

G.I.-30 SEPT. 1976

GEOCRES No. 30M15-54

DIST. 7 REGION

W.P. No. 59-75-09

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 401

LOCATION C.N.R. SUBWAY AND Hwy 401  
0.3 MILES EAST OF WAVERLY RD

No of PAGES - 1

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 59-75-09

DIST #7

HWY #401

STR SITE #21-427

C.N.R. Subway and Highway 401  
0.3 Miles East of Waverly Road

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## FOUNDATION INVESTIGATION REPORT

For

C.N.R. Subway and Highway 401  
0.3 Miles East of Waverly Road  
W.P. 59-75-09, Site 21-427  
Highway 401, District 7, Port Hope

### INTRODUCTION

This report contains the results of a foundation investigation carried out for the above described project. Fieldwork consisted of 5 sampled boreholes accompanied by 3 dynamic cone penetration tests. This work was carried out during the period March 11th to 17th, 1980 employing a track mounted auger machine. Both solid stem and hollow stem augers were employed to advance the boreholes to bedrock with bedrock being proven in 2 locations through the recovery of BXL size rock cores.

### SITE DESCRIPTION

The site is located on the existing Highway 401 alignment approximately 1/3 of a mile east of the Waverly Road, Highway 401 interchange. The surrounding area is gently rolling with an overall slope to the south toward Lake Ontario. Land use in the area remains agricultural with a nursery located south of Highway 401. Physiographically the area is part of the Iroquois Plain which in this area forms a mosaic of till plains and drumlins intermixed with cohesive lacustrine deposits.

### SUBSURFACE CONDITIONS

#### Subsoil General

Subsoil at the site consists of 10 to 18 feet of silty clay of low to intermediate plasticity followed by 7 to 19 feet of silt to silty clay with sand and some gravel. This lower deposit which immediately overlies

the limestone bedrock is of glacial origin.

Reference should be made to the Record of Borehole Sheets which are contained in the report Appendix. They show a summary of all field and laboratory tests performed. Reference should also be made to Drawing No. 597509-A which shows the locations and elevations of all borings, together with an inferred subsoil stratigraphy. A brief description of the various soil types encountered follows.

#### Silty Clay

The upper 10 to 18 feet of subsoil consists of a lacustrine deposit of silty clay of low to intermediate plasticity. Results of Atterberg Limit Tests on representative samples are shown on a plasticity chart as Figure 1 of the Appendix. Based on Standard Penetration Test 'N' values, which ranged from 3 to 24, as well as field vane tests, it is estimated that the undrained shear strength of this deposit ranges from 900 to 4000 p.s.f. This indicates a firm to very stiff consistency. A consolidation test, the results of which are summarized in Figure 3, indicates a high degree of preconsolidation.

Laboratory testing performed on representative samples from the deposit give the following results.

<u>Index Properties</u> (6 tests)	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)%	19-37	28
Liquid Limit (w <sub>L</sub> )%	35-44	37
Plastic Limit (w <sub>p</sub> )%	14-15	14
Plasticity Index (I <sub>p</sub> )%	19-28	23

#### Silt to Silty Clay with Sand Some Gravel

Located between the silty clay deposit and the underlying bedrock is a 7 to 19 foot thick layer consisting of a heterogeneous mixture of silt, sand, clay and gravel of glacial origin. This deposit generally shows slight plasticity with results of Atterberg Limit Tests plotting in the CL-ML range of the plasticity chart as illustrated in Figure 1. Typical grain size distribution is shown as an envelope in Figure 2. The moisture content of samples tested ranged from 13 to 6 percent with a general decrease with depth. Based on Standard Penetration 'N' values

which ranged from 6 to in excess of 100 blows per foot it is estimated that the consistency varies from firm to hard with an increase in strength with depth.

#### Limestone Bedrock

Limestone bedrock was proven through the recovery of BXL rock cores in 2 of the boreholes. With the exception of the upper foot which was moderately weathered the bedrock is sound. The surface varies between elevation 235 and 238 some 24 to 30 feet below the ground surface.

#### Groundwater

Groundwater levels were recorded in the open boreholes during the period of the fieldwork. They varied from 2 to 12 feet below the ground surface, ranging from elevation 254 to 258. This variation in elevation probably results from the addition of surface water from melting snow and rain combined with the low permeability of the subsoil.

## DISCUSSION AND RECOMMENDATIONS

### Discussion

It is proposed that the structure to carry the C.N.R. spurline over Highway 401 either be a 2 span structure with full height abutments or a 4 span structure with shoulder piers and perched abutments. In either case the approach fills will be approximately 15 feet in height to the north of the structure and between 20 and 25 feet high to the south.

### RECOMMENDATIONS

#### H-Piles

It is recommended that the proposed structure be supported on steel H-piles driven to bedrock. Loads equal to the allowable structural capacity of the section chosen may be employed. For example, a 12 BP 74 H-pile will carry a design load of 130 tons per pile. Pile lengths should be estimated based on a pile tip elevation of 234. In all cases the pile tips should be reinforced by standard flange plates to prevent damage from boulders in the till layer and to increase the contact area between the pile tip and the bedrock.

#### Earth Pressure

The abutments should be designed for earth pressures based on granular material weighing 130 lb/cu. ft. and a coefficient of earth pressure related to the allowable amount of wall movement. If the wall will deflect 0.2 percent of its height a coefficient of active earth pressure  $k_a$  equal to 0.3 may be used. If the deflection will be less than 0.2 percent of its height an at rest coefficient of earth pressure  $k_o$  equal to 0.5 should be used.

#### Approach Fills

Based on the minimum undrained shear strength of the subsoil of 900 p.s.f. approach fills up to 25 feet in height will be stable provided 2 horizontal to 1 vertical slopes are employed.

If the abutments are perched, the area of the fill through which piles will be driven should not contain cobbles or boulders in excess of 3 inches in diameter.

### Settlement

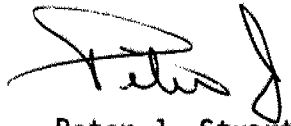
Settlement of the structure if founded on H-piles driven to bedrock will be negligible. Settlement under the approach fills will not exceed 4 inches. It will increase approximately linearly from zero at the toe of slope to a maximum of 4 inches under the full height of the embankment.

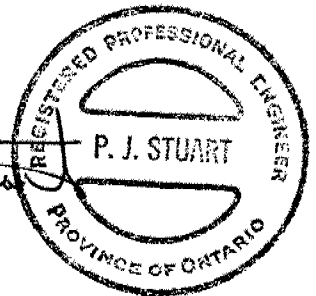
### Frost Protection

The base of all pile caps should have a minimum of 4 feet of cover as protection against frost action.

### Dewatering

No dewatering problems are anticipated for footing excavations due to the relatively impervious nature of the subsoil. Any seepage into the excavation may be removed by pumping from sumps.

  
Peter J. Stuart  
Foundations Engineer



  
M. Devata  
Senior Foundations Engineer

April 14, 1980.




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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 59-75-09 LOCATION Co-ords. N 15 951 478; E 1 215 246 ORIGINATED BY FL  
DIST 7 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PJS  
DATUM Geodetic DATE March 12, 1980 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							WATER CONTENT (%)
								SHEAR STRENGTH							
							○ UNCONFINED	+ FIELD VANE							
							● QUICK TRIAXIAL	x LAB VANE							
268.1	Ground Level							1000	2000						GR SA SI CL
0.0	Silty Clay of Low to Intermediate Plasticity		1	SS	19		260						114	e <sub>s</sub> = 0.807 P <sub>c</sub> = 4.4 TSF C <sub>c</sub> = 0.31	
	Stiff to Very Stiff		2	SS	15										
			3	TW	PH										
257.1			4	SS	9										
11.0	Silt to Silty Clay, with Sand		5	TW	PH										
	Some Gravel		6	TW	PH										
	Firm to Hard (Glacial Till)		7	SS	12										
	Refusal to Auger		8	SS	100		1"	240							
238.0															
30.1	Probable Bedrock End of Borehole														

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

OFFICE REPORT ON SOIL EXPLORATION





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RECORD OF BOREHOLE No 2

W P 59-75-09 LOCATION Co-ords. N 15 951 426; E 1 215 222 ORIGINATED BY PL  
DIST 7 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PJS  
DATUM Geodetic DATE March 11, 1980 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
260.4	Ground Surface							○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE					
0.0	Silty Clay of Low to Intermediate Plasticity		1	SS	20		260							
	Very Stiff		2	SS	20									
250.9			3	SS	14									
9.5	Silt to Silty Clay With Sand Some Gravel Firm to Hard (Glacial Till)		4	SS	9		250							9 30 41 20
			5	SS	16									
			6	SS	15									9 37 36 18
			7	SS	13		240							
235.4			8	SS	50/1"									
25.0	Limestone Bedrock		9	BXL	85% REC		230							RQD = 60%
229.9	Sound			RC	REC									
30.5	End of Borehole													

+3, x5: Numbers refer to Sensitivity

20  
15  
10

5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 3

W P 59-75-09 LOCATION Co-ords. N 15 951 318; E 1 215 195 ORIGINATED BY PL  
DIST 7 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS  
DATUM Geodetic DATE March 17, 1980 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	1000 2000	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
262.9	Ground Surface													GR SA SI CL
0.0	Silty Clay of Low to Intermediate Plasticity Stiff to Very Stiff		1	SS	8		260							
			2	SS	9									
250.9			3	SS	10				+ >2200					
12.0	Silt to Silty Clay With Sand Some Gravel Firm to Hard (Glacial Till)		4	SS	15		250							
			5	SS	12									
			6	SS	13									
236.8	Refusal to Auger		7	SS	14		240							20 32 32 16
26.1	Probable Bedrock End of Borehole													

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10

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RECORD OF BOREHOLE No 4

W P 59-75-09 LOCATION Co-ords. N 15 951 212; E 1 215 152 ORIGINATED BY PL  
DIST 7 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS  
DATUM Geodetic DATE March 13, 1980 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
259.7	Ground Surface												
0.0	Silty Clay of Low to to Intermediate Plasticity Very Stiff to Stiff		1	SS	15								
			2	SS	13								
			3	SS	12								
			4	SS	8								
246.7													
13.0	Silt to Silty Clay With Sand Some Gravel Firm to Hard (Glacial Till)		5	SS	6								19 29 34 18
235.7													
24.0	Limestone Bedrock Sound		6	BXL RC	95% RC								RQD = .75%
230.8													
28.9	End of Borehole												

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

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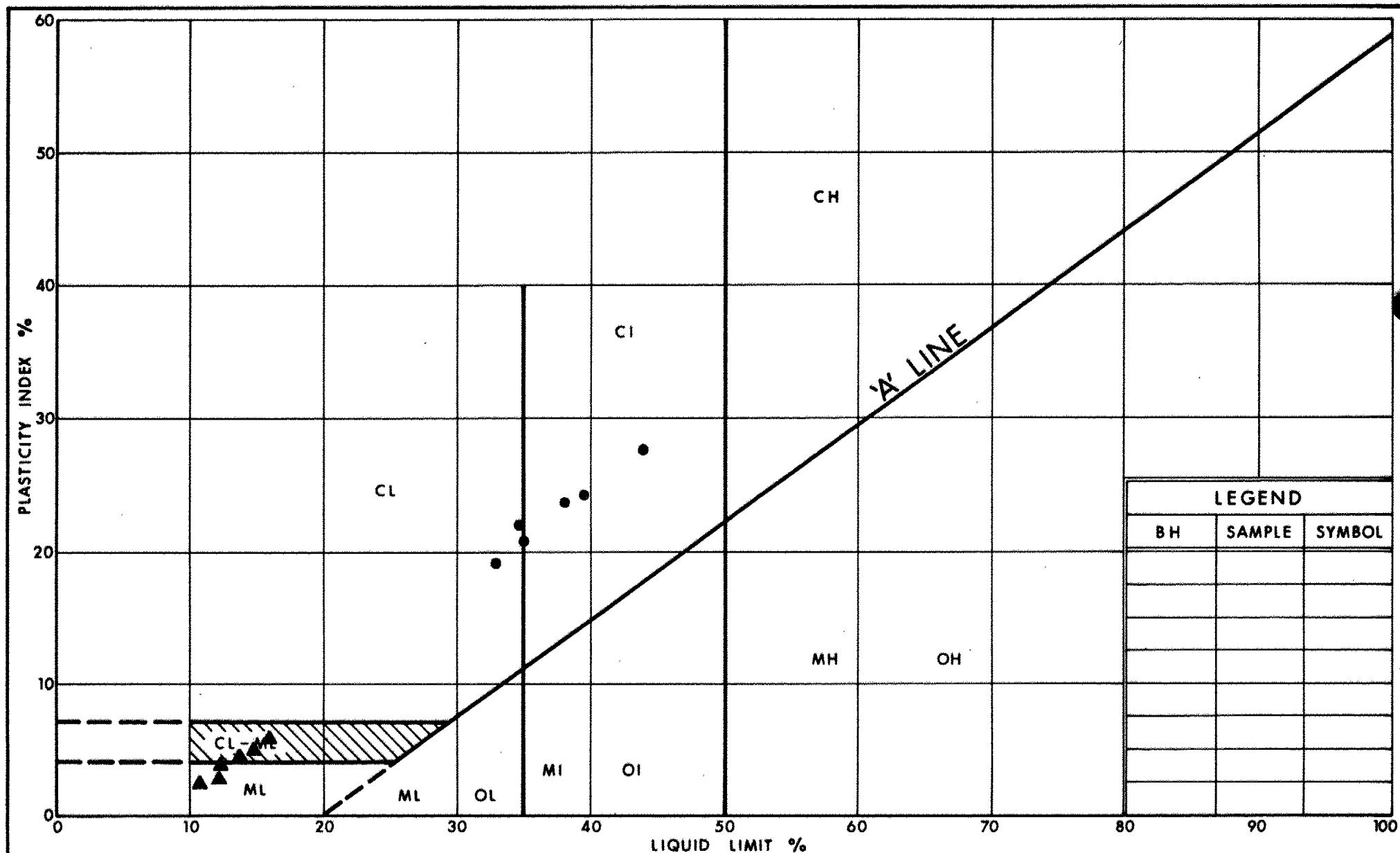
RECORD OF BOREHOLE No 5

W P 59-75-05 LOCATION Co-ords. N 15 951 164; E 1 215 146 ORIGINATED BY PL  
DIST 7 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS  
DATUM Geodetic DATE March 13, 1980 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
261.5	Ground Surface									
0.0	Silty Clay of Low to Intermediate Plasticity		1	SS	24					
			2	SS	17					
			3	SS	7					
	Very Stiff to Firm		4	SS	6					
243.5			5	SS	3					
18.0	Silt to Silty Clay With Sand, Some Gravel		6	SS	24					
236.5	Hard (Glacial Till)									
25.0	Probable Bedrock									
	End of Borehole									

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+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
20  
15  
10  
5 (%) STRAIN AT FAILURE



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**ENGINEERING SERVICES BRANCH**

**PLASTICITY CHART**

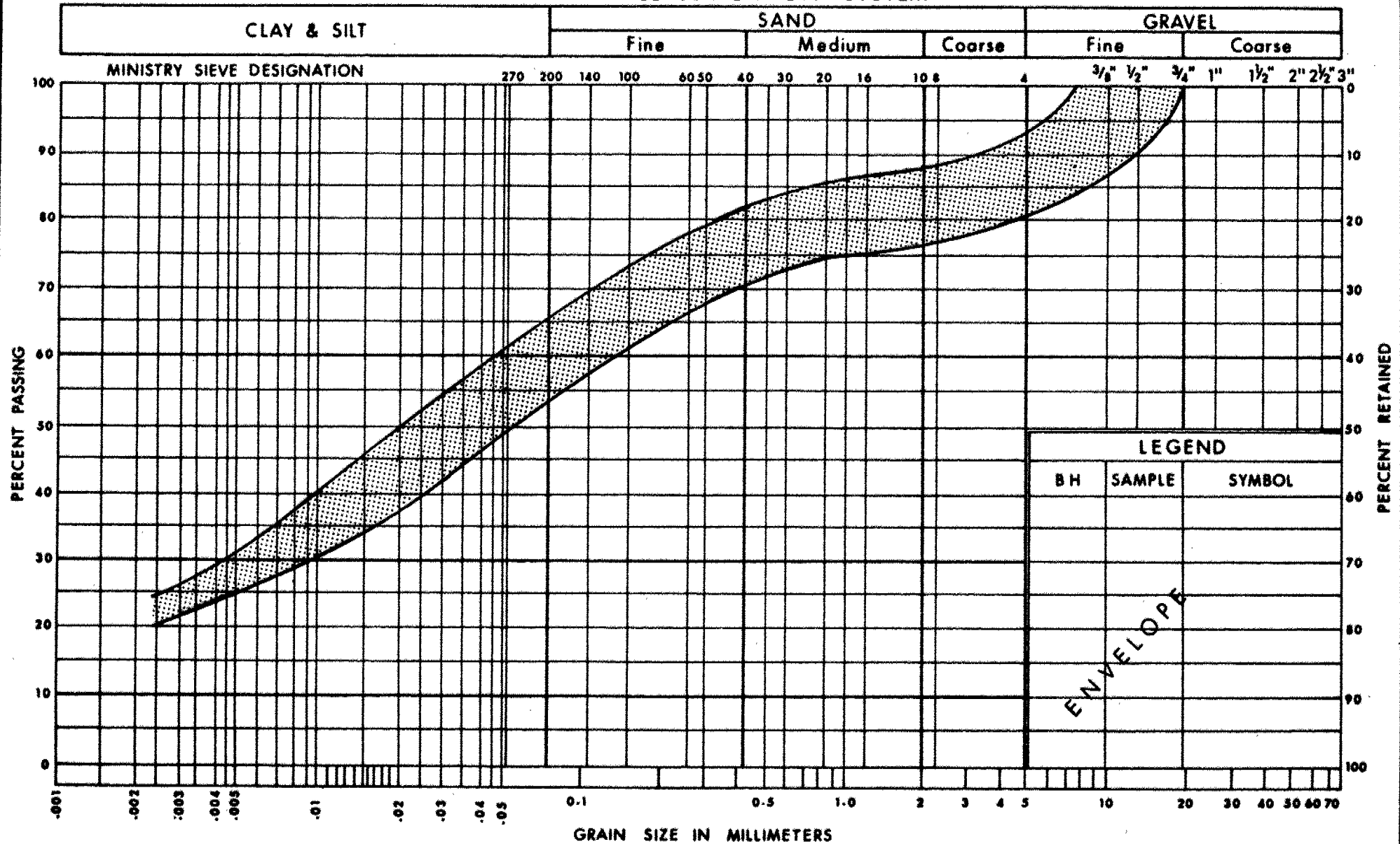
SILTY CLAY — ●

SILT TO SILTY CLAY WITH SAND SOME GRAVEL — ▲

FIG No 1

W P 59-75-09

## UNIFIED SOIL CLASSIFICATION SYSTEM



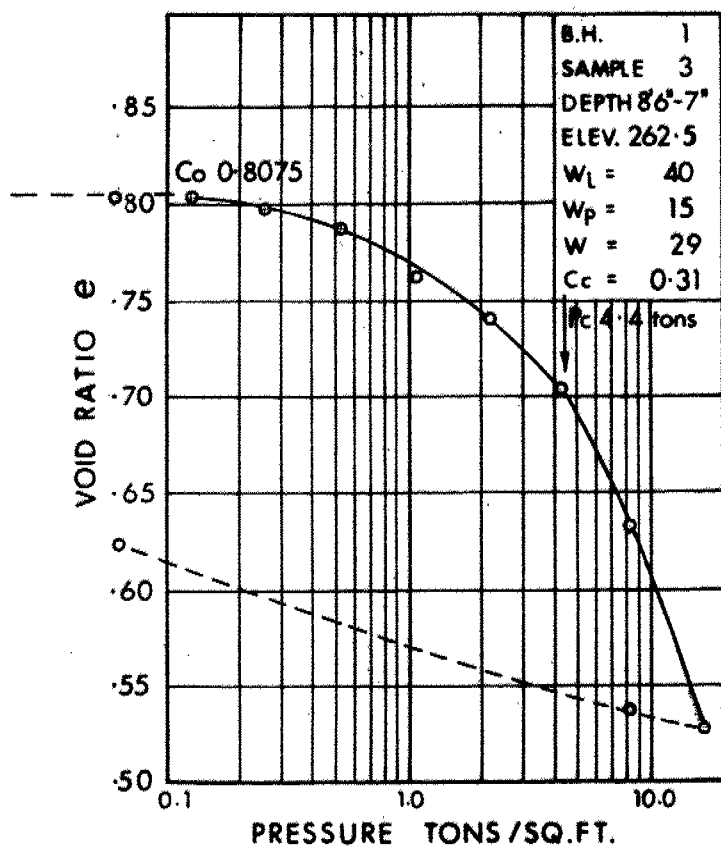
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**GRAIN SIZE DISTRIBUTION**  
**SILT TO CLAYEY SILT**  
WITH SAND SOME GRAVEL (GLACIAL TILL)

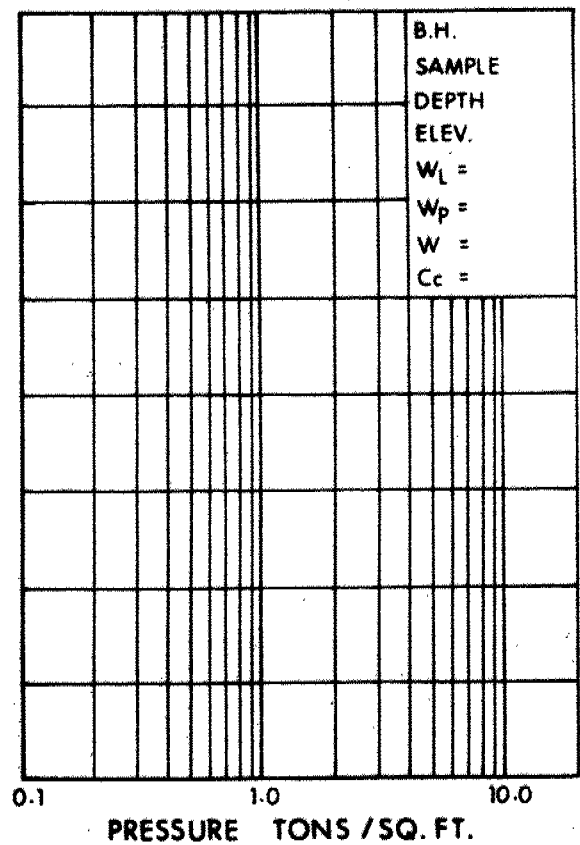
FIG No 2

W P 59-75-09

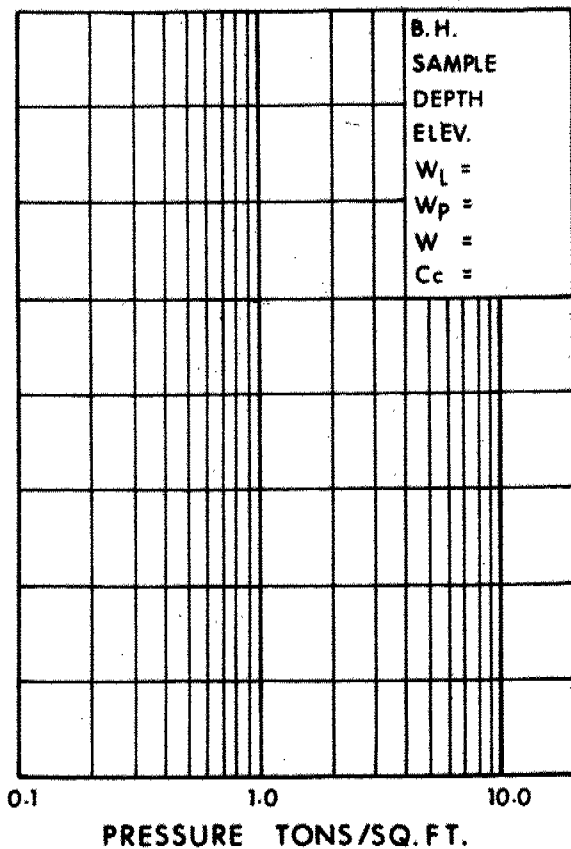
# VOID RATIO - PRESSURE CURVES



VOID RATIO  $e$



VOID RATIO  $e$



VOID RATIO  $e$

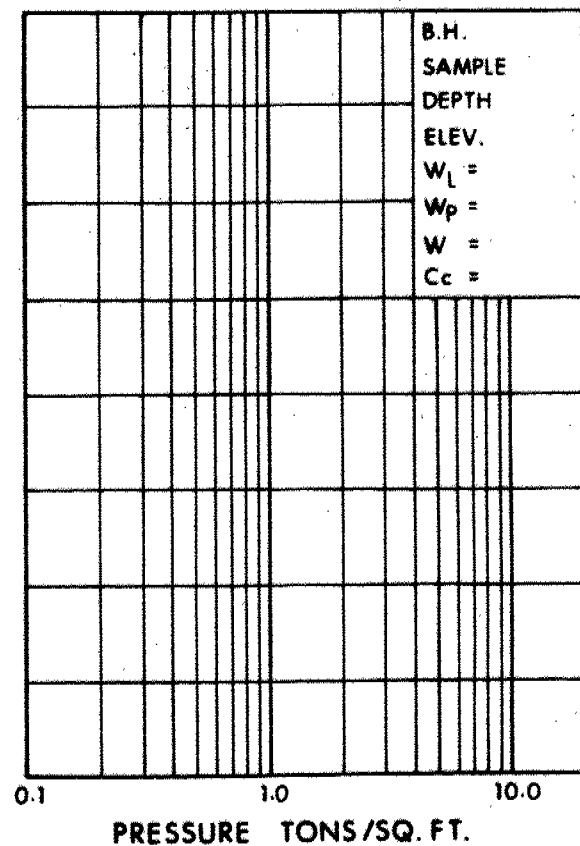


FIG. 3

W.P. 59-75-09

# 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  $N_c$ .

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. CIU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

### FIELD SAMPLING

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

### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  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  
 $w$  SLOPE ANGLE-BACKFACE OF WALL  
 $\beta$  ANGLE OF SLOPE  
 $N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  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 =  $\frac{I_P \text{ of soil}}{2.4 \mu m \text{ Soil Fraction}}$   
 $Om$  ORGANIC MATTER CONTENT  
 $S_r$  DEGREE OF SATURATION  
 $S$  SENSITIVITY =  $\frac{S_u (\text{undisturbed})}{S_u (\text{remoulded})}$

### STRENGTH PARAMETERS

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  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  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  POISSON'S RATIO  
 $E$  MODULUS OF ELASTICITY  
 $G$  MODULUS OF SHEAR DEFORMATION  
 $k_a$  MODULUS OF SUBGRADE REACTION  
 $m, n$  STABILITY COEFFICIENTS  
 $A, B$  PORE PRESSURE COEFFICIENTS

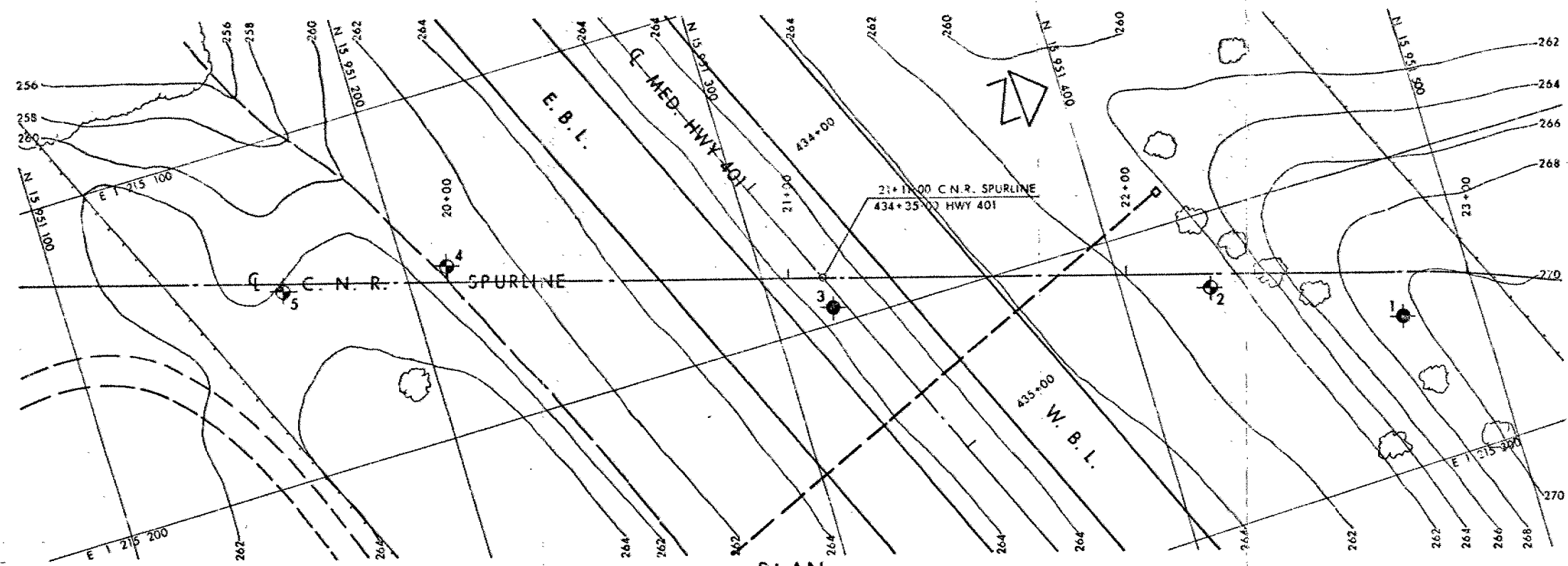
NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

### HYDRAULIC TERMS

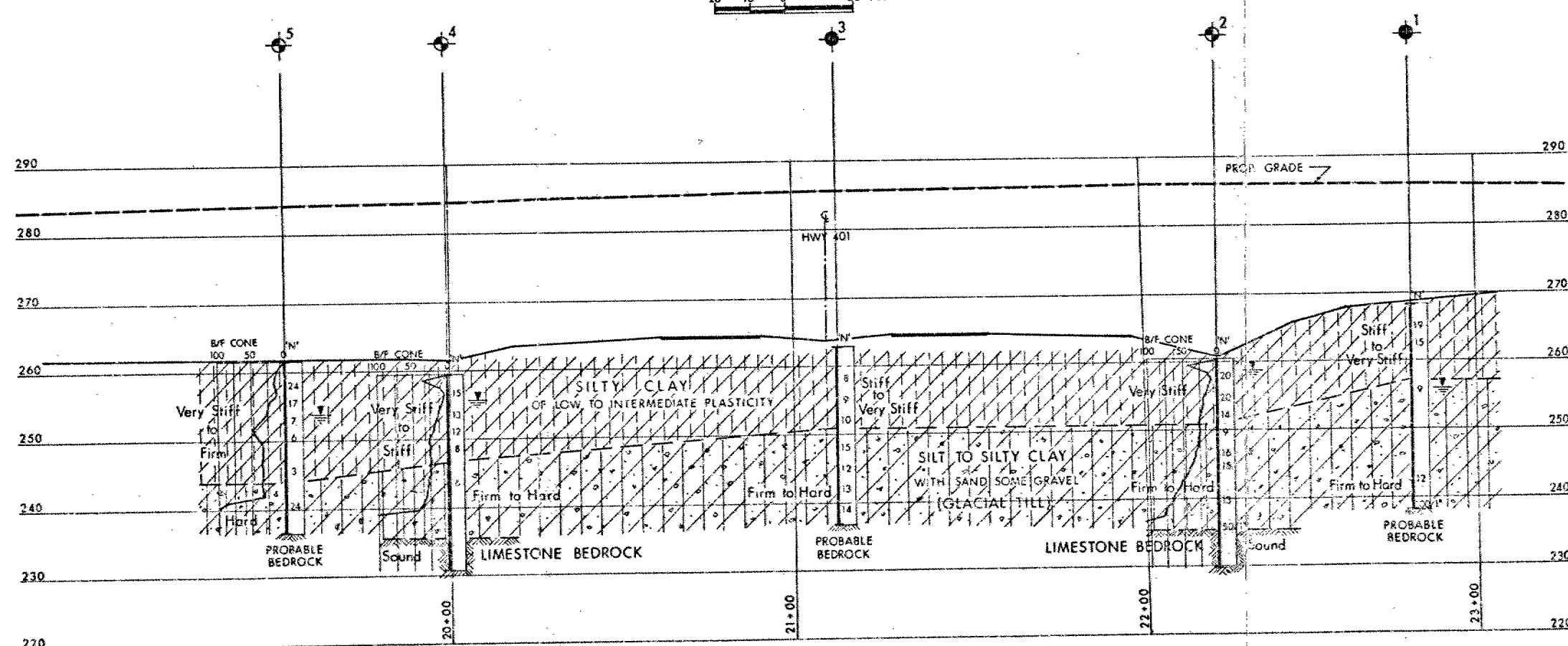
$h$  HYDRAULIC HEAD OR POTENTIAL  
 $q$  RATE OF DISCHARGE  
 $v$  VELOCITY OF FLOW  
 $i$  HYDRAULIC GRADIENT  
 $j$  SEEPAGE FORCE PER UNIT VOLUME  
 $\eta$  COEFFICIENT OF VISCOSITY  
 $k$  COEFFICIENT OF HYDRAULIC CONDUCTIVITY  
 $k_h$   $k$  IN HORIZONTAL DIRECTION  
 $k_v$   $k$  IN VERTICAL DIRECTION  
 $m_v$  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  
 $O_c$  OVERCONSOLIDATION RATIO (OCR)



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

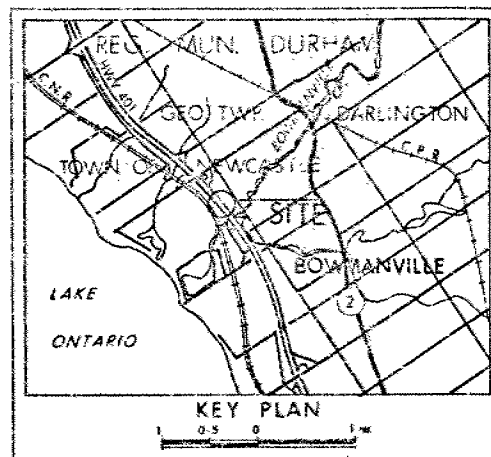


PLAN  
SCALE  
20 10 0 20 FT.



PROFILE C.N.R. SPURLINE

SCALE  
HOR. 20 10 0 20 FT.  
VERT. 10 5 0 10 FT.



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- WL at time of investigation 80 03 12

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	268.1	15 951 478	1 215 266
2	260.4	15 951 426	1 215 222
3	262.9	15 951 318	1 215 195
4	259.7	15 951 212	1 215 152
5	261.5	15 951 164	1 215 146

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

GEOCRE5 No 30M15-54

REVISIONS	DATE	BY	DESCRIPTION

HWY No 401  
SUBMITTER'S CHECKED DATE NO 04 02  
ORIGINATOR'S CHECKED DATE NO 04 02  
PAGE 597509-A

# memorandum



To: Mr. M. Devata,  
Senior Foundation Engineer,  
Pavement & Foundation Design  
Section,  
Central Building, Downsview.

Date: 79-12-17

Central Region

RE: Foundation Investigation,  
Relocation of C.N.R. Spurline At  
Bowmanville over Highway 401,  
Highway 401 Widening, W.P. 59-75-09,  
District 7, Port Hope

As a part of the Highway 401 widening project (from Waverly Road to Highway 35 and 115), the present single track C.N.R. spur line, crossing Highway 401 at grade, located between Waverly Road and Liberty Street, is proposed to be removed and to be replaced with a new line at a different location. The new C.N.R. spur begins at the team track at Bowmanville on the main Toronto-Montreal line, crosses Bowmanville Creek immediately upstream of the existing C.N.R. bridge (Mile 290.0, Kingston Subdivision), joins the main track at east of Waverly Road, extends northward by crossing Highway 401, turns easterly crossing Bowmanville Creek again and then continues north to the Goodyear Plant (see the attached plan).

There are three new bridges and two new culverts included in this new C.N.R. Spurline:

- (1) South of Highway 401, a new bridge (a single span of 60'+) crosses Bowmanville Creek immediately upstream of the existing C.N.R. Bridge. WP 59-75-11
- (2) A 4'x 4' (130'+ long) concrete box culvert located under the new C.N.R. Spurline embankment and is to be connected to the existing culvert under the existing C.N.R. main line embankment. WP 59-75-13
- (3) A 12'x 12' (90'+ long) concrete open culvert located under the new Spurline embankment, serving as a passage for the Brookdale-Kingston Nursery. WP 59-75-12
- (4) A new bridge carrying the C.N.R. track over Highway 401, it is proposed to investigate a two equal span (90'+ ) structure and also a four span structure with 35'+ end span and 90'+ mid-span; the approximate locations of abutment footings and pier footings are marked (in green) on the 1"= 40' scale plan. The site number given to this structure is not available yet. WP 59-75-09
- (5) A new bridge (a single span of 90'+ ) carries the C.N.R. track over Bowmanville Creek at approximately 200'+ upstream of the existing Bowmanville Creek Bridge which carries Highway 401 over Bowmanville Creek. WP 59-75-10

.....2

Would you please carry out detail foundation investigation for the above five structures. Please also include subsoil information, such as type, depth and grain size, in the streambed of the two Bowmanville Creek crossings mentioned in (1) and (5) because we need the information of streambed subsoil materials for our hydrology study. Please provide us with streambed subsoil information by the middle of February 1980, so that we can maintain our present schedule.

As I discussed with you in our meeting at your office on 79-12-11, we wanted to obtain subsoil information such as the type, depth and grain size in the streambed under the existing Bowmanville Creek/Highway 401 Bridge for our hydrology study. Because the subsoil information of the streambed material was not included in the Foundation Report for Bowmanville Bridge Site 21-161, W.P. 59-75-06, we would like to request the streambed subsoil investigation be included in this project (W.P. 59-75-09). It is proposed to drill three boreholes on the streambed to EL. 240+, one located at the middle of the stream under the existing structure, and one located at 12'+ upstream of the existing structure and one at 12'+ downstream of the existing structure. These three borehole locations are marked in red on the plan (Plan E-5456-1) attached herewith. We would like to receive this information by the end of January 1980, because of the very tight schedule.


Attached please find two prints of 1"=40' plan with the locations of the five new structures marked in red. The approximate locations of abutment footings and pier footings of the C.N.R. - Highway 401 structure mentioned in (4) are marked in green. Detailed bridge site plans will be available in January, 1980. The structures mentioned in (1), (3) and (5) have no site number because all these structures (including the structure (4)) will be designed, constructed and maintained by C.N.R. The group W.P. for these five structures is 59-75-09. Individual W.P. number may be given pending the recommendation of the Priority Development Branch. You will be informed if there are individual W.P. numbers for each of the five structures. We will advise you regarding the site number of structure (4).

The present schedule calls for the completion/submission of the last Foundation Report of these five structures by 80-03-21.

We would greatly appreciate it if you could send us each of the Foundation Reports as soon as it is completed. If there are any questions, please contact us.

ASPM:gj  
Attach.

c.c. V. Mitranic  
R. Fitzgibbon  
D. Gunter  
J. Anderson  
A. Teoh (De Leuw Cather)

  
A.S.P. Ma,  
Senior Structural Engineer  
for:  
G.C.E. Burkhardt,  
Head, Structural Section.