DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-130

DIST. 64 REGION

W.P. No. 146-75-05

CONT. No. 81-67

W. O. No.

STR. SITE No. 10-57

HWY. No. 401

LOCATION C.N.R. Overhead Widening

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 146-75-05 DIST 4

HWY 401 STR SITE 10-57

C.N.R. Overhead Widening
0.5 Mile East of Hwy. 25

CONT 81-67

DISTRIBUTION

See last page

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 01 25	RJD
TUBES	—	—
ROCK CORES	—	—

GEOCRES 30M12 130

DATE JAN 2 5 1978

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin Street, Downsview
Attention: Mr. F.I. Hewson

From: Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

Date: 78 01 23

Our File Ref.

In Reply to

Subject: Re: C.N.R. Overhead Widening
0.5 Mile East of Hwy. 25
Site 10-57, W.P. 146-75-05
District 6, Toronto, Hwy. 401

INTRODUCTION

Further to your request of 77 10 27 we have completed our foundation investigation for the proposed widening of the above mentioned structure and related approach slopes.

The fieldwork was carried out on December 15, 1977 and consisted of a total of two sampled boreholes, one accompanied by a dynamic cone penetration test. The borings were advanced by means of hollow stem augers to depths of up to 52 feet below the ground surface. The borings were located within the highway median set back 12 feet from the west median retaining wall and 9 feet from the east median wall. The Record of Borehole Sheets are attached for your information. In addition, two test pits were dug with a backhoe. Both pits were located south of Hwy. 401 and east of the east retaining wall. One pit was dug 9 feet into the embankment fill and one pit was dug at the toe of the slope and advanced 13 feet into the parent subsoil. A record of the Test Pit Results is also attached for your information.

SUBSOIL CONDITIONS

The borings indicated that behind the median retaining walls subsoil consists of up to 30 feet of moderately compacted fill material. The fill material is generally composed of sand with some gravel and silt; however, in one boring the upper 5 feet is comprised of sand, some silt and a trace of clay. Typical grain size distribution curves for the deposit are shown on Figure 1 attached.

Below this fill material is a 3 to 4 foot stiff to very stiff deposit composed of clayey silt to silty clay, some sand. The upper ½ foot of this thin layer is black and contains a trace of organic material; this zone is the parent topsoil. The results of Atterberg Limit testing on two samples from this deposit are plotted on the Plasticity Chart, Figure 2 and are summarized below.

		B.H. 1, Sample 10	B.H. 2, Sample 18
Natural Moisture Content	(W) %	25	21
Liquid Limit	(W_L) %	31	38
Plastic Limit	(W_L) %	20	21
Plasticity Index	(I_p) %	11	17

cont'd.....

These results indicate that the material is inorganic and of low to intermediate plasticity (CL-CI zone).

Immediately below this clayey silt to silty clay deposit is a stratum of cohesive glacial till. The deposit is composed of a heterogeneous mixture of clayey silt, sand and gravel. In one borehole the upper 4 feet of this deposit was found to be in a reworked condition and based on Standard Penetration Test 'N' values it is estimated to have a stiff consistency. Below this reworked zone the 'N' values indicate that the deposit has a hard consistency. The results of grain size distribution testing are shown in an envelope form on Figure 3 of the Appendix. The results of Atterberg Limit Testing are plotted on the Plasticity Chart, Figure 2 and also are summarized below.

		Range	Average
Natural Moisture Content	(W) %	10-15	13
Liquid Limit	(W_L) %	22-27	25
Plastic Limit	(W_P) %	12-19	15
Plasticity Index	(I_p) %	9-11	10

The above results indicate that the material is inorganic and of low plasticity (CL zone).

Groundwater was encountered in only one borehole at a depth of some five feet below the existing ground elevation within the median which corresponds to elevation 711.0.

The test pits indicate that the roadway fill material consists of up to 2 feet of topsoil overlying dense sand and gravel fill. By visual inspection the existing side slopes appear to be stable.

DISCUSSION AND RECOMMENDATIONS

Reconstruction proposals call for decking the median and widening the structure approximately 12 feet on the south side. At the present time it is proposed to remove the median retaining walls and construct a single span concrete rigid frame in its place. The widening will be accomplished by removing that portion of the affected retaining walls and constructing a single span concrete rigid frame with wing walls. This extension scheme would necessarily incorporate slopes as steep as 1 3/4:1 in certain locations in order that the wing walls would not be excessively long.

Structure

The concrete rigid frame additions (at the median and also at the extension) can be supported on spread footings located within the competent glacial till deposit. To ensure the new footings are placed on undisturbed subsoil it is recommended that the footing founding level be ½ foot below the existing base level (i.e. for new footings the founding level should be at or below elevation 681.5). The subsoil is such that footings located at this elevation could be designed with an allowable bearing capacity of 2.5

cont'd.....

t.s.f. However, a higher design bearing capacity could be attained by founding the footing below the zone of reworked glacial till. If the footing is located below this zone (i.e. below elevation 678) the footing could be designed with an allowable load of 3.5 t.s.f. During construction care should be taken to ensure that while excavating for the new footing the existing footings are not undermined.

The anticipated settlements of the rigid frame additions will not exceed one inch and will be of a recompression nature occurring during construction. An expansion joint must be provided between the existing structure/retaining walls and the new rigid frame structures to accommodate any differential settlements that will occur between the various structural systems. To estimate the horizontal resistance to sliding between the rough concrete and the cohesive glacial till subsoil an adhesion of 2000 p.s.f. may be used.

Furthermore, to prevent the buildup of hydrostatic pressures behind the rigid frame concrete wall, free draining granular material should be used for backfill behind the retaining wall as per current M.T.C. Standards. Compaction of the backfill should be carried out by means of lightweight mechanical equipment to a minimum of 95% of the maximum dry density and to a maximum of 100% of the maximum dry density.

Roadway Protection and Dewatering

Construction of the additional structural sections will require roadway protection. This could be accomplished by soldier beams and sheeting and any water seeping into the excavation could be removed by pumping from the sumps.

For estimating earth pressure on the rigid frame structure wall or on the roadway protection wall a coefficient of active earth pressure Ka=0.3 may be used if some movement at the top of the wall is permitted; whereas, if no movement is anticipated a coefficient of earth pressure at rest of Ko=0.5 may be used for design purposes.

Embankment Slopes

Alterations in the structure will require the steepening of some adjacent slopes. The fill material and subsoil types are such that the steeper slopes will be stable if the following measures are adopted.

1. Embankment slopes not steeper than 1 3/4 horizontal to 1 vertical

2. The existing topsoil shall be removed and the additional embankment fill shall be keyed to existing according to the current M.T.C. "Benching of Earth Slopes Standard" (DD-414)

3. The side slopes shall be protected against erosion by sodding according to the current M.T.C. Standard "Sodding of Side Slopes" (DD-403).

cont'd.....

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

M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MD/MM/gs

Attach.

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

Files

APPENDIX

RECORD OF TEST PITS

For

C.N.R. Overhead, Hwy. 401
Site 10-57, W.P. 146-75-05
District 6, Toronto

Test Pit #1

Date: December 15, 1977

Location: South of Hwy. 401, 10' East of East Retaining Wall

Embankment Cut

0-2'	Clayey silt with sand and gravel (Topsoil)
2-7'	Sand and gravel, dense
7-9'	Silty clay, some sand and gravel, very hard (Parent Subsoil)

Test Pit #2

Date: December 15, 1977

Location: South of Hwy. 401, 15' East of East Retaining Wall

Toe Cut

0-2'	Clayey silt with sand and gravel (Fill)
2-3'	Clayey silt with sand and organics (Topsoil)
3-4'	Clayey silt to silty clay, hard
4-7'	Clayey silt with sand and gravel (Reworked Glacial Till)
7-13'	Clayey silt with sand and gravel (Hard Glacial Till)

Note: 1. Seepage from 3' below top of T.P. 2

2. Top of T.P. 2 level with R/R tracks

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 146-75-05 LOCATION ℄ 9 Feet E. of E. Median Retaining Wall ORIGINATED BY TK

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MM

DATUM Geodetic DATE Dec. 15, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
716.0	Ground Level										
0.0	Sand, Some Silt, Trace Of Clay — FILL		1	SS	40	▼	710		○		0 74 17 9
			2	SS	30				○		22 64 (14)
			3	SS	10						
			4	SS	17				○		22 66 (12)
			5	SS	34						
	Sand, Some Gravel, Some Silt		6	SS	24		700				
			7	SS	28				○		
			8	SS	14		690				
686.0			9	SS	19				○		
30.0	Clayey Silt, Organic Some Sand,		10	SS	14						0 16 65 19
683.0	Stiff		11	SS	8						
33.0	Het. Mixture Clayey Silt, Some Sand. Glacial Till — Stiff		12	SS	14		680				0 36 44 20
	Hard		13	SS	33						0 20 60 20
669.5			14	SS	43		670				
46.5	End Of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 ◇ 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W P 146-75-05 LOCATION ℄ 12 Feet W. Of West Median Retaining Wall ORIGINATED BY TK

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Test COMPILED BY MM

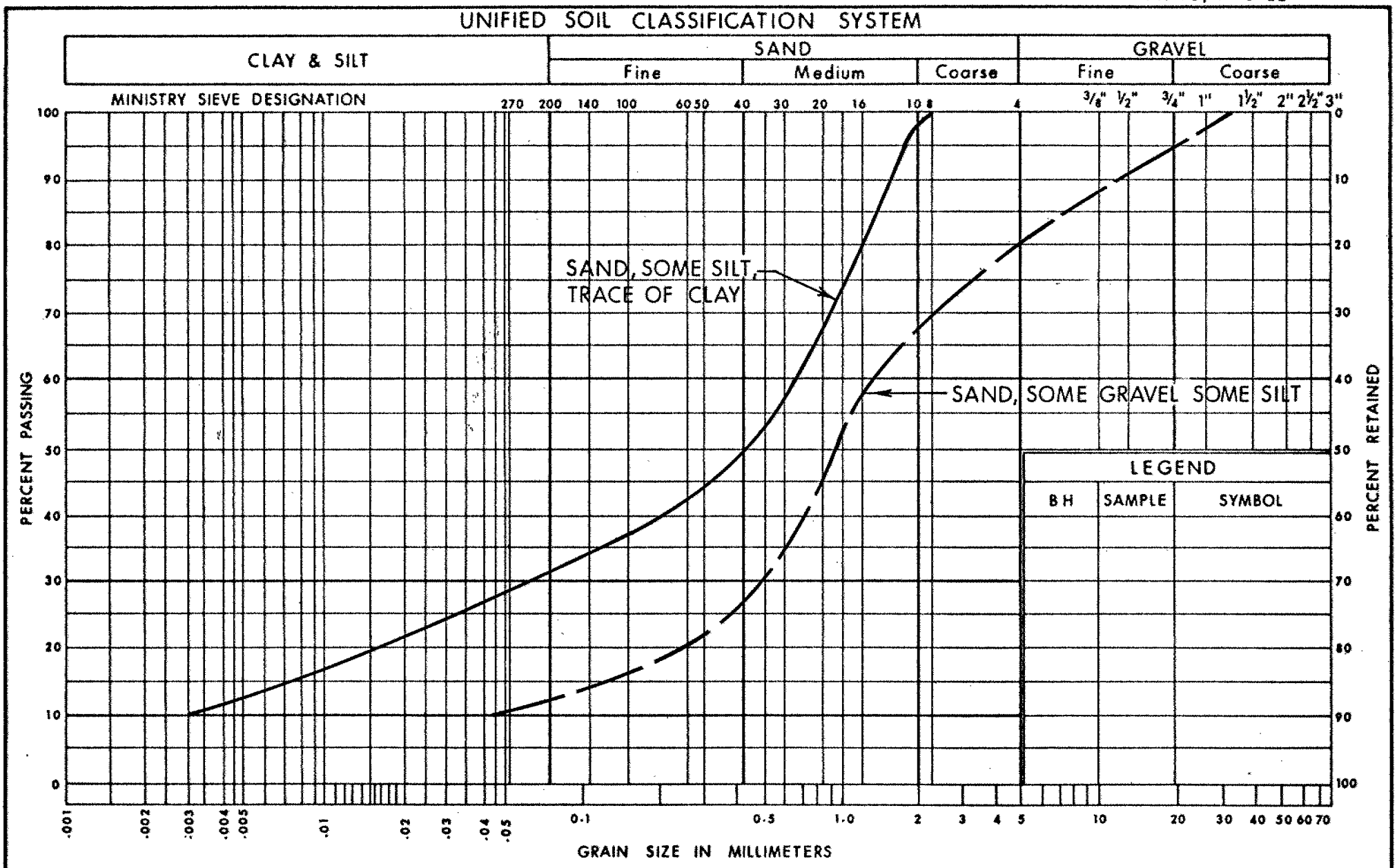
DATUM Geodetic DATE Dec. 15, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
716.0	Ground Level									Org.	
0.0	FILL Sand, Some Gravel, Some Silt		1	SS	35		710				21 64 (15)
			2	SS	20						
			3	SS	4						9 84 (7)
			4	SS	19		700				
			5	SS	48						17 71 (12)
			6	SS	25		690				
686.0											
30.0	Clayey Silt Organic To Silty Clay Some Sand, Some Gravel Very Stiff		7	SS	18					2.1%	10 19 45 26
682.0											
34.0	Heterogenous Mixture Clayey Silt, Some Sand. Glacial Till Hard		8	SS	49		680				3 23 53 21
			9	SS	83						4 23 52 21
							670				
664.5			10	SS	75						
51.5	End of Borehole										

Note: Ground Water Not Encountered

+3, ×5 : Numbers refer to Sensitivity

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



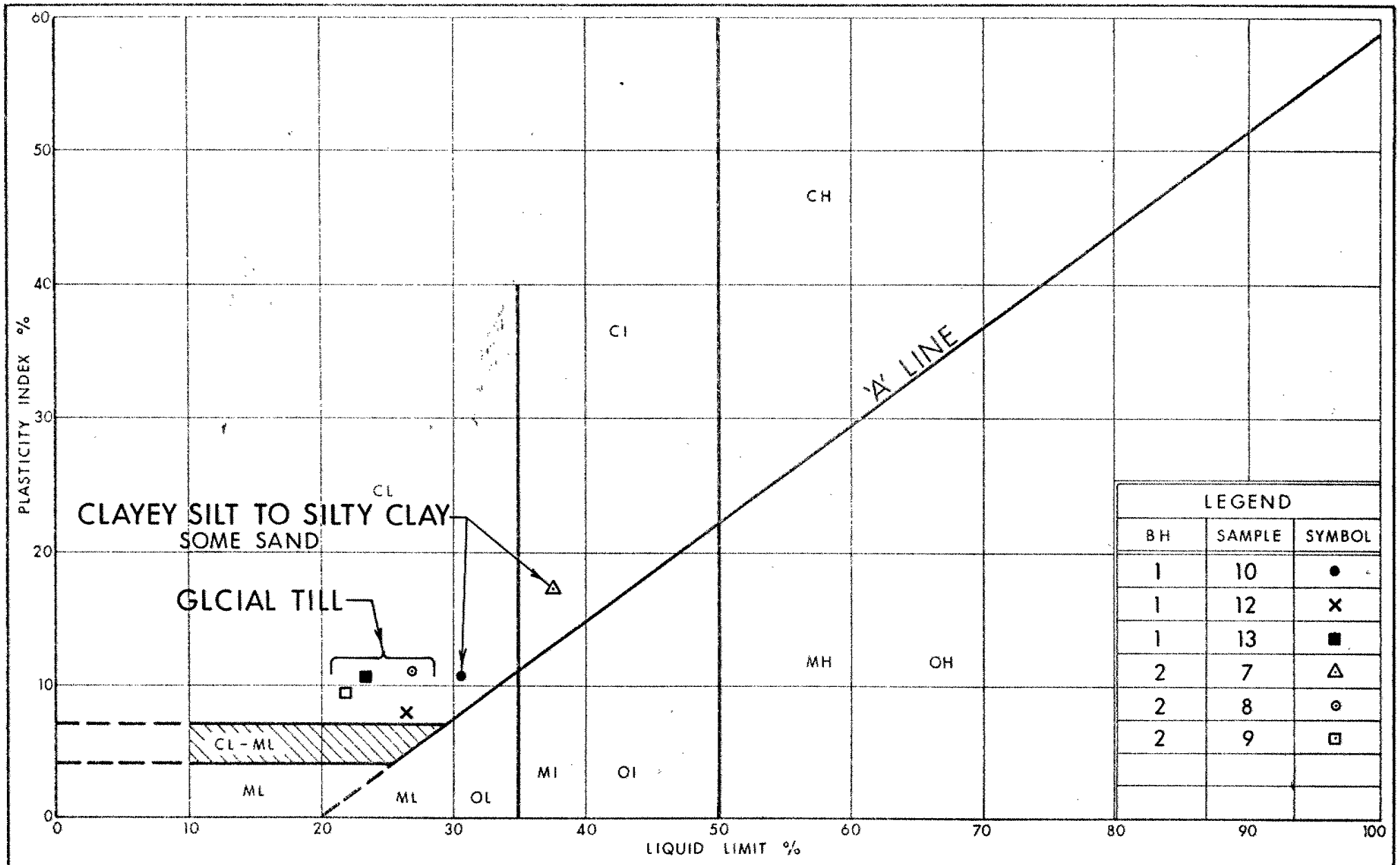
Ministry of Transportation and Communications
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION

FILL

FIG No 1

W P 146 - 75 - 05



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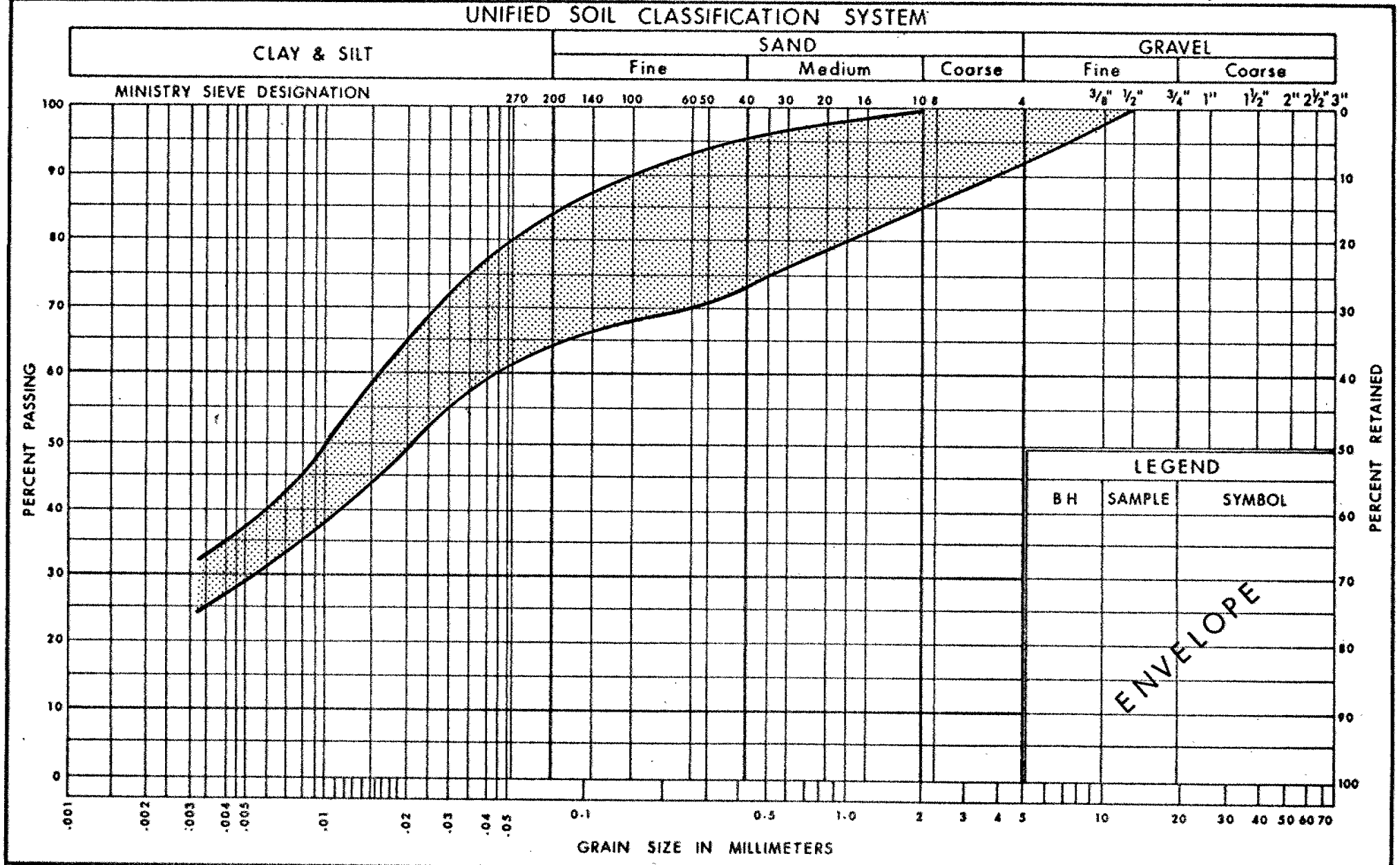
PLASTICITY CHART

FIG No 2
W P 146 - 75 - 05



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Ontario

GRAIN SIZE DISTRIBUTION
GLACIAL TILL
HETEROGENEOUS MIXTURE CLAYEY SILT, SOME SAND

FIG No 3
W P 146 - 75 - 05

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U)
ISOTROPICALLY (I) OR NOT (A)
AND SHEARED DRAINED (D) OR UNDRAINED (U)
WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS)
EG. $\overline{CIU}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT
UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ	COEFFICIENT OF FRICTION
δ	ANGLE OF WALL FRICTION
k_o	COEFFICIENT OF EARTH PRESSURE AT REST
k_A	COEFFICIENT OF ACTIVE EARTH PRESSURE
k_P	COEFFICIENT OF PASSIVE EARTH PRESSURE
i	ANGLE OF INCLINATION OF SURCHARGE
ω	SLOPE ANGLE-BACKFACE OF WALL
β	ANGLE OF SLOPE
N_γ, N_q, N_c	BEARING CAPACITY FACTORS
D_f	DEPTH OF FOOTING
B,L	FOOTING DIMENSIONS

INDEX PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G_s	SPECIFIC GRAVITY OF SOLIDS
e	VOIDS RATIO
e_o	INITIAL VOIDS RATIO
e_{max}	e IN LOOSEST STATE
e_{min}	e IN DENSEST STATE
D_r	RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n	POROSITY
w	WATER CONTENT
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
w_S	SHRINKAGE LIMIT
I_p	PLASTICITY INDEX = $w_L - w_P$
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
A_c	ACTIVITY = $\frac{I_p \text{ of soil}}{\% \times 2\mu m \text{ Soil Fraction}}$
Om	ORGANIC MATTER CONTENT
S_r	DEGREE OF SATURATION
S	SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

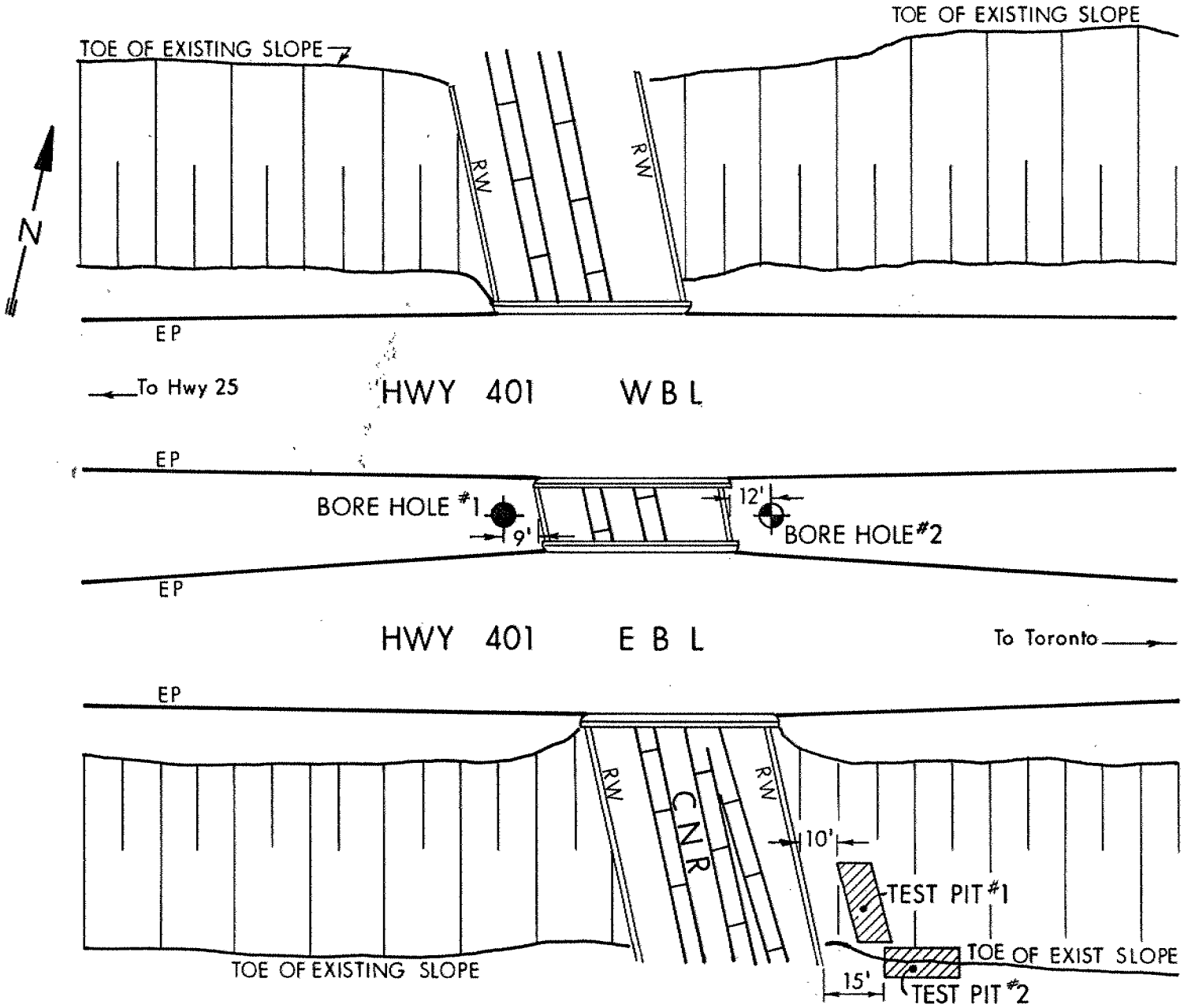
STRENGTH PARAMETERS

ϕ	ANGLE OF SHEARING RESISTANCE
τ_f	PEAK SHEAR STRENGTH
τ_R	RESIDUAL SHEAR STRENGTH
c	COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	NORMAL PRINCIPAL STRESSES
u	PORE WATER PRESSURE
u_e	EXCESS u
r_u	PORE PRESSURE RATIO
q_u	UNCONFINED COMPRESSIVE STRENGTH
s_u	UNDRAINED SHEAR STRENGTH
ϵ	%LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO
E	MODULUS OF ELASTICITY
G	MODULUS OF SHEAR DEFORMATION
k_s	MODULUS OF SUBGRADE REACTION
m,n	STABILITY COEFFICIENTS
A,B	PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX
C_r	RECOMPRESSION INDEX
d	DRAINAGE PATH DISTANCE
T_v	TIME FACTOR
U	DEGREE OF CONSOLIDATION
OCR	OVERCONSOLIDATION RATIO (OCR)



Reg Mun of HALTON
Town of MILTON
DIST 6 SITE 10-57

TEST PIT AND BORE HOLE LOCATIONS

NTS

WP No 146 - 75 - 05

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Mr. W.L. Lin

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 07 18

Re: CNR Overhead Widening at Hwy. 401
W.P. 146-75-05, Site 10-57
District 6, Toronto

Further to your request of 78 06 13, we have reviewed the Preliminary Bridge Plan Drawing 10-57-P1. Our comments are as follows:

1. To ensure the new footings are placed on undisturbed subsoil it is recommended that they be founded at least ½ foot below the base of the existing footings (i.e. if the underside of the existing footings is at elevation 682.0, the new footings should be placed at or below elevation 681.5). We also recommend that the excavation be inspected by the Soil Mechanics Section and a statement to that effect be included in the contract.

2. Differential settlements between the new structures and the existing structures can be anticipated; therefore, an expansion joint between the new and the existing structures should be provided to accommodate any differential settlements.

3. Construction of the additional structural sections will require roadway protection. When such a scheme, together with the sequence of construction, is available, this Section would provide necessary comments.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: G.C.E. Burkhardt
D. MacDonald
Files