kN (50T).

Pre-augering may be required locally in order to achieve the minimum required penetration. The piles should be driven with a hammer of sufficient energy to attain the required capacity, and a pile load test should be carried out at the start of construction to verify that the required capacity is being obtained with the contractor's equipment and construction procedures.

The installation operations should be inspected on a full-time basis by qualified geotechnical personnel to ensure uniformity of set, founding elevation, alignment and plumbness, as well as proper splice welds.

6.1.3 Abutments on Compacted Fill

In the event a multi-span combined bridge structure is used, it may be advantageous to consider shallow abutments supported on a section of granular fill in the approach embankment. The standard MTO method of constructing abutments on compacted fill embankments with a Granular 'A' core is shown on appended Figure 8. Abutment footing design can be based on a SLS bearing capacity of 300 kPa, considering a settlement of about 25 mm. The ULS bearing capacity for the dense compacted Granular 'A' is estimated to be 750 kPa. If this method of abutment design and construction is adopted, all materials and methods of construction should conform to current MTO Standards.

6.1.4 Lateral Earth Pressures

The abutments should be designed to resist the unbalanced lateral forces acting against them. In this regard, provided that MTO standard practice is followed involving the provision of free draining granular backfill and the installation of weepholes or weeping tiles behind the abutment to prevent the build-up of hydrostatic pressures, design may be based on the following geotechnical parameters:

Friction angle of compacted granular backfill, $\phi = 30^\circ$

Friction angle between granular fill and concrete, $\delta = 24^\circ$

Adhesion between footing and glacial till, 50 kPa

Bulk density for compacted granular fill behind the abutment $\gamma = 21.2 \text{ kN/m}^3$

Alternatively, lateral earth pressures for the granular backfill may be determined from the Highway

even ... 50 kPa.
75 kPa.
45 kPa/m.
Passive earth pressure
is not enough

Bridge Design Code, Section 6.6.1.2.2, using equivalent fluid pressures:

ULS (active state) 8.0 kPa/m

SLS (active state) 6.5 kPa/m

6.2 Structure 22

The proposed structure will carry the ramp 400S to 7EW above the ramp 407E to 400N. It is understood the structure will be single span rigid frame approximately 40.0 m long by 10.9 m wide.

As with structure 14, the soil and ground water conditions at the site are considered suitable for the use of shallow spread footing foundations.

6.2.1 Spread Footings

The west and east abutments for the proposed structure may be supported on shallow spread footings placed on the very stiff glacial till at or below elevation 189.8 and 190.3, respectively. The factored bearing capacity at Ultimate Limit States (ULS) is 450 kPa. It is estimated that settlement will be less than 25 mm for a bearing capacity at Serviceability Limit States Type II (SLS) of 300 kPa.

If higher spread footing bearing capacities are required, the foundations may be placed on hard clayey silt till at or below elevation 188.3 and 189.5 for the west and east abutments, respectively. The factored bearing capacity at ULS is 800 kPa. The bearing capacity at SLS is estimated at 500 kPa.

All foundations must be provided with a minimum 1.2 m of earth cover or equivalent insulation to provide adequate protection against possible frost damage.

6.2.2 Driven Piles

While the soil conditions are generally competent for shallow spread footings, there may be structural or economic reasons for utilization of deep foundations. In this regard, driven piles may be used to support the bridge structure.

Based on the subsurface stratification, it appears that a non-displacement type, such as steel H-pile would provide an acceptable type of deep foundation. In general, piles may be driven to practical refusal in the hard clayey silt till or very dense sandy silt till.

For estimating purposes, an HP310X79 (HP12X53) steel H-pile driven to about 8 to 10 m below existing grade should have a factored capacity at ULS of 890 kN (100T). The capacity at SLS is estimated at 580 kN (65T). We refer to Section 6.1.2 for further comments concerning driven piles.

6.2.3 Abutments on Compacted Fill

We refer to Section 6.1.3 for recommendations concerning construction of abutments on compacted fill.

6.2.4 Lateral Earth Pressures

We refer to Section 6.1.4 for recommendations concerning unbalanced lateral forces acting against the abutments.

6.3 Retaining Walls

Construction of four (4) retaining walls will be required in association with the approach embankments to the two bridge structures.

The soil and ground water conditions are suitable for the use of shallow spread footing foundations.

6.3.1 Spread Footings

The various retaining walls may be supported on shallow spread footings placed on the very stiff glacial till at or below the recommended founding levels as summarized below. The factored bearing capacity at Ultimate Limited States (ULS) is 450 kPa. It is estimated that settlement will be less than 25 mm for a bearing capacity at Serviceability Limit States Type II (SLS) of 300 kPa.

If higher spread footing bearing capacities are required, the foundations may be placed on the hard clayey silt till at or below the recommended founding levels. The factored bearing capacity at ULS is 800 kPa. The bearing capacity at SLS is estimated at 500 kPa.

RECOMMENDED FOUNDING ELEVATIONS FOR RETAINING WALLS

Serviceability Limit States Type II <u>Location</u>	<u>300 kPa Elevation (m)</u>	<u>500 kPa Elevation (m)</u>
. West side of 407W to 400N ramp south of structure 14	187.5	185.3
. East side of 400S to 7EW ramp between structures 14 and 22	189.9	188.0
. West side of 400S to 7EW ramp between structures 14 and 22	189.8	188.3
. West side of 400S to 7EW north of structure 22	191.2	189.8

All foundations must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate protection against possible frost damage.

6.3.2 Lateral Earth Pressures

We refer to Section 6.1.4 for recommendations concerning unbalanced lateral forces acting against the retaining walls.

6.4 Approach Embankments

The proposed construction will involve approach embankments some 5 m in height. Prior to construction of the embankment, or granular structural fill, all topsoil, and any obviously deleterious materials should be subexcavated and the exposed surface proof rolled to ensure at least 95% standard Proctor maximum dry density.

We recommend longitudinal and transverse slopes of 2 horizontal to 1 vertical for the approach embankment. Provided suitable borrow material is employed and MTO standard construction procedures are observed, we do not anticipate any slope or base stability problems. Standard MTO slope protection involving seeding or sodding should be observed to control erosion due to surface run-off.

6.5 Excavation and Ground Water Control

No real advantage is derived from construction of the approach fill in advance of construction (surcharging the site). However, the construction sequence of the approach embankment should be designed so as to facilitate construction of the foundation type that is utilized.

Excavation slopes should be cut at 1 horizontal to 1 vertical, above a 1.2 m vertical height, subject to geotechnical inspection. All excavation should be carried out in accordance with The Ontario Occupational Health and Safety Act, 1981.

Ground water should not pose any special problems. Local nuisance seepage or surface run-off that enters any proposed excavation should be handled by conventional sump pumping.

Peto MacCallum Ltd.



J. F. Wright, B.Sc.
Geologist



Alastair E. Gorman, P.Eng.
Manager - Toronto
Geotechnical Engineering

JFW:lm

Job No. 87 F 600
May, 1988

TABLE I
ATTERBERG LIMIT TEST RESULTS

STRUCTURES 14 AND 22
HIGHWAY 400 AND 407 INTERCHANGE

<u>BOREHOLE No.</u>	<u>SAMPLE No.</u>	<u>DEPTH (m)</u>	<u>NATURAL WATER CONTENT (W) %</u>	<u>LIQUID LIMIT (WL) %</u>	<u>PLASTIC LIMIT (WP) %</u>	<u>PLASTICITY INDEX (Ip) %</u>	<u>REMARKS</u>
<u>Sandy Clayey Silt (Glacial Till)</u>							
1	2	1.52- 1.98	17.8	24	12	12	Clayey silt
2	2	1.52- 1.98	13.7	37	20	17	Silty clay
4	2	1.52- 1.98	19.3	20	14	6	Clayey silt to silt
7	2	1.52- 1.98	11.8	23	16	7	Clayey silt
<u>Clayey Silt (Glacial Till)</u>							
2	8	7.62- 8.08	12.3	22	17	5	Clayey silt to silt
<u>Silty Clay</u>							
2	11	12.19-12.65	24.6	38	18	20	Silty clay
2	14	16.76-17.22	23.4	20	13	7	Clayey silt to silt
2	19	24.38-24.84	25.9	28	16	12	Clayey silt
6	12	13.71-14.17	31.1	36	24	12	Silty clay

Job No. 87 F 600
May, 1988

TABLE II
"QUICK" TRIAXIAL COMPRESSION TEST RESULTS

STRUCTURES 14 AND 22
HIGHWAY 400 AND 407 INTERCHANGE

<u>BOREHOLE</u>	<u>SAMPLE</u>	<u>ELEV. DEPTH</u> (m)	<u>NATURAL WATER CONTENT</u> (w) %	<u>UNIT WEIGHT</u>		<u>VOID RATIO</u> (e)	<u>DEGREE OF SATURATION</u> S_r (%)	<u>CELL PRESSURE</u> (σ_3) (kPa)	<u>FAILURE STRAIN</u> (ϵ_f) (%)	<u>SHEAR STRENGTH</u> (τ_f) (kPa)
				<u>WET</u> (γ) (kN/m ³)	<u>DRY</u> (γ_d) (kN/m ³)					
1	2	1.52-1.98	14.9	21.41	18.63	0.42	95	37.3	20	125
3	3	2.29-2.74	15.7	22.15	19.15	0.38	100	55.9	10	108
4	2	1.52-1.98	14.2	22.15	19.40	0.36	100	38.7	17	92
7	2	1.52-1.98	10.4	22.18	20.09	0.31	88	38.7	20	209

Note:

Tests were carried out on split spoon samples. Based on previous experience, Peto MacCallum Ltd. have found relatively little disturbance for split spoon samples in some glacial till deposits, however, the reported shear strength values are considered to be conservative.

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

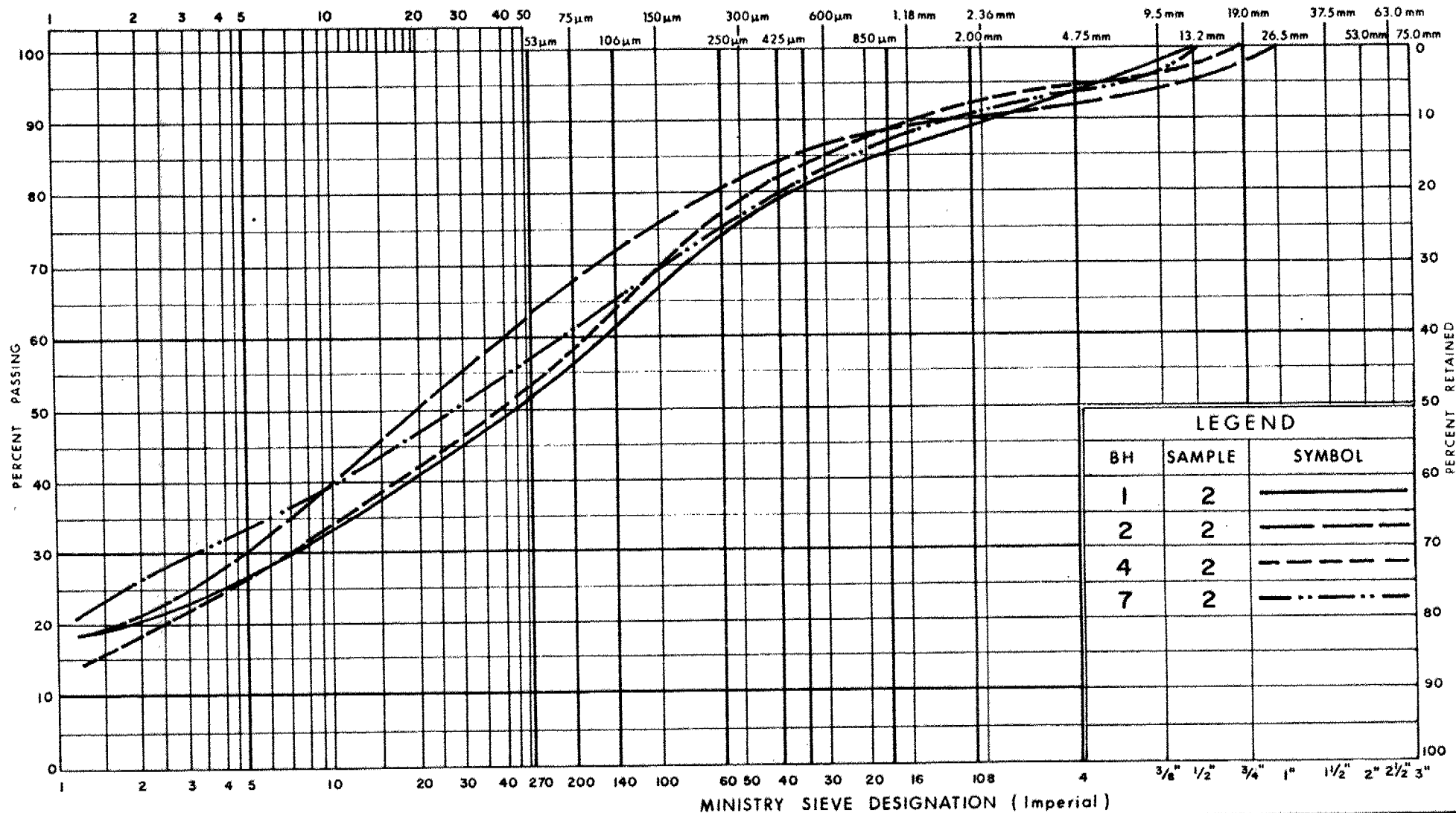
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH	SAMPLE	SYMBOL
1	2	—
2	2	- - - - -
4	2	- . - . -
7	2	- . . . -



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Communications

GRAIN SIZE DISTRIBUTION
SANDY CLAYEY SILT (GLACIAL TILL)
TRACE GRAVEL

FIG No 1

W P 142 - 87 - 02

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

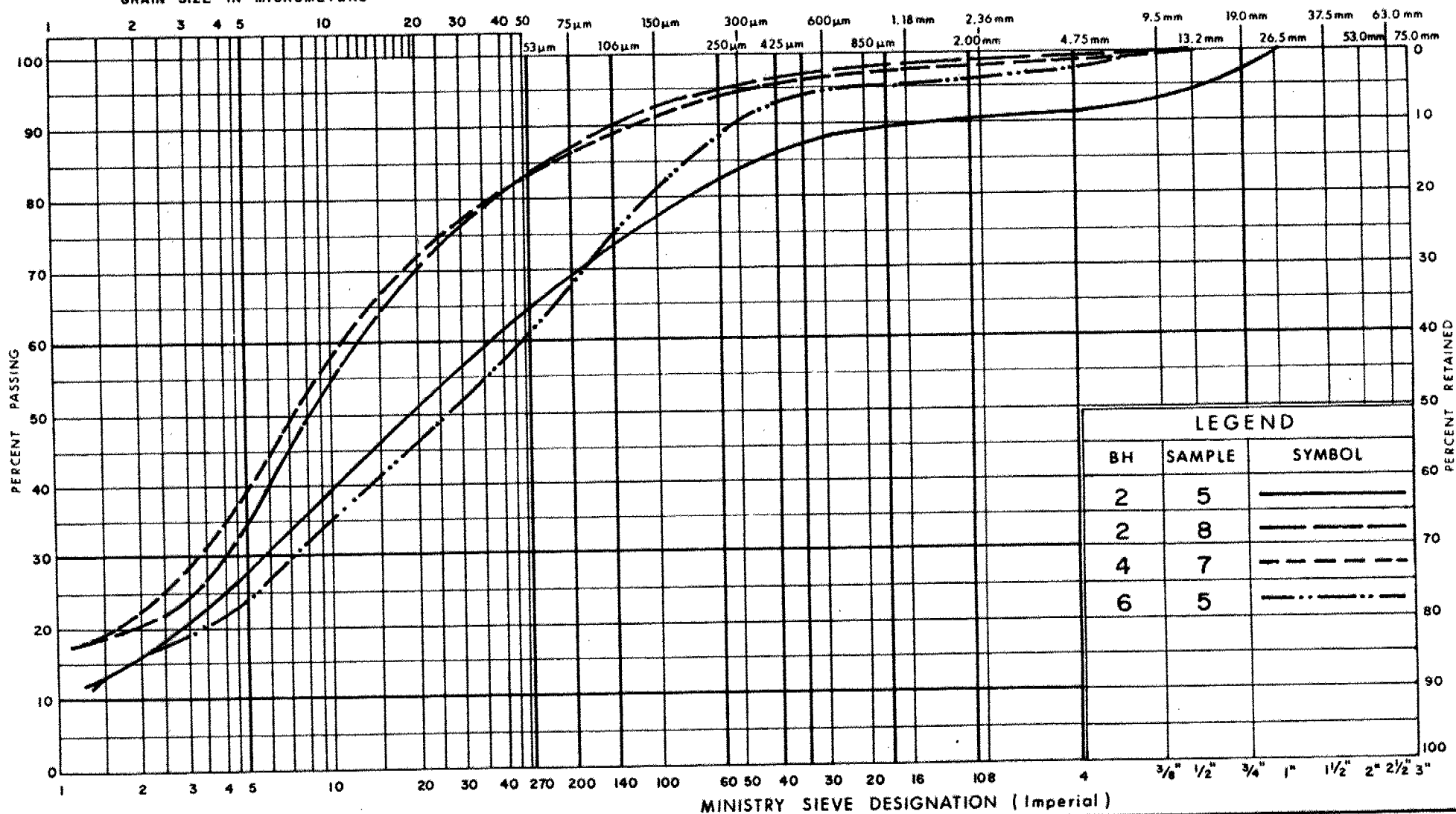
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



GRAIN SIZE DISTRIBUTION
CLAYEY SILT (GLACIAL TILL)
WITH SAND, TRACE GRAVEL

FIG No 2

W P 142-87-02



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UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

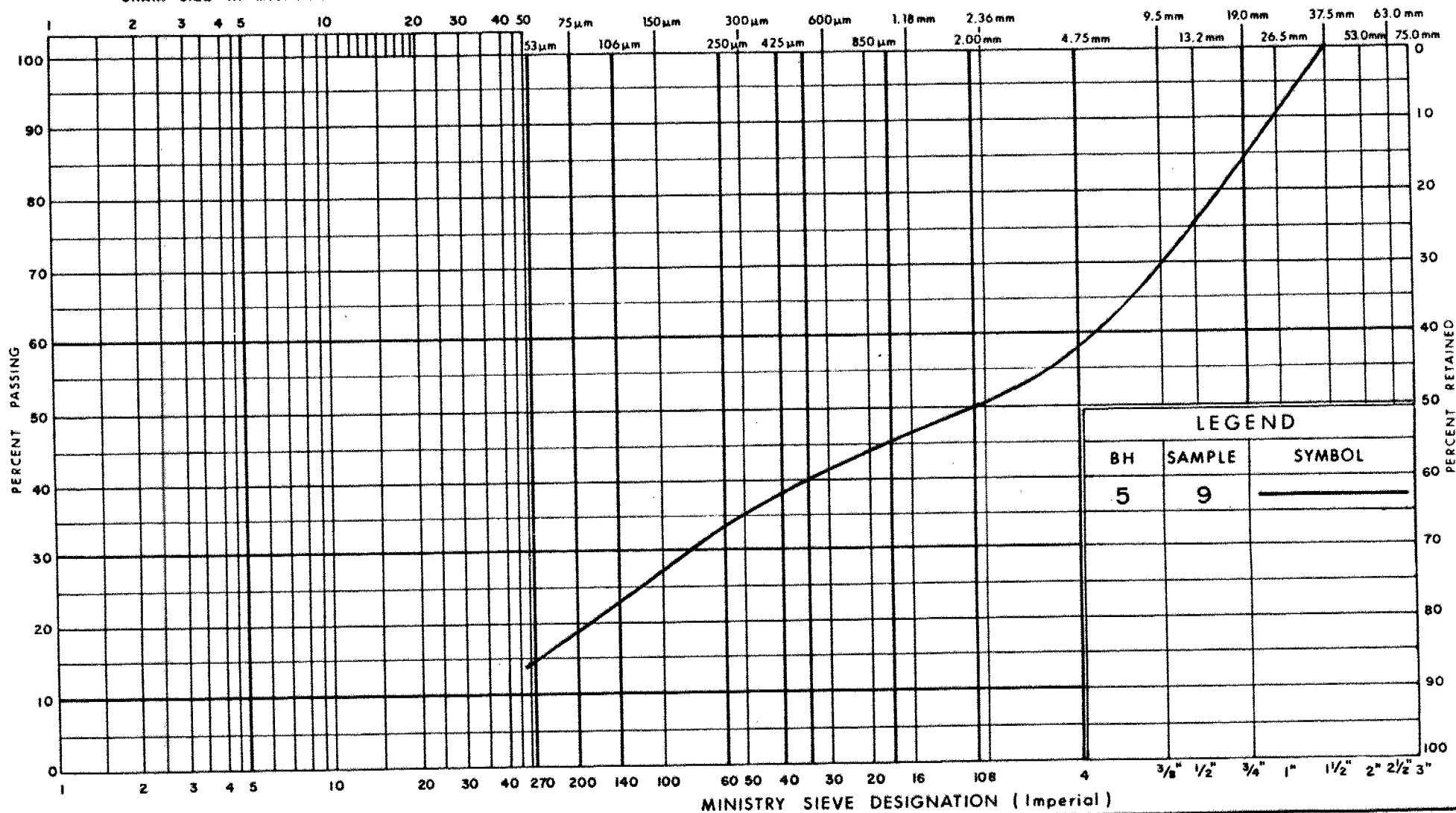
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH	SAMPLE	SYMBOL
5	9	—

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Transportation

GRAIN SIZE DISTRIBUTION
SANDY GRAVEL
WITH SILT

FIG No 3

W P 142-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

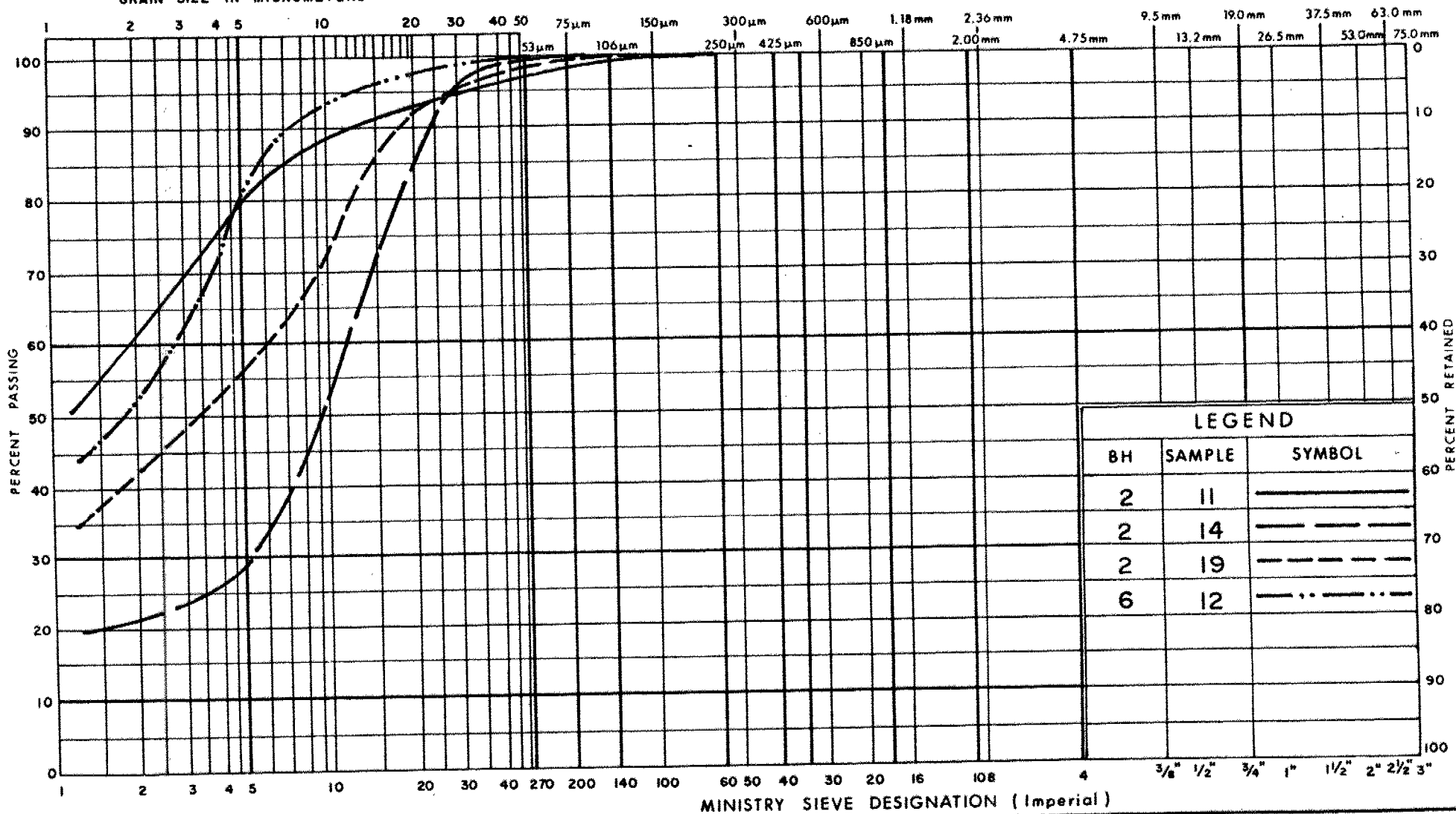
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

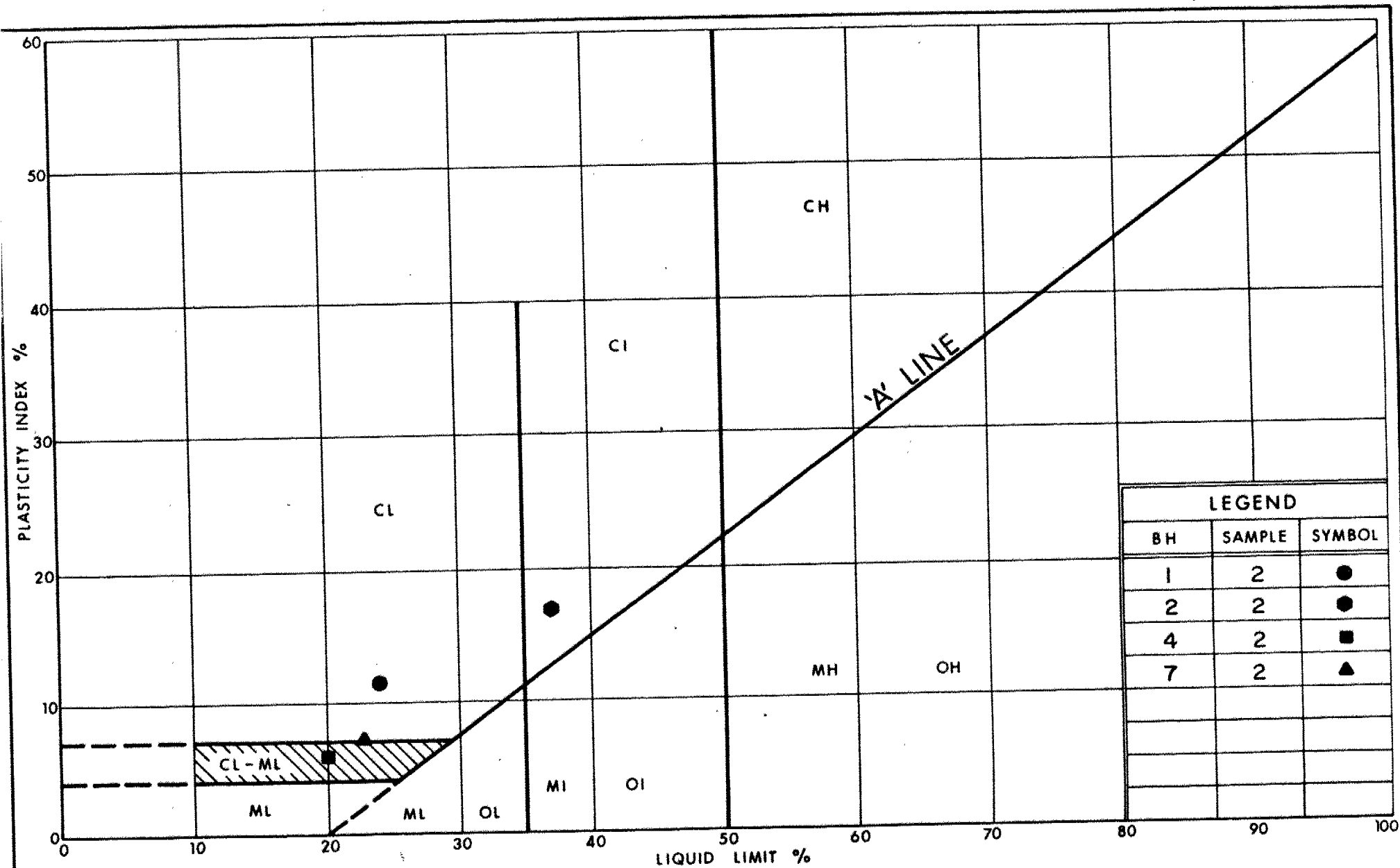
BH	SAMPLE	SYMBOL
2	11	—————
2	14	- - - - -
2	19
6	12	-

Ministry of
TransportationGRAIN SIZE DISTRIBUTION
SILTY CLAY

TRACE SAND, WITH LAYERS OF CLAYEY SILT AND SILT

FIG No 4

W P 142 - 87 - 02



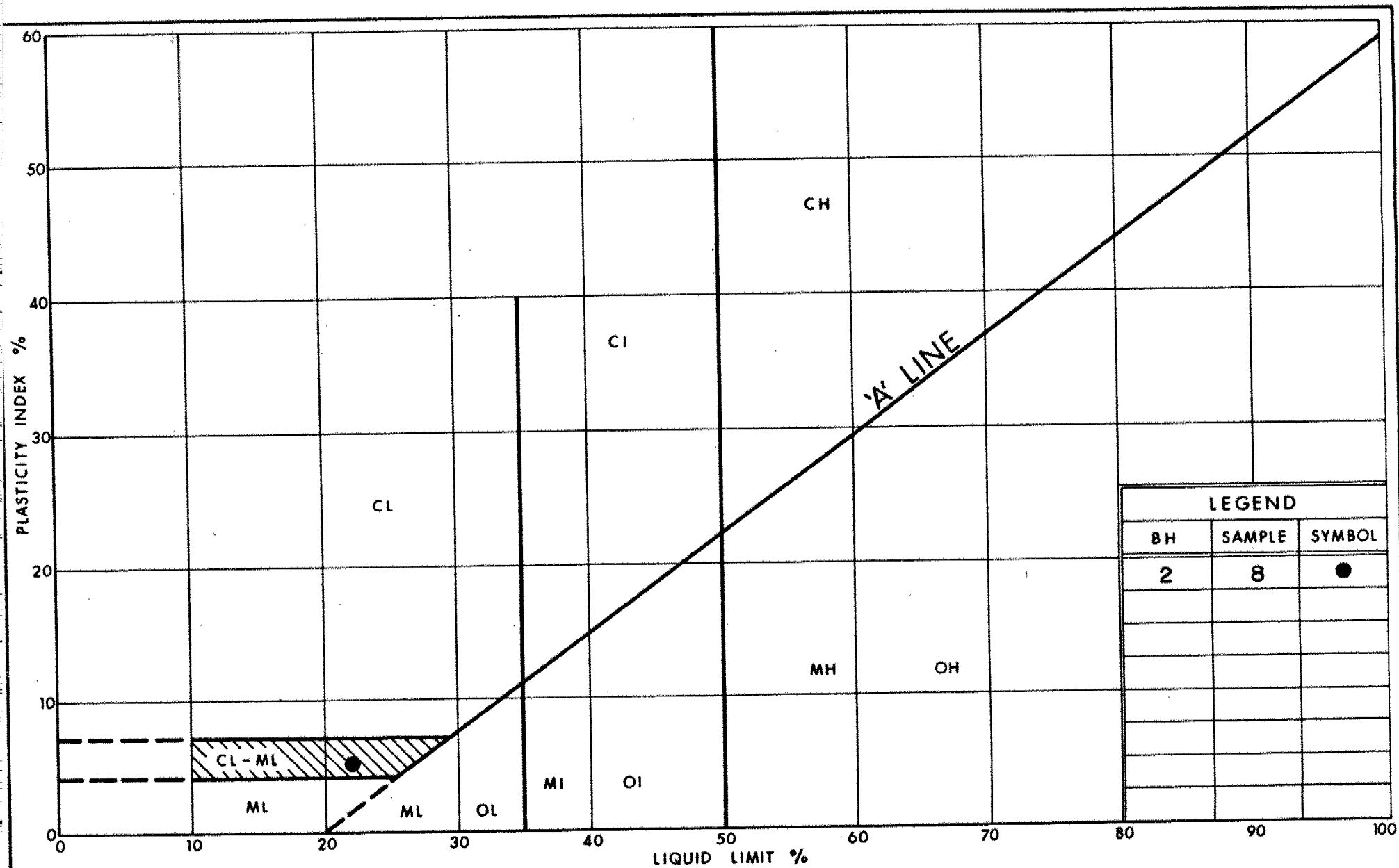
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PLASTICITY CHART
SANDY CLAYEY SILT (GLACIAL TILL)
TRACE GRAVEL

FIG No 5

W P 142 - 87 - 02



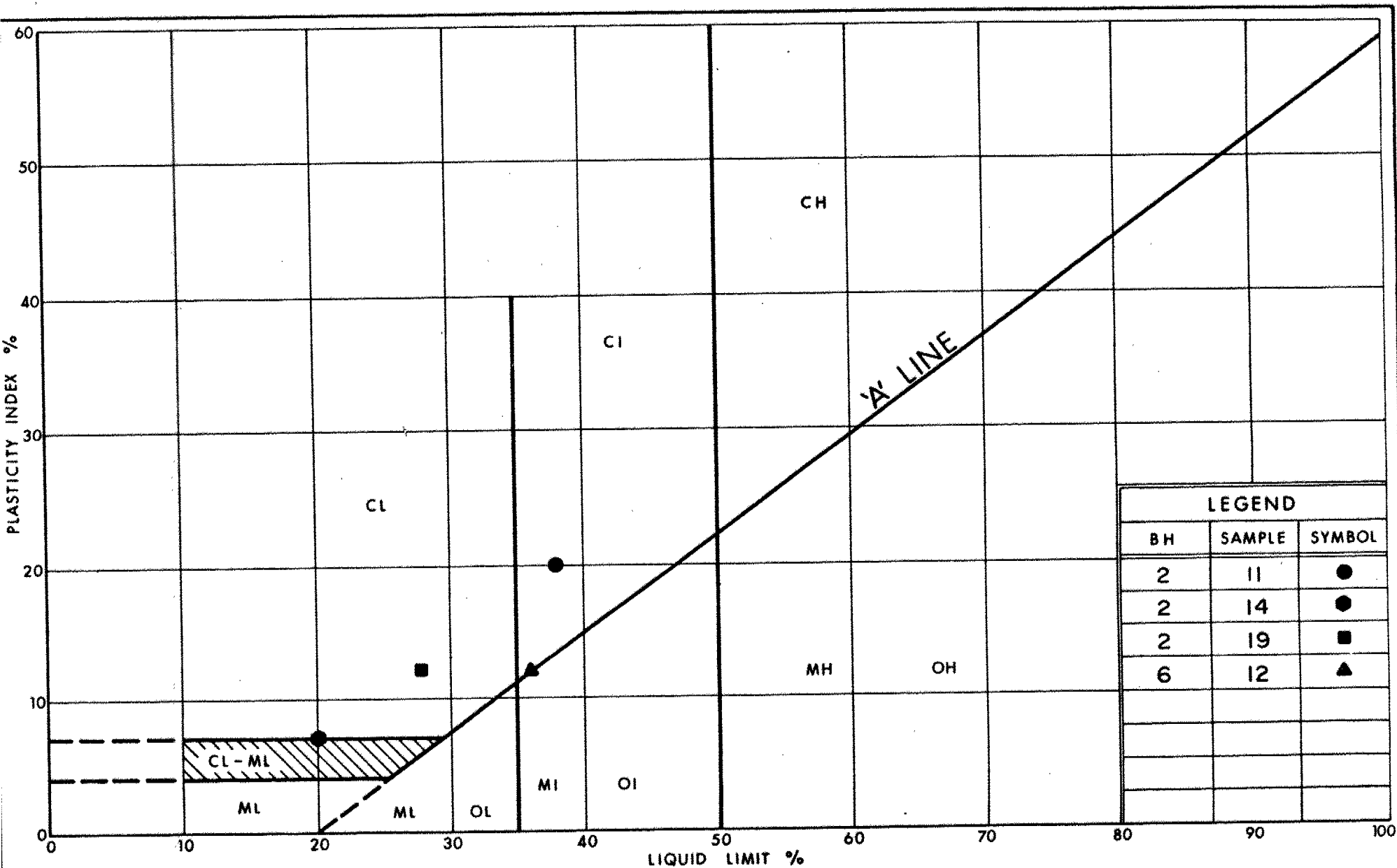
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PLASTICITY CHART
CLAYEY SILT (GLACIAL TILL)
WITH SAND, TRACE GRAVEL

FIG No 6

W P 142-87-02



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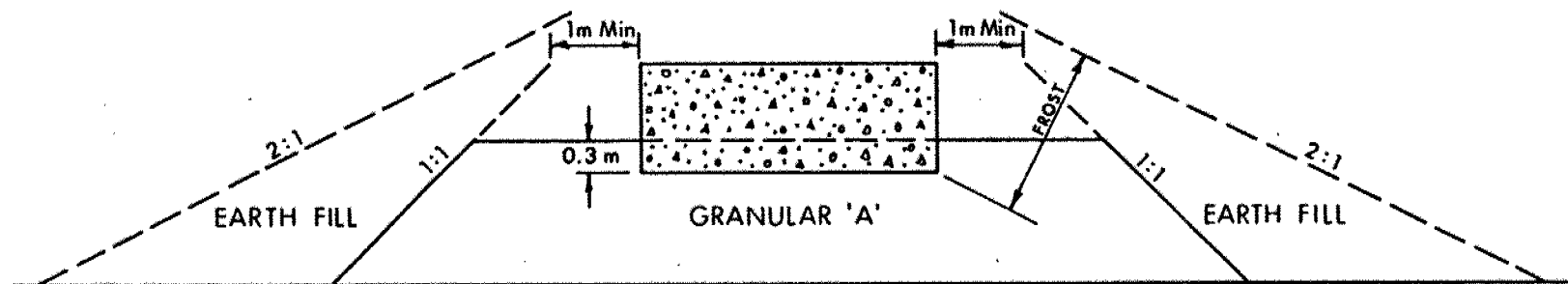
Ontario

PLASTICITY CHART SILTY CLAY

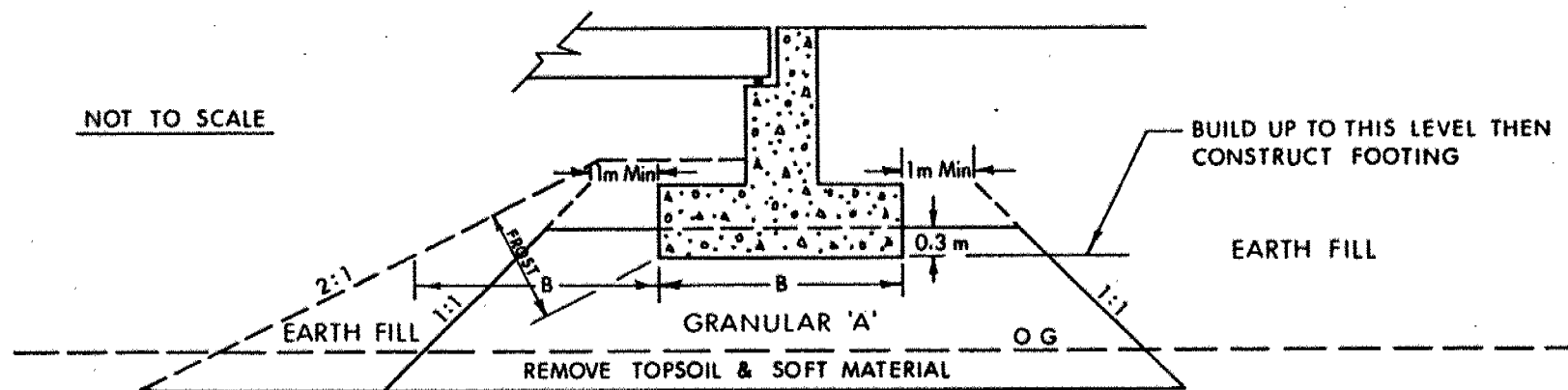
TRACE SAND, WITH LAYERS OF CLAYEY SILT AND SILT

FIG No 7

W P 142 - 87 - 02



X SECTION



LONGITUDINAL SECTION

NOTES:

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

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	T'P	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
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	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 = $\frac{w_L - w_p}{w - w_p}$	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				k	m/s	HYDRAULIC CONDUCTIVITY

RECORD OF BOREHOLE No 1

METRIC

W P 142-87-02 LOCATION N 4849458 E 301779 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE January 26/27, 1988 CHECKED BY JFW

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					
190.85	Ground Level																
190.54	Topsoil, clayey silt, low organic, black		1	SS	8		190										
0.35	Sandy clayey silt, trace gravel (Glacial Till)		2	SS	12												
			3	SS	12												
187.54	Brown Stiff		4	SS	19		188										
3.35	Clayey silt, with sand, trace gravel (Glacial Till)		5	SS	22												
			6	SS	28		186										
	Grey Very Stiff Hard		7	SS	56		184										
			8	SS	32		182										
			9	SS	39												
180.39			10	SS	60		180										
10.50	Sandy silt, with gravel (Glacial Till)		11	SS	60		178										
179.39	Grey Very Dense		12	SS	70		176										
11.50	Silty Clay, trace sand, with layers of clayey silt and silt		13	SS	55		174										
	Grey Hard		14	SS	53		172										
			15	SS	78		170										
			16	SS	49		168										
			17	SS	45												
			18	SS	40												
			19	SS	37												
166.05	End of Borehole																
24.84	Note: Upon completion of augering, water at elevation 189.67 inside augers Piezometer installed at elevation 166.71 with seal at elevation 169.55																
	Water																
	Date Elevation																
	Jan. 27/88 172.04																
	Jan. 29/88 180.52																
	Feb. 5/88 180.60																
	Feb. 8/88 180.66																

▽ water level in open borehole
▽ piezometric level

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE RETURN ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 142-87-02 LOCATION N 4849502 E 301767 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE January 25, 1988 CHECKED BY JFW

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			SHEAR STRENGTH							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
							20 40 60 80 100			10 20 30					
191.66	Ground Level														
191.31	Topsoil, clayey silt, low organic, black		1	SS	15										
0.35	Sandy Clayey Silt, silty clay, trace gravel, random cobbles (Glacial Till)		2	SS	19									8 26 42 24	
			3	SS	28										
188.00	Brown Very Stiff		4	SS	17										
3.66	Clayey Silt to silt with sand, trace gravel (Glacial Till)		5	SS	35									8 23 47 22	
			6	SS	49										
	Grey Hard		7	SS	70										
			8	SS	93									2 10 63 25	
			9	SS	74										
181.56	Silty Clay, trace sand, with layers of clayey silt and silt		10	SS	66										
10.10			11	SS	45									0 2 36 62	
	Grey Hard		12	SS	50										
			13	SS	45										
			14	SS	67									0 0 75 25	
			15	SS	57										
	Very Stiff		16	SS	28										
	Hard		17	SS	60										
			18	SS	60										
			19	SS	78									0 2 54 44	
166.82	End of Borehole														
24.84	Note: Upon completion of augering, water at elevation 188.61 inside augers. Piezometer installed at elevation 167.80 with seal at elevation 169.41														
	Date	Water Elevation													
	Jan. 25/88	170.32													
	Jan. 27/88	178.19													
	Jan. 29/88	179.36													
	Feb. 5/88	180.48													
	Feb. 8/88	180.58													

OFFICE REPORT ON SOIL EXPLORATION

▽ Water level in open borehole
▽ piezometric level

*3, *5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

METRIC

W P 142-87-02 LOCATION N 4849529 E 301771 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE January 27/28, 1988 CHECKED BY JFW

[illegible]

▽ Water level in open borehole
▼ Piezometric level

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 142-87-02 LOCATION N 4849556 E 301759 ORIGINATED BY RR
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
 DATUM Geodetic DATE February 1/2, 1988 CHECKED BY JFW

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
191.95	Ground Level																	
191.35	Topsoil, clayey silt, low organic, dark brown																	
0.60	Sandy Clayey Silt to silt, trace gravel (Glacial Till)		1	SS	11													
189.82	Brown Stiff		2	SS	15													
2.11	Clayey Silt, with sand, trace gravel (Glacial Till)		3	SS	29													
	Brown Very Stiff Hard		4	SS	25													
			5	SS	58													
			6	SS	70													
			7	SS	71													
			8	SS	56													
183.35	Sandy Silt, with gravel (Glacial Till)		9	SS	100	150 mm												
8.60	Grey Very Dense		10	SS	100	130 mm												
			11	SS	100	170 mm												
178.95	Silty Clay, trace sand, with layers of, clayey silt, and silt		12	SS	73													
13.00	Grey Hard Very Stiff		13	SS	28													
			14	SS	25													
	Hard		15	SS	45													
	Very Stiff		16	SS	29													
	Hard		17	SS	45													
			18	SS	42													
167.11	End of Borehole		19	SS	39													
24.84	Note: Upon completion of augering water at elevation 188.29 inside augers. Piezometer installed at elevation 167.92 with seal at elevation 171.07.																	
	Water Date Elevation																	
	Feb. 2/88 179.30																	
	Feb. 5/88 180.75																	
	Feb. 8/88 180.62																	

OFFICE REPORT ON SOIL EXPLORATION

∇ Water level in open borehole
 ▼ Piezometric level

+3, x5: Numbers refer to
 Sensitivity

20
 15
 10
 5
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W P 142-87-02 LOCATION N 4849580 E 301748 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE February 2/3, 1988 CHECKED BY JFW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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		
192.55	Ground Level													
192.38 0.30	Topsoil, clayey silt, low organic, dark brown		1	SS	14		192							
	Sandy Clayey Silt, trace gravel (Glacial Till)		2	SS	19		190							
			3	SS	20		188.5							
188.85 3.70	Brown Stiff Very Stiff		4	SS	21		186							
	Clayey Silt, with sand, trace gravel (Glacial Till)		5	SS	97		184							
			6	SS	100		182							
	Grey Hard		7	SS	84		180							
			8	SS	79		178							
183.55 9.00	Sandy Gravel, with silt		9	SS	*		176							
182.39 10.16	Grey		10	SS	100		174							
	Sandy silt, with gravel (Glacial Till)		11	SS	100		172							
	Grey Very Dense		12	SS	62		170							
179.15 13.40	Silty Clay, trace sand with layers of clayey silt, and silt		13	SS	36		168							
	Grey Hard		14	SS	26		166							
	Very Stiff		15	SS	39		164							
	Hard		16	SS	32		162							
			17	SS	42		160							
	Very Stiff		18	SS	24		158							
167.71	Hard		19	SS	36		156							
24.84	End of Borehole													
<p>Note: * Sampler penetrated 0.36 m under weight of rods. Before sample 10, water at elevation 184.32 inside augers. Upon completion of augering water at elevation 184.32 inside augers. Piezometer installed at elevation 168.09 with seal at elevation 169.39.</p> <p>Water Date Elevation Feb. 3/88 171.06 Feb. 5/88 178.91 Feb. 8/88 181.29</p>														

OFFICE REPORT ON SOIL EXPLORATION

▼ Water level in open borehole
▼ Piezometric level

3, x 5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 142-87-02 LOCATION N 4849597 E 301787 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE February 5/8, 1988 CHECKED BY JFW

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					
191.45	Ground Level																
191.15	Topsoil, clayey silt, low organic, dark brown		1	SS	6		192										
0.30	Sandy Clayey Silt, trace gravel (Glacial Till)		2	SS	10												
190.55	Brown Firm to Stiff/ Very Stiff		3	SS	20												
2.90	Clayey Silt, with sand to sandy, trace gravel (Glacial Till)		4	SS	12		190										
	Grey Stiff		5	SS	83												
	Hard		6	SS	65												
			7	SS	58		188										
			8	SS	35		186										
184.45	Sandy Silt with gravel (Glacial Till)		9	SS	28		184										
	Grey Compact		10	SS	250 mm												
	Very Dense						182										
181.85	Silty Clay, trace sand with layers of clayey silt, and silt		11	SS	45		180										
11.60	Grey Hard		12	SS	57		178										
			13	SS	62		176										
			14	SS	45		174										
			15	SS	85		172										
			16	SS	50		170										
			17	SS	32												
	Very Stiff		18	SS	25												
			19	SS	47												
168.61	Hard																
24.84	End of Borehole																
	Note: Upon completion of augering water at elevation 170.74 in open borehole. Piezometer installed to elevation 169.07 with seal at elevation 173.69																
	Water Date Feb. 8/88 Elevation 171.41																
	Water level had not stabilized at completion of field work.																

▽ Water level in open borehole
▽ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 7

METRIC

W P 142-87-02 LOCATION N 4849619 E 301782 ORIGINATED BY BB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE February 3/4, 1988 CHECKED BY JFW

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 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%)										
193.99	Ground Level							50 100 150 200 250	10 20 30								
193.69	Topsoil, clayey silt, low organic, dark brown																
0.30			1	SS	22		192					22.18	6 34 33 27				
	Sandy Clayey Silt, trace gravel (Glacial Till)		2	SS	23												
191.09			3	SS	21												
2.90	Brown Very Stiff		4	SS	80												
	Clayey Silt, with sand, trace gravel, random boulders (Glacial Till)		5	SS	62		190										
			6	SS	69												
	Grey Hard		7	SS	46		188										
			8	SS	44		186										
185.19																	
8.60	Sandy Silt, with gravel (Glacial Till)																
181.99	Grey Very Dense						184										
10.00	Silty Clay, trace sand with layers of clayey silt and silt		10	SS	33												
			11	SS	31		182										
	Grey Hard		12	SS	59		180										
			13	SS	34		178										
			14	SS	34												
			15	SS	36		176										
							Bentonite Seal										
			16	SS	48		174										
			17	SS	36		172										
			18	SS	38												
							170										
169.15			19	SS	32		Piezometer Tip										
24.84	End of Borehole																
	Note: Upon completion of augering water at elevation 190.94 inside augers. Piezometer installed at elevation 169.61 with seal at elevation 175.09																
	Water																
	Date Elevation																
	Feb. 5/88 181.62																
	Feb. 8/88 181.52																

OFFICE REPORT ON SOIL EXPLORATION

▽ Water level in open borehole
▽ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

W P 142-87-02 LOCATION N 4849555 E 301786 ORIGINATED BY RB
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JFW
DATUM Geodetic DATE January 27/28, 1988 CHECKED BY JFW

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
192.45	Ground Level													
192.19	Topsoil, clayey silt, low organic, dark brown		1	SS	6									
0.30			2	SS	9									
190.39	Sandy Clayey Silt, trace gravel (Glacial Till)		3	SS	28									
2.10			4	SS	92									
	Brown Firm to Stiff		5	SS	60	150 mm								
	Clayey Silt, with sand, trace gravel (Glacial Till)		6	SS	80	150 mm								
	Brown Very Stiff		7	SS	61									
	Grey Hard		8	SS	54									
183.89			9	SS	90									
8.60	Sandy Silt, with gravel (Glacial Till)		10	SS	45	150 mm								
	Grey Very Dense		11	SS	46									
180.99			12	SS	41									
11.50	Silty Clay, trace sand with layers of clayey silt and silt		13	SS	27									
	Grey Hard		14	SS	23									
	Very Stiff		15	SS	40									
	Hard		16	SS	50									
			17	SS	40									
			18	SS	35									
			19	SS	38									
167.65														
24.84	End of Borehole													
	Note: Upon completion of augering water at elevation 169.63 inside augers. Piezometer installed at elevation 167.65 with seal at elevation 175.12													
	Water Date Elevation													
	Jan. 28/88 170.62													
	Feb. 5/88 180.98													
	Feb. 8/88 180.93													

▽ Water level in open borehole
▽ Piezometric level

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

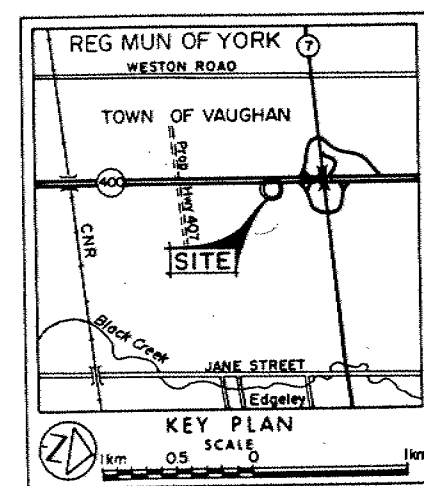
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES.

CONT No
WP No 142-87-02

SHEET

STRUCTURES 14 AND 22
HWYS 400/407 INTERCHANGE
BORE HOLE LOCATIONS & SOIL STRATA

PETO MACCALLUM LTD.



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Feb 1988 in Piezometer
- W L in open Bore Hole
- PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	190.89	4 849 458	301 779
2	191.66	4 849 502	301 767
3	192.25	4 849 529	301 771
4	191.95	4 849 556	301 759
5	192.55	4 849 580	301 748
6	193.45	4 849 597	301 787
7	193.99	4 849 619	301 782
8	192.49	4 849 555	301 786

NOTE: The location and elevation at each Bore Hole were provided by MTO. At the time of drilling, local construction activities were underway.

NOTE: The water level in piezometer 6 had not stabilized at completion of field work.

NOTE

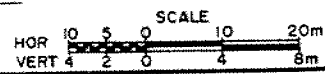
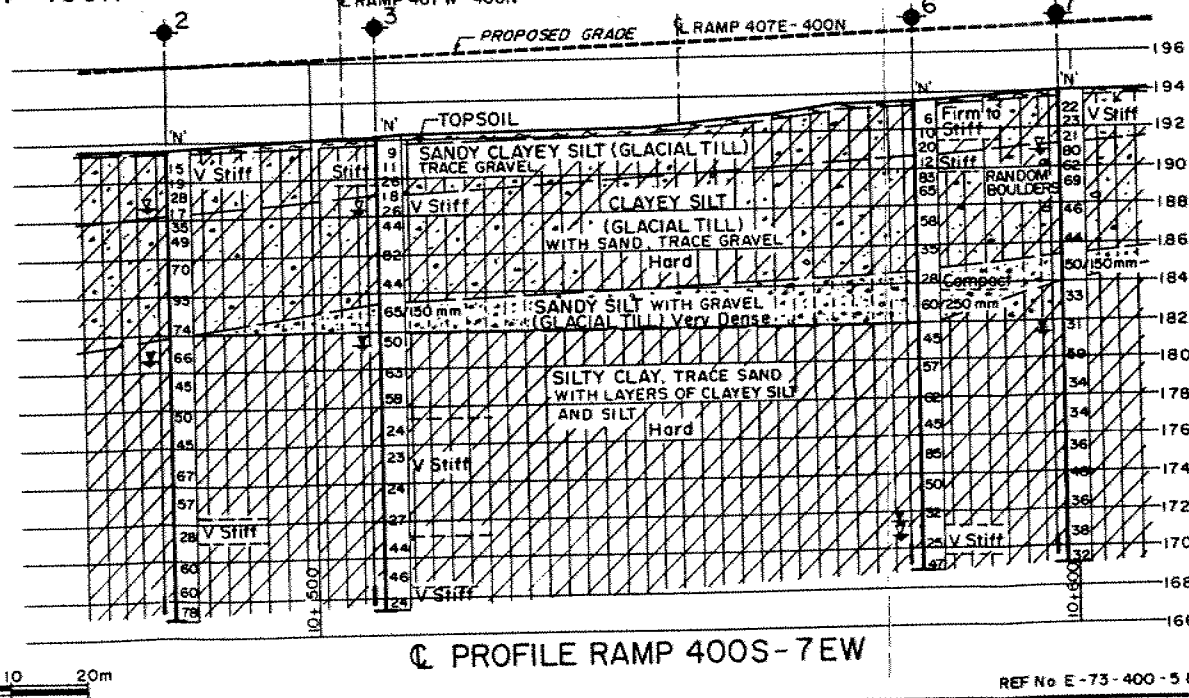
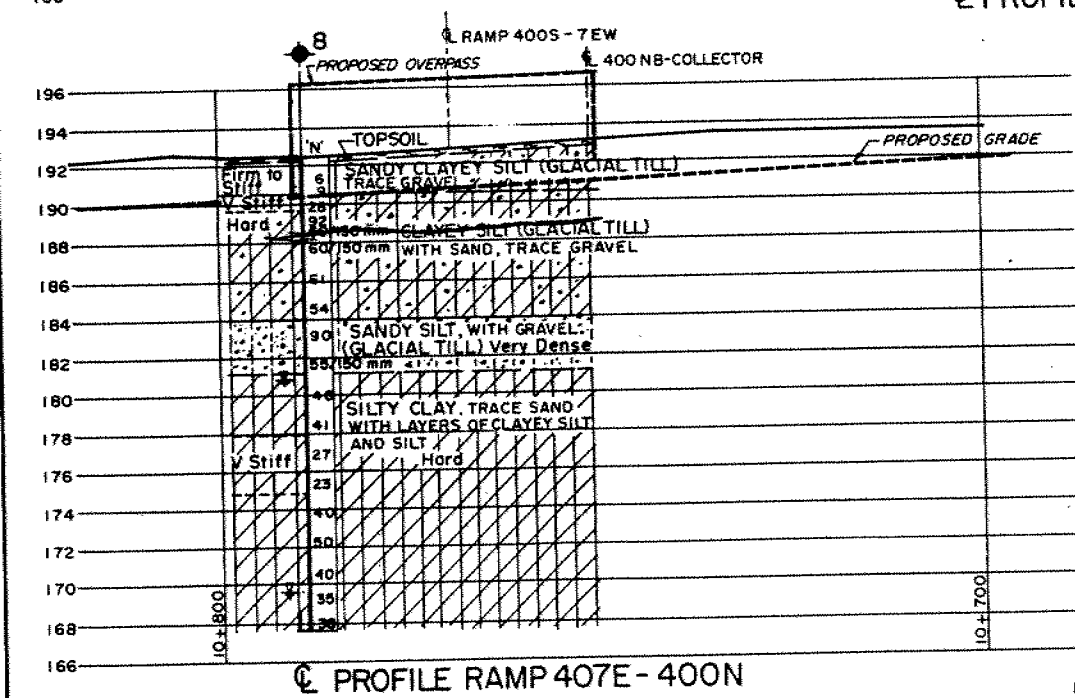
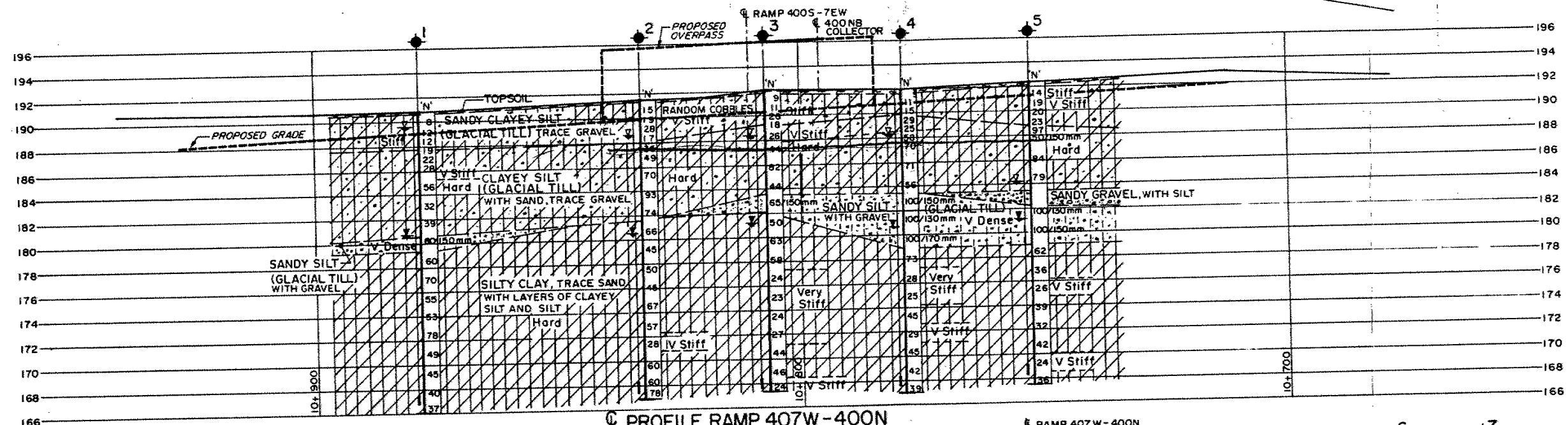
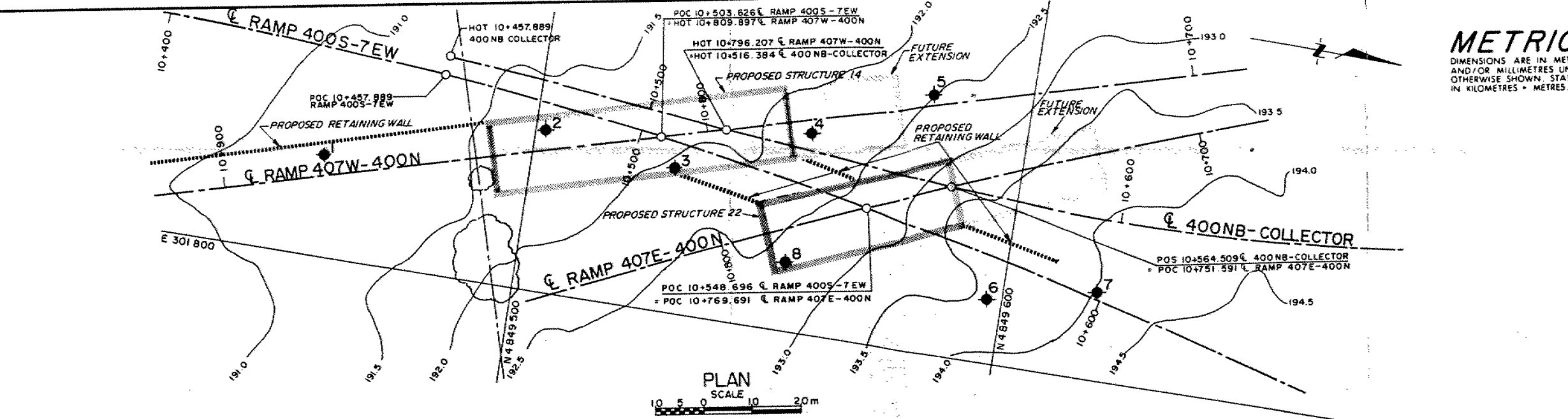
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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
1			

Geocres No 30M13-77

HWY No 400	CHECKED BY	DATE 1988 03	DIST 6
SUBMD J.W.	CHECKED BY	DATE 1988 03	SITE
DRAWN K.K.	CHECKED BY	DATE 1988 03	DWG 1428702-A



REF No E-73-400-5 & 6

memorandum



To: G. Al-Bazi
Structural Office
7th Floor, Atrium Tower

Date: 91 08 27

Attn: N. Chatzitheodorou
Design Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Reinforced Earth Retaining Walls
Ramp 400S - 7EW over Ramp 407W - 400N
W.P. 142-87-02, Site 37-1178 (Structure #14)
District 6, Toronto

The Reinforced Earth retaining wall drawings for the above mentioned structure have been reviewed by our Section. There is a concern that, with limited subsurface information at the south retaining wall, the computed bearing pressures might be a little excessive. However, given the consistent subsurface conditions encountered at the Highways 400/407 site and the relative flexibility of Reinforced Earth structures, it is considered that the proposed design of both retaining walls is satisfactory.

A handwritten signature in cursive script that reads "B. Bennett".

Betty Bennett, P.Eng.
Foundation Engineer

August 16, 1991

Ministry of Transportation
Structural Office
7th Floor Atrium Tower
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. G. Al-Bazi, P. Eng.
Design Engineer (Central Region)

RE: RAMP 400S - 7EW OVER
RAMP 407W - 400N
MTO W.P. 14-87-02
REWAL FILE NO. 8871

Dear Sir:

Please find enclosed two copies of the revised reinforced earth retaining wall drawings (DWGS. 16, 17 & 18) for your onward transmission to the Foundation Section for review.

The walls are designed to withstand the earth pressure and subcharge loads as a function of the design parameters listed below:

1. Design Code OHBDC 1983
2. Traffic Surcharge 12.4 kPa.
3. Backfill $\phi(R/E) = 36^\circ$, ϕ (Behind R/E) = 36° , ϕ (Foundation) = 26°
Unit weight R/E = 21 KN/m³ (Compacted granular fill).
4. Seismic $a/g = 0.04$

If you have any questions please feel free to contact us.

Yours very truly,

R.E. WINTER & ASSOCIATES LTD.

Per: Daniel Ip
Senior Bridge Engineer

DI/mg

Encls.



memorandum



To: G. Al-Bazi
Design Engineer
Structural Office
7th Floor, Atrium Tower

Date: 1991 03 11

FROM: Foundation Design Section
Room 315, Central Building

RE: General Arrangement Drawing
Ramp 400 S - 7 EW over Ramp 407W-400N
W.P. 142-87-02, Site 37-1178 (Str. 14)
District 6, Toronto

The preliminary General Arrangement Drawing for the above-mentioned project has been reviewed. The drawing was found to comply with the Foundation Design Report and the subsequent memo dated 91 02 13. We have no comments at this time.

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

B. Bennett, P. Eng.
Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

BB/mmj

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1991 02 13

Attn: J. Lam
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Foundation Recommendations for
Structure #14 Re-location
W.P. 142-87-02(B), Site 37-1178
Highways 400/407 Interchange
District 6, Toronto

This memo contains revised recommendations for the above-mentioned project following the design change of August 1990 favouring a single structure (# 14) to carry Highway 400 Northbound Collector and Ramp 400S-7EW over Ramp 407W-400N and Ramp 407E-400N. It was originally proposed to construct two single span rigid frame structures. The revised structure proposed is a considerably larger single span rigid frame bridge measuring 97 m long and 22 m wide. As a result of the change, the length and number of retaining walls have been reduced. A 40 m \pm long retaining wall will extend south of the west abutment and a 45 m \pm long retaining wall will extend north of the east abutment.

A foundation investigation and design report was prepared by Peto MacCallum Ltd. in May 1988 for the original structure configuration, i.e. structures # 14 and # 22. Upon reviewing the scope of the investigation, it was found that the boreholes advanced for the original structures provide adequate subsurface information for the revised proposal. Hence, many of the recommendations are applicable to the revised structure. The recommendations are summarized below. However, the original report should be referred to in conjunction with this memo. Revised recommendations have been provided for the retaining walls and supercede those found in the report.

Structure Foundations

The subsurface conditions are suitable for spread footings founded on original ground.

West Abutment

The west abutment footing may be founded on original ground as described in the Report, Section 6.1.1 Spread Footings for Structure # 14.

East Abutment

The east abutment footing may be founded on original ground as discussed in the Report, Section 6.2.1 Spread Footings for Structure #22, West Abutment.

Alternatively, the West and East Abutments of the revised structure may be perched and founded on a compacted Granular "A" pad as outlined in the Report, Section 6.1.3. The granular pad should have a minimum 2.0 m thickness.

Deep foundations may also be considered. Refer to Section 6.1.2 of the Peto MacCallum Report for piled foundation details.

Retaining Walls

South Retaining Wall

The south retaining wall may be supported on shallow foundations placed on original ground, with the following bearing capacities:

	Founding Elevation	
	<u>187 - 186.0</u>	<u>Below El. 186</u>
Factored Bearing Capacity at U.L.S	375 kPa	525 kPa
Bearing Capacity at S.L.S. Type II	250 kPa	350 kPa

North Retaining Wall

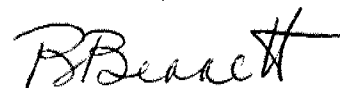
The retaining wall extending north of the proposed structure may be founded on spread footings on original ground, with the following bearing capacities:

	Founding Elevation	
	<u>El. 190.0 - 188.9</u>	<u>Below El. 188.9</u>
Factored Bearing Capacity at U.L.S.	375 kPa	800 kPa
Bearing Capacity at S.L.S. Type II	250 kPa	500 kPa

The remaining recommendations for the retaining walls are outlined in Section 6.3 of the Peto MacCallum Report.

Refer to the Report also for recommendations concerning lateral earth pressures, approach embankments, excavation and dewatering, and frost protection.

If there are any questions, please advise.



B. Bennett, P. Eng.
Foundation Engineer

for

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

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-77

DIST. _____ REGION _____

W.P. No. 142 -87-02 ~~04~~
-04

CONT. No. _____

W. O. No. _____

STR. SITE No. 37-1184
37-1178

HWY. No. 400/407

LOCATION BRIDGES #22 & #14

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No 6

CONT No

WP No 142-87-04

RAMP 400 S TO 7E,W
OVER RAMP 407 E TO 400 N
(STRUCTURE 22)
GENERAL ARRANGEMENT

SHEET

DELCAN

ENGINEERING
PLANNING
ARCHITECTS

NOTE

W.P. DENOTES WORKING POINT
T/A DENOTES TOP OF ASPHALT
PAVEMENT

GENERAL NOTES

1. CLASS OF CONCRETE 30 MPa
2. CLEAR COVER TO REINFORCING STEEL
FOOTINGS 100 ± 25
ABUTMENTS AND WINGWALLS
FRONT FACE 80 ± 20
BACK FACE 70 ± 20
DECK TOP 70 ± 20
BOTTOM 50 ± 10
REMAINDER 70 ± 20 UNLESS OTHERWISE NOTED
3. REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX C DENOTE COATED BARS.

CONSTRUCTION NOTES

1. SIDES OF FOOTINGS SHALL BE CAST AGAINST UNDISTURBED SOIL.
2. BACKFILL BEHIND EITHER ABUTMENT MAY BE COMPLETED BEFORE BACKFILLING BEHIND THE OTHER ABUTMENT.
3. CONCRETE BARRIER WALL ON WINGWALL AND RETAINING WALLS SHALL NOT BE CAST UNTIL THE WINGWALL AND RETAINING WALL BACKFILL HAS BEEN COMPLETED.

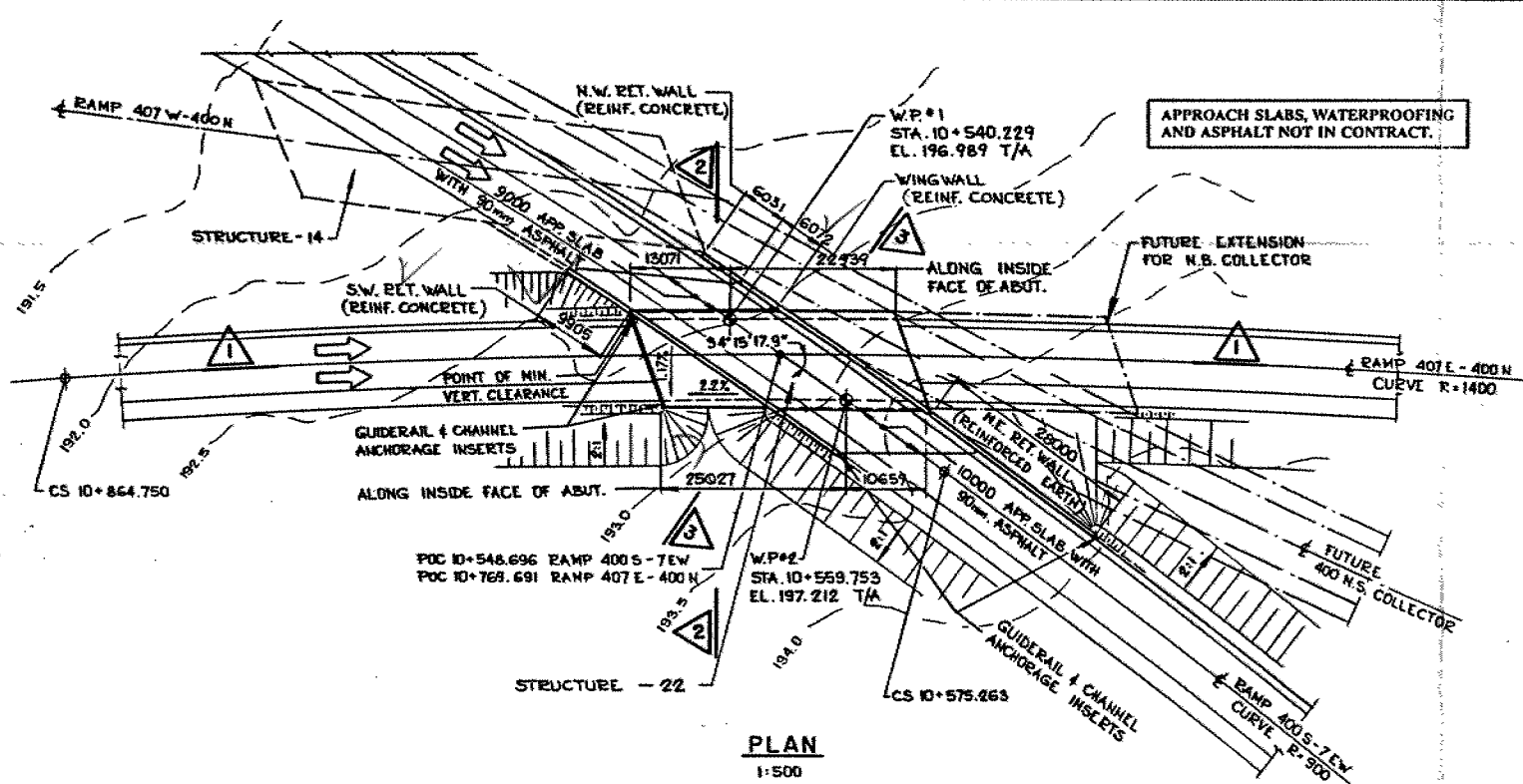
LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS & SOIL STRATA
3. FOUNDATION LAYOUT
4. FOOTING REINFORCING
5. WEST ABUTMENT
6. WEST ABUTMENT WINGWALL
7. EAST ABUTMENT
8. DECK LAYOUT AND DETAILS
9. DECK REINFORCING
10. DECK PAVING
11. RETAINING WALLS
12. BARRIER WALL ON STRUCTURE
13. BARRIER WALL ON REINFORCED EARTH
14. RETAINING WALL
15. BARRIER WALL ON APPROACH SLAB
16. APPROACH SLABS
17. STANDARD DETAILS
18. BRIDGE DATE & SITE NUMBER DATA
19. AS CONSTRUCTED ELEV & DIM
20. REINFORCED EARTH RETAINING WALL, PLAN & DETAILS
21. REINFORCED EARTH RETAINING WALL, ELEVATION AND SECTIONS
22. REINFORCED EARTH RETAINING WALL, TYPICAL DETAILS
23. QUANTITIES - STRUCTURE

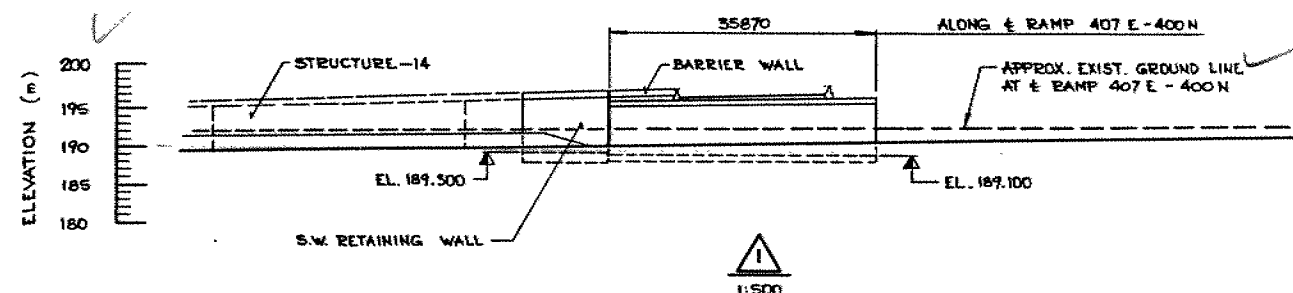
JUN 27 1989

APPLICABLE STANDARD DRAWINGS

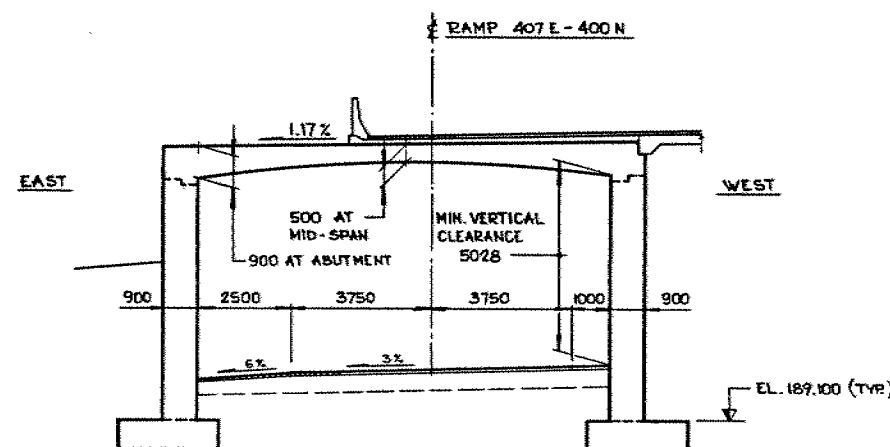
OPSD-3489.02 BRIDGE DECK WATERPROOFING
OPSD-3489.03 BRIDGE DECK WATERPROOFING DETAILS
DD-3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS



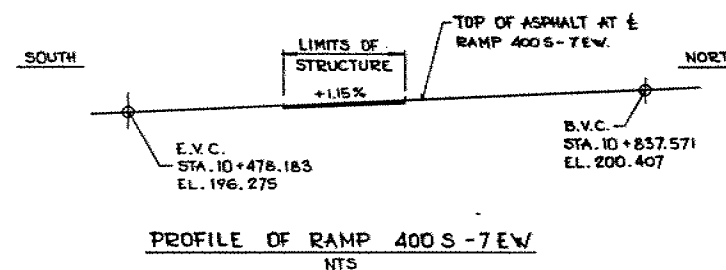
PLAN
1:500



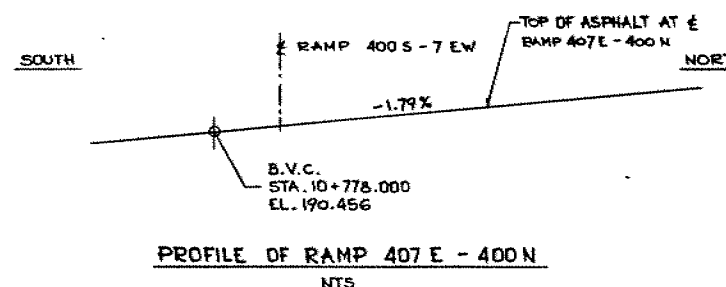
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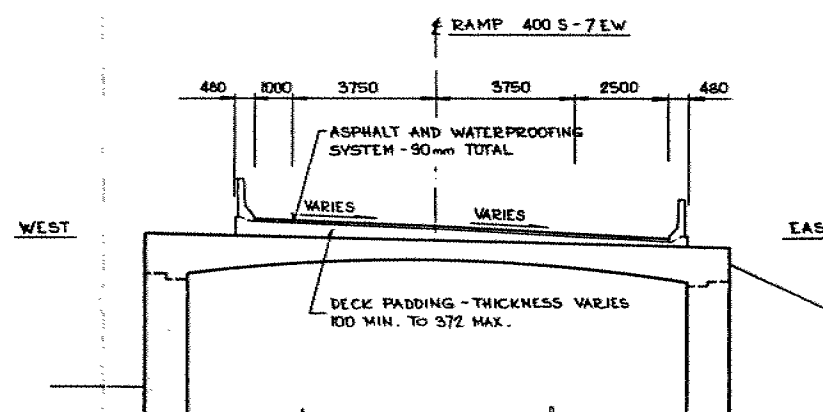
2
1:100



PROFILE OF RAMP 400 S-7E W
NTS



PROFILE OF RAMP 407 E-400 N
NTS



3
1:100



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

BM 190.832
GEODETIC DATUM
N4 W IN NW 200' 0.4' WILLOW
30.5 RT II+629.4
HIGHWAY 400

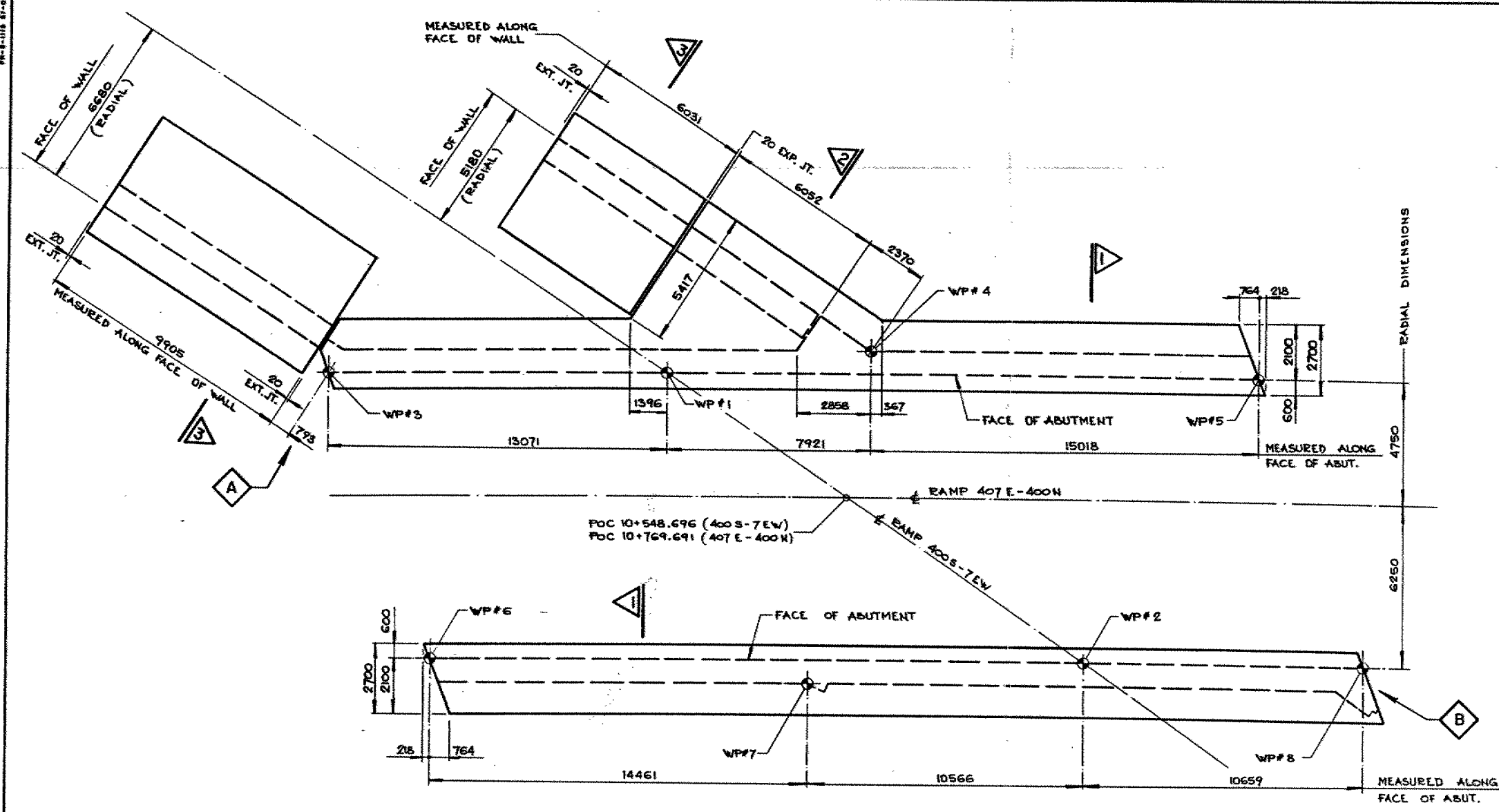
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	B.R.F.	CHECK	D.B.M. LOADING
DRAWING	W.K.	CHECK	D.B.F. SITE No
			37-1184
			DATE APR '89
			DWG 1

PR-8-1118 37-50

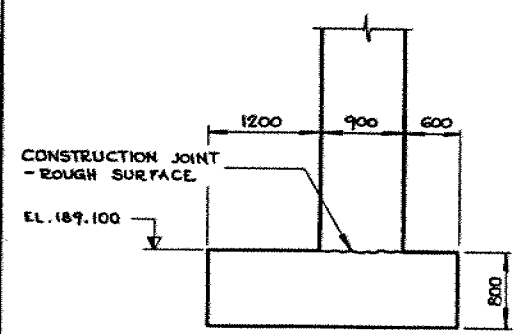
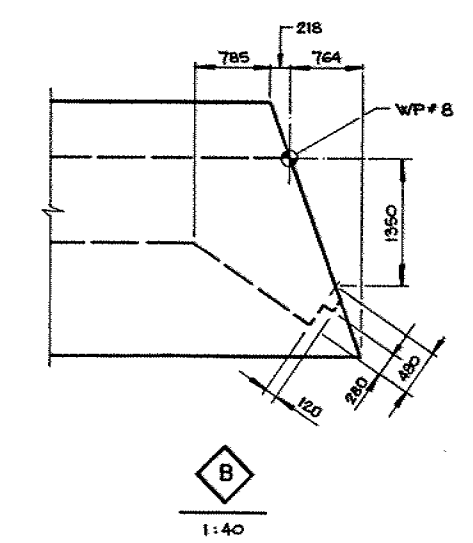
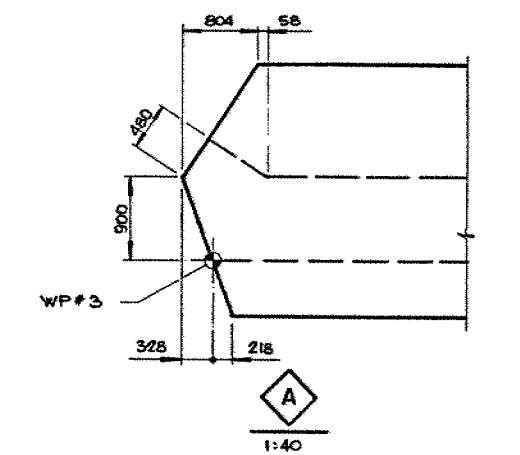
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No WP No 142-87-04		SHEET
RAMP 400S TO 7E,W OVER RAMP 407E TO 400N (STRUCTURE 22) FOUNDATION LAYOUT		
DELCAN <small>ENGINEERING PLANNING ARCHITECTS</small>		

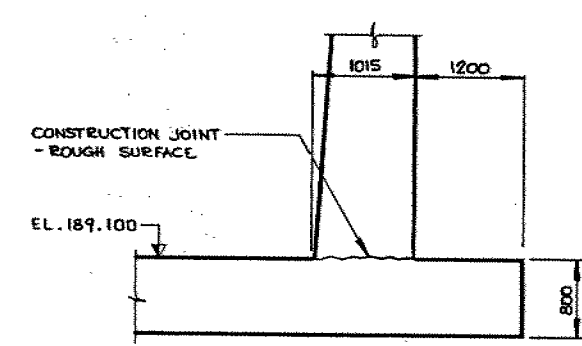
WORKING POINT	CO-ORDINATES	
	NORTH	EAST
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2	4849580.712	301774.976
3	4849549.589	301776.387
4	4849568.497	301767.209
5	4849582.703	301762.240
6	4849557.708	301784.830
7	4849571.332	301779.913
8	4849590.563	301770.905



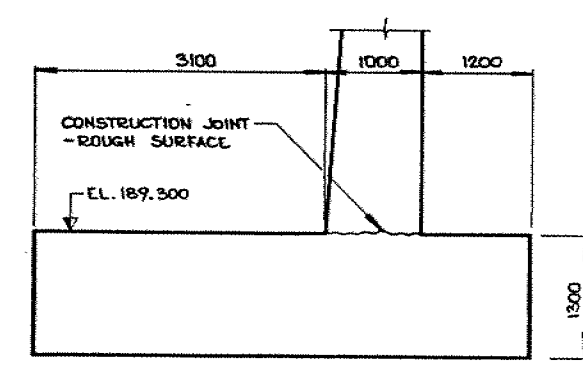
PLAN
1:100



1
1:40



2
1:40

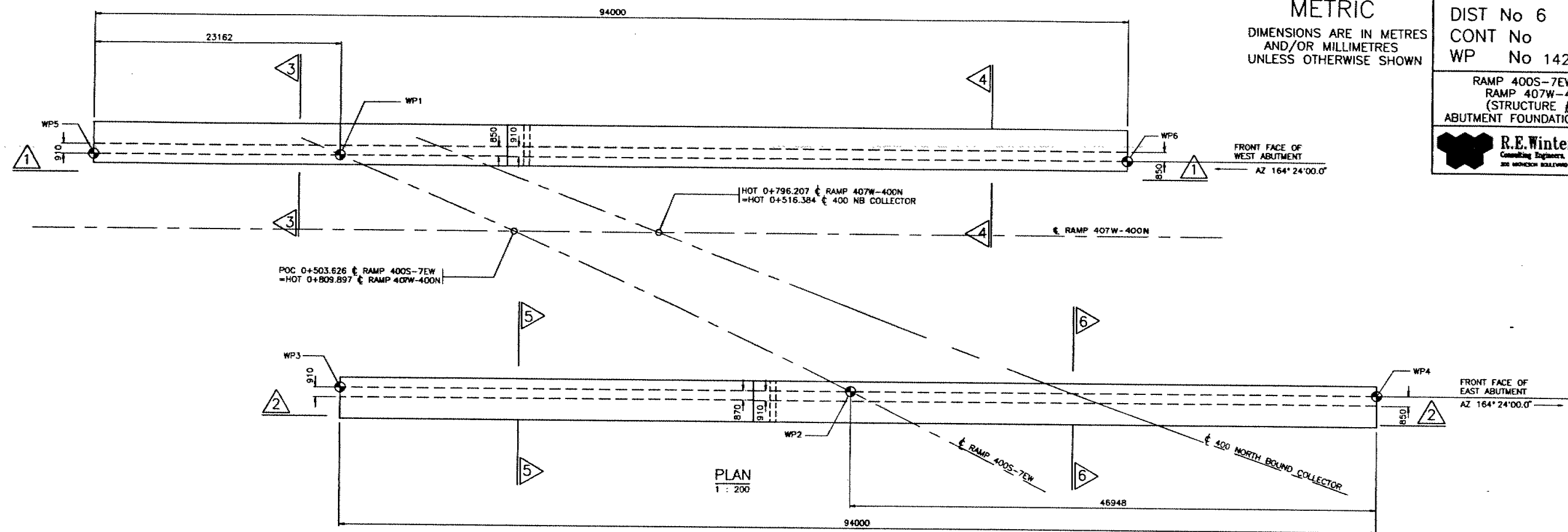


3
1:40

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REVISIONS	DATE	BY	DESCRIPTION
DESIGN DBM	CHK BRJ	CODE DBM	83 LOAD CLASS A DATE APR '89
DRAWN WJK	CHK DBM	SITE 37-1184	STRUCT 22 SCHEME DWG. 3



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

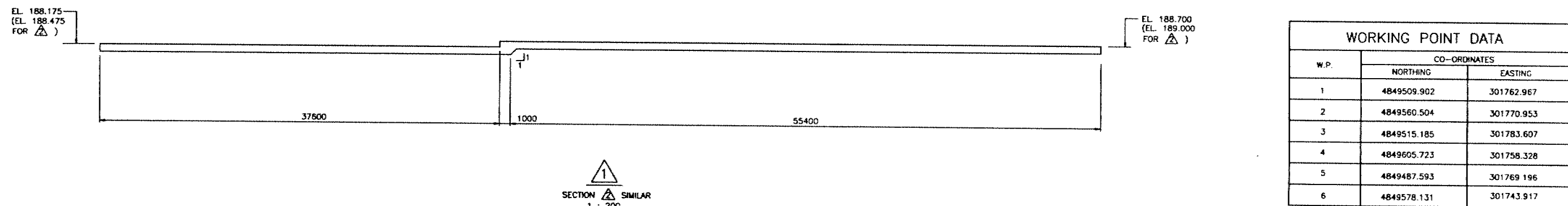
DIST No 6
CONT No
WP No 142-87-02



RAMP 400S-7EW OVER
RAMP 407W-400N
(STRUCTURE #14)
ABUTMENT FOUNDATION LAYOUT

R.E. Winter & Associates Ltd.
Consulting Engineers, Architects, Planners and Landscape Architects
200 MONROE BOULEVARD WEST, MISSISSAUGA, ONT. L4Z 1K1 TEL. (416) 670-0319

SHEET

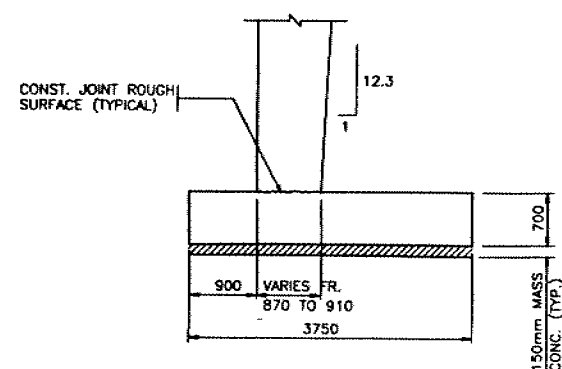


WORKING POINT DATA

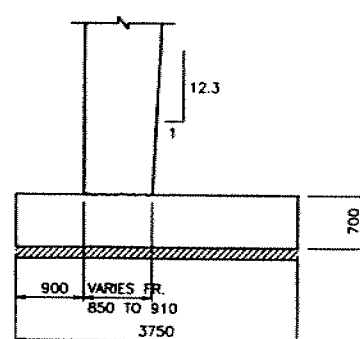
W.P.	CO-ORDINATES	
	NORTHING	EASTING
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2	4849560.504	301770.953
3	4849515.185	301783.607
4	4849605.723	301758.328
5	4849487.593	301769.196
6	4849578.131	301743.917

NOTE:

1. A 150mm THICK MASS CONCRETE SEAL SLAB SHALL BE CAST WITHIN 4 HRS. AFTER COMPLETION OF FOOTING EXCAVATION.



SECTION 3
1 : 50



SECTION 4
1 : 50



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	CHK	APP	DATE	BY	CHK	APP	DATE	BY	CHK	APP
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

DESIGN BY CHK VZ CODE OHBDC-83 LOAD CLASS A DATE JULY 1991
DRAWN BY CHK DI SITE 37-1178 STRUCT SCHEME DWG 03

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

DIST No 6
CONT No
WP No 142-87-02



RAMP 400S-7EW OVER
RAMP 407W-400N
(STRUCTURE #14)
GENERAL ARRANGEMENT

SHEET

R.E. Winter & Associates Ltd.
Consulting Engineers, Architects, Planners and Landscape Architects
200 WILSON BOULEVARD WEST, WINDSOR, ONT. L9C 1K1 TEL. (416) 298-0319

GENERAL NOTES:

CLASS OF CONCRETE

ALL CONCRETE	30MPa
CLEAR COVER TO REINFORCING STEEL	
FOOTINGS	100±25
ABUTMENTS	
FRONT FACE	80±20
BACK FACE	70±20
TOP	70±20
BOTTOM	50±10
REMAINDER	70±20 UNO

REINFORCING STEEL

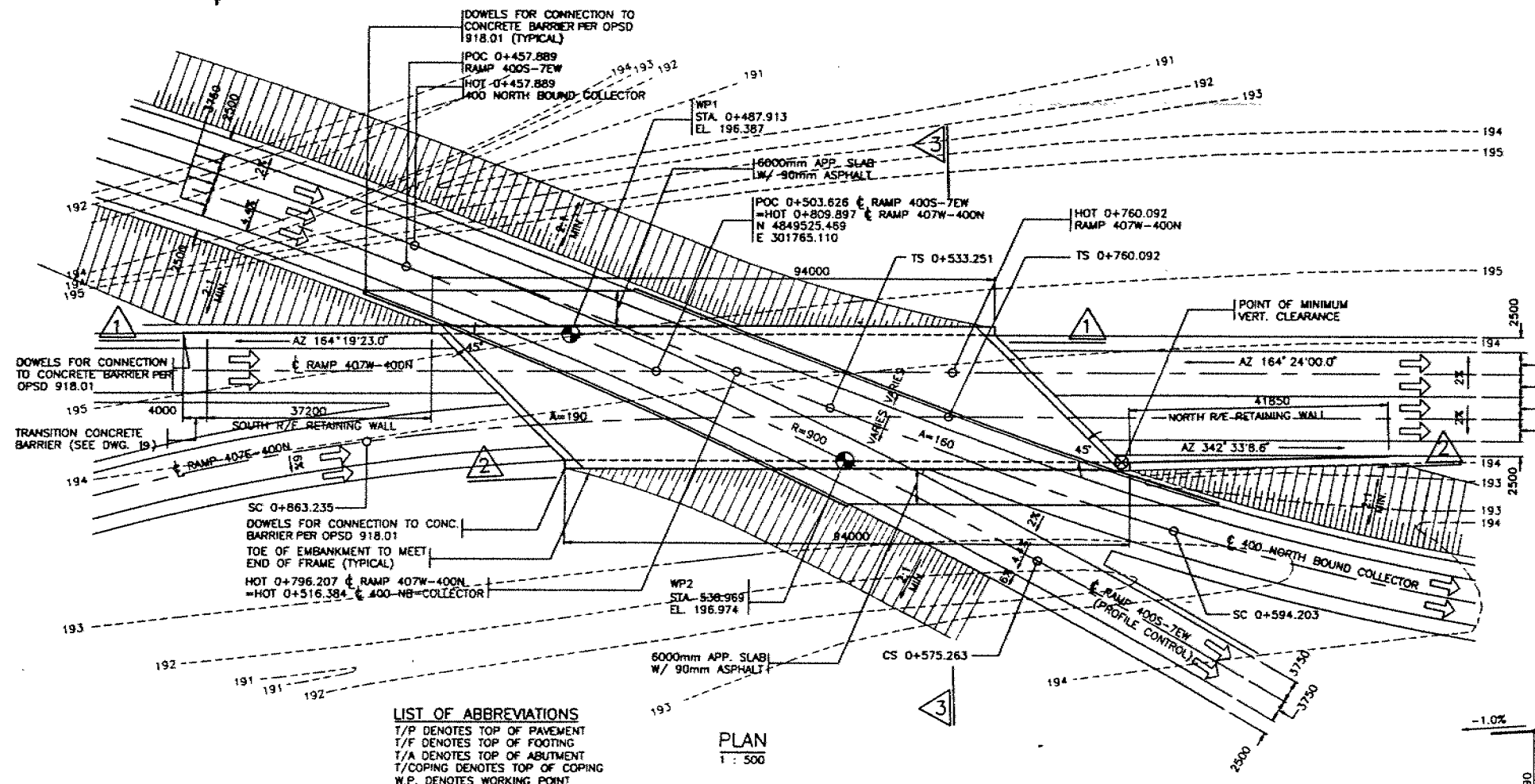
- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.

CONSTRUCTION NOTES:

- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
- FOOTINGS SHALL BE CAST AGAINST UNDISTURBED SOIL.

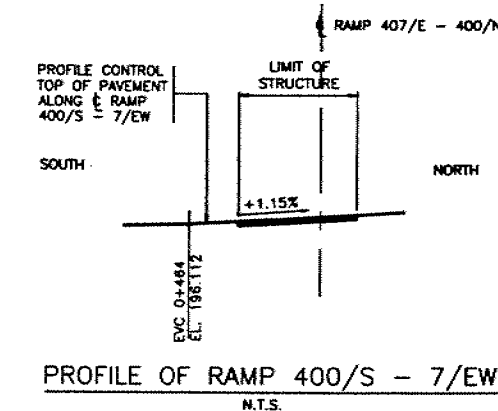
LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS & SOIL STRATA
- ABUTMENT FOUNDATION LAYOUT
- ABUTMENT FOUNDATION REINFORCEMENT
- WEST ABUTMENT REINFORCING
- EAST ABUTMENT REINFORCING
- DECK LAYOUT AND DETAILS
- DECK REINFORCING I
- DECK REINFORCING II
- SCREED ELEVATIONS
- DECK PAVING
- BARRIER WALL
- 6000mm APPROACH SLAB
- AS CONSTRUCTED ELEV. AND DIM.
- ELECTRICAL EMBEDDED WORK
- R/E RETAINING WALLS PLAN & SECTIONS
- R/E RETAINING WALLS FRONT FACE ELEVATION
- R/E RETAINING WALLS TYPICAL DETAILS
- STANDARD DETAILS I
- STANDARD DETAILS II
- QUANTITIES STRUCTURE



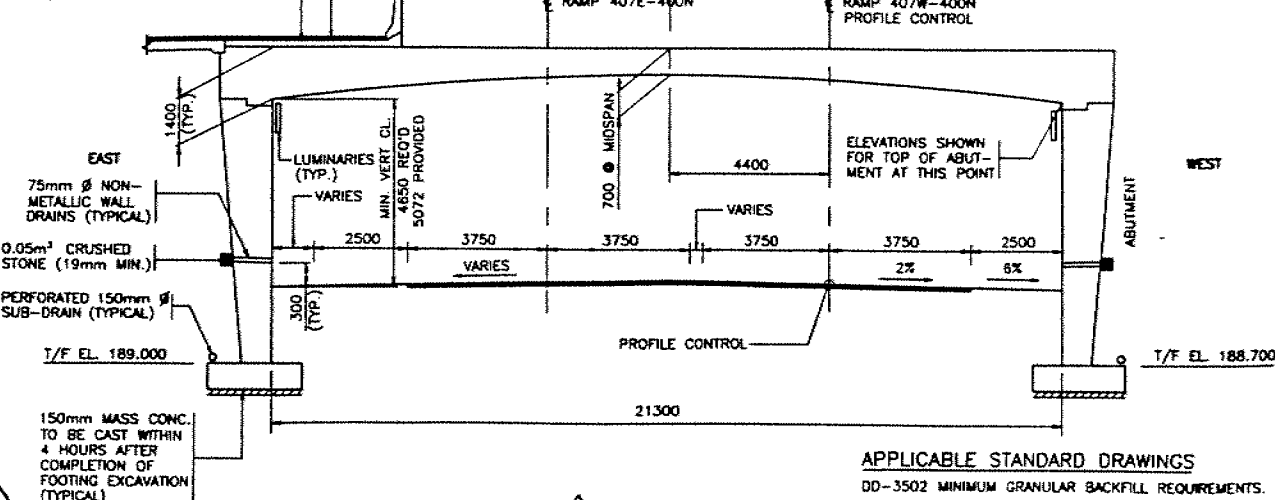
LIST OF ABBREVIATIONS
T/P DENOTES TOP OF PAVEMENT
T/F DENOTES TOP OF FOOTING
T/A DENOTES TOP OF ABUTMENT
T/COPING DENOTES TOP OF COPING
W.P. DENOTES WORKING POINT

PLAN
1:500

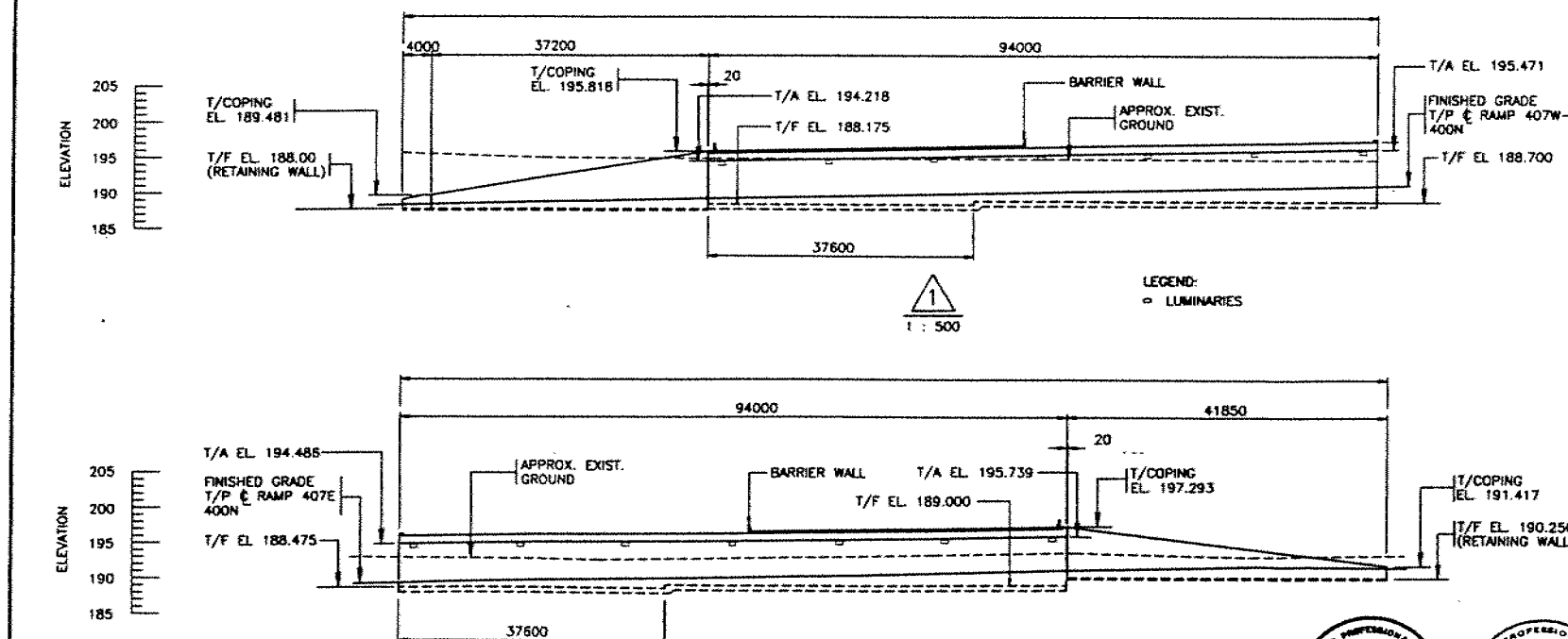


PROFILE OF RAMP 407/W - 400/N
N.T.S.

ASPHALT AND WATERPROOFING SYSTEM - 90mm TOTAL
DECK PAVING - THICKNESS VARIES 100mm MINIMUM TO 672mm MAXIMUM



APPLICABLE STANDARD DRAWINGS
DD-3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS.



BM 195.348
GEODETIC DATUM
N & W IN NW CORNER 0.4 WILLOW
30.3 RT 11+629.4
HWY 400

2
1:500



3
1:100
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY
DESIGN BY	CHK VZAR	CODE QHBC-83
DRAWN BY	CHK OF	SITE 37-1178
		STRUCT
		SCHEME
		DWG. 01

*Need additional site investigation or not?
review and comments?*

MINISTRY OF TRANSPORTATION
m e m o r a n d u m

structural section

central region

TO: W. Lankinen, Senior Project Manager
Planning and Design

1990-06-25

ATTN: Mr. Stephen S. Chiu, Giffels

RE: RAMP 400S TO 407E,W OVER RAMP 407E,W TO 400N
Hwy 400, Steeles Avenue northerly to Highway 7
G.W.P. 142-87-00, Highway 407/400 Interchange
District 6, Toronto

Recently, Planning and Design has reviewed and submitted a draft horizontal profile for the above captioned bridge. Based on the submitted plan, the recommended bridge span varies and the span is approximately 21m to 24m.

In reviewing the bridge type and configuration, the proposed Ramp structure is envisaged as single span reinforced concrete rigid frame structure, concrete deck depth varies, approximately 800mm mid-span to 1700mm end-span.

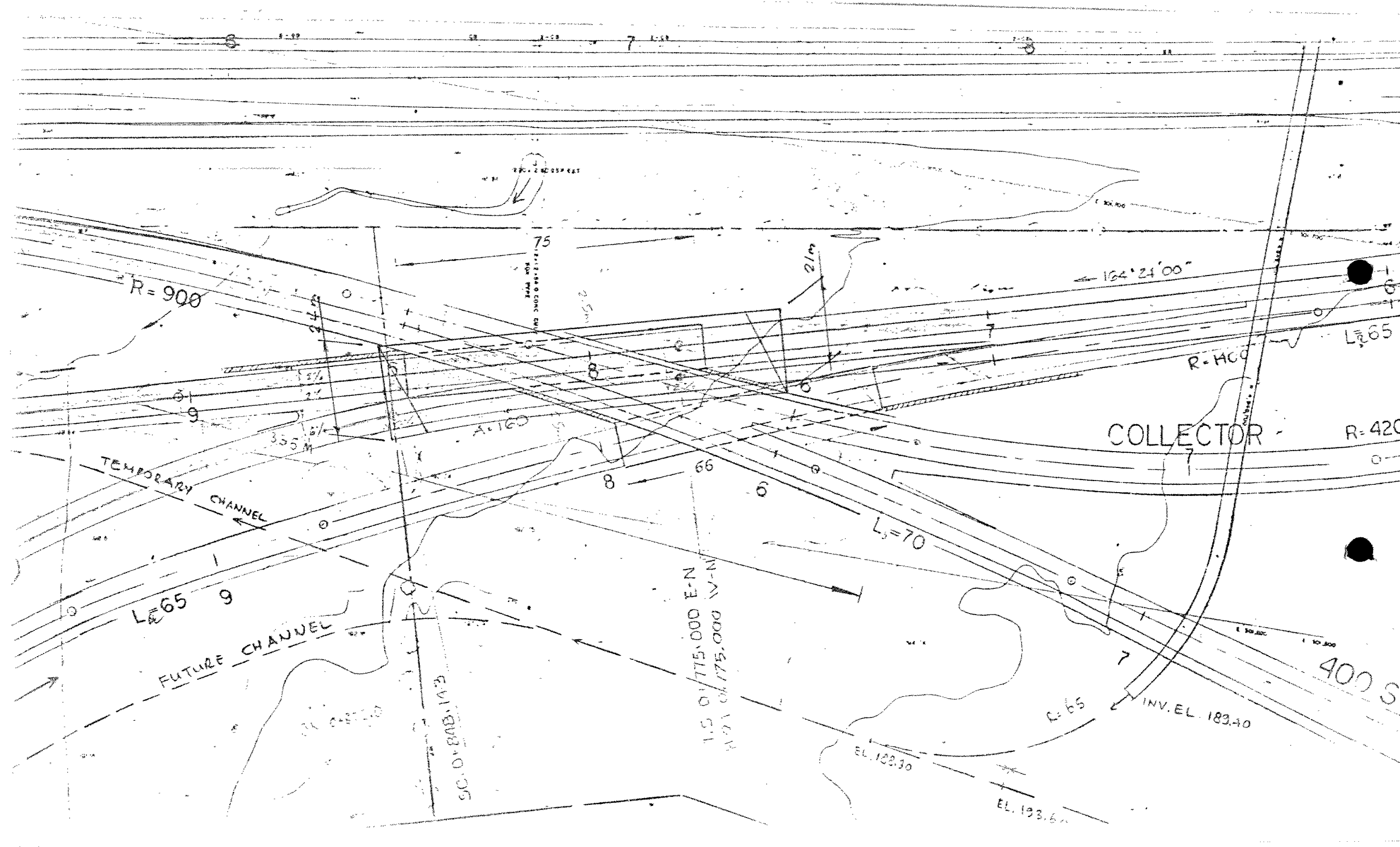
The alternative to the above option is a precast, prestressed concrete girder (continuous for live load) with 225mm concrete slab and 90mm asphalt and waterproofing system. The concrete girder would probably be CPCI 1200 prestressed concrete girders, total deck depth including asphalt and waterproofing is 900 + 100 (haunch) + 225 + 90 (mm), totalling 1600mm.

It should be noted that minimum vertical clearance from top of pavement to deck soffit is 4.65m for rigid frame structure and 5.00m for prestressed concrete girders. Construction clearance, if required, is 4.50m to underside of falsework.

Kindly review the vertical profile to ensure that the above recommended structure type is feasible.

John K. Lam
Senior Structural Engineer
for:
V.F. Boehnke
Head, Structural Section

cc: G. AlBazi, Structural Office



June 11, 1990

SCHEDULE "A" APPENDIX 1
TERMS OF REFERENCE

GROUP WORK PROJECT 142-87-00, HIGHWAY 407
HIGHWAY 400, FROM STEELES AVE. NORTHERLY TO
HIGHWAY 7 - GRADING, DRAINAGE, GRANULAR BASE,
PAVING, AND STRUCTURES (2), 2.9 KM

PROJECT DEFINITION (SCOPE OF WORK)

W.P. 142-87-01: Highway 400, from Steeles Ave.
Northerly to Highway 7 - 2.9 km
Grading, Drainage, Granular Base
and Paving

This project involves the reconstruction and widening of Highway 400 on the north and south approaches to the Highway 400 advance structures over Highway 407 to be constructed under Contract 90-18 (W.P. 137-87-00). The project limits extend from approximately 0.6 km south of Steeles Ave. northerly to approximately 0.4 km north of Highway 7 to facilitate the closure and removal of the existing Highway 400 Detour.

Included are the following sections of the future Highway 400 North and Southbound Collector roads and final Steeles Ave. and Highway 7 interchange ramp connections.

Northbound Collector: From 400S - 7EW Ramp to just south of
7E - 400N Ramp

Southbound Collector: From Highway 400 to just north of
7E - 400S Ramp

Ramp 400S - 7EW and Realignment and connection to
Ramp 7W-400N Northbound Collector

Ramp 7E - 400S and Realignment and connection to
Ramp 7W - 400S: Southbound Collector

Ramp Steeles Ave.
EW - 400S and
Ramp 400S - Steeles Ave. EW: Realignment

The limits of ultimate widening and reconstruction on Highway 400 are assumed as follows:

North Limit - Sta. 12+200 Highway 400, just north of
Highway 7

South Limit - Sta. 19+200 Highway 400, just south of
Steeles Ave.

The north limits of construction on Highway 400 and on the North and Southbound Collectors shall be as recommended in the Pre-design study being completed by McCormick Rankin, Consulting Engineers between Highway 407 and Major MacKenzie Drive. Approved recommendations should be available by July 31, 1990.

Also included in the project are the following:

- 1) Realignment of the southerly portion of existing Highway 400 SB Detour to the existing Highway 400 NB lanes for stage construction of Highway 400, including a cross-median detour from Highway 400 NB to Highway 400 SB south of Steeles Ave.

- 2) Detours of Highway 7 interchange Ramps 400S - 7 EW, 7W - 400N, 7E - 400N, 7E - 400S, and 7W - 400S.
- 3) Grading and drainage of future Ramp Meter Bypass Lanes on Highway 7 interchange Ramps 7W-400N, 7E-400N, 7E-400S, and 7W-400S.
- 4) Completion of the westerly portion of the stormwater management pond in southwest quadrant of the Highway 407/Weston Rd. interchange with control structure and outlet culvert under Ramp 407W - Weston Rd. NS.
- 5) Grading of Ramp 407W - Weston Rd. NS at the crossing of the control structure culvert in the outfall channel.
- 6) Grading and drainage of advance cuts on Highway 407 and on Ramps 400N - 407W, 400S - 407W, 407W - 400N, 407W - 400S, and 407E - 400S between Weston Rd. and Highway 400 as required for earth balance.
- 7) Grading and drainage of advance cuts on Highway 407, Ramps 407W - 400N, 400S - 407W, 407W - Weston Rd. NS, and Weston Rd. NS - 407W between Weston Rd. and Station 17 + 950 Highway 407 west of Weston Rd. as required for earth balance.
- 8) Grading and drainage of the future storm-water management pond in the northwest quadrant of the Highway 407/Weston Rd. interchange as required for earth balance.
- 9) Grading of the advance cut on Ramp 407W - 400N east of Highway 400 as required for drainage and earth balance.
- 10) Grading and drainage for removal of the existing Highway 400 detour as required for construction staging and earth balance.
- 11) East and west extensions of the box culvert at Station 11+855 Highway 400 under Ramp 400S - 7EW, future Ramp 400N - 407E, and the Highway 400 SB Collector.

W.P. 142-87-02: Highway 400S - Highway 7EW Ramp Structure over Highway 407W - Highway 400N Ramp (Structure 14)

W.P. 142-87-04: Highway 400S - Highway 7EW Ramp Structure over Highway 407E - Highway 400N Ramp (Structure 22)

These projects involve construction of one Highway 400S - Highway 7EW Ramp and Highway 400 Northbound Collector structure over each of the future 407E - 400N and 407W - 400N Ramps.

CONSULTANT SERVICES

The Services to be provided by the Consultant under Articles 2.1, 2.3 and 2.5 of this Agreement are defined or qualified where applicable, by the following terms of reference.

General

1. The Ministry's Central Region Timely Accountability Detail Design (TADD) process shall be utilized by the Consultant in the development of the design and preparation of the contract package.

memorandum



To: G.C.E. Burkhardt
Head, Structural Section
4th Floor, Atrium Tower

Date: 1989 09 13

Atten: J. Lam, Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Ramp 400S - 72W/Ramp-407 W -400 N
Structure #14
W.P. 142-87-02, Site 37-1178
Ramp 400 S - 7 Ew/Ramp 407E - 400 N
Structure #22
W.P. 142-87-04, Site 37-1184
Highway 407/400, District 6

Further to your memo of 1989 06 29, this letter summarizes our review on the submitted final drawings and provisions.

Based on our review, it is concluded that the design confirms to our recommendations and comments. However, it should be noted that with regard to the design of the Reinforced Earth Retaining Walls, the drawings are only review by this Section since the updated special provisions for the R.E.R.W. were not included in this package.

We have no further comments. If you have any questions, please contact us.

Tae C. Kim
Tae C. Kim, P. Eng.
Foundation Design Engineer

for

Dr. Balu Iyer, P. Eng.
Sr. Foundation Engineer

TCK/BI/mmj

memorandum



Tel: 3731

To: G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1989 02 13

Atten: J. Lam, Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Ramp 400 S - 7 EW/Ramp 407 W-400 N
Structure #14, Site 37-1178
Ramp 400 S - 7 EW/Ramp 407 E-400 N
Structure #22, Site 37-1184
W.P. 142-87-02
District 6, Toronto

We received a memo from Mr. B.R. Friesen of DelCan on February 7, 1989, with regard to the geotechnical design of the footings for the above structures. He also raised the same questions over the phone on February 6, 1989. It is understood that the sliding stability of the footing of each structure at the ultimate limit state is not satisfactory, using the total strength parameters recommended in the geotechnical report (Peto MacCallum Ltd., May 5, 1988).

Based on our review, it is our opinion that the effective stress analysis should be applied for the sliding stability calculation, using the following geotechnical parameters:

Backfill Materials

Granular 'A' $\gamma = 22.8 \text{ kN/m}^3$ $\phi' = 35^\circ$

Granular 'B' $\gamma = 21.2 \text{ kN/m}^3$ $\phi' = 30^\circ$

Cohesive Glacial Till

$\gamma = 21 \text{ kN/m}^3$ $\phi' = 30^\circ$ $c' = 0$

We believe that this letter meets with your present requirements. If you have any questions, please contact us.

A handwritten signature in black ink, appearing to read "Taschall Kim".

T.C. Kim, P. Eng.
Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

TCK/MD/mmj

c.c. - K. Bassi
B.R. Friesen (DelCan)

DELCANENGINEERS
PLANNERS
ARCHITECTS

1989 02 07

Our Ref: 04-1772-A-00

Mr. T. Kim, P.Eng.
Foundation Design Section
Ministry of Transportation
3rd Floor, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Dear Sir:

Re: Ramp 400S-7EW/Ramp 407W-400N
Structure 14
W.P. 142-87-02, Site 37-1178

Ramp 400S-7EW/Ramp 407E-400N
Structure 22
W.P. 142-87-02, Site 37-1184

Highway 400/407, District 6

This letter is to confirm the questions that we raised over the phone Monday, February 6 with regard to the geotechnical design of the footings for the above structures. We have found our present design to be deficient in sliding stability by as much as 60%. We would like to clarify the geotechnical design parameters that we are to use and make reference to the geotechnical report by Peto MacCallum dated May 1988, their No. 87 F 600.

The reactions and footing geometries are shown on the attached sketches of Structures 14 and 22. The footings are founded in the hard clayey silt till at elevations 187.5 and 188.3 respectively and are to be cast against undisturbed ground.

We have checked the sliding stability of the footing of each structure at the ultimate limit state. The sliding resistance was taken to be the sum of the adhesion resistance at the base of the footing and the passive soil resistance in front of the footing, multiplied by a performance factor of 0.8.

DELCAN CORPORATION

2001 THURSTON DRIVE, P.O. BOX 0004, OTTAWA, ONTARIO, K1G 9H5 • (613) 738-4160 TELEX 08-9888-BR
FAX: (613) 738-7105

ST. JOHN'S, TORONTO, MONTREAL, HAMILTON, NIAGARA FALLS, LONDON, THUNDER BAY, WINNIPEG, REGINA, SASKATOON, EDMONTON, CALGARY, VICTORIA, NEW WESTMINSTER, CHILLIWACK, NANAIMO, PORT ALBERT

DELCAN

Mr. T. Kim
1989 02 07
Page 2

75 kPa is more reasonable

The value used for adhesion between the footing and the till was 50 kPa as recommended in the geotechnical report, page 10. Is this value appropriate for the hard clayey silt till at the ultimate limit state?

For the passive soil resistance, we used an equivalent fluid pressure of 45 kPa/m as recommended in the OHBDC for drained granular backfill at the ultimate limit state. This is clearly not appropriate for the passive resistance of the till and we would like guidance on a correct value to be used. The depth of soil considered for passive resistance was from sub-grade, assumed to be 0.8 m below finished grade, to the base of the footing.

If you require any further clarification, please feel free to call.

No. 1.2 m.

Yours very truly



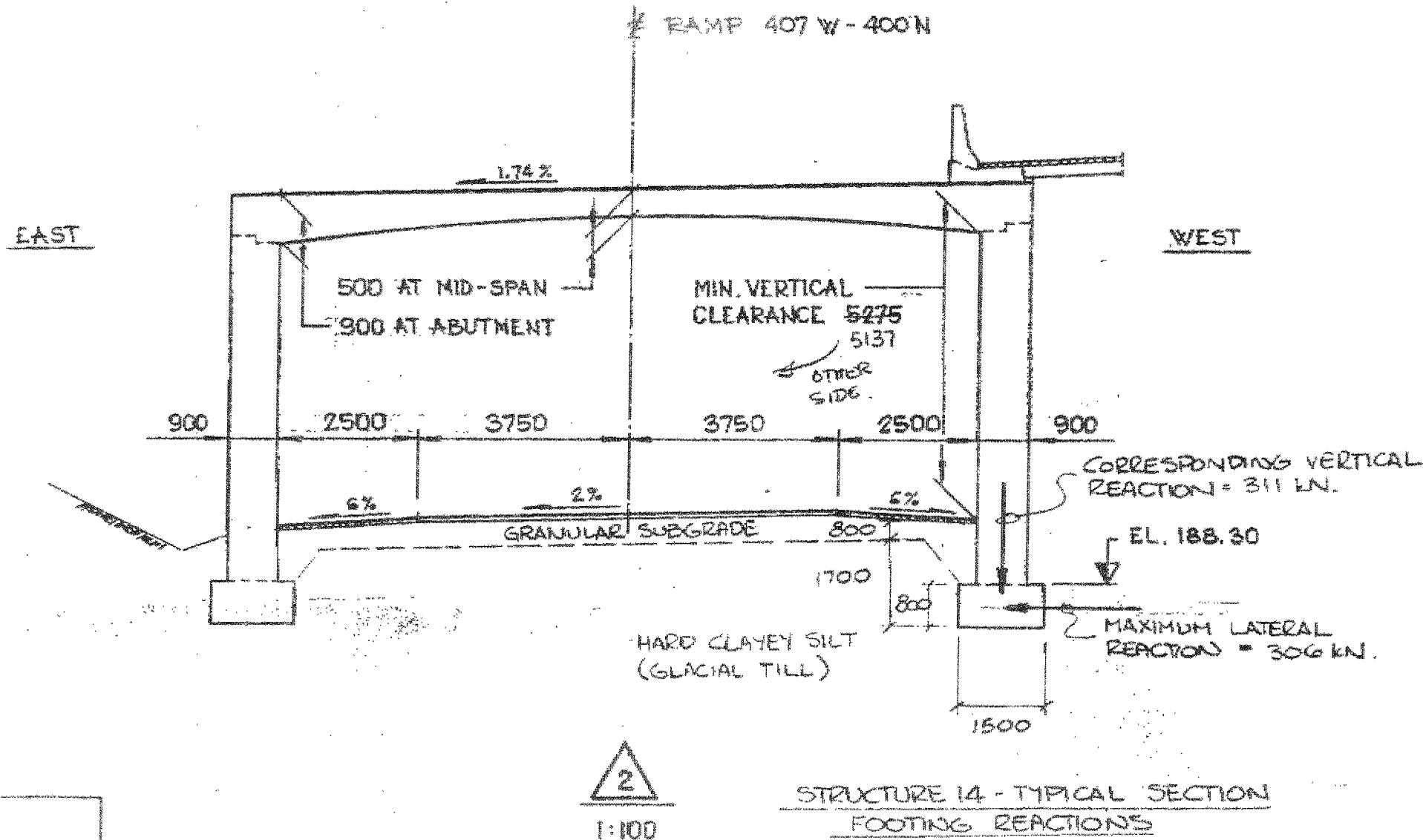
B.R. Friesen, P.Eng.
Senior Structural Engineer

BRF:lmb

Encl.

cc: Mr. J.K. Lam (M.T.O.)

Call Radio Christian



T.F.M. 89/10/103

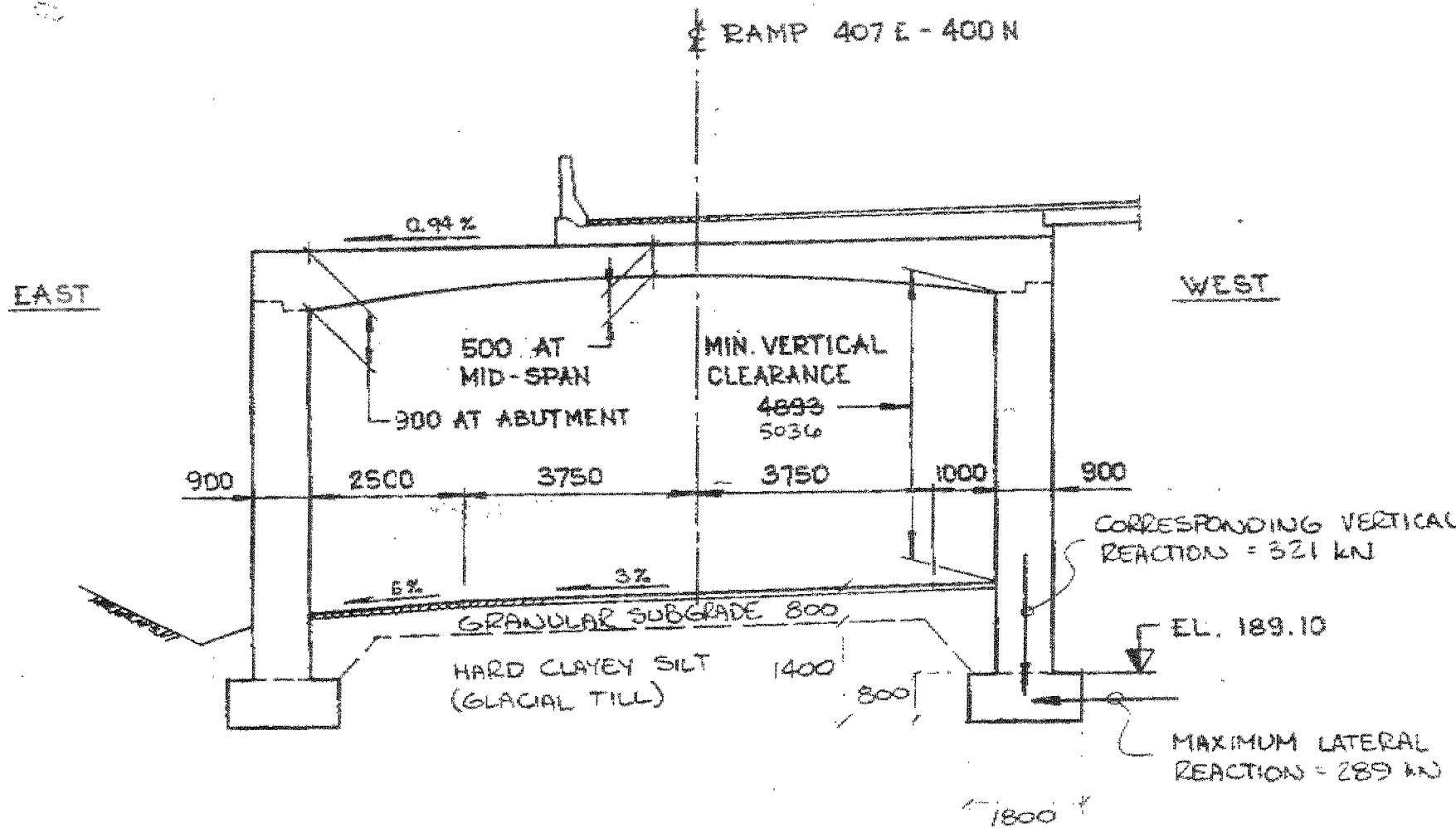
SEP 11 09 09:53

14706698

TOTAL E.05

14706698

WILLOW



2
1:100

STRUCTURE 22 - TYPICAL SECTION
FOOTING REACTIONS

20/01/03

02/07/1989 10:02 DELCAN DTT, 613 739-7105 14706698 P.05

memorandum



To: G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1989 01 06

Atten: J. Lam, Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Review of Drawings
Ramp 400S - 7 EW/Ramp 407 W-400N
Structural #14, Site No. 37-1178
Ramp 400S-7EW/Ramp 407E-400N
Structure #22, Site No. 37-1184
W.P. 142-87-02, Hwy. 400/407
District #6, Toronto

Further to your memo of 1988 12 14, this letter summarizes our review of the submitted drawings for Structures #14 and #22. As shown, the drawings for the above structures, reflecting the replacement of the conventional concrete retaining walls with the reinforced earth retaining walls has been reviewed by this Section and the following geotechnical related comments are provided.

Reinforced Earth Retaining Walls

As discussed in our previous memorandum for Structure No. 13 (W.P.142-87-03, December 22, 1988), the major geotechnical considerations associated with the concept of reinforced earth retaining walls must be reviewed thoroughly before the final decision is made. In addition, the related external stability beyond this reinforced earth wall module and settlement of the reinforced wall unit should be considered. However, it should be noted that there is not detailed information concerning the dimension of this kind of wall unit which is enough to evaluate the stability and its settlement.

Comments Related to Structure Foundations

Based on our review, the following comments can be made on the drawings for Structures #14 and #22.

Structure #14 (Drawing P1)

1. There are no elevation scales and no original ground surface indicated on Section 1. (see Red marked No. 1) ✓
2. Section 2 is not drawn properly along 2 - 2 straight line. (see red marked No. 2) ✓
3. On Section 3, side slope of earth work is not shown on the drawing (see red marked No. 3). ✓
4. Reinforced earth retaining wall should be indicated and earth slope should be clearly shown on plan (see red marked No. 4) ✓

.....2

5. An additional section is required along Section $\triangle A$ - $\triangle A$ (marked with red pen) to shown the relationships between the reinforced earth retaining wall and embankment slope. (See red marked No. 5).
6. It is not clear whether the retaining wall between two structures is a conventional retaining wall or a reinforced earth retaining wall. (see red marked No. 6).

Structure #22 (Drawing P1)

1. As discussed for Structure #14, elevation scale and a line of original ground surface are required on Section $\triangle 1$ (red marked No. 1). ✓
2. It is not clear whether S.W. and N.W. Retaining walls are conventional concrete retaining walls or reinforced earth retaining walls. (see red marked No. 2). ✓
3. N.W. retaining wall should be extended to Structure #22 as shown on Plan (see red marked No. 3) ✓
4. Symbol of cut slope in front of S.W. Retaining Wall should be revised as shown on Plan (see red marked No. 4)
5. It is suggested that a line of cut slope in the vicinity of the southeast corner #22 be moved southerly as shown on Plan view in order to stabilize the slope stability of east approach fill (see red marked No. 5). ?
6. An additional section is required along Section $\triangle A$ - $\triangle A$ to present the scheme of reinforced earth retaining wall (see red marked No. 6). For this section, stability analyses may be required to ensure the overall slope stability.

It should be also emphasized that the footings must have a minimum of earth cover of 1.2 m to the underside of the footings to provide adequate frost protection as discussed in our report.

We have no further comments. If you have any questions, please contact us.

Taecheul Kim
T.C. Kim, P. Eng.
Foundation Engineer
for

M. Devata, P. Eng.
Chief Foundation Engineer

TCK/mmj

c.c. - K. Bassi (No Drawings)

memorandum



To: G.C.E. Burkhardt
Head, Structural Section
5000 Yonge Street

Date: 1988 06 06

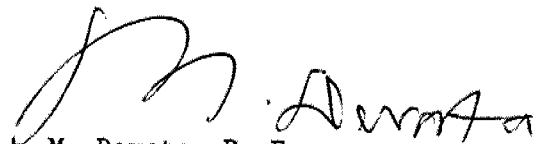
From: Foundation Design Section
Room 315, Central Building

RE: Foundation Investigation for
Proposed Hwy. 400/Hwy. 407 Interchange
W.P. 142-87-02, Site 37-1178 (Structure #14)
and Site 37-1184 (Structure #22)
District 6, Central Region

Peto MacCallum Ltd. has been retained by the Ministry to carry out a foundation investigation at the above-mentioned locations and provide factual subsurface data together with recommendations for the design and construction of foundations and related earthworks.

Attached please find their final report and drawing describing the subsurface conditions and foundation recommendations. We have reviewed the draft report for the technical content and format. All our comments have been incorporated in the final report prepared by the geotechnical consultant and we have no further comments at this time.

Should you require further clarification or additional information, please contact us.


M. Devata, P. Eng.
Chief Foundations Engineer
(East)

MD/mmj

Attach.

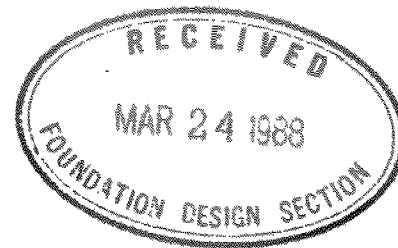
c.c. - G.C.E. Burkhardt (3)
G. Cautillo
A. Wittenberg
J. Smrcka (2)
K. Bassi
J.H. Peer
T. Yakutchuk
G. Szekreny

March 7, 1988

Our Ref: 87 F 600

Ministry of Transportation
and Communications
Pavement and Foundation Design Section
Room 315, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. M. Devata, P.Eng.
Chief Foundations Engineer



Dear Sirs:

Preliminary Design Recommendations
Geotechnical Investigation
Structures 14 and 22
Highway 400 and 407 Interchange
District 6 (Toronto) Central Region
W.P. 142-87-02

We are pleased to present our preliminary design recommendations for the noted project as requested by Mr. Tae C. Kim of the M.T.C. Foundation Design Section.

The stratigraphy encountered at the site generally comprises surficial topsoil over glacial till units underlain at depths of 10.0 to 13.4 m by a major deposit of silty clay.

Subsurface conditions are favourable for the use of spread footings to support the proposed bridge structures and associated retaining walls. Shallow spread footings placed on stiff to very stiff glacial till at depths of 1.5 m below existing grade may be designed for a bearing capacity of 240 kPa at Serviceability Limit States Type II. The factored bearing capacity at Ultimate Limit States is 360 kPa.

If higher spread footing bearing capacities are required, the foundations may be supported on the hard clayey silt till at depths of 2.1 to 5.9 m below existing grade. The factored bearing capacity at Ultimate Limit States is 800 kPa. The bearing capacity at Serviceability Limit States Type II is estimated at 500 kPa.

...2

Mr. M. Devata, March 7, 1988, P2

87 F 600

While the soil conditions are generally suitable for shallow foundations, there may be structural or economic reasons for utilization of deep foundations. In this regard, driven piles may be used to support the bridge structures. Based on the subsurface stratification, it appears that a displacement type such as a steel tube pile would be suitable.

For estimating purposes, a 300 mm diameter steel tube pile driven to practical refusal in the hard clayey silt till or very dense sandy silt till at depths of 8 to 10 m below existing grade should have a factored capacity at Ultimate Limit States of 670 kN (75T). The capacity of Serviceability Limit States Type II is estimated at 450 kN (50T).

If a pile foundation is selected, particular attention must be given to the founding level of each pile. Any piles which inadvertently penetrate the base of the glacial till deposits and terminate within the silty clay stratum will encounter only medium driving resistance and will have a reduction in bearing capacity.

Pre-augering may be required locally in order to achieve the minimum required penetration. A pile load test should be carried out at the start of construction to verify that the required capacity is being obtained with the contractors equipment and construction procedures.

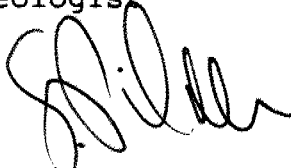
We trust the foregoing information will be sufficient for your present requirements, however, should you have any questions, please do not hesitate to contact our office.

Sincerely

Peto MacCallum Ltd.



John F. Wright, B.Sc.
Geologist



S. Pilch, P.Eng.
Chief Geotechnical Engineer

JFW:hm

memorandum



To: Mr. M. Devata
Chief Foundation Engineer - East
Foundation Design Section
Central Building - Downsview

Date: 1987-11-12

Central Region

RE: Foundation Investigation for the Proposed

(a) Ramp S EW (Hwy 7) over Ramp 407
E & W to 400 N (Structure 22)
W.P. 142-87-02 site 37-1184)

✓ (b) Ramp to EW over Ramp 407 EW
to 400 N (Structure 14)
W.P. 142-87-02 Site 37-1178

Highway 407, District 6



With reference to our memo dated 1987-10-30 and further discussion with you dated 1987-11-10 regarding the above noted structures, we would like to confirm the following:

- 1/ The possibility of combining structure 14 and 22 into one structure has been eliminated. Your foundation report for structure 14 and 22 should include information on two rigid frame structures with retaining walls only.
- 2/ The above noted structures will be located at the Highway 407 detour ramps. As the structures cannot be constructed until the traffic has reverted to Highway 400, the scheduling submission date for the foundation investigation report has been postponed to March 25, 1988.

Please take appropriate action.

John Lam

J.K. Lam
Senior Structural Engineer
for:
G.C.E. Burkhardt
Head, Structural Section

JKL/jf
c.c. S. Miles (D.S. Lea)
J. Klowak
B. Lankinen