

G.I.-30 SEPT. 1976

GEOCRES No. 3165-104 A & BDIST. 9 REGION                     W.P. No. 435-64-01, 02CONT. No. 76-12W. O. No.                     STR. SITE No. 3-290HWY. No. 417LOCATION Carp River BridgeNo. of PAGES -=====  
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     REMARKS:

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 76-12



Ministry of  
Transportation and  
Communications



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## ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

### PENETRATION RESISTANCE

**'N'** STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

**DYNAMIC PENETRATION RESISTANCE** : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

### SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" " ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

## ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

### SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
$w_s$	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$c_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_r$	SENSITIVITY

### GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF $\sigma$
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF $\sigma$ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

### STRESS AND STRAIN

$u'$	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

### FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

# FOUNDATION INVESTIGATION REPORT

For

Hwy. 417, Carp River Bridge

W.P. 435-64-01            EB Lanes

W.P. 435-64-02            WB Lanes

## INTRODUCTION

This report contains results of a foundation investigation carried out at the following sites:

Carp River Bridge

W.P. 435-64-01          EB Lanes

W.P. 435-64-02          WB Lanes

For purposes of this Contract, all other Foundation Investigation Reports prepared by or for the Ministry in connection with the above mentioned project are superceded by this report.

## SITE DESCRIPTION AND GEOLOGY

The site is located approximately  $1\frac{1}{4}$  miles north of Hwy. 7 and  $\frac{1}{2}$  mile east of Goulbourn Road, in the Township of March. The terrain is flat to gently undulating in relief between about elevations 304 to 306. The land is cultivated and being used for farming purposes.

The north-south flowing Carp River traverses the area. The river channel is approximately 50 feet wide and 6 feet deep and has flat slopes. The Carp River, in this area, has a broad flood plain which is very often flooded during periods of high precipitation, such as during the spring of the year.

This area is situated in the physiographic region known as the 'Ottawa-Valley Clay Plains.' In this region extensive clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region; in some localized areas it is known to extend to depths in excess of 200 feet. The clay is underlain by glacial till.

The overburden deposits are underlain by limestone bedrock of the Trenton and Black River groups, Ordovician Period.

## SUBSURFACE CONDITIONS

### General

The predominant stratum across the site is composed of a 37 to 63 ft. thick very stiff to soft grey silty clay.

In the immediate vicinity of the Carp River and its flood plain 1 to 7 ft. deep surficial organic material is present above the silty clay. The cohesive stratum is underlain by a competent non-cohesive glacial till deposit, whose thickness ranges from 1 to 20 feet. The glacial till is, in turn, underlain by limestone bedrock. The boundaries of the various deposits, as determined in the boreholes, are shown on the Record of Borehole Sheets which are contained in the Appendix to this report. The locations and elevations are shown on Drawings No. D-7075-2 and D-7079-2 of the Contract Drawings. Estimated stratigraphical profiles and sections are shown also. A description of soil types and bedrock encountered is as follows:

#### Organic Silt to Organic Clay

A surficial deposit, composed of a soft black organic silt to organic clay was encountered in the Carp River Channel, as well as along this river's flood plain, which primarily extends in an easterly direction from the river channel. The thickness of this layer ranges from 1.5 to 4 feet. An investigation carried out by the Regional Materials Section, Eastern Region, however, indicated that, in isolated areas, the thickness of the organic material is up to 7 feet.

#### Silty Clay (Sensitive Leda Clay)

Directly beneath the surficial organic material or a 1 foot layer of topsoil is the predominant stratum composed of silty clay of marine origin. The overall thickness of the cohesive soil varies from 37 to 63 feet. The upper 2 to 11 feet of the stratum is mottled grey and brown in colour which is an indication that this upper zone has been subjected to desiccation. Beneath this desiccated zone the clay is grey. Numerous partings and seams of silt, up to 3" thick, are present throughout the deposit.

The properties of the upper desiccated, as well as the lower portion of the stratum, are summarized in tabular form below (Refer Fig. 1).

<u>Identity Tests</u>		<u>Upper Desiccated Zone</u>	<u>Lower Zone</u>
Bulk Density (p.c.f.)	( $\gamma$ )	108-113	97-105
Liquid Limit (%)	( $W_L$ )	40-43	33-52
Plastic Limit (%)	( $W_p$ )	21-22	20-26
Moisture Content (%)	( $W$ )	21-38	45-62



<u>Identity Tests</u>	<u>Upper Desiccated Zone</u>	<u>Lower Zone</u>
Liquidity Index ( $I_L$ )	0-0.7	1.1-2.0
<u>Consolidation Characteristics</u>		
Number of Tests Performed	1	2
Initial Void Ratio ( $e_o$ )	1.1	1.6 - 1.8
Compression Index ( $C_c$ )	0.60	0.9 - 1.3
Degree of Preconsolidation (p.s.f.) ( $P'_c - P'_o$ )	2,800	1,000 - 1,750
<u>Undrained Shear Strength (p.s.f.)</u>		
Field Tests	1,100- > 2,000	400-1,500
Lab. Tests	1,050- > 2,000	400-1,200
<u>Standard Penetration Resistance</u>		
'N' Values (Blows/ft.)	3-5	1-6

The Atterberg Limit tests are also plotted on the Plasticity Chart, Figure No. 2. The cohesive subsoil is essentially inorganic with a plasticity that is generally in the intermediate range. The natural water content, in the upper desiccated zone, is located between the liquid and plastic limits, while in the lower zone it is consistently well above the liquid limit. The latter is indicative of a sensitive material.

The consistency of the upper desiccated zone varies from stiff to very stiff, while that of the lower zone is in the soft to stiff range.

The consolidation characteristics of the stratum are shown as Void Ratio vs. Pressure plots on Fig. No. 3. The clay stratum, below the desiccated zone, is preconsolidated by about 1,000 to 1,750 p.s.f. in excess of existing overburden pressure. In the upper desiccated zone the degree of preconsolidation is higher than this range.

For design purposes, the following parameters are recommended.

Design Parameters

<u>Elevation</u>	<u>Soil Type</u>	<u>Bulk Density (p.c.f.)</u>	<u>Undrained Shear Strength (Cu.-p.s.f.)</u>	<u>Apparent Angle of Shear Resistance (<math>\phi</math> - degrees)</u>
<u>Eastbound Lanes - Approaches</u>				
304-294	Silty Clay (Desiccated)	110	1000	(west approach only)
304-294	Silty Clay	105	600	(east approach only)
294-284	Silty Clay	100	450	
284-273	Silty Clay	105	650	
273-263	Silty Clay	110	1000	
263-	Glacial Till	140		40

Westbound Lanes - Approaches

305-297	Silty Clay (Desiccated)	110	1200	
297-287	Silty Clay	110	1000	
287-277	Silty Clay	100	500	
277-245	Silty Clay	105	650	
245-	Glacial Till	140		40

NOTE: Groundwater level in Surficial Deposits and  
Silty Clay Stratum at Elevation 301.

Heterogeneous Mixture of Silt, Sand and  
Gravel, Trace of Clay (Glacial Till)

The clay stratum is underlain by a non-cohesive glacial till deposit composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. The thickness of the till generally ranges from 1 to 2 feet, except in certain locations along the east bank of the Garp River, where it is as much as 20 feet. Where the till is thicker, the lower 11 feet of it contains boulders up to 8 inches in size. Grain-size distribution curves for samples of the matrix of the glacial till are plotted on Figure No. 4.

The Standard Penetration Tests gave 'N' values which range from 6 blows/ft. to 100 blows for 1 inch, with the lower values being confined to the upper 1 to 2 feet. Based on these values it is estimated that the relative density of the upper 'reworked' zone (where present) varies from loose to compact, while the remainder of the deposit is in the very dense range.

### Limestone Bedrock

The glacial till is directly underlain by bedrock. The bedrock surface varies between elevations 237 and 243, which corresponds to depths below ground surface of from 51 to 70 feet.

The bedrock is composed of limestone with occasional irregular shaly interbeds. In some localized areas the upper 2 to 3 feet of the bedrock is in a fractured and jointed condition. Below this upper zone (where present) the bedrock is sound.

### GROUNDWATER CONDITIONS

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. The observations are presented on the Record of Borehole Sheets, as well as on Drawings No. D-7075-2 and D-7079-2. The results indicate that the groundwater level in the surficial deposits and cohesive stratum varies from 1 to 3 feet below the ground surface. These levels correspond closely with the water level in the Carp River (elev. 303) at the time of the investigation.

An artesian condition was encountered in the non-cohesive glacial till deposit which overlies the bedrock. The artesian pressure head was between elevations 306.5 and 308.5, which corresponds to 2 to 4.5 feet above the existing ground surface. The glacial till is relatively pervious with respect to the overlying silty clay stratum, as well as the underlying sound portion of the bedrock, and is acting as a confined aquifer which is being charged with groundwater from the surrounding terrain which is at a higher elevation.

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April, 1976

## APPENDIX

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 435-64-02 LOCATION Sta. 127 + 98, O/S. 20' Lt. W.B.L. ORIGINATED BY SAA  
 DIST 9 HWY 417 BORING DATE July 7, 8 and 13, 1971 COMPILED BY SAA  
 DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing, BX Rock Core CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS  % GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV	20	40	60	80	100	$w_p$ — $w$ — $w_L$				
						SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						WATER CONTENT % 20 40 60				
						400 800 1200 1600 2000										
303.9	Ground Level															
0.0	Clayey Topsoil															
1.0	Desiccated Zone Stiff to very stiff.		1	TW	PM	300							113.5			
			2	SS	3											
	Silty Clay, trace of sand (sensitive)		3	SS	1											
	(Occasional partings and seams of silt up to 2" thick below elev. 270)		4	SS	4	290										
			5	TW	PM											
			5A	SS	3									97.5		
			6	TW	PM	280										
	Grey		7	SS	3											
	Stiff to firm.		8	TW	PM	270								103		
			9	SS	1											
			10	TW	PM	260										
			11	SS	3											
			12	SS	4	250										
		13	SS	6												
244.9	Glacial Till															
243.1	Very Dense		14	SS	100/1"											
60.8	Limestone Bedrock			RC	100%											
238.1	shale seams through- out. Sound		15	BX	Rec	240										
65.8	End of borehole.															
	St = Sensitivity															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 435-64-02 LOCATION Sta. 128 + 04; 18' Rt. W.B.L. ORIGINATED BY SAA  
 DIST 9 HWY 417 BORING DATE July 7, 1971 COMPILED BY SAA  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS			
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT % $w_p$ — $w$ — $w_L$		
305.5	Ground Surface																		
0.0	Probably silty clay.					300													
						290													
						280													
						270													
						260													
244.5						250													
243.2	Probably Glacial Till																		
62.3	End of cone test. Probably bedrock.					240													

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

WP 435-64-02 LOCATION Sta. 128 + 30; O/S 20' Lt. W.B.L. ORIGINATED BY SAA  
 DIST 9 HWY 417 BORING DATE July 6, 1971 COMPILED BY SAA  
 DATUM Geodetic BOREHOLE TYPE Cone Penetration Test Only CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
302.0	Ground Surface									
297.5	Probably organic silt or clay									
4.5	Probably silty clay.									
240.0										
238.3	Probably glacial till									
63.7	End of cone test. Probable bedrock									

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 435-64-02 LOCATION Sta. 128 + 34; 18' Rt. W.B.L. ORIGINATED BY SAA  
 DIST 9 HWY 417 BORING DATE July 7, 1971 COMPILED BY SAA  
 DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing - BX Rock Core CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS Art. Head % 306
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
302.0	Ground Surface															
0.0	Org. Silt to Org. clay soft.		1	SS	5	300									14%	
298.0	Desiccated Zone		2	SS	5											
4.0	Stiff to very stiff		3	TW	PM										108	
	Silty clay, trace of sand (sensitive)		4	SS	1											
	(Occasional partings and seams of silt up to 2" thick below elev. 280)		5	TW	PM										99.5	
	Grey		6	SS	1											
	Firm to Stiff		7	TW	PM										104	
			8	SS	6											
			9	SS	12											
			10	TW	PM											
			11	TW	PM											
			12	SS	4											
			13	TW	PM											
242.0	Glacial Till Loose		14	SS	6	240										
61.9	Limestone bedrock, seams of shale.		15	RC	100%											
235.0	Grey. Sound			BX	REC											
67.0	End of Borehole															
						230										



## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 5

WP 435-64-02

LOCATION Sta. 128 + 73; E.W.B.L.

ORIGINATED BY SAA

DIST 9 HWY 417

BORING DATE July 9, 10 &amp; 12, 1971

COMPILED BY SAA

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH PSF				
							O UNCONFINED + FIELD VANE			● QUICK TRIAXIAL x LAB VANE						
											WATER CONTENT % $w_p$ — $w$ — $w_L$					
											WATER CONTENT %					
											GR SA SI CL					
303.7	Ground Surface															
0.0	Org. silt to org. clay. Soft															
300.7	Desiccated zone. Stiff															
3.0			1	SS	2											
			2	TW	PM											
			3	TW	PM											
			4	SS	1											
			5	TW	PM											
			6	TW	PM											
			7	SS	2											
			8	TW	PM											
			9	TW	PM											
			10	SS	1											
			11	TW	PM											
			12	SS	1											
241.7																
240.4	Glacial Till compact															
69.3	End of borehole Probably bedrock															

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

# RECORD OF BOREHOLE NO 6

WP 435-64-02

LOCATION Sta. 127 + 77 & W.B.L.

ORIGINATED BY SAA

DIST 9 HWY 417

BORING DATE July 9 and 12, 1971

COMPILED BY SAA

DATUM Geodetic

BOREHOLE TYPE Washboring

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
305.4	Ground Surface															
304.3	Clayey topsoil															
1.1	Desiccated zone. Stiff															
	Silty clay, trace of sand		1	SS	3											
	(Sensitive)		2	TW	PM											
	(Occasional partings and seams of silt up to 3" thick below elec. 280)		3	TW	PM											
			4	SS	2											
			5	TW	PM											
			6	SS	1											
			7	TW	PM											
			8	SS	1											
	Gray		9	TW	PM											
	Firm to Stiff		10	SS	1											
			11	TW	PM											
			12	SS	1											
242.0	Glacial till Compact															
240.5	End of borehole															
64.9	Probably bedrock															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE No 7

WP 435-64-01

LOCATION Sta. 127 + 83 O/S 20' Rt. E.B.L.

ORIGINATED BY ML

DIST 9 HWY 417

BORING DATE July 21, 1971

COMPILED BY BTD

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY                     

[illegible]

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

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 8

WP 435-64-01

LOCATION Sta. 127 + 73 O/S 18' Lt. E.B.L.

ORIGINATED BY ML

DIST 9 HWY 417

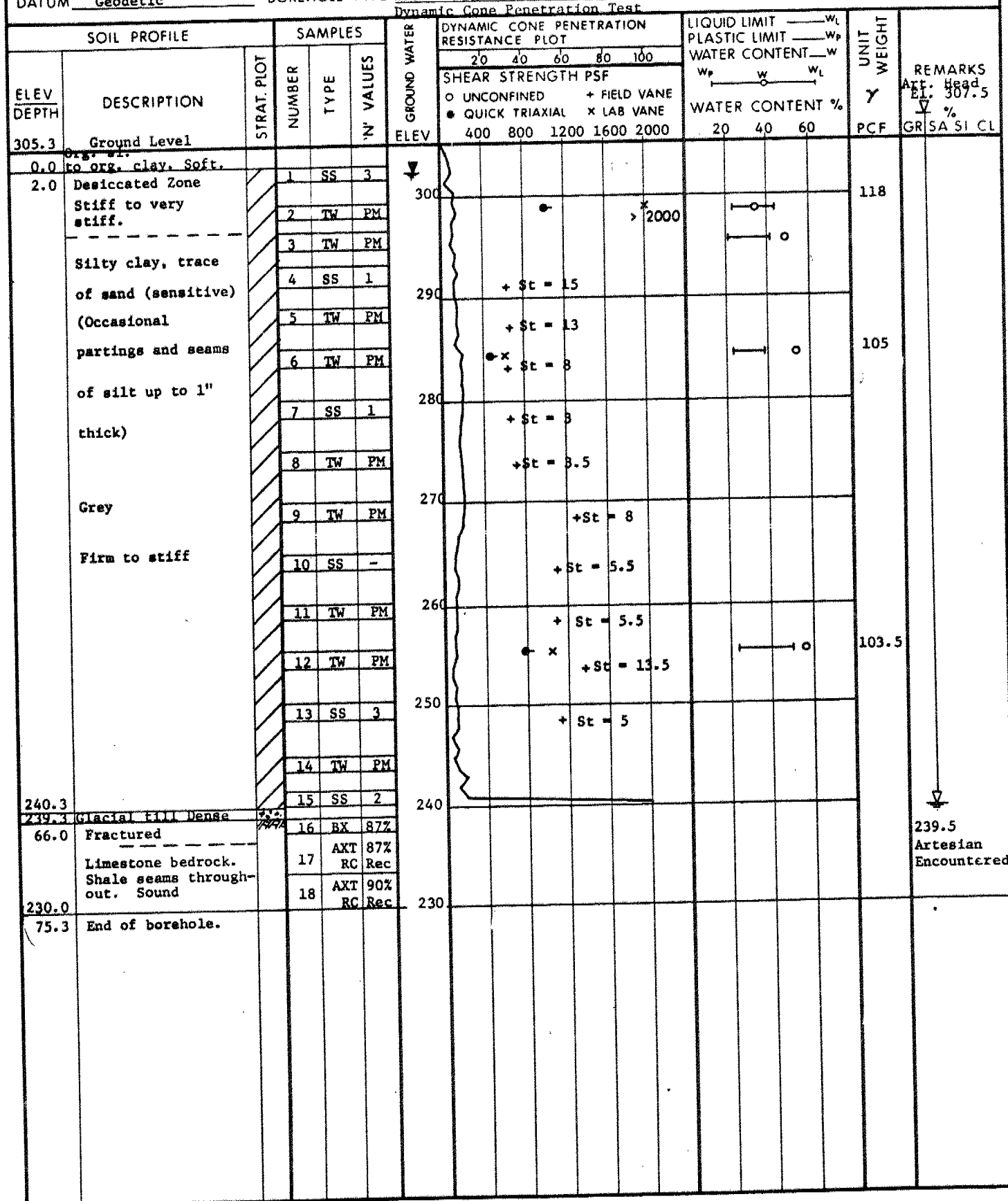
BORING DATE July 21 and 22, 1971

COMPILED BY BTB

DATUM Geodetic

BOREHOLE TYPE Washboring - NX, BX Casing - BX, AXT Rock Core

CHECKED BY



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

# RECORD OF BOREHOLE NO 9

WP 435-64-01 LOCATION Sta. 128 + 14 O/S 18' Lt. E.B.L. ORIGINATED BY ML  
DIST 9 HWY 417 BORING DATE July 14, 1971 COMPILED BY BTB  
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
302.7 0.0	Ground Level									
	Probably silty clay.									
250.2	Probably Glacial Till									
52.5	End of Cone Test									

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

# RECORD OF BOREHOLE NO 10

WP 435-64-01 LOCATION Sta. 128 + 25 O/S 20' Rt. E.B.L. ORIGINATED BY ML  
DIST 9 HWY 417 BORING DATE July 14, 15, 16 and 19, 1971 COMPILED BY BTD  
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX, AX Casing - AXT Rock Core CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS Art. Head El. 308 % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
305.3	Ground Level															
303.3	Org. sil. to org. clay. Soft		1	SS	3											
2.0	Desiccated zone (Mottled grey and brown) Stiff to very stiff.		2	SS	3											
			3	TW	PM											
	Silty clay, trace of sand (sensitive) (Occasional seams and partings of silt up to 1" thick) Grey. Soft to stiff		4	TW	PM											
			5	TW	PM											
			6	TW	PM											
			7	TW	PM											
			8	TW	PM											
			9	TW	PM											
			10	TW	PM											
			11	TW	PM											
257.3			12	SS	139											
48.0	Het. mixture of sil. sand and gravel, trace of clay (glacial till) (Bouldery below elev. 248-boulders up to 8" in size)		13	SS	100% 1											
			14	AXT-RC	3%											
			15	AXT RC	15% Rec											
236.8	Very dense		16	AXT	36%											
68.5	Fractured		17	AXT	84%											
	Limestone bedrock, shale seams throughout. Grey Sound		18	AXT	89%											
			19	AXT	91%											
224.8			20	AXT RC	85% Rec											
80.5	End of borehole															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 11

WP 435-64-01 LOCATION Sta. 128 + 62 - 6 E.B.L ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE July 13 and 12, 1971 COMPILED BY BTD  
 DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
303.5	Ground Level															
300.5	Org. silt to org. clay. Soft.					300										
3.0	Silty clay, trace of sand (Sensitive) (Occasional seams of silt up to 1" thick throughout) Grey Soft to stiff.		1	SS	1											
			2	TW	PM											
			3	TW	PM	290										
			4	SS	1											
			5	TW	PM	280										
			6	TW	PM											
			7	SS	1	270										
263.0			8	SS	16											
40.5	Het. mixture of silt, sand & gravel (Glacial Till) Compact to very dense		9	SS	82	260										
254.2			10	SS	100/2"											
49.3	End of borehole					250										

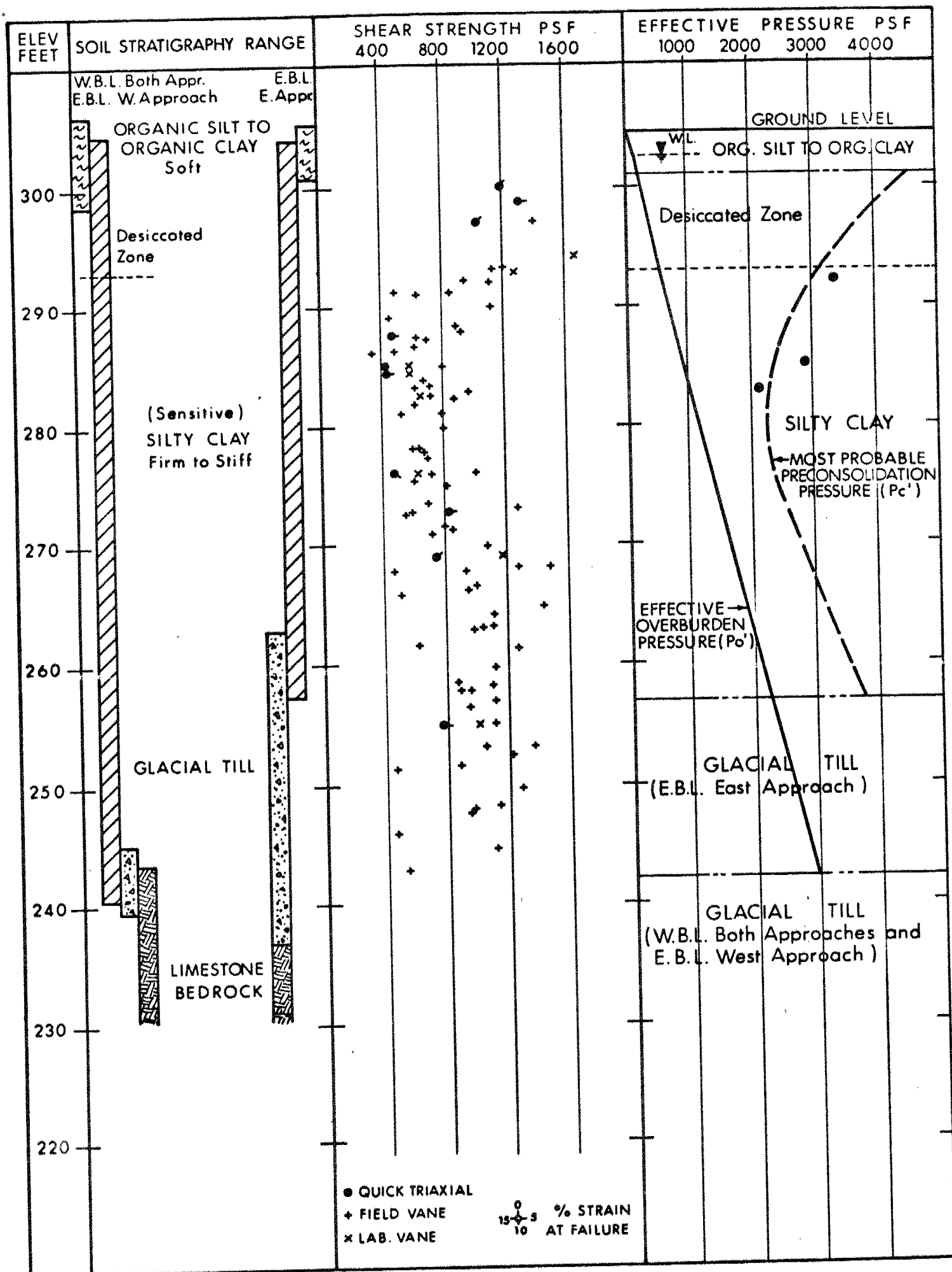
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 12

WP 435-64-01 LOCATION Sta. 127 + 58, E.E.L. ORIGINATED BY YL  
 DIST 9 HWY 417 BORING DATE July 22, 1971 COMPILED BY BT  
 DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY BT

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					$w_p$ — $w$ — $w_L$				
							SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000					WATER CONTENT %				
305.3	Ground Level															
303.8	Org. silt. Soft.															
1.5	Desiccated zone (Mottled grey and brown) Stiff to very stiff		1	SS	4	300										
			2	TW	PM											
						290										
			3	TW	PM											
			4	TW	PM	280										
			5	TW	PM											
			6	TW	PM	270										
			7	TW	PM											
			8	TW	PM	260										
			9	TW	PM											
			10	TW	PM	250										
			11	TW	PM											
241.3						240										
239.6	Glacial Till V.dense		12	SS	100/2"											
65.7	End of borehole. Probably bedrock					230										

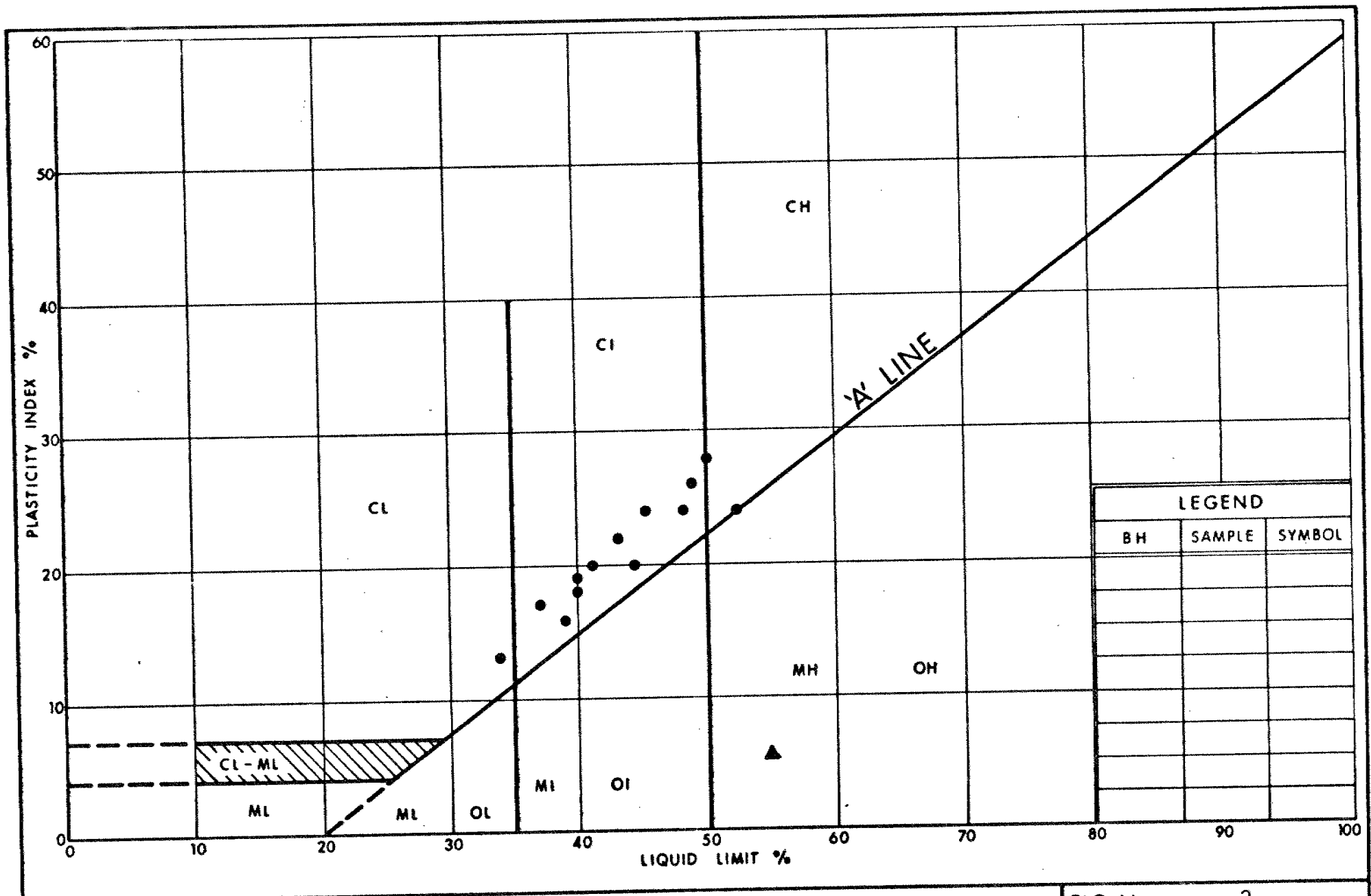




SUMMARY PLOT OF ENGINEERING PROPERTIES

FIG. 1

W.P. 435-64-01 &amp; 02



## VOID RATIO-PRESSURE CURVES

W.P. NO. 435-64-02

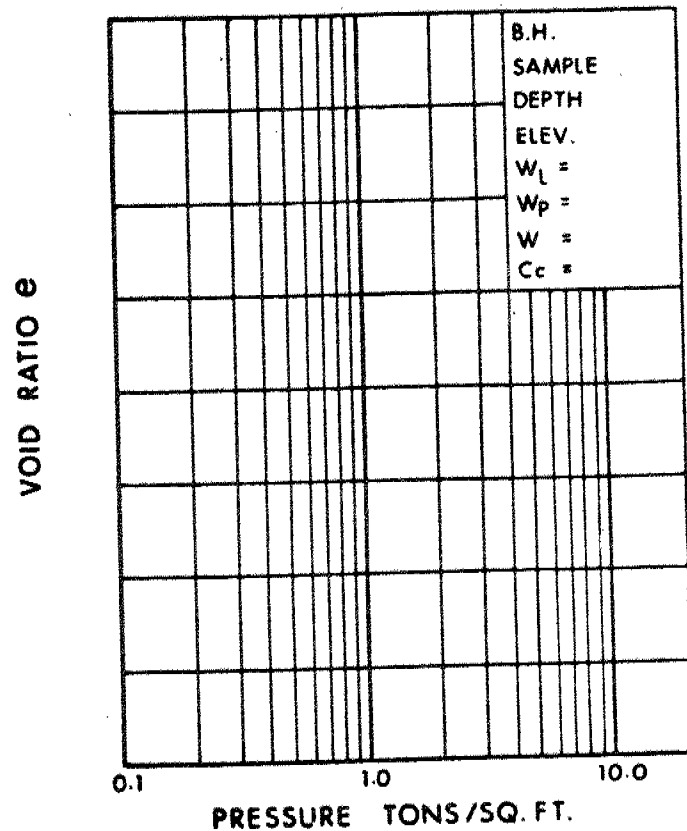
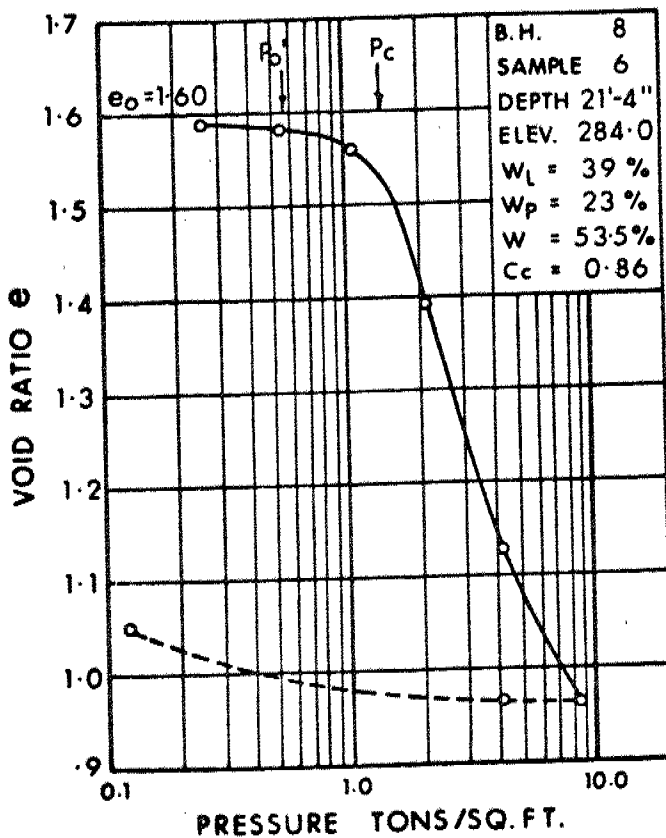
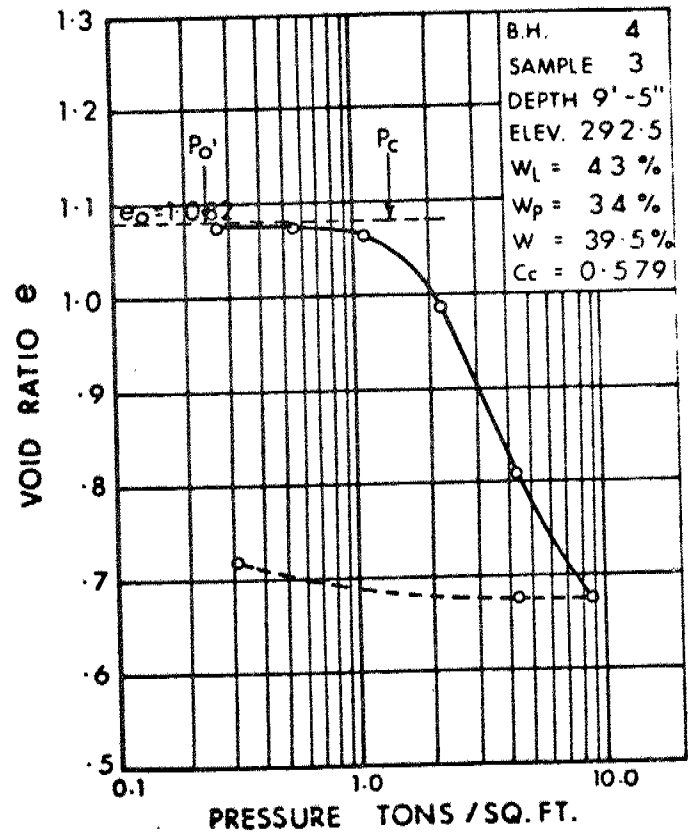
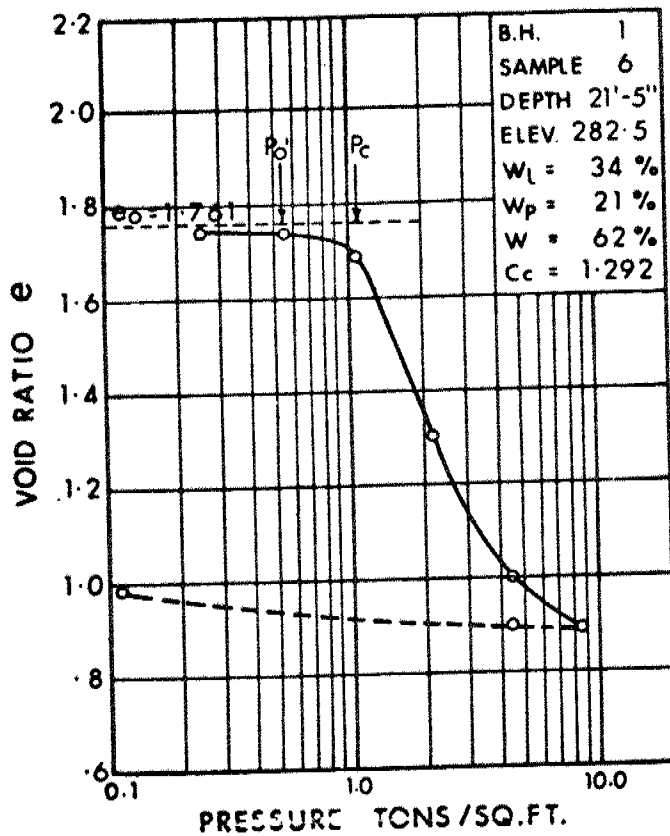


FIG. 3

FOUNDATION INVESTIGATION REPORT

For

W.P. 437-64-00

Hwy. 417, Regional Road No. 5  
Interchange Underpass

## INTRODUCTION

This report contains results of a foundation investigation carried out at the following site:

W.P. 437-64-00      Regional Road No. 5  
Interchange Underpass

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

## SITE DESCRIPTION AND GEOLOGY

The site is located approximately  $1\frac{1}{2}$  miles north of the village of Stittsville, in the Township of Huntley, Regional Municipality of Ottawa-Carleton.

North-south running Regional Road No. 5 is a two-lane paved roadway with wide shoulders: 3 to 4 feet deep ditches run parallel to the driving surface.

The terrain in the area is gently undulating in relief between elevations 426 and 430. An exception to this pattern occurs immediately to the east of the road. This area has been commercially developed as a source for sand and gravel (Spratt Sand and Gravel Pit). The base of the pit, during April, 1971, generally was found to vary from elevation 373 to 385 - i.e., approximately 40 to 50 feet below the level of the surrounding terrain. The highest slopes of the pit are standing at about 1:1. In those areas not commercially developed, the land is grass-covered.

Physiographically, the site is situated in the region known as the "Smith Falls Limestone Plain". The soil deposits in this area are marine beach sands and gravels laid down during an interglacial stage of the Wisconsinian glacial period, underlain by a competent glacial till of morainic origin. The overburden is followed by limestone bedrock of the Trenton-Black River formations, Ordovician Period.

## SUBSURFACE CONDITIONS

### General

The surficial deposit across the site is composed of 21 to 42 ft. thick sand with a trace to some silt and gravel, underlain by a 1 to 22 feet thick bouldery glacial till sheet. The overburden is underlain by sound limestone bedrock about 40 feet below the original ground surface.

The boundaries of the various deposits, as determined in the boreholes, are shown on the Record of Borehole Sheets which are contained in the Appendix to this report. The locations and elevations are shown on Drawings No. D-7066-2A & 2B of the Contract Drawings. Estimated stratigraphical profiles and sections are shown also. A description of soil types and bedrock encountered in the borings is as follows:

### Roadway Fill

1.5 to 3 feet of fill was encountered along Regional Road No. 5. The fill is primarily composed of brown sand to gravelly sand with a trace of silt. The 'N' values range between 14 and 36 flows/ft.

### Sand, Trace to Some Silt

The surficial deposit across the site is composed of a brown, uniformly graded, irregularly stratified sand with a trace to some silt and occasional gravel sizes. The thickness of the deposit varies from 21 to 42 feet. Occasional bouldery zones are present at random locations throughout the deposit, the boulders are up to 9 inches in size. At some locations a layer of silty fine sand to silt was encountered near the base of this deposit. The thickness of this layer generally ranges between 1.5 and 2.5 feet. Grain-size distribution curves for samples of this stratum are plotted on Fig. 1.

Standard Penetration Tests carried out within this deposit are plotted on the Record of Borehole Sheets. The testing gave 'N' values which vary from 19 blows/ft., near the surface of the deposit, increasing with depth to as many as 188 blows/ft. It is estimated that the relative density of this granular subsoil ranges from compact to very dense.

### Glacial Till

The sand deposit is underlain by a competent brown to grey bouldery glacial till sheet. The thickness of the glacial till varies between 1 foot and 22 feet. The matrix of the till is composed of a heterogeneous mixture of sand and gravel with some silt. This deposit is very bouldery throughout; in order to advance the borings through this zone, it was necessary to use diamond drilling techniques. The boulders vary from 6

to 16 inches in size. Grain-size distribution for samples of the matrix of the glacial till are plotted on Fig. 2.

Standard Penetration Tests gave 'N' values which range from 156 blows/ft. to 175 blows for 5 inches. Based on these results, it is estimated that the relative density of the till matrix is very dense.

#### Limestone Bedrock

The glacial till sheet is underlain by bedrock. The surface of the bedrock is located between 40 and 43 feet below the original ground surface, corresponding to elevations ranging from 382 to 385.

The bedrock is grey limestone with random shale interbeds. In addition, occasional sand seams, up to 2 inches thick, are present throughout. The bedrock is sound.

#### Groundwater Conditions

Groundwater level observations have been carried out, during the period of the investigation, in the open boreholes. The results are plotted on the Record of Borehole Sheets, as well as on Contract Drawings No. D-7066-2A & 2B. These observations indicate that the groundwater level varies between elevations 391 and 396, which corresponds to depths of from 32 to 36 feet below the existing ground surface.

*A. Prakash*

A. PRAKASH, P. Eng.  
Senior Engineer



*M. Devata*  
M. DEVATA, P. Eng.  
Supervising Engineer

April, 1976

## APPENDIX



ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 437-64-00

LOCATION Sta. 99 + 55 O/S 19' Lt (Reg. Rd. #5)

ORIGINATED BY JDW

DIST 9 HWY 417

BORING DATE April 19, 20 and 21, 1971

COMPILED BY AED

DATUM Geodetic

BOREHOLE TYPE Washboring - NX, BX Casing - BX Rock Core

CHECKED BY

Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
427.1	Ground Level															
425.0	Gra. sd. trace of org. matter (fill).		1	SS	15											
2.1	compact															
	Boulders up to 6" in size		2	SS	19											
			2A	BXT	40%											
			3	SS	29											
	Sand, trace to some silt, occasional gravel (uniformly graded- irregularly stratified)		4	SS	82											
			5	SS	170											
	Brown		6	SS	85											
393.1	Compact to very dense		7	SS	51											
			8	SS	93/8"											
34.0	Het. Mix. sand & gra. trace of silt		9	SS	210											
	Glacial till (occ. boulders up to 6" in size throughout) V.		10	BX	49%											
395.1	Dense		11	BX	19%											
			12	BX	25%											
42.0	Limestone Bedrock, Occ. shaly seams (Random, ss seams up to 1" thick grey sand)		13	BX	Rec 80%											
77.6			14	BX	75%											
49.5	End of Borehole															

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 2

WP 437-64-00

LOCATION Sta. 99 + 55, O/S 19' Rt (Reg. Rd. #5)

ORIGINATED BY BTD

DIST 9 HWY 417

BORING DATE April 26, 28 and 29, 1971

COMPILED BY AED

DATUM Geodetic

BOREHOLE TYPE Washboring - NX, BX Casing

CHECKED BY So

Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N VALUES		20 40 60 80 100	WATER CONTENT % 20 40 60	GR SA SI CL			
427.0	Ground Level											
0.0	Gr. sa. trace of sl.											
425.0	(fill) compact		1	SS	36							
2.0	Sand, trace to some silt, occasional gravel throughout (Uniformly graded - irregularly stratified)		2	SS	77							
			3	SS	57							
			4	SS	48							
			5	SS	60							
			6	SS	43							
	Brown		7	SS	123							
			8	SS	188							
			9	SS	152							
400.0	Dense to very dense		10	BX	44%							
27.0	Hat. Mix. of sand & gravel, trace of sl., Glacial till (occ. boulders up to 7 in. in size)		11	SS	100/3"							31 40 (29)
			12	BX	91%							
			13	SS	100/5"							
					Rec							
387.0	Grey very dense		14	BX	24%							
40.0	End of Borehole											

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

### RECORD OF BOREHOLE NO 3

WP 437-64-00 LOCATION Sta. 100 + 73, o/s 19' Lt. (Reg. Rd. #5) ORIGINATED BY BTD  
DIST 9 HWY 417 BORING DATE April 21, 22 and 23, 1971 COMPILED BY AED  
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX, AX Casing CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
428.0	Ground Level															
0.0	Sa. some gra. & si.	X	1	SS	26											
425.0	(Fill) Compact															
3.0	Sand, trace to some silt, occasional gravel	.	2	SS	41	420										
	(Uniformly graded - irregularly stratified)		3	SS	54											
	Brown		4	SS	45	410										
			5	SS	109											
402.5	Dense to very dense		6	SS	82											
25.5	Het. Mix. of silt, sa. & gra., Glacial till (Boulders up to 16" in size throughout)	.	7	BX	85% Rec	400										
391.3	(Grey) very dense		8	AXT	47% Rec											
36.7	End of Borehole					390										

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 4

WP 437-64-00

LOCATION Sta. 100 + 73, o/s 19' Rt. (Reg. Rd. #5)

ORIGINATED BY JDW

DIST 9 HWY 417

BORING DATE April 21, 22, 26 and 27, 1971

COMPILED BY BTD

DATUM Geodetic

BOREHOLE TYPE Washboring - NX, BX, AX Casing  
BX and AX Rock CoreCHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — W <sub>L</sub> PLASTIC LIMIT — W <sub>P</sub> WATER CONTENT — W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		
428.1	Ground Level															
0.0	Sa. some gra. & si.		1	SS	14											
425.1	(Fill) Brown, Compact		2	SS	150/5"											
3.0	Boulders up to 9" in size		3	BX	38%	420										
	Sand, trace to some silt, occasional gravel sizes (Uniform - irregularly stratified)		4	SS	21											
	Brown		5	SS	93	410										
			6	SS	163											
404.4	Compact to very dense		7	SS	124											
23.7	Het. Mix. of silt, sand & gravel		8	BX	100%	400										
	Glacial Till		9	BX	65%											
	Very Bouldery throughout-boulders up to 10" in size		10	SS	156											
	Gray to Brown		11	BX	39%											
	Very dense		12	SS	88/5"	390										
			13	BX	50%											
			14	SS	174/5"											
			15	BX	23%											
			16	SS	283											
382.1			17	AXT	56% Rec											
46.0	Limestone Bedrock		18	AXT	100% Rec	380										
	Numerous shale seams															
	Gray		19	AXT	95% Rec											
372.1	Sound															
56.0	End of Borehole					370										

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 5

WP 437-64-00

LOCATION Sta. 101 + 91, o/s 19' Lt. (Reg. Rd. #5)

ORIGINATED BY BTD

DIST 9 HWY 417

BORING DATE April 19, 20, and 21, 1971

COMPILED BY AED

DATUM Geodetic

BOREHOLE TYPE NX, BX Casing - BX Rock Core  
Dynamic Cone Penetration TestCHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
428.8	Ground Level															
427.3	Sa. some gra. (fill) Brown Dense		1	SS	33											
1.5	Sand, trace to some silt occasional gravel throughout		2	SS	56											
			3	SS	76											
	Brown		4	SS	52											
	Dense to very dense		5	SS	49											
			6	SS	78											
			7	SS	73											
			8	SS	80											
			9	SS	72											
			10	SS	98											
			11	SS	65											
385.3			12	SS	125											
384.1	Glacial Fill		13	SS	140											
44.7	Limestone Bedrock, seams of shale, occ. sand seams up to 2" thick		14	BX	69%											
			15	BX	75% Rec											
			16	BX	83%											
374.1	Gray Sand		17	BX	71%											
54.7	End of Borehole															

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 6

WP 437-64-00

LOCATION Sta. 101 + 91, 0/s 19' Rt. (Reg. Rd. #5)

ORIGINATED BY JDW

DIST 9 HWY 417

BORING DATE April 23 and 26, 1971

COMPILED BY AED

DATUM Geodetic

BOREHOLE TYPE NX Casing

CHECKED BY

## Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W_L$		
428.5	Ground Level		1	SS	19										
0.0	Sa trace of gra & silt (fill) compact														
426.5															
2.0	Sand, trace to some silt, occ. gravel		2	SS	75										
						420									
	uniformly graded-irregularly stratified		3	SS	33										
			4	SS	45										
			5	SS	37										
	Brown		6	SS	41	410									
			7	SS	45										
	Dense to very dense		8	SS	58										
			9	SS	109										
						400									
			10	SS	125										
			11	SS	135										
						390									
			12	SS	103										
386.3															
42.2	End of Borehole Probable Bedrock					380									

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 437-64-00  
DIST 9 HWY 417  
DATUM Geodetic

LOCATION Sta. 704 + 00, E.B.L. C  
BORING DATE April 28, 1971  
BOREHOLE TYPE Continuous Flight Auger (Penndrill)

ORIGINATED BY JDW  
COMPILED BY AED  
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
430.4	Ground Level					430										
0.0	Sand, trace to some silt, occ. gravel		1	SS	33											
			2	SS	80											
	Uniformly graded - irregularly stratified		3	SS	70	420										
			4	SS	130											
	Brown		5	SS	97	410										
	Dense to very dense		6	SS	102											
			7	SS	100	400										
393.9			8	SS	150											
36.5	End of Borehole					390										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 437-64-00  
DIST 9 HWY 417  
DATUM Geodetic

LOCATION Sta. 700 + 68, WBL - C  
BORING DATE April 26, 1971  
BOREHOLE TYPE Continuous Flight Auger (Penndrill)

ORIGINATED BY BTD  
COMPILED BY AED  
CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
428.2	Ground Level															
0.0	Sand, trace of silt, uniformly graded - irregularly stratified		1	SS	57	420										0 90 (10)
	Very dense		2	SS	63											BH Dry
	Sand and gravel		3	SS	168	410										
			4	SS	175											
	Silty fine sand		5	SS	132	400										0 64 (36)
396.9			6	SS	100/4"											
31.3	End of Borehole					390										



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

# RECORD OF BOREHOLE NO 9

WP 437-64-00 LOCATION Sta. 700 + 35, EBL / E  
DIST 9 HWY 417 BORING DATE April 26, 1971  
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger (Penndrill)  
ORIGINATED BY BTB  
COMPILED BY AED  
CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	WATER CONTENT % $w_p$ — $w$ — $w_L$			
423.6	Ground Level														
0.0	Sand, trace to some silt					420									
	Uniformly graded - irregularly stratified		1	SS	78										
			2	SS	66	410									
	Brown Very dense		3	SS	89										
402.1	Silty fine sand		4	SS	92	400									
21.5	End of Borehole														

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

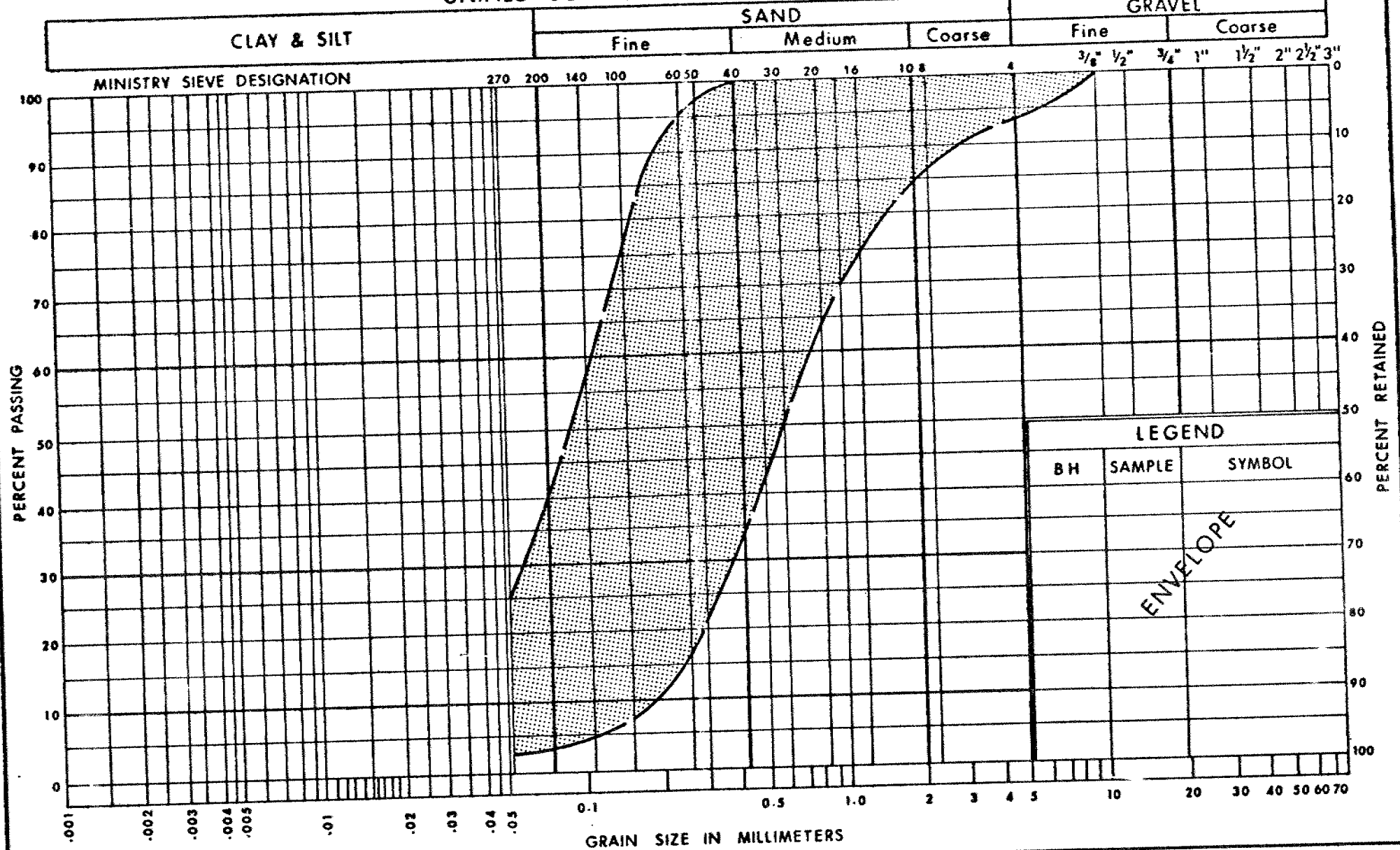
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE No 10

WP 437-64-00 LOCATION Sta. 100 + 13, o/s 19' Rt (Reg. Rd. #5) ORIGINATED BY JDW  
 DIST 9 HWY 417 BORING DATE April 29, 1971 COMPILED BY AED  
 DATUM Geodetic BOREHOLE TYPE NX, BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					$W_P$ $W$ $W_L$				
							SHEAR STRENGTH					WATER CONTENT %				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					20 40 60			GR SA SI CL		
427.8	Ground Level															
425.8	Sa. & Gra. (fill) compact	⊗														
2.0	Sand, trace to some silt, occ. gravel  Uniformly graded - irregularly stratified  Brown Very Dense	⋮	1	SS	74	420									BH Dry	
			2	SS	143											
			3	SS	70	410										
			4	SS	109											
403.8			5	SS	213	400									42 42 (16)	
24.5	End of Borehole															
	Het. Mix. of silt sand and gravel Glacial Till very dense															

# UNIFIED SOIL CLASSIFICATION SYSTEM

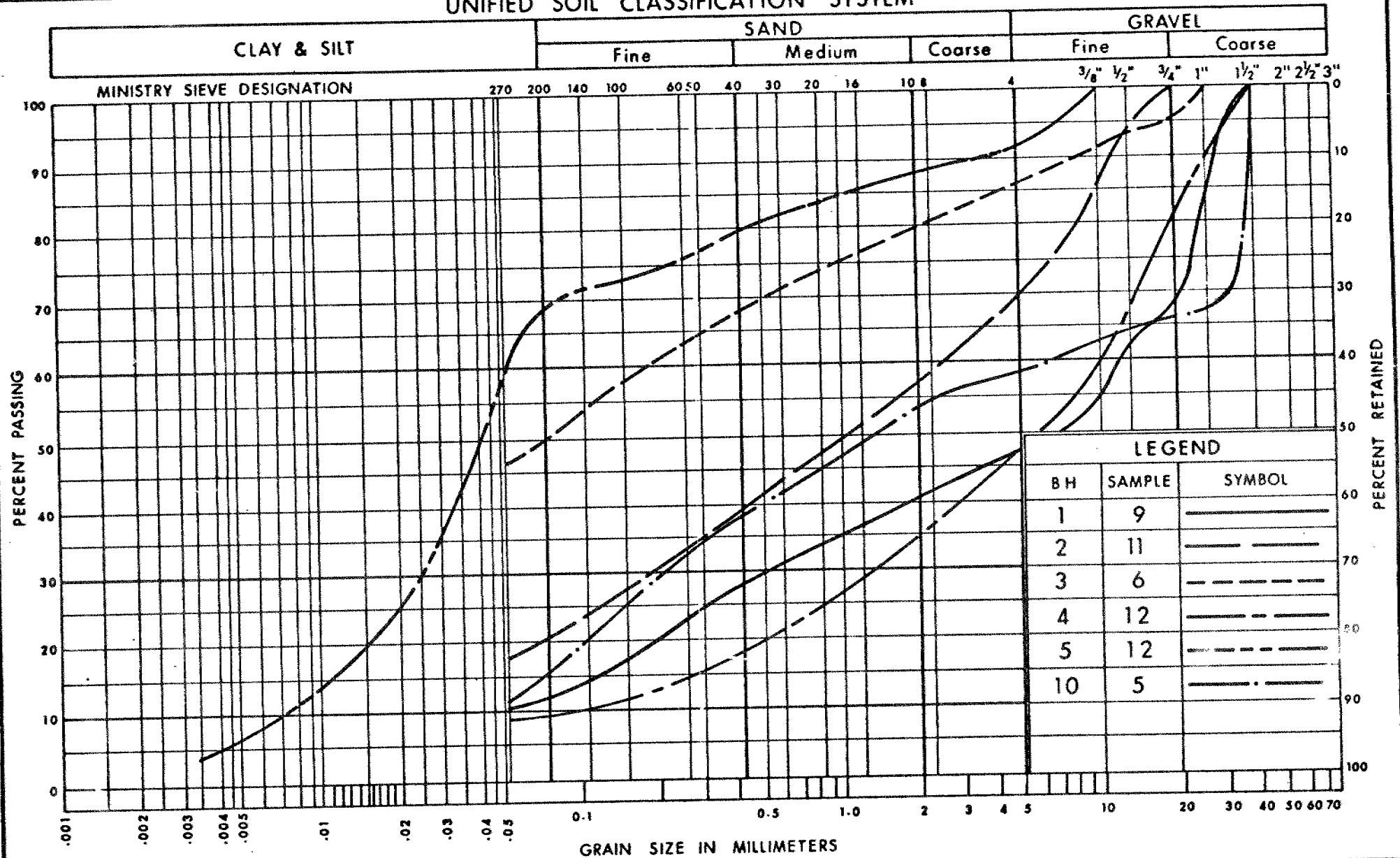


Ministry of  
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Communications  
Ontario  
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION  
SAND  
TRACE TO SOME GRAVEL

FIG No 1  
W P 437-64-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

Ontario

ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION  
GLACIAL TILL  
HET. MIXTURE OF SILT, SAND & GRAVEL

FIG No 2

W P 437-64-00

FOUNDATION INVESTIGATION REPORT

For

Hwy. 417, Goulbourn Road

Interchange Underpass

W.P. 434-64-00

## INTRODUCTION

This report contains results of a foundation investigation carried out at the following site:

W.P. 434-64-00 Goulbourn Arterial Interchange Underpass

For purposes of this contract all other Foundation Investigation Reports prepared by or for the Ministry in connection with the above mentioned projects are superceded by this report.

## SITE DESCRIPTION AND GEOLOGY

The site is located about 500 feet east of existing Goulbourn Road, approximately 1.2 miles north of the Village of Hazeldean.

The area is within pasture fields, used for general farming purposes. The surrounding terrain slopes gradually towards the west. In the immediate vicinity of the site the ground elevation ranges from 330 to 340. Near the existing Goulbourn Road, occasional bedrock outcrops are visible.

Physiographically, the site is situated in the "Ottawa Valley Clay Plains" region. The area is characterized by a stratum of marine clay deposited by the Champlain Sea. This is underlain by glacial till which, in turn, is followed by sandstone bedrock of the Beekmantown Groups, Potsdam Formation.

## SUBSURFACE CONDITIONS

### General

The predominant overburden stratum across the site is composed of a firm to stiff silty clay, followed by a thin glacial till deposit. The glacial till is, in turn, underlain by sandstone bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the Record of Borehole Sheets which are contained in the Appendix to this report. The locations and elevations are shown on Drawing No's D-7082-2 of the Contract Drawings. Estimated stratigraphical profiles and sections are shown also. A description of soil types and bedrock encountered is as follows:

### Silty Clay

Across the site there is a layer of cohesive topsoil about 1 foot thick. Directly beneath the topsoil is the predominant stratum which is composed of a grey silty clay. The overall thickness of the stratum varies

from 2 to 13 feet. The upper 2 to 3 feet of this cohesive stratum has been desiccated. Throughout the stratum, there are random pockets and seams of sand and gravel (less than  $\frac{1}{2}$ " thick). Grain-size distribution curves for samples of the cohesive subsoil are shown on Figure #2.

The engineering properties of the stratum are presented below:

<u>Identity Tests</u>		<u>Range</u>
Bulk Density (p.c.f.)		106 - 118
Liquid Limit (%)	( $W_L$ )	36 - 45
Plastic Limit (%)	( $W_p$ )	19 - 29
Natural Moisture Content (%)	( $W$ )	32 - 57

#### Consolidation Characteristics

Initial Void Ratio	( $e_o$ )	1.45 and 1.44 )	
Compression Index	( $C_c$ )	0.52 and 0.82 )	Two Tests
Degree of Preconsolidation		3.0 and 3.5 )	
(t.s.f.)	( $P_c - P'_o$ )		

#### Undrained Shear Strength ( $C_u$ ) (p.s.f.)

(1) Field Tests	> 2,000
(2) Lab. Tests	500 - 2,000

Standard Penetration Tests	2 - 16
( $'N'$ Value)	
(Blows/ft.)	

The Atterberg limit tests are also plotted on the Plasticity Chart, Figure #1. The material is essentially inorganic with a plasticity in the intermediate range. The natural water content generally exceeds the liquid limit; this is indicative of a sensitive material.

The consistency of the stratum generally varies from firm to stiff, with localized soft areas in the lower portion.

The consolidation characteristics of the stratum are shown as Void Ratio vs. Pressure plots on Figure #4. The cohesive stratum is preconsolidated by about 3 to 3.5 t.s.f. in excess of existing overburden pressure.

For design purposes the following soil parameters are recommended:

Soil Type	Elevation (Ft.)	Undrained Shear Strength $C_u$ (p.s.f.)	Bulk Density (p.c.f.)
Silty Clay	336 - 330	1,500	110
	330 - 325	1,000	110
	325 - 320	500	110

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

The cohesive stratum is generally underlain by a thin deposit of glacial till from 1 to 2 feet in thickness. In certain locations no glacial till deposit occurs, while in other locations the till deposit is up to 7 feet thick.

The till, which is basically cohesive in nature, consists of clayey silt, binding sand and gravel and rock fragments. Grain-size distribution curves for samples of this deposit are shown on Figure #3.

The Standard Penetration Tests gave 'N' values which range from 4 to 27 blows/ft. The lower values were obtained in the thin deposits of glacial till; it is inferred that these zones have been 'reworked' - i.e. it was once exposed to the atmosphere and weathered by the elements. Based on the 'N' values, the consistency of the glacial till ranges from firm to very stiff.

Atterberg limit tests for the matrix of the glacial till are plotted on the Plasticity Chart, Figure #1. The matrix is inorganic with a low plasticity.

Sandstone Bedrock

The glacial till is directly underlain by bedrock. Over the site the bedrock surface varies randomly between elevations 320 and 330, i.e. 3 to 15 feet below ground surface.

The bedrock is sandstone with occasional irregular shaley seams and interbeds up to  $\frac{1}{2}$  inch in thickness. The bedrock is sound.

GROUNDWATER CONDITIONS

During the period of the investigation, groundwater level observations were carried out in the open boreholes. The groundwater level in the



overburden is at a depth of 2 to 4 feet below the existing ground surface. This depth corresponds to elevations between 328 and 335, with the phreatic surface generally corresponding to the slope of the ground.

*A. Prakash*

A. Prakash, P. Eng.  
Senior Engineer



*M. Devata*

M. Devata, P. Eng.  
Supervising Engineer

April, 1976

**APPENDIX**

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 434-64-00 LOCATION Sta. 99+37 Goulbourn Rd. Rev'n o/s 18' Rt. ORIGINATED BY ML  
DIST 9 HWY 417 BORING DATE June 18 - 21, 1971 COMPILED BY WH  
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY NS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
332.1	Ground Level															
0.0	Topsoil		1	SS	8											
1.0	Silty clay		2	SS	9	330										
	Firm to Stiff		3	SS	5											
324.1	Glacial Till		4	TW	PM											
322.1	Very Stiff															
10.0	Bedrock Sandstone		5	RC	Rec	320										
317.1	Sound Light Grey			BX	93%											
15.0	End of Borehole															
						310										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 434-64-00 LOCATION Sta. 99+39 Goulbourn Rd. Rev'n. o/s 38' Lt. ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE June 21, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY *ML*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$ $W_P$ — $W$ — $W_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
333.5	Ground Level													
0.0	Topsoil		1	SS	16	330								
330.5	Silty Clay													
3.0	Bedrock Sandstone		2	RC BX	Rec 83%									
	Sound Light Grey		3	RC BX	Rec 80%									
320.7														
12.8	End of Borehole					320								

## RECORD OF BOREHOLE NO 3

WP 434-64-00 LOCATION Sta. 100 + 74 Goulbourn Rd. Rev'n. o/s 27' Rt. ORIGINATED BY ML  
DIST 9 HWY 417 BORING DATE June 21, 1971 COMPILED BY WH  
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY ML

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT % $w_p$ — $w$ — $w_L$	
335.0	Ground Level					ELEV												
0.0						330												
324.6																		
10.4	End of Borehole Probable Bedrock					320												

15  $\phi$  5 % STRAIN AT FAILURE

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 434-64-00 LOCATION Sta. 100 + 74 Goulbourn Rd. Rev'n. o/s 29' Lt. ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE June 21, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY H.L.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
336.2	Ground Level															
0.0	Topsoil		1	SS	15											
1.0	Silty clay. Stiff		2	SS	19											
333.2	Grey		3	SS	27											
3.0	Glacial Till															
	Clayey silt with sand															
	trace of gravel.															
326.4	Very Stiff Grey															
9.8	Bedrock Sandstone		4	RC	Rec											
322.2	Sound Light Grey			BX	84%											
14.0	End of Borehole															

## RECORD OF BOREHOLE No 5

[illegible]

15  $\overset{20}{\underset{10}{\diamond}}$  5 % STRAIN AT FAILURE

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 6

WP 434-64-00

LOCATION Sta. 102 + 12 Goulbourn Rd. Rev'n o/s 20' Lt.

ORIGINATED BY ML

DIST 9 HWY 417

BORING DATE June 21, 1971

COMPILED BY WH

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY H.P.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			
337.0	Ground Level														
0.0															
321.6															
15.4	End of Cone Test Probable Bedrock														



## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 7

WP 434-64-00 LOCATION Sta.98 +88 Goulbourn Rd. Rev'n. o/s 13' Lt. ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE June 22, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY ML

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
331.0	Ground Level															
0.0	Topsoil		1	SS	6	330										
1.0	Silty clay with some sand.		2	SS	16											
	Stiff Grey		3	SS	8											
			4	TW	PM											
319.8	Glacial Till - Firm					320										
11.2	Bedrock Sandstone		5	RC	Rec											
314.8	Sound Light Grey			BX	88%											
16.2	End of Borehole					310										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

56

RECORD OF BOREHOLE NO 8

WP 434-64-00 LOCATION Sta. 102 + 62 Goulbourn Rd. Rev'n. o/s 12' Rt. ORIGINATED BY ML  
DIST 9 HWY 417 BORING DATE June 22, 1971 COMPILED BY WH  
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY P.J.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
337.3	Ground Level															
0.0	Topsoil		1	SS	8											
1.0	Silty clay with some sand.		2	SS	12											
	Firm to Stiff		3	SS	8	330									118	
	Grey		4	TW	PM											
323.8	Glacial Till		5	SS	6											
322.8	Bedrock Sandstone		6	BX	100%											
14.5	Sound		7	BX	75%	320										
16.5	End of Borehole															

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 9

WP 434-64-00 LOCATION Sta. 99 + 38 Goulbourn Rd. Rev'n.o/s 10' Lt. ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE July 20-21, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY H. S.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
332.1	Ground Level															
0.0	Topsoil		1	SS	13											
1.0	Silty clay, some sand.		2	SS	15	330										
327.1	Stiff Grey		3	SS	12											
5.0	Glacial till, v. stiff		4	SS	20											
6.0	Bedrock Sandstone		5	RC AXT	Rec 64%	320										
	Sound Light Grey		6	RC AXT	Rec 95%											
316.1																
16.0	End of Borehole					310										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 10

WP 434-64-00 LOCATION Sta. 99 + 37 Goulbourn Rd. Rev'n. o/s 4' Rt. ORIGINATED BY ML  
 DIST 9 HWY 417 BORING DATE July 20, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY 1.5

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
332.1 0.0	Ground Level					330										
322.1 10.0	End of Cone Test Probable Bedrock					320										

## MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE No 11

WP 434-64-00

LOCATION Sta. 99 + 38 Goulbourn Rd. Rev'n. o/s 24' Lt. ORIGINATED BY ML

DIST 9 HWY 417

BORING DATE July 20, 1971

COMPILED BY WH

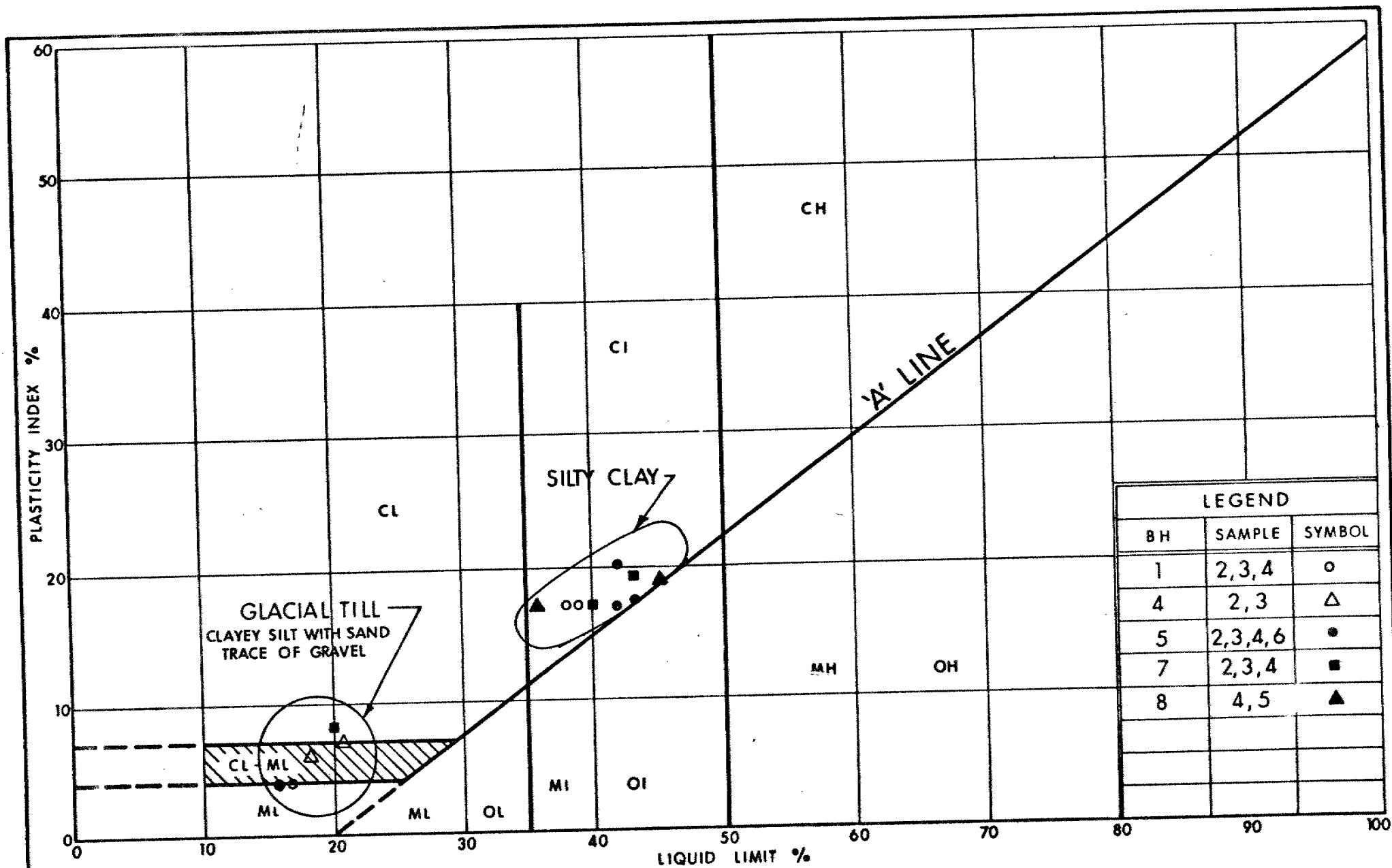
DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY JLS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	WATER CONTENT % $w_p$ $w$ $w_L$			
332.5	Ground Level														
0.0						330									
327.7	End of Cone Test														
4.8	Probable Bedrock														
						320									

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10



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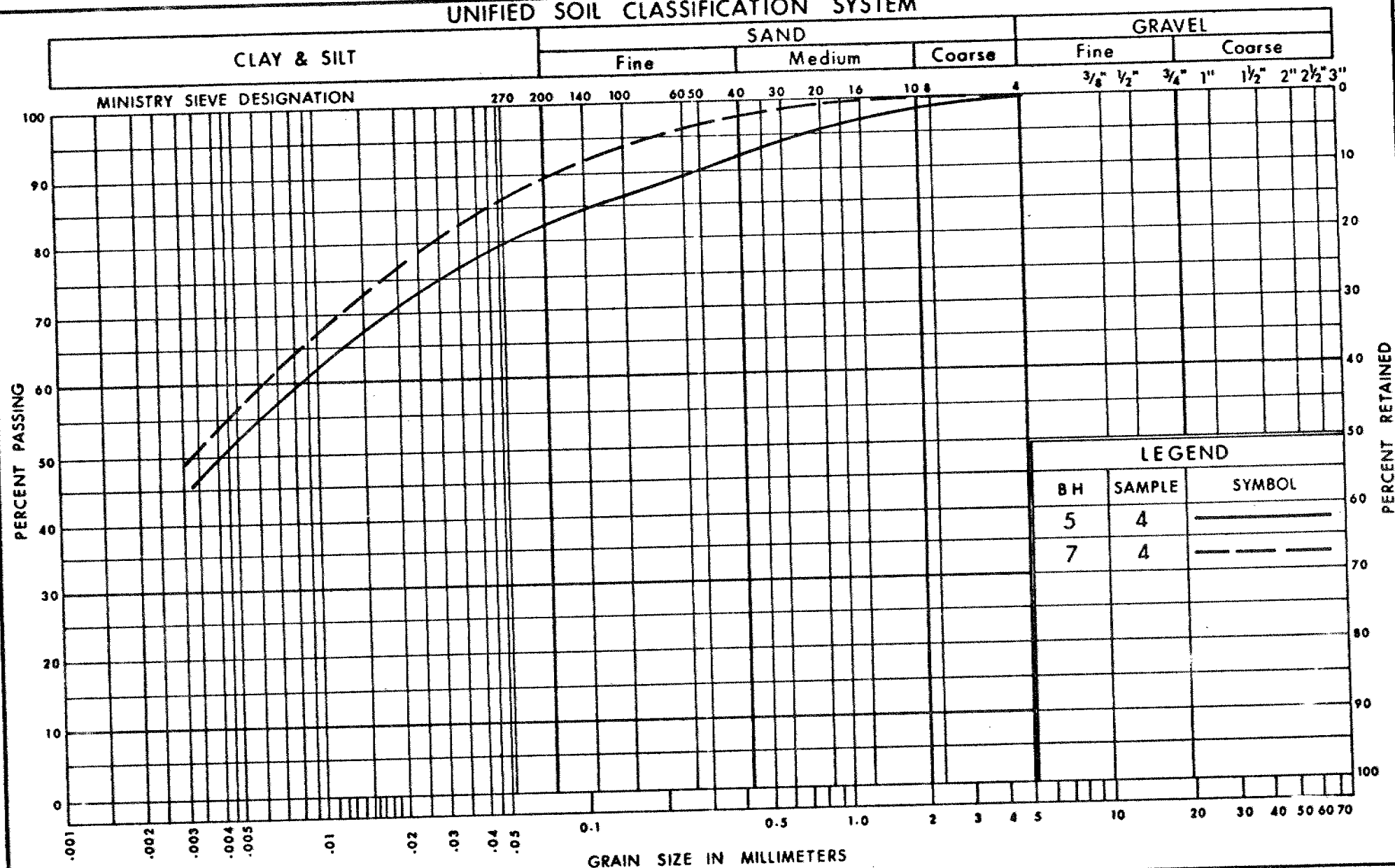
ENGINEERING SERVICES BRANCH

PLASTICITY CHART

FIG No 1

W P 434-64-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



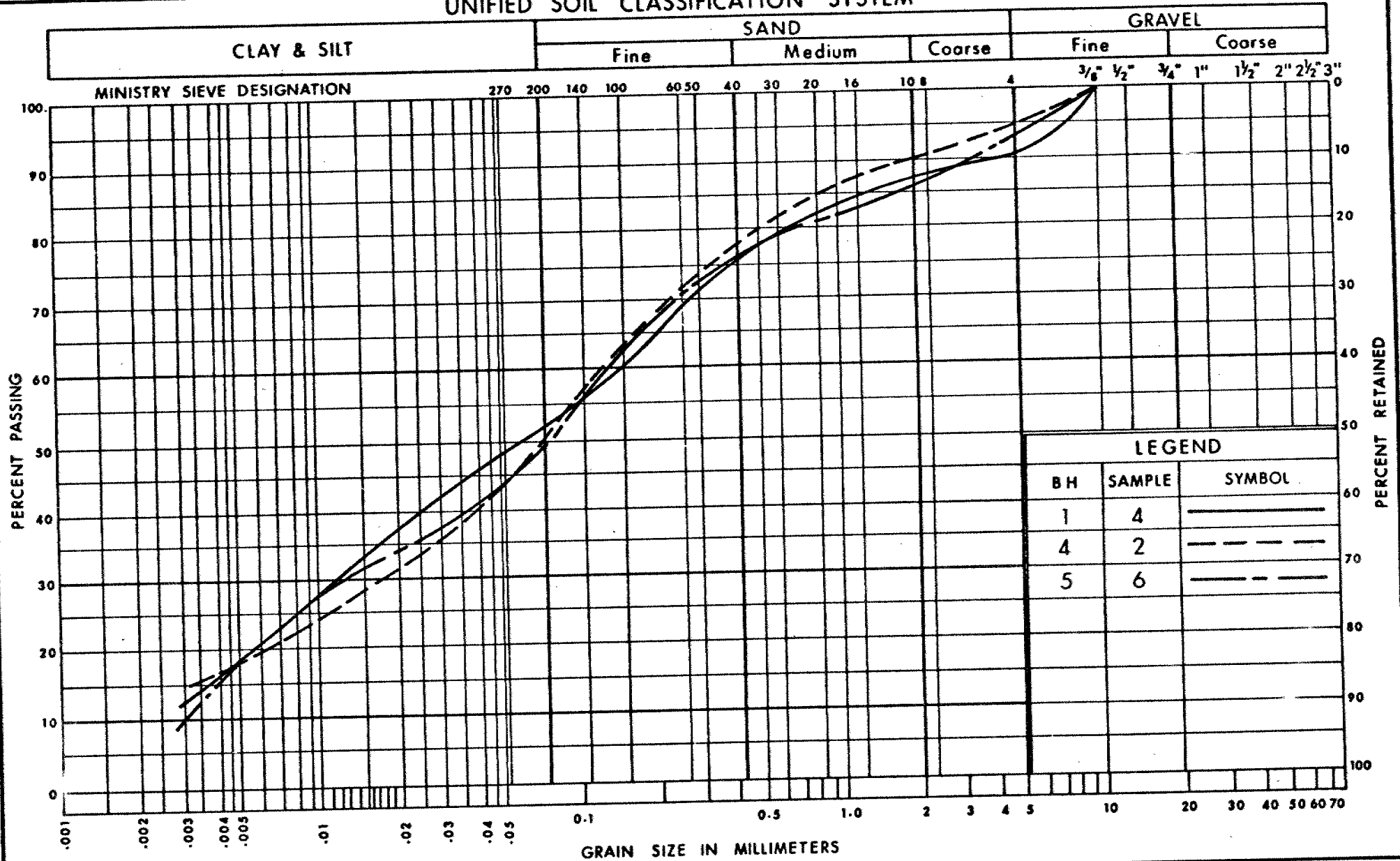
Ontario  
ENGINEERING SERVICES BRANCH

Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY  
WITH SOME SAND

FIG No 2  
WP 434-64-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
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Communications

Ontario  
ENGINEERING SERVICES BRANCH

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

FIG No 3  
W P 434-64-00



# VOID RATIO - PRESSURE CURVES

W.P. NO. 434 - 64 - 00

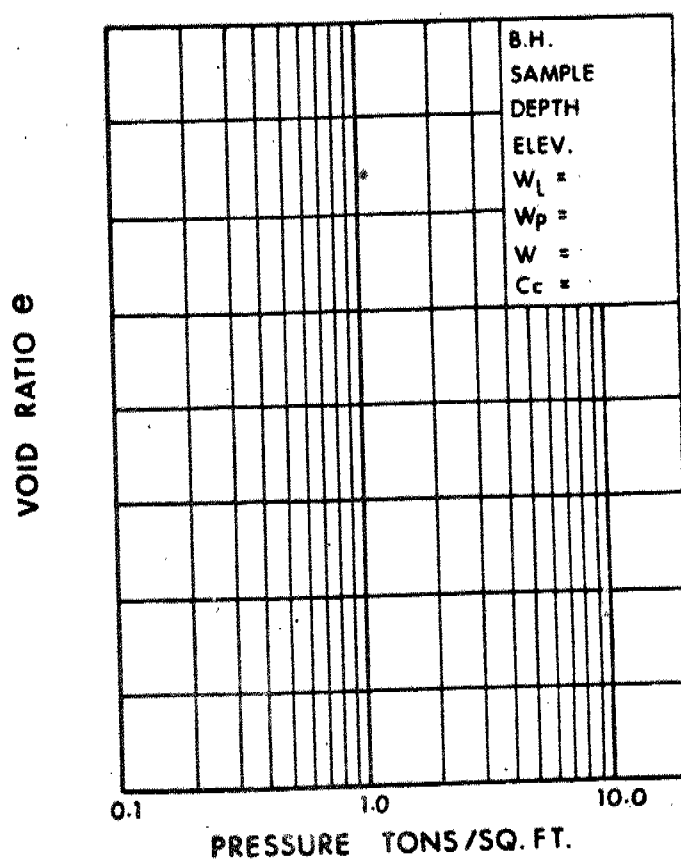
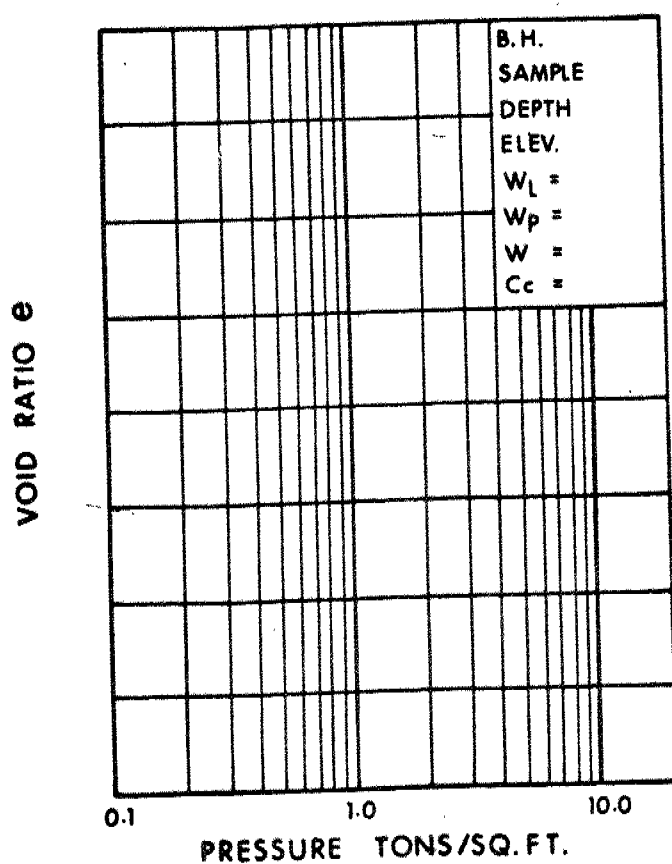
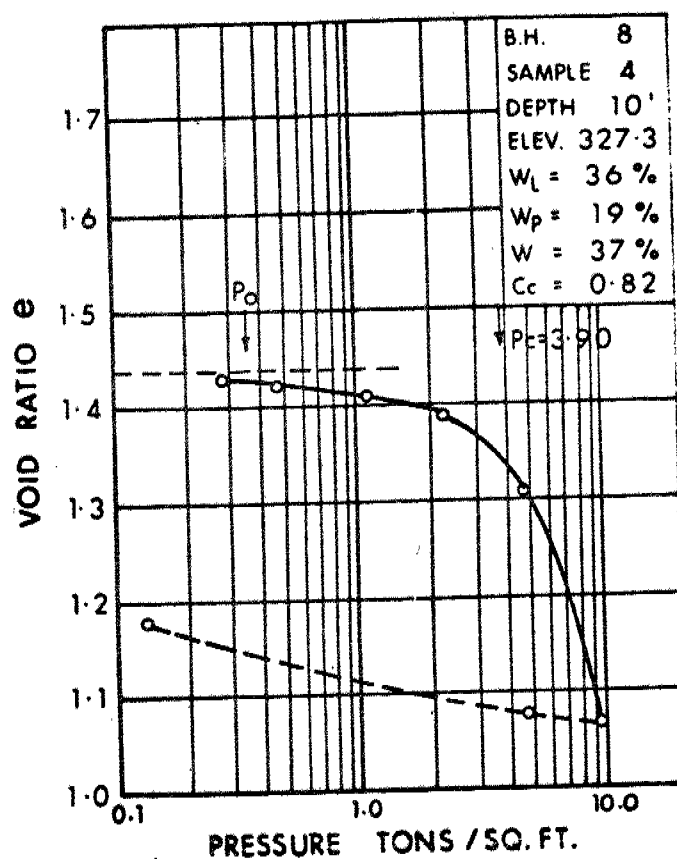
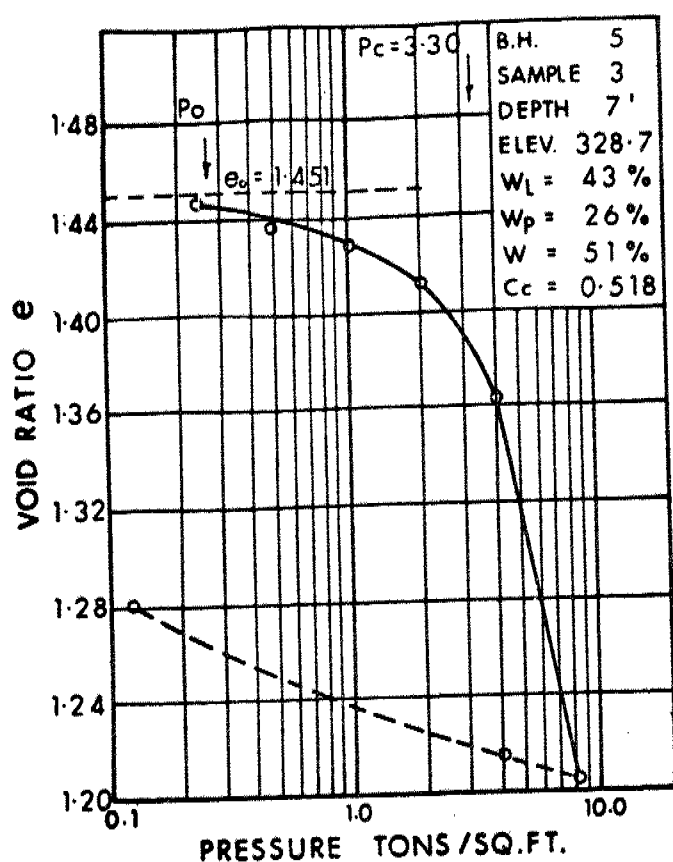


FIG. 4

MEMORANDUM

TO: Mr. T. C. Kingsland, (2)  
Regional Bridge Planning Eng.,  
Eastern Region,  
Kingston, Ontario.

FROM: Foundations Office,  
Design Services Branch,  
Downsview, Ontario.

ATTENTION:

DATE: September 9, 1971.

OUR FILE REF.

IN REPLY TO

SEP 17 1971

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For  
The Proposed Structures at the  
Crossing of Hwy. #417 & the Carp River  
Twp. of March - Reg. Mun. of  
Ottawa - Carleton  
District No. 9 (Ottawa)  
W.O. 71-11051 - W.P. 435-64-01 (E.B.L.)  
W.P. 435-64-02 (W.B.L.)

Attached, we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above structure sites.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/ao  
Attach.

*A. G. Stermac*  
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PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT  
For  
The Proposed Structures at the  
Crossing of Hwy. #417 & the Carp River  
Twp. of March - Reg. Mun. of  
Ottawa - Carleton  
District No. 9 (Ottawa)  
W.O. 71-11051 - W.P. 435-64-01 (E.B.L.)  
W.P. 435-64-02 (W.E.L.)

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1. INTRODUCTION:

The Foundation Office was requested to carry out subsurface investigations for the proposed structure sites where the East and Westbound lanes of Hwy. #417 cross the Carp River, in the Township of March, Regional Municipality of Ottawa-Carleton. The request was contained in a memo from Mr. T. C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated July 20, 1971. The investigations were subsequently carried out by this Office to determine the subsoil, bedrock and groundwater conditions at the crossings.

This report contains the factual results obtained from the investigations, together with recommendations pertaining to the foundations of the proposed structures as well as the stability and settlement considerations associated with the approach fills.

2. DESCRIPTION OF THE AREA AND GEOLOGY:

The area under investigation is located approximately  $1\frac{1}{4}$  miles north of Hwy. #7 and  $\frac{1}{2}$  mile east of Goulbourn Road, in the Township of March. The terrain is flat to gently undulating in relief between about elevations 304 to 306. The land is cultivated and being used for farming purposes.

The north-south flowing Carp River traverses the area. The river channel is approximately 50 feet wide and 6 feet deep and has flat slopes.

## 2. DESCRIPTION OF THE AREA AND GEOLOGY: (Cont'd) ...

At the time of the field investigation the river water level was at elevation 303 - i.e., the water was about 3 feet deep. The Carp River, in this area, has a broad flood plain which is very often flooded during periods of high precipitation, such as during the spring of the year.

This area is situated in the physiographic region known as the 'Ottawa-Valley Clay Plains.' In this region extensive clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region; in some localized areas it is known to extend to depths in excess of 200 feet. In the area under consideration, however, it is generally of the order of 50 to 60 feet deep. The clay is underlain by glacial till.

The overburden deposits are underlain by limestone bedrock on the Trenton and Black River groups, Ordovician Period.

## 3. FIELD AND LABORATORY WORK:

Eight sampled boreholes, four of which were accompanied by a dynamic cone penetration test, as well as four additional dynamic cone penetration tests, were put down at the two sites investigated, using conventional diamond drill rigs adapted for soil sampling purposes.

Samples of the cohesive stratum, as well as the lower glacial till deposit were obtained, at required intervals, in a 2-inch O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. This testing procedure was supplemented by obtaining some 2" I.D. Shelby tubes in the cohesive portion of the overburden; these tubes were manually pushed into the soil. In addition, field vanes were carried out, where possible, to determine the undrained shear strength of the clay stratum.

### 3. FIELD AND LABORATORY WORK: (Cont'd) ...

Bedrock was proven in 4 of the boreholes by obtaining BX or AXT size rock core samples.

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. Artesian groundwater conditions were encountered at a number of the boring locations. The artesian flow, in the open boreholes, was properly sealed at the source following the sampling and drilling operations.

The soil, bedrock and groundwater conditions, encountered at the boring locations, are presented on the Record of Borelog sheets appended to this report. The location and elevation of the various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a Geodetic datum. The boring locations and elevations are shown on Drawings No. W.O. 71-11051A (E.B.L.) and W.O. 71-11051B (W.B.L.). Stratigraphical sections, inferred from the boring data, are also presented on the aforementioned drawings.

All the samples were subjected to a careful visual examination in the field, and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

- Bulk Density
- Organic Content
- Natural Moisture Content
- Atterberg Limits
- Grain-Size Distribution
- Undrained Shear Strength
- Consolidation Characteristics

The results of this testing are plotted on the Record of Borelog sheets and summarized on Figures No. 1 to 4, inclusive, all contained in the Appendix of this report.

### 4. SUBSOIL AND BEDROCK CONDITIONS:

#### 4.1) General:

The predominant stratum across the site is composed of a very stiff to soft grey silty clay.

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd) ...

4.1) General: (cont'd) ...

The thickness of this stratum varies from 37.5 to 63 feet. In the immediate vicinity of the Carp River and its flood plain surficial organic material is present above the silty clay; the thickness of this layer is known to range from 1.5 to 7 feet. The cohesive stratum is underlain by a competent non-cohesive glacial till deposit, whose thickness ranges from 1 to 20.5 feet. The glacial till is, in turn, underlain by limestone bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying borehole sheets. The stratigraphical sections, shown on Drawings No. W.O. 71-11051A and B are inferred from this data.

From ground surface downward, the various soil types encountered, are as follows:

4.2) Organic Silt to Organic Clay:

A surficial deposit, composed of a soft black organic silt to organic clay was encountered in the Carp River Channel, as well as along this river's flood plain, which primarily extends in an easterly direction from the river channel. At those borings which penetrated this layer the thickness was found to range from 1.5 to 4 feet. An investigation carried out by the Regional Materials Section, Eastern Region, however, indicated that, in isolated areas, the thickness of organic material was even greater than this range. The verbal information provided by the Regional Materials Section is summarized as follows:

	<u>Approx. Stations</u>	<u>Thickness of Organic Material</u>
E.B.L. - Hwy. #417	127+40 to 130+00	1.5' to 7'
W.B.L. - Hwy. #417	128+50 to 130+00	1' to 7'

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd) ...

4.3) Silty Clay (Sensitive Leda Clay):

Directly beneath the surficial organic material or a 1 foot layer of topsoil is the predominant stratum composed of silty clay of marine origin. The overall thickness of the cohesive soil varies from 37.5 to 63 feet. The upper 2 to 11 feet of the stratum is mottled grey and brown in colour which is an indication that this upper zone has been subjected to desiccation. Beneath this desiccated zone the clay is grey. Numerous partings and seams of silt, up to 3" thick, are present throughout the deposit.

The properties of the upper desiccated, as well as the lower portion of the stratum, as determined by field and laboratory testing, are summarized on Figure #1. A brief resume, presented in tabular form, follows:

<u>Identity Tests</u>		<u>Upper Desiccated Zone Range</u>	<u>Lower Zone Range (Average)</u>	
Bulk Density (p.c.f.)	( $\gamma$ )	108 - 113.5	97.5 - 105.4	(103)
Liquid Limit (%)	( $W_L$ )	40 - 43	33 - 52	(44)
Plastic Limit (%)	( $W_P$ )	21 - 22	20 - 26	(22)
Natural Moisture Content (%)	( $W$ )	21 - 38	45 - 62	(55)
Liquidity Index	( $I_L$ )	0 - 0.7	1.1 - 2.0	(1.7)
<u>Consolidation Characteristics</u>				
Initial Void Ratio	( $e_o$ )	1 Test $\left\{ \begin{array}{l} 1.1 \\ 0.60 \\ 2,800 \end{array} \right.$	2 Tests $\left\{ \begin{array}{l} 1.6 \text{ to } 1.8 \\ 0.9 \text{ to } 1.3 \\ 1,000 \text{ to } 1,750 \end{array} \right.$	
Compression Index	( $C_c$ )			
Degree of Preconsolidation (p.s.f.)	( $P_c - P'_o$ )			



4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd) ...

4.3) Silty Clay (Sensitive Leda Clay): (cont'd) ...

<u>Undrained Shear Strength</u> (p.s.f.)	<u>Upper Desiccated Zone Range</u>	<u>Lower Zone Range (Average)</u>
1) Field Tests	1,100 -> 2,000	400 - 1,500
2) Lab. Tests	1,050 -> 2,000	400 - 1,200

Standard Penetration Resistance

Testing ('N')  
(Blows/ft.)

3 - 5

1 - 6

The Atterberg limit tests are also plotted on the Plasticity Chart, Figure #2. These results indicate that the cohesive subsoil is essentially inorganic with a plasticity that is generally in the intermediate range. The natural water content, in the upper desiccated zone, is located between the liquid and plastic limits, while in the lower zone it is consistently well above the liquid limit. The latter is indicative of a sensitive material.

The results of the undrained shear strength testing carried out indicates that the consistency of the upper desiccated zone varies from stiff to very stiff, while that of the lower zone is in the soft to stiff range.

The consolidation characteristics of the stratum were determined by carrying out three laboratory tests, the results of which are shown as Void Ratio vs. Pressure plots on Figure #3. The testing indicates that the clay stratum, below the desiccated zone, is preconsolidated by about 1,000 to 1,750 p.s.f. in excess of existing overburden pressure. In the upper desiccated zone the degree of preconsolidation was found to be higher than this range.

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd) ...

4.3) Silty Clay (Sensitive Leda Clay): (cont'd) ...

The relatively high values for the initial void ratio ( $e_0$ ) and the compression index ( $C_c$ ) compare favourably with those of other cohesive deposits in this area, and are a further indication of the sensitive nature of the stratum.

4.4) Heterogeneous Mixture of Silt, Sand and Gravel, Trace of Clay (Glacial Till):

The clay stratum is underlain by a non-cohesive glacial till deposit composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. Over the major portion of the area under investigation the thickness of the till ranged from 1 to 2 feet. An exception to this pattern occurs, however, along the east bank of the Carp River in the vicinity of the proposed Hwy. #417 E.B.L. crossing (refer to B.H.'s #10 and #11). Here the thickness of the glacial till was found to be as much as 20.5 feet. At B.H. #10 the lower 11 feet of the till is bouldery in nature; the boulders are up to 8 inches in size. Grain-size distribution curves for samples of the glacial till are plotted on Figure #4.

The Standard Penetration Tests, carried out within the glacial till deposit are plotted on the Record of Borelog sheets, as well as on Figure #1. This testing gave 'N' values which ranged from 6 blows/ft. to 100 blows for 1 inch, with the lower values being confined to the upper 1 to 2 feet. Based on these values it is estimated that the relative density of the upper 'reworked' zone (where present) varies from loose to compact, while the remainder of the deposit is in the very dense range.

4.5) Limestone Bedrock:

The glacial till is directly underlain by bedrock which was proven in 4 of the boreholes, by obtaining between 5 and 12 ft. of BX or AXT size rock core samples. Over the site the bedrock surface was found to vary between elevations 239.5 and 243, which corresponds to depths below ground surface of from 61 to 68.5 feet.

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd) ...

4.5) Limestone Bedrock: (cont'd) ...

The bedrock is composed of limestone with occasional irregular shaly interbeds. In some localized areas the upper 2 to 3 feet of the bedrock is in a fractured and jointed condition. Below this upper zone (where present) the bedrock is sound as evidenced by the high percentage of core recovery.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. The observations are presented on the individual borelog sheets as well as on Drawings No. W.O. 71-11051A and B. The results indicate that the ground water level in the surficial deposits and cohesive stratum varies between elevations 301 and 303.5. These water levels correspond to depths below ground surface of from 1 to 3 feet. These levels correspond closely with the water level in the Carp River at the time of the investigation.

An artesian groundwater pressure head was observed in a number of the borings put down, namely B.H.'s 4, 8, 10 and 11. The artesian condition was encountered in the non-cohesive glacial till deposit which overlies the bedrock. Once the borings penetrated into this deposit water rose instantaneously in the casing. It eventually stabilized itself at elevations between 306.5 and 308.5, which corresponds to heights of from 2 to 4.5 feet above the existing ground surface. It is pertinent to note that the glacial till is relatively pervious with respect to the overlying silty clay stratum as well as the underlying sound portion of the bedrock. It is inferred that the glacial till is acting as a confined aquifer which is being charged with groundwater from the surrounding terrain which is at a higher elevation.

## 6. DISCUSSION AND RECOMMENDATIONS:

### 6.1) General:

It is proposed to construct twin parallel single-span structures at the proposed crossings of the east and westbound lanes of Hwy. #417 and the Carp River, in the Township of March, Regional Municipality of Ottawa-Carleton. Preliminary design details for the structures will be approximately 85 feet and 88 feet long respectively; each will be about 42 feet wide. The structures are separated by a median which is about 100 feet wide.

It is understood that the profile grade of the E.B. and W.B. lanes of Hwy. #417, in the vicinity of the crossings will be at about elevations 314.5 and 315.5 respectively. Further, the invert of the Carp River Channel will be at elevation 301. The associated approach fills will, therefore, have a maximum height of the order of 11 feet above existing ground surface in the transverse direction. In the longitudinal direction, however, the crest of the fills will be approximately 13.5 and 14.5 feet above the invert of the channel along the E.B.L. and W.B.L., respectively.

The Carp River Channel, in the vicinity of the crossings, is to have a base width of 28 feet and side slopes of 2:1.

The predominant stratum across the site is composed of a very stiff to soft grey silty clay, the thickness of which varies from 37.5 and 63 feet. In the immediate vicinity of the Carp River and its flood plain surficial organic material (1.5 to 7 feet thick) is present. The cohesive stratum is underlain by a competent non-cohesive glacial till whose thickness ranges from 1 to 20.5 feet. The glacial till is followed by limestone bedrock.

The presence of the soft, compressible cohesive stratum, at a shallow depth below ground surface, is the governing factor from a foundation point of view, since it will be necessary to ensure that it is not overstressed by either the embankment or structure surcharge loadings.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd) ...

6.1) General: (cont'd) ...

These aspects will be discussed in detail in the sub-sections to follow.

6.2) Approaches:

6.2.1) Stability Considerations:

As discussed previously a surficial deposit composed of an organic silt-organic clay is present in the Carp River Channel as well as above the river's flood plain, which is primarily located east of the channel. It is recommended that wherever this organic material is encountered this should be completely sub-excavated from within the plan limits of the proposed embankments, prior to the placement of any fill. The excavations so formed should be backfilled with suitable non-cohesive material extending at least one foot above the prevailing water level. Any other acceptable earth material may be used above this level. The exact vertical and lateral extent of this organic deposit should be provided by the Regional Materials Section, Eastern Region, Kingston.

The critical condition for stability of an embankment on slightly over-consolidated cohesive subsoils, as is the case at this site, generally occurs during or immediately after construction. This being the case, a total stress analysis ( $\phi = 0$ ) provides a suitable means of assessing the stability of the embankment section. In this method of analysis, stability is governed by the applied loads and by the stress-strain and undrained shear strength characteristics of the foundation and embankment soils.

Analyses have been carried out, therefore, in terms of total stresses making use of the electronic computer, to determine the stability of the approaches.

The stability in the longitudinal direction will be of primary importance since the approaches will be highest, namely 13.5 feet and 14.5 feet in the case of the E.B.L. and W.B.L. structures, respectively.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd) ...

6.2) Approaches: (cont'd) ...

6.2.1) Stability Considerations: (cont'd) ...

The most critical approach to each structure was checked. The assumptions made for computational purposes are presented in the table to follow:

Soil Properties

<u>Elevation</u>	<u>Soil Type</u>	<u>Design Parameters</u>		
		Bulk Density (p.c.f.)	Undrained Shear Strength (Cu.-p.s.f.)	Effective Angle of Internal Friction ( $\phi = 0$ )
<u>East Approach to the E.B.L. Structure (Forward Direction)</u>				
314.5 - 304	Embankment Fill (2:1 Slopes)	145		30°
304 - 292	Silty Clay	105	600	
292 - 284	Silty Clay	100	450	
284 - 273	Silty Clay	105	650	
273 - 263	Silty Clay	110	1,000	
263 -	Glacial Till	140		40°
<u>West Approach to the W.B.L. Structure (Forward Direction)</u>				
315 - 305	Embankment Fill (2:1 Slopes)	145		30°
305 - 297	Silty Clay (Desiccated)	110	1,200	
297 - 287	Silty Clay	110	1,000	
287 - 277	Silty Clay	100	500	
277 - 245	Silty Clay	105	650	
245 -	Glacial Till	140		40°

NOTE: Ground water level in Surficial Deposits and Silty Clay stratum at Elevation 301.

## 6. DISCUSSION AND RECOMMENDATIONS: (cont'd) ...

### 6.2) Approaches: (cont'd) ...

#### 6.2.1) Stability Considerations: (cont'd) ...

The results of the computations indicate that, approaches of the heights contemplated will be stable provided standard 2:1 slopes are employed.

The approaches should be protected against the scour action of the river; rip-rapping to a point above the design high water level would be suitable for this purpose.

#### 6.2.2) Settlement Considerations:

The underlying compressible clay stratum will settle, over a long term period, due to the loading of the approach fills. In addition, some settlement will take place in the underlying granular glacial till deposit. This settlement will be elastic in nature and negligible in magnitude. The estimated consolidation settlements due to the embankment loading are summarized in tabular form.

#### Consolidation Settlement Beneath Centre-Line of Approach Fills (Maximum Height 11.5 feet)

<u>Time</u>	<u>Settlement</u>
2 years	2 to 1½ inches
12 years	4 to 5 inches (max.)

### 6.3) Structure Foundations:

The presence of the very stiff to soft compressible silty clay at a shallow depth below ground surface will dictate the necessity of supporting the abutments of both structures on end-bearing piles. At all the abutment locations, with the exception of the east abutment of the E.B.L. structure the piles will be driven to bedrock. At the latter location, however, the piles will be located in the very dense granular glacial till stratum. The estimated pile tip elevations at the various proposed abutment locations are given below:

6. DISCUSSION AND RECOMMENDATIONS: (cont'd) ...

6.3) Structure Foundations: (cont'd) ...

<u>Location</u>	<u>Estimated Pile Tip Elev. (Possible Range)</u>	
<u>E.B.L. Structure</u>		
West Abutment (BH'S #7 and 8)	239	(to Bedrock)
East Abutment (BH'S #9 and 10)	245 to 248	(within Glacial Till)
<u>W.B.L. Structure</u>		
West Abutment (BH'S #1 and 2)	243 to 244	(to Bedrock)
East Abutment (BH'S #3 and 4)	238 to 240	(to Bedrock)

The pile driving during construction, particularly in the case of the east abutment of the E.B.L. structure, should be controlled by employing the Hiley Dynamic Pile Driving Formula, in accordance with current Department Standards, in order to obtain the required loads.

The allowable loads will be dependent on the pile section chosen. In view of the anticipated settlements at the approaches and the subsequent negative skin frictional forces expected on the piles, it would be desirable to limit the design loads to about 85% of the maximum allowable load of the pile section selected. For example 12 BP ~~53~~ steel H piles, which are usually designed using a maximum allowable load of 70 tons per pile should be designed using a reduced value of 60 tons per pile if employed on this site.

At least 5 feet of earth cover should be provided to the underside of the abutment pile caps for frost protection purposes.

The base of the pile cap excavations will be located within the cohesive stratum at or slightly below the groundwater level recorded during the period of the investigation.



6. DISCUSSION AND RECOMMENDATIONS: (cont'd) ...

6.3) Structure Foundations: (cont'd) ...

Because of the impervious nature of the subsoil no major dewatering problems are anticipated. Any groundwater seepage from this source could be handled using standard techniques, such as pumping from sumps. The excavations will, however, be located on the banks of the Carp River. Some river water may, therefore, flow into them. This could be prevented by temporarily diverting the river channel away from the construction area.

A lean concrete working slab should be placed immediately after each of the pile cap excavations have been completed in order to prevent softening of the foundation base material.

7. MISCELLANEOUS:

The field work for this project was carried out during the period of July 6 to 22, 1971, under the supervision of Messrs. S. A. Ahmad, Project Foundation Engineer and M. Logan, Student Technician, Field.

The equipment was owned and operated by Dominion Soil Investigation Ltd., Toronto.

This report was written by Mr. B. T. Darch, Senior Foundation Engineer. This project was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer who also reviewed this report.

September, 1971.

APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1 (W. B. L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta 127 + 98, O/S. 20' Lt. ORIGINATED BY S.A.A.  
W.P. 435-64-02 BORING DATE July 7, 8 and 13, 1971 COMPILED BY S.A.A.  
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing, BX Rock Core CHECKED BY   
Dynamic Cone Penetration Test.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	400	800	1200			
						○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB. VANE					$w_p$ — $w$ — $w_L$						
303.9	Ground level.																
0.0	Clayey Topsoil.																
1.0	Desiccated Zone		1	TW	PM	300											
			2	SS	3												
	Silty Clay, trace		3	SS	1												
	of sand (sensitive)		4	SS	4	290											
	(Occasional		5	TW	PM												
	partings and seams		5A	SS	3												
	of silt up to 2"		6	TW	PM	280											
	thick below elev.		7	SS	3												
	270)		8	TW	PM	270											
	Grey		9	SS	1												
	Stiff to firm.		10	TW	PM	260											
			11	SS	3												
			12	SS	4	250											
		13	SS	6													
244.9	Glacial Till.																
243.1	Very dense.		14	SS	100/1"												
60.8	Limestone Bedrock,		15	RC	100%	240											
238.1	shale seams through			BX	Rec												
	out. Sound.																
65.8	End of borehole.																

20  
15-5 % STRAIN AT FAILURE  
10



DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3 (W.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 30; O/S 20' Lt. ORIGINATED BY S.A.A.  
W.P. 435-64-02 BORING DATE July 6, 1971 COMPILED BY S.A.A.  
DATUM Geodetic BOREHOLE TYPE Cone Penetration Test Only. CHECKED BY    

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS/FOOT 20 40 60 80 100					SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE				
302.0	Ground surface.					300										
	Probably organic silt or clay.					290										
	Probably silty clay.					280										
						270										
						260										
						250										
						240										
238.3	Probably glacial till.															
63.7	End of cone test.															
	Probable bedrock.					230										

20  
10-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4 (W.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 34: 18' Rt. ORIGINATED BY S.A.A.  
W.P. 435-64-02 BORING DATE July 7, 1971 COMPILED BY S.A.A.  
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing-BX Rock Core CHECKED BY *[Signature]*  
Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS Art. $\nabla$ Head 302.7			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100	UNCONFINED + FIELD VANE QUICK TRIAXIAL x LAB. VANE					$w_p$ — $w$ — $w_L$		
							400	800	1200	1600	2000	20 40 60							
302.0	Ground surface.																		
298.0	Org. Silt to org. clay. Soft.		1	SS	5	300									14%	301.0			
4.0	Desiccated Zone		2	SS	5														
		3	TW	PM															
	Stiff to very stiff.		4	SS	1	290													
		5	TW	PM															
		6	SS	1	280														
		7	TW	PM															
		8	SS	6	270														
		9	SS	12															
		10	TW	PM	260														
		11	TW	PM															
		12	SS	4	250														
		13	TW	PM															
		242.0	Glacial till Loose.		14	SS	6	240										240.0 $\nabla$	
61.9	Limestone bedrock, seams of shale.		15	RC	100%											Artesian Head			
235.0	Grey. Sound.			BX	Rec											Encountered			
67.0	End of borehole.					230													

20  
15-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5 (W.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 73; @ W.B.L. Hwy. #417 ORIGINATED BY S.A.A.  
W.P. 135-64-02 BORING DATE July 9, 10 & 12, 1971 COMPILED BY S.A.A.  
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w <sub>L</sub> PLASTIC LIMIT ——— w <sub>p</sub> WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					w <sub>p</sub> ——— w ——— w <sub>L</sub> WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE									
							400 800 1200 1600 2000									
303.7	Ground surface.															
300.7	Org. silt to org. clay. Soft.															
300.7	Designated zone.															
300.7			1	SS	2	300									301.0	
	Silty clay, trace of sand and gravel (Occasional partings and seams of silt up to 3" thick below elev. 280)		2	TW	PM	290			+4.2						W.L. in open B.H. July 12, 1971	
			3	TW	PM	290			+16.0							
			4	SS	1	280			+8.0							
			5	TW	PM	280			+ 8.0							
			6	TW	PM	270			+12.0							
	Grey.		7	SS	2	270			+ 6.9							
			8	TW	PM	260			+8.0							
			9	TW	PM	260			+ 3.3							
			10	SS	1	250			+ 2.2							
			11	TW	PM	250										
241.7	Glacial till.		12	SS	1	240										
240.4	Compact.															
63.3	End of borehole. Probably bedrock.															

20  
15-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6 (W.B.L.)

FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 127 + 77 @ W.B.L. Hwy. #417 ORIGINATED BY S.A.A.  
W.P. 435-64-02 BORING DATE July 9 and 12, 1971 COMPILED BY S.A.A.  
DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY ///

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %					
							400 800 1200 1600 2000										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE										
305.4	Ground surface.																
304.3	Clayey topsoil.																
1.1	Desiccated zone. Stiff.																
	Silty clay, trace of sand (Sensitive) (Occasional partings and seams of silt up to 3" thick below elev. 280) Grey. Firm to stiff.		1	SS	3	300										302.5 W.L. in open B.H. July 12, 1971	
			2	TW	PM												
			3	TW	PM	290											
			4	SS	2												
			5	TW	PM	280											
			6	SS	1												
			7	TW	PM	270											
			8	SS	1												
			9	TW	PM	260											
			10	SS	1												
			11	TW	PM	250											
			12	SS	1												
242.0	Glacial till.																
240.5	Compact.																
64.9	End of borehole. Probably bedrock.					240											
						230											

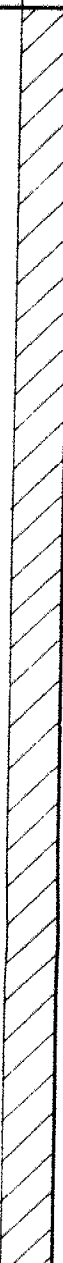
20  
15-5 % STRAIN AT FAILURE  
10



DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7 (E. B. L.) FOUNDATION SECTION

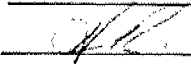
JOB 71-11051 LOCATION Sta. 127 + 83 O/S 20' Rt. ORIGINATED BY M.L.  
W.P. 435-64-01 BORING DATE July 21, 1971 COMPILED BY B.T.D.  
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test. CHECKED BY ll

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$				BULK DENSITY $\gamma$ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE						$w_p$ — $w$ — $w_L$ WATER CONTENT %		
305.3	Ground level.																			
0.0	Probably silty clay.																			
239.4																				
65.9	End of cone test. Probably bedrock.																			

20  
10 5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8 (E.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 127 + 73 O/S 18' Lt. ORIGINATED BY M.L.  
W.P. 435-64-01 BORING DATE July 21 and 22, 1971 COMPILED BY B.T.D.  
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing-BX, AXT Rock Core CHECKED BY   
Dynamic Cone Penetration Test.


SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS Art. Head Bl. 307.5 GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT 20 40 60 80 100					WATER CONTENT % $w_p$ ——— $w$ ——— $w_L$				
							SHEAR STRENGTH P.S.F.									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE									
												400 800 1200 1600 2000				
305.3	Ground level.															
0.0	Org. silty to org. clay. Soft.															
2.0	Desiccated Zone. Stiff to very stiff.		1	SS	3	300								118	302.5 W.L. in B.H. 204.4-49	
			2	TW	PM											
			3	TW	PM											
	Silty clay, trace of sand (sensitive) (Occasional partings and seams of silt up to 1" thick)  Grey.  Firm to stiff.		4	SS	1	290								105	July 22, 1971	
			5	TW	PM											
			6	TW	PM	280										
			7	SS	1											
			8	TW	PM	270										
			9	TW	PM											
			10	SS		260										
			11	TW	PM											
			12	TW	PM	250										
			13	SS	3											
	240.3 Glacial till. Dense 239.3 Fractured 66.0 Limestone bedrock. Shale seams through- out. Sound.		14	TW	PM	240								103.5	239.5 Artesian Head Encountered.	
			15	SS	2											
			16	BX	87%											
			17	AXT RC	87% Rec	230										
			18	AXT RC	90% Rec											
75.3	End of borehole.															

20  
15-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9 (E.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 14 O/S 18' Lt. ORIGINATED BY M.L.  
W.P. 435-64-01 BORING DATE July 14, 1971 COMPILED BY B.T.D.  
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test. CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	$w_p$ — $w$ — $w_L$ WATER CONTENT %						
302.7	Ground level.																	
0.0	Probably silty clay.					300												
						290												
						280												
						270												
						260												
250.2	Probably silty clay with gravel.					250												
52.5	End of cone test.																	

20  
15 — 5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.10 (E.B.L.) FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 25 O/S. 20' Rt. ORIGINATED BY M.L.  
W.P. 435-64-01 BORING DATE July 14, 15, 16 and 19, 1971 COMPILED BY B.T.D.  
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX, AX Casing-AXT Rock Core CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	Artesian Head REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT									
							20 40 60 80 100									
							SHEAR STRENGTH P.S.F.									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 400 800 1200 1600 2000					WATER CONTENT % 20 40 60				
305.3	Ground level.														308.7	
303.3	Org. silty clay. Soft.														GR. SA. SI. CL.	
2.0	Desiccated zone (Mottled grey and brown) Stiff to very stiff.		1	SS	3	300									303.5	
			2	SS	3										W.L. in	
			3	TV	PM										open B.H.	
	Silty clay, trace of sand (sensitive) (Occasional seams and partings of silt up to 1" thick) Grey. Soft to stiff.		4	TV	PM	290									July 19, 1971	
			5	TV	PM											
			6	TV	PM											
			7	TV	PM	280										
			8	TV	PM											
			9	TV	PM	270										
			10	TV	PM											
			11	TV	PM	260										
257.3																
48.0	Het. mixture of silty sand and gravel, trace of clay (glacial till) (Bouldery below elev. 243-boulders up to 8" in size) Very dense.		12	SS	139										35 47 (18)	
			13	SS	100	250									247.0	
			14	AXT-RO	33%										Artesian Head Encountered	
			15	AXT	15%											
236.8	Fractured Limestone bedrock, shale seams throughout. Grey. Sound.		16	AXT	36%											
68.5			17	AXT	84%											
			18	AXT	89%											
			19	AXT	91%	230										
			20	AXT	85%											
224.8				RO	Rec											
80.5	End of borehole.					220										

20  
15 5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11 (E.B.L.)

FOUNDATION SECTION

JOB 71-11051 LOCATION Sta. 128 + 62 - 4 ORIGINATED BY M.L.  
W.P. 435-64-01 BORING DATE July 13 and 12, 1971 COMPILED BY B.T.D.  
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	Artesian Head REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %					
												$w_p$ ——— $w$ ——— $w_L$					
						400 800 1200 1600 2000					20 40 60						
303.5	Ground level.														306.0	Artesian Head	
300.5	Org. silt to org. clay. Soft.															301.5	W.L. in open B.H.
3.0	Silty clay, trace of sand (Sensitive) (Occasional seams of silt up to 1" thick throughout) Grey. Soft to stiff.		1	SS	1												July 13, 1971
			2	TV	PM												
			3	TV	PM												
			4	SS	1												
			5	TV	PM												
			6	TV	PM												
			7	SS	1												
263.0			8	SS	16												
40.5	Het. mixture of silt, sand & gravel (Glacial Till) Compact to very dense.		9	SS	82												259.0
254.3			10	SS	100/2"												56 (38)
49.2	End of borehole.																48 39 (13)
																	Artesian Head Encountered

20  
15-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 12 ( E.B.L.) FOUNDATION SECTION

JOB 71-11051

LOCATION Sta. 127 + 58 , 6

ORIGINATED BY M.L.

W.P. 435-64-01

BORING DATE July 22, 1971

COMPILED BY B.T.D.

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— W <sub>L</sub> PLASTIC LIMIT ——— W <sub>P</sub> WATER CONTENT ——— W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					W <sub>P</sub> ——— W ——— W <sub>L</sub> WATER CONTENT %				
305.3	Ground level.															
303.8	Org. silt. Soft.															
1.5	Desiccated zone (Mottled grey and brown) Stiff to very stiff.		1	SS	L	300									▼ 303.0	
			2	TW	PM					+ 8					W.L. in open B.H.	
						290				+ 11					July 22, 1971	
	Silty clay, trace of sand (sensitive)		3	TW	PM					+ 6						
	Occasional seams and partings of silt up to 2" thick.		4	TW	PM	280				+ 3						
			5	TW	PM					+ 5						
	Grey.		6	TW	PM	270				+ 6						
	Firm to stiff.		7	TW	PM					+ 7						
			8	TW	PM	260				+ 3						
			9	TW	PM					+ 5						
			10	TW	PM	250				+ 12						
			11	TW	PM					+ 2						
241.3						240										
239.6	Glacial till. V. dense		12	SS	100/2"											
65.7	End of borehole. Probably bedrock.					230										

## ABBREVIATIONS USED IN THIS REPORT

### SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
s	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$c_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

### GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

### STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

### FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

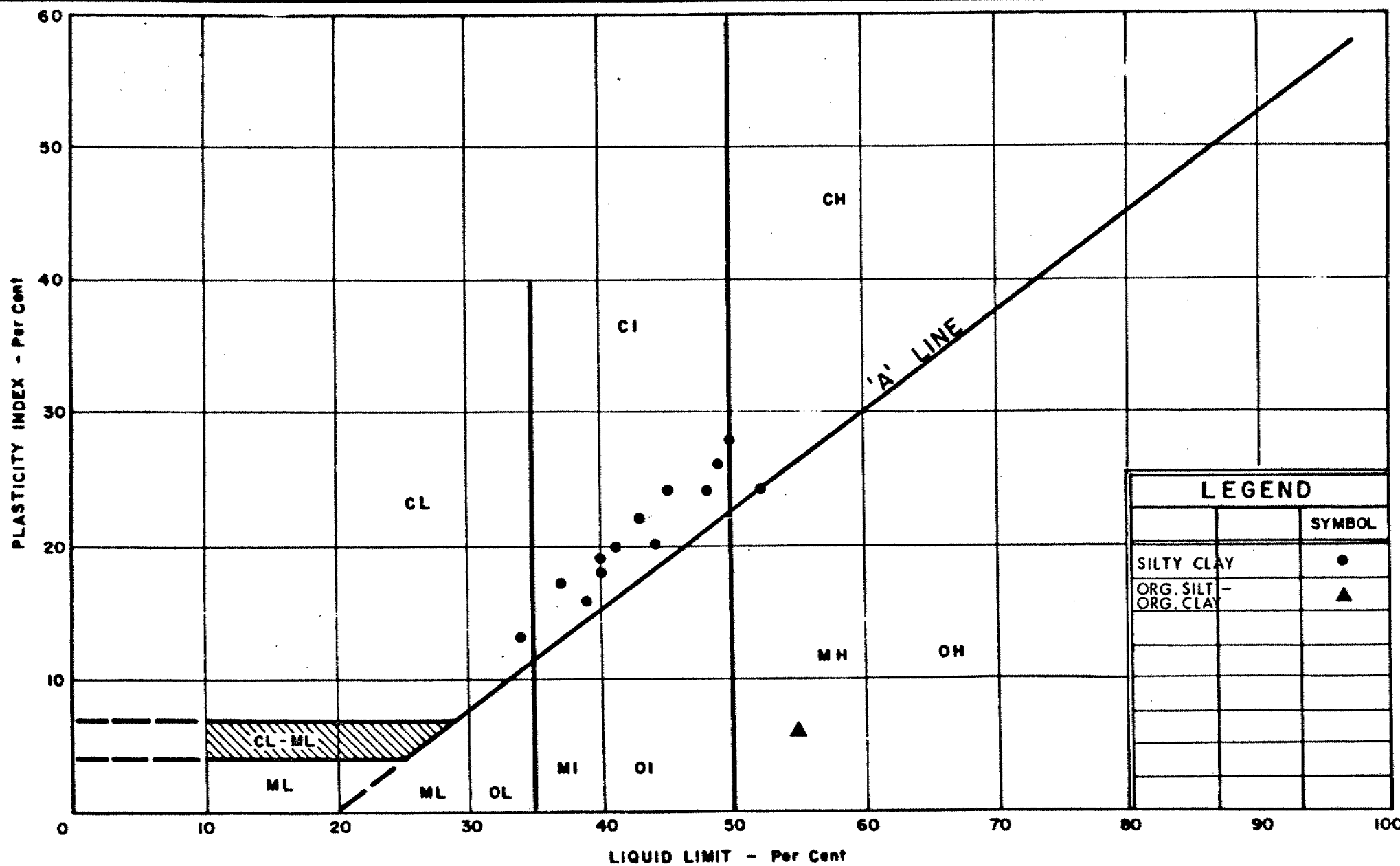
### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY





DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

## PLASTICITY CHART

W.P. No. 435 - 64 - 02

JOB No. 71 - 11051

FIG. 2

# VOID RATIO-PRESSURE CURVES

JOB NO. 71-11051

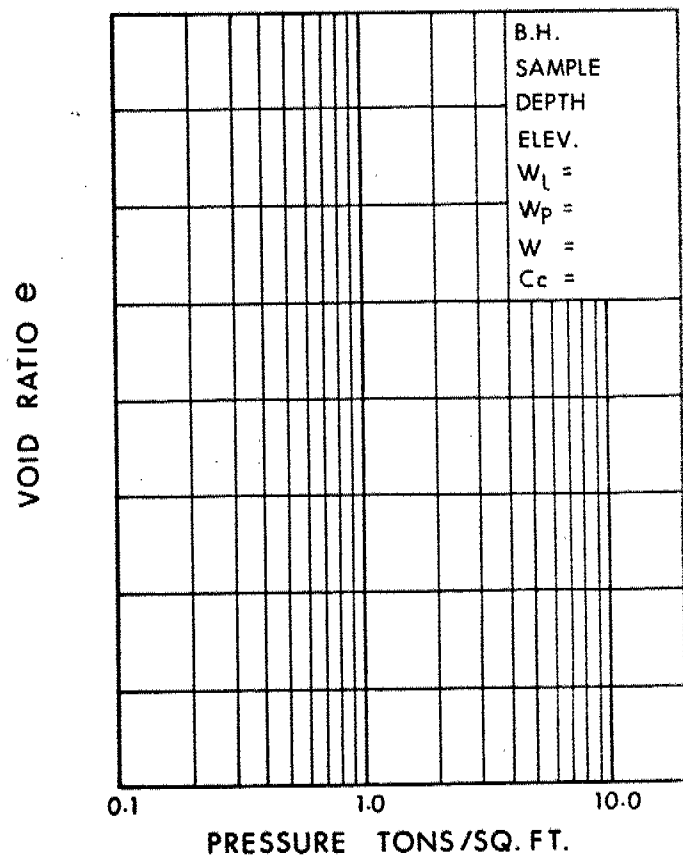
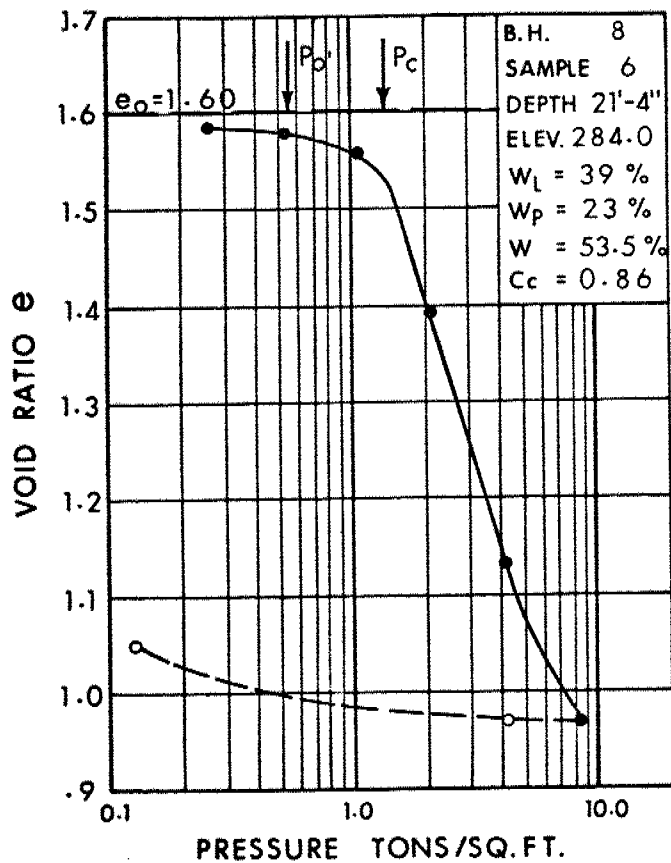
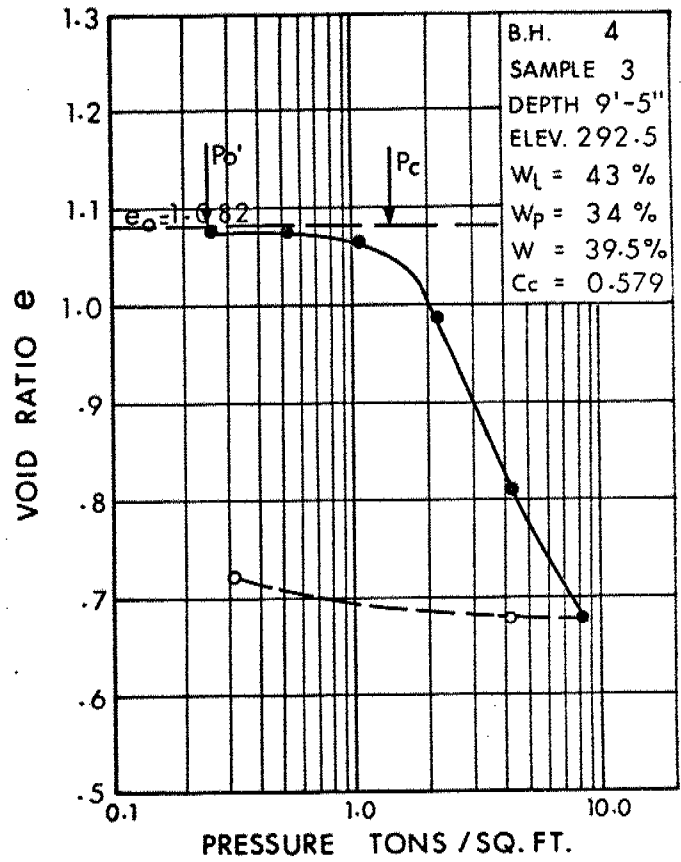
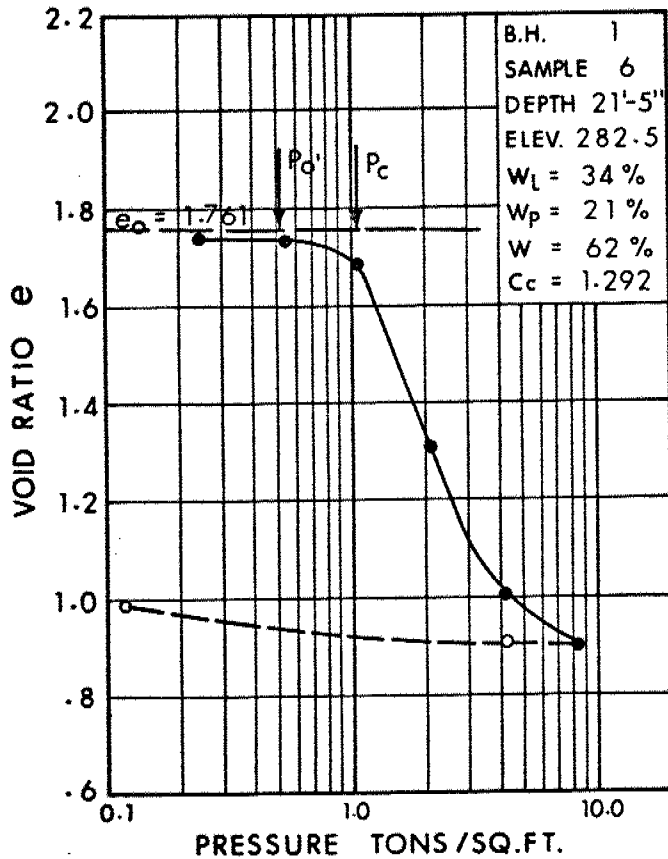
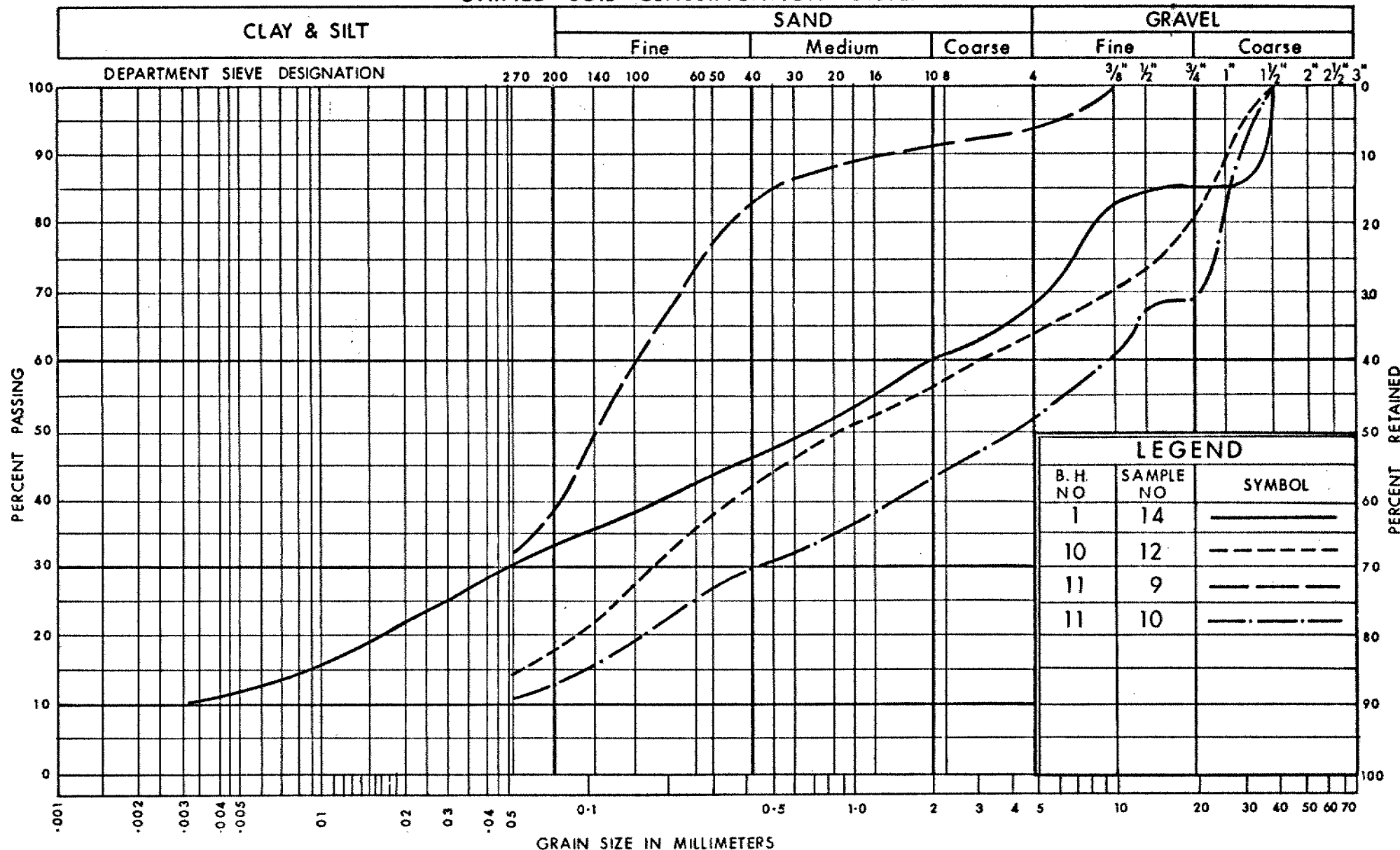


FIG. 3

# UNIFIED SOIL CLASSIFICATION SYSTEM



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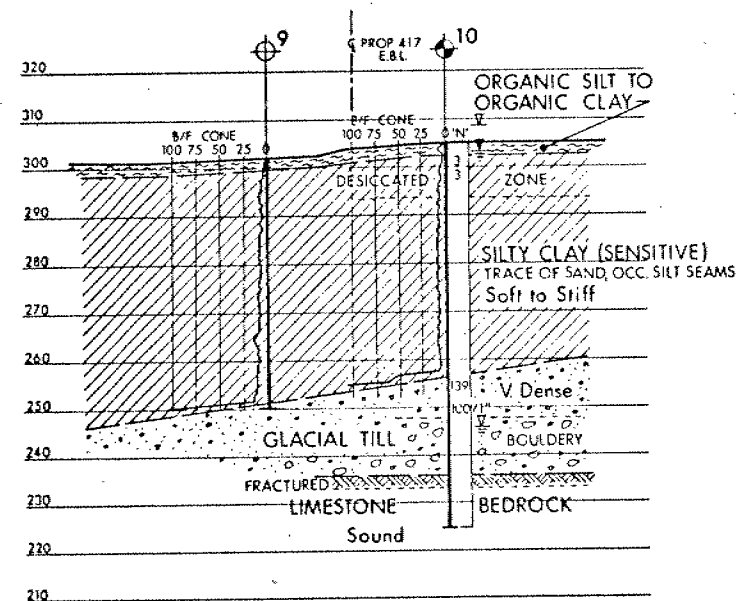
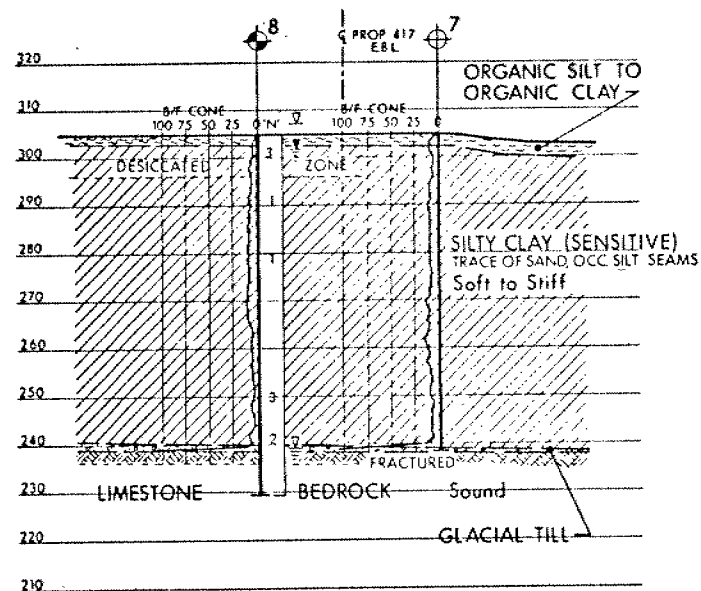
DESIGN SERVICES  
BRANCH

**GRAIN SIZE DISTRIBUTION**  
**GLACIAL TILL**  
HET. MIX. OF SILT, SAND & GRAVEL

W.P. No. 435 - 64 - 02

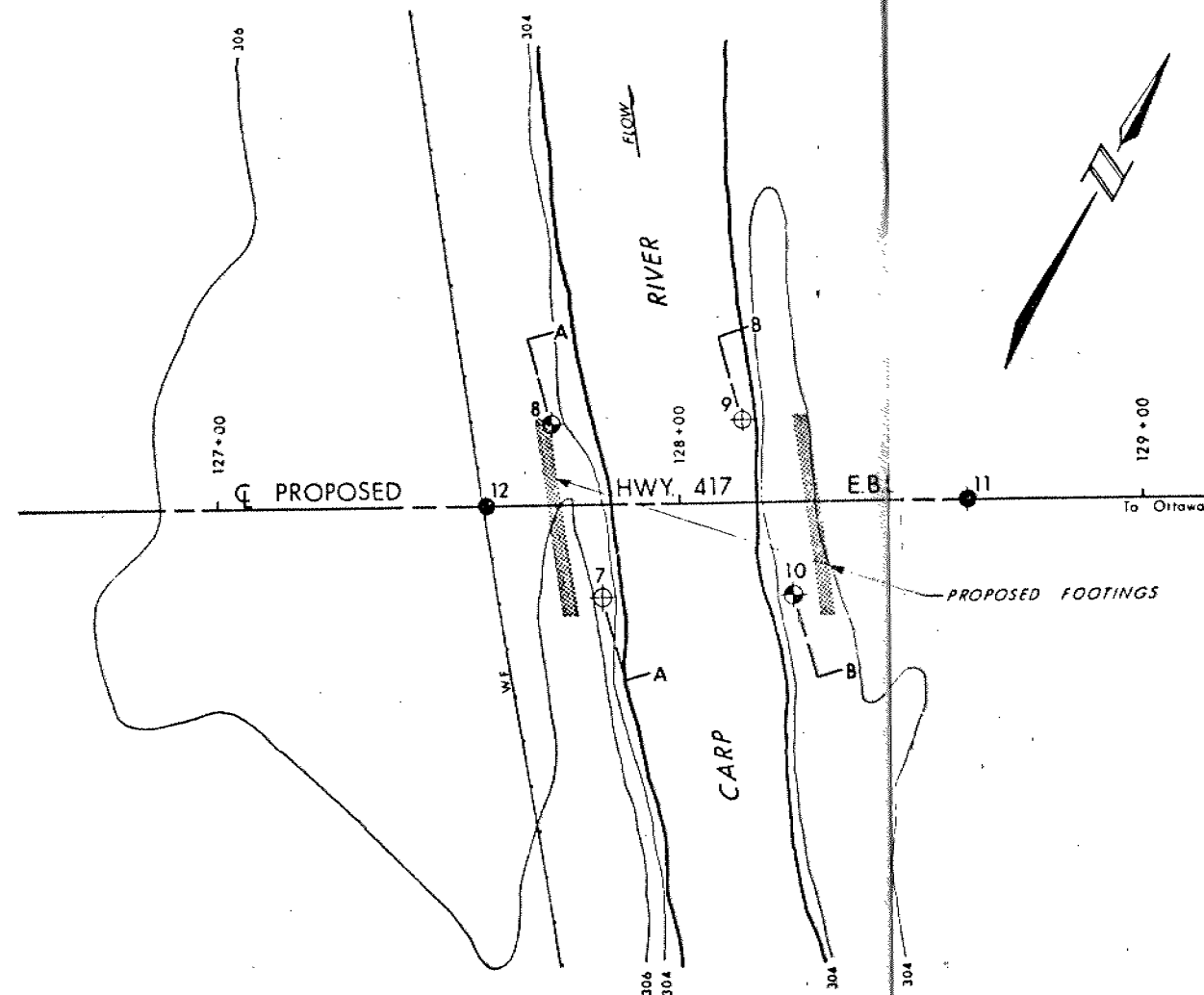
JOB No. 71 - 11051

FIG. 4

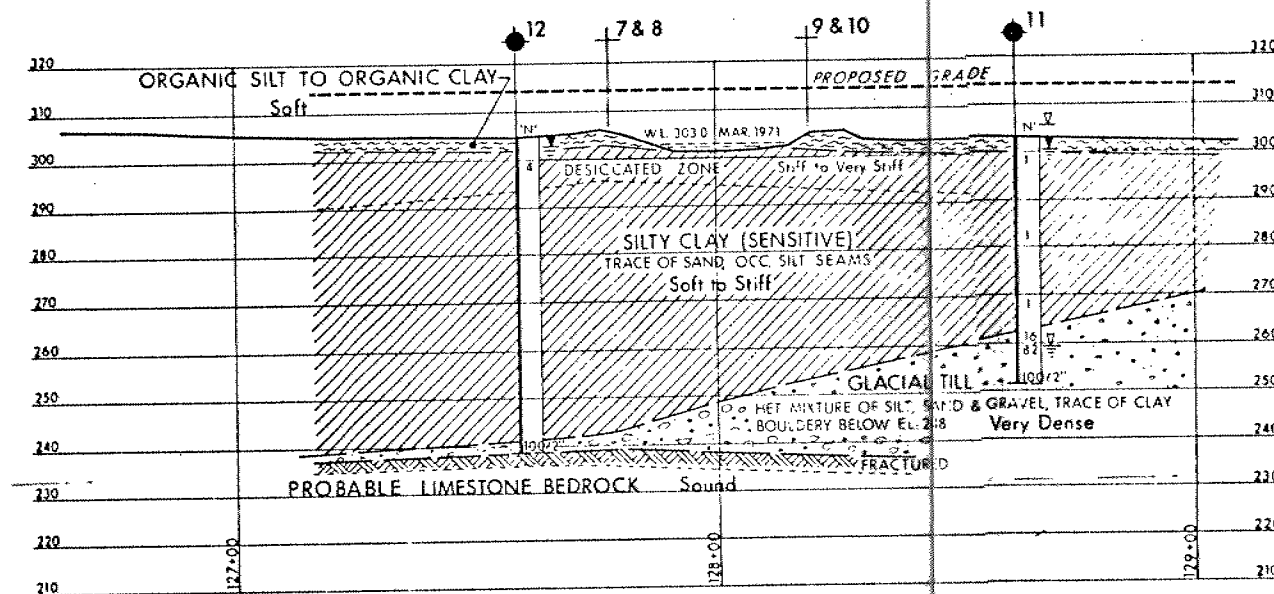


**SECTIONS**

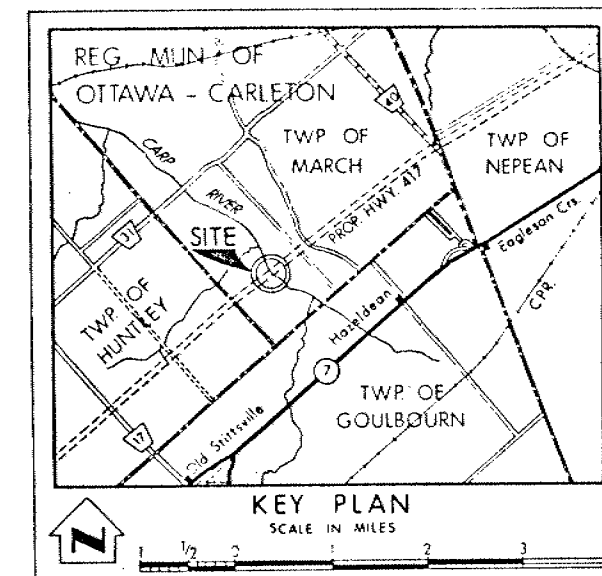
20 10 0 SCALE 20 40 FT



20 10 0 SCALE 20 40 FT



20 10 0 SCALE 20 40 FT



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation July 1971		
	HEAD		
	ENCOUNTERED		
NO	ELEVATION	STATION	OFF-SET
7	305.3	127+83	20' RT
8	305.3	127+73	18' LT
9	302.7	128+14	18' LT
10	305.3	128+25	20' RT
11	303.5	128+62	CL
12	305.3	127+58	CL

**NOTE**

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS  
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

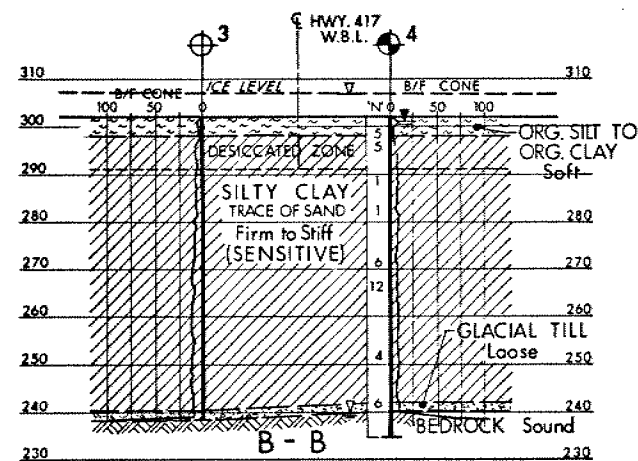
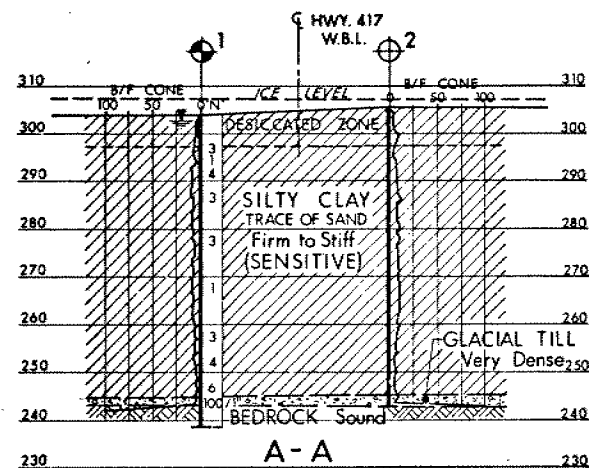
**CARP RIVER**

HIGHWAY NO. 417 EBL. DIST NO. 9  
REG. MUNICIPALITY OF OTTAWA - CARLETON  
TWP. MARCH 101 2 101 1

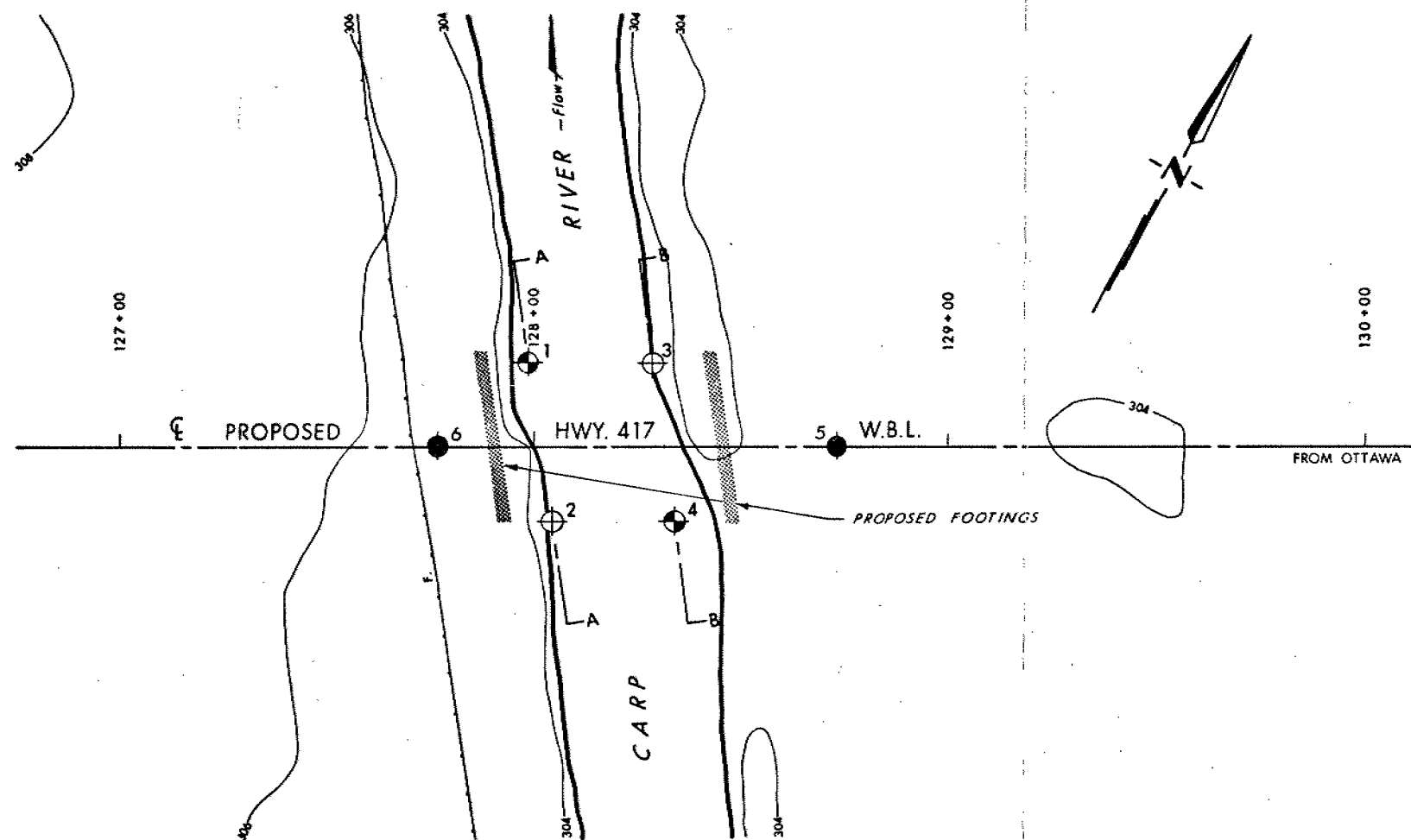
**BORE HOLE LOCATIONS & SOIL STRATA**

SUBMIT SA	CHECKED	W.P. NO. 435-64 01	DATE 3 SEPT 1971
DRAWN D.M.	CHECKED	JOB NO. 71-11051	SITE NO.
APPROVED		CONT NO.	

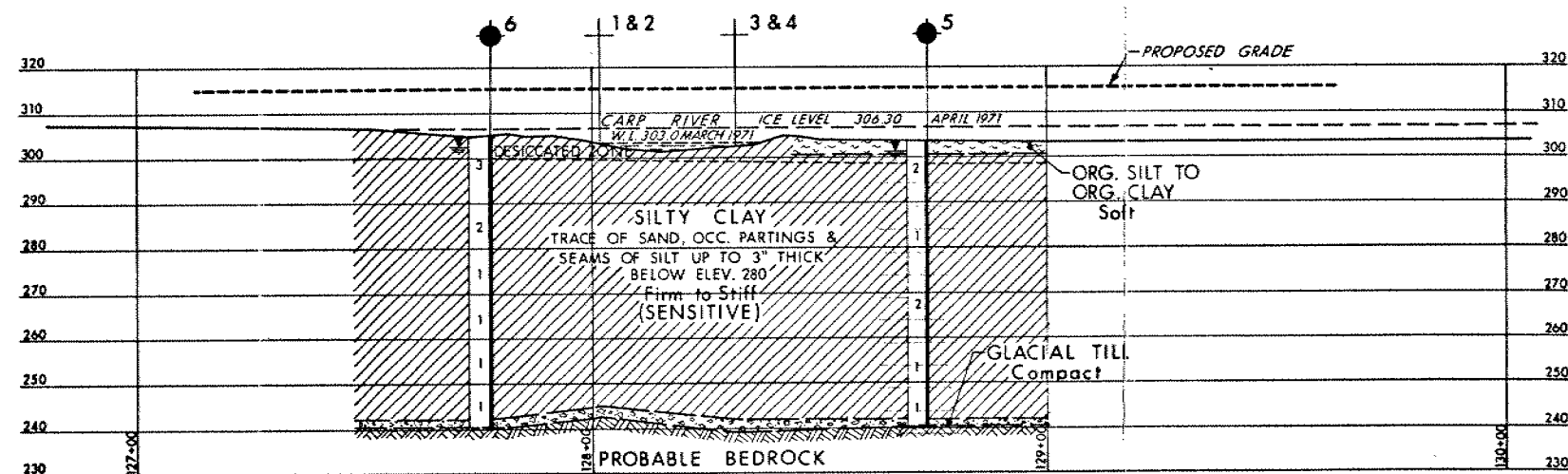
71-11051A



SECTIONS  
20 10 0 SCALE 20 40 FT.



PLAN  
20 10 0 SCALE 20 40 FT.



PROFILE HWY. 417 W.B.L.  
20 10 0 SCALE 20 40 FT.

SEE DRAWING No. 71-11051 A



KEY PLAN  
SCALE IN MILES

### LEGEND

- Bore Hole
- ⊕ Cone Penetration Test
- ⊕ Bore Hole & Cone Test
- ▽ Water Levels established at time of field investigation, July 1971.
- ▽ Head Artesian Water Level
- ▽ Encountered

NO.	ELEVATION	STATION	OFFSET
1	303.9	127+98	20' LT.
2	305.5	128+04	18' RT.
3	302.0	128+30	20' LT.
4	302.0	128+34	18' RT.
5	303.7	128+73	CL
6	305.4	127+77	CL

### NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS  
DESIGN SERVICES BRANCH—FOUNDATION OFFICE

### CARP RIVER

HIGHWAY NO. 417 W.B.L. DIST. NO. 9  
REG. MUNICIPALITY OF OTTAWA - CARLETON  
TWP. MARCH LOT 2 CON. 1

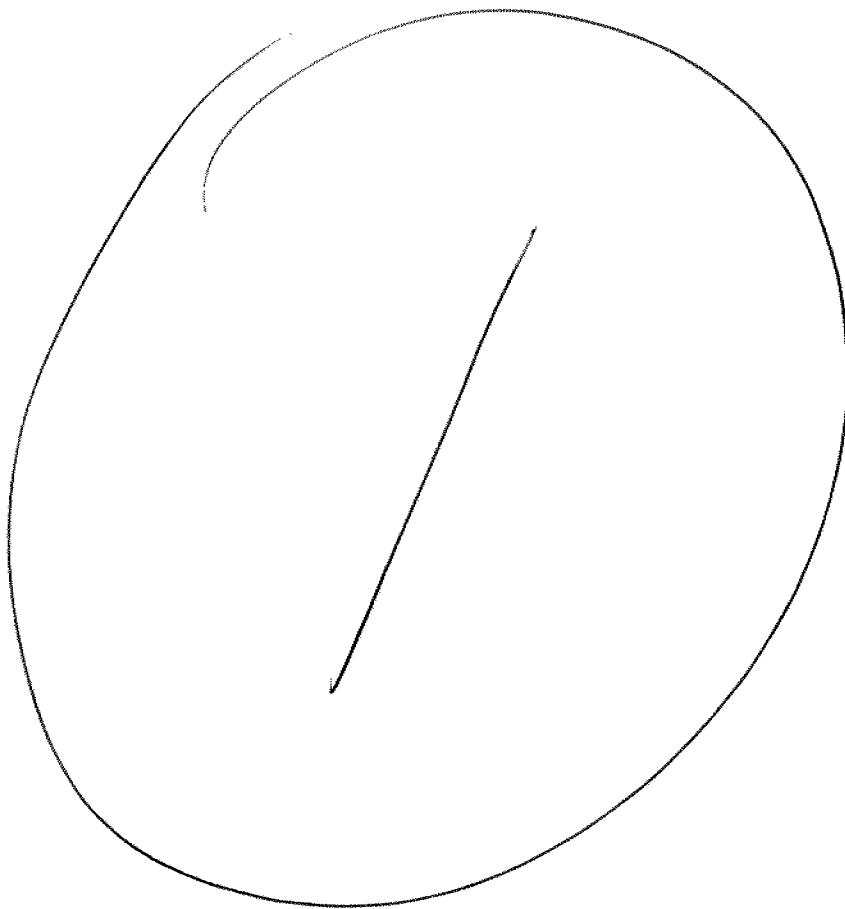
### BORE HOLE LOCATIONS & SOIL STRATA

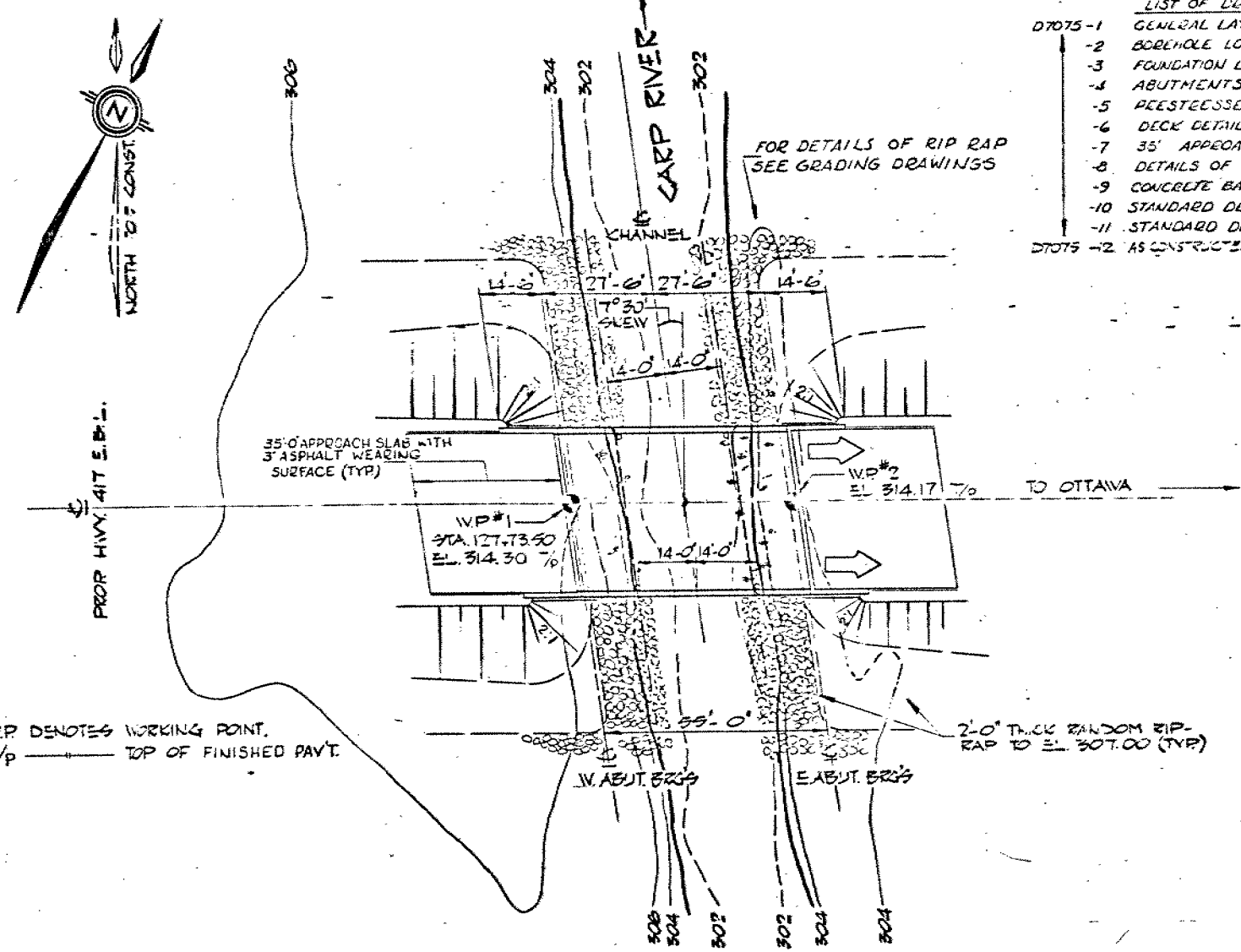
SUBMD. S.A. CHECKED	W.P. NO. 435-64-02	DRAWING NO.
DRAWN S.R. CHECKED	JOB NO. 71-11051	71-11051 B
DATE SEPTEMBER 1, 1971	SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>Ultima</i>	CONT. NO.	
PRINCIPAL FOUNDATION ENGINEER		

REF. No. E-5209-1

35MM

DRAWING



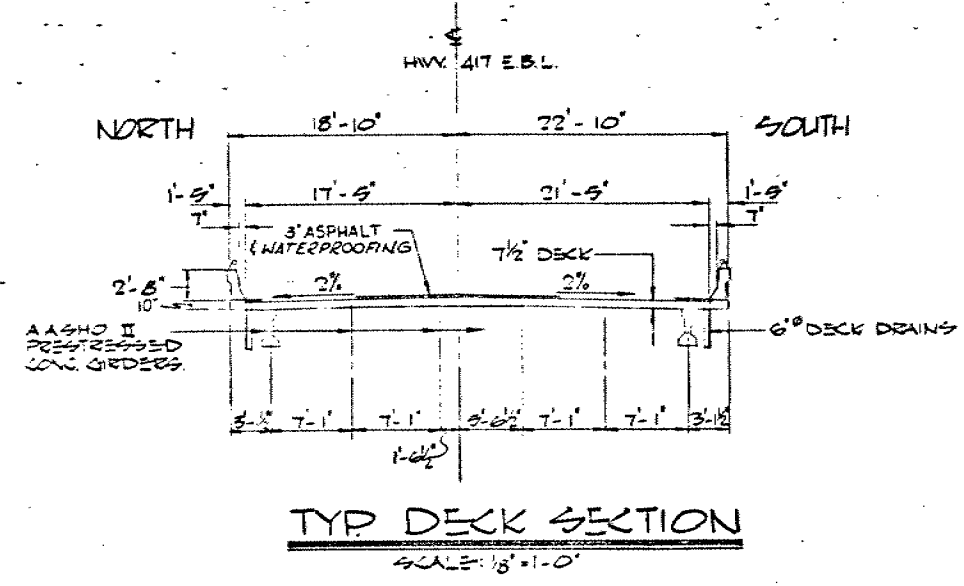
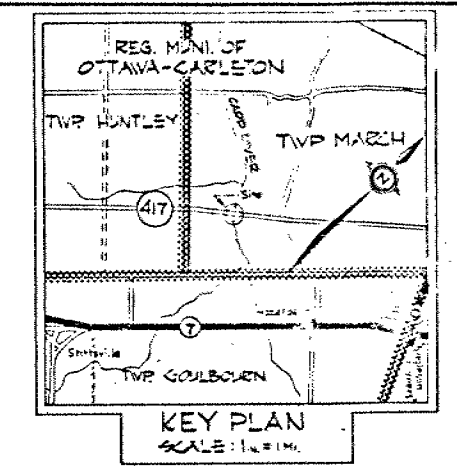


- LIST OF DRAWINGS**
- 07075-1 GENERAL LAYOUT
  - 2 BOREHOLE LOCATIONS & SOIL STRATA
  - 3 FOUNDATION LAYOUT
  - 4 ABUTMENTS
  - 5 PRESTRESSED GIRDERS & BEARINGS
  - 6 DECK DETAILS AND REINFORCEMENT
  - 7 35' APPROACH SLAB FOR BARRIER WALL
  - 8 DETAILS OF 9' HIGH STEEL PARAPET RAILING
  - 9 CONCRETE BARRIER WALL
  - 10 STANDARD DETAILS I
  - 11 STANDARD DETAILS II
  - 07075-12 AS CONSTRUCTED ELEV. & DIM.

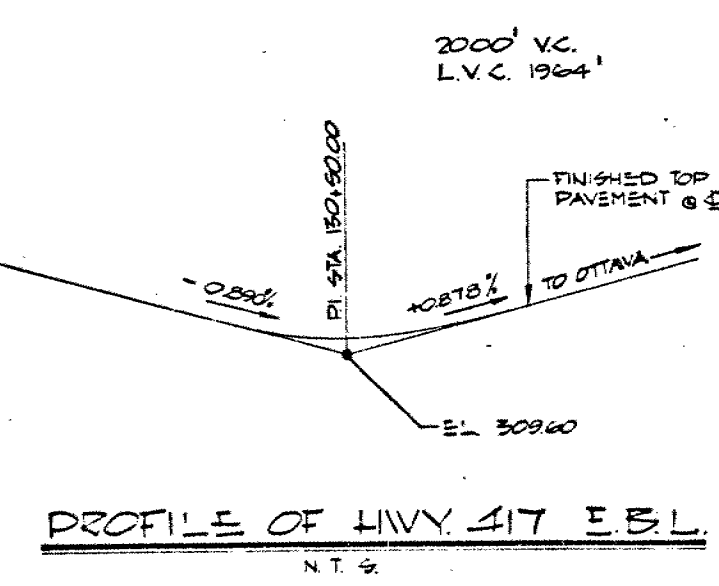
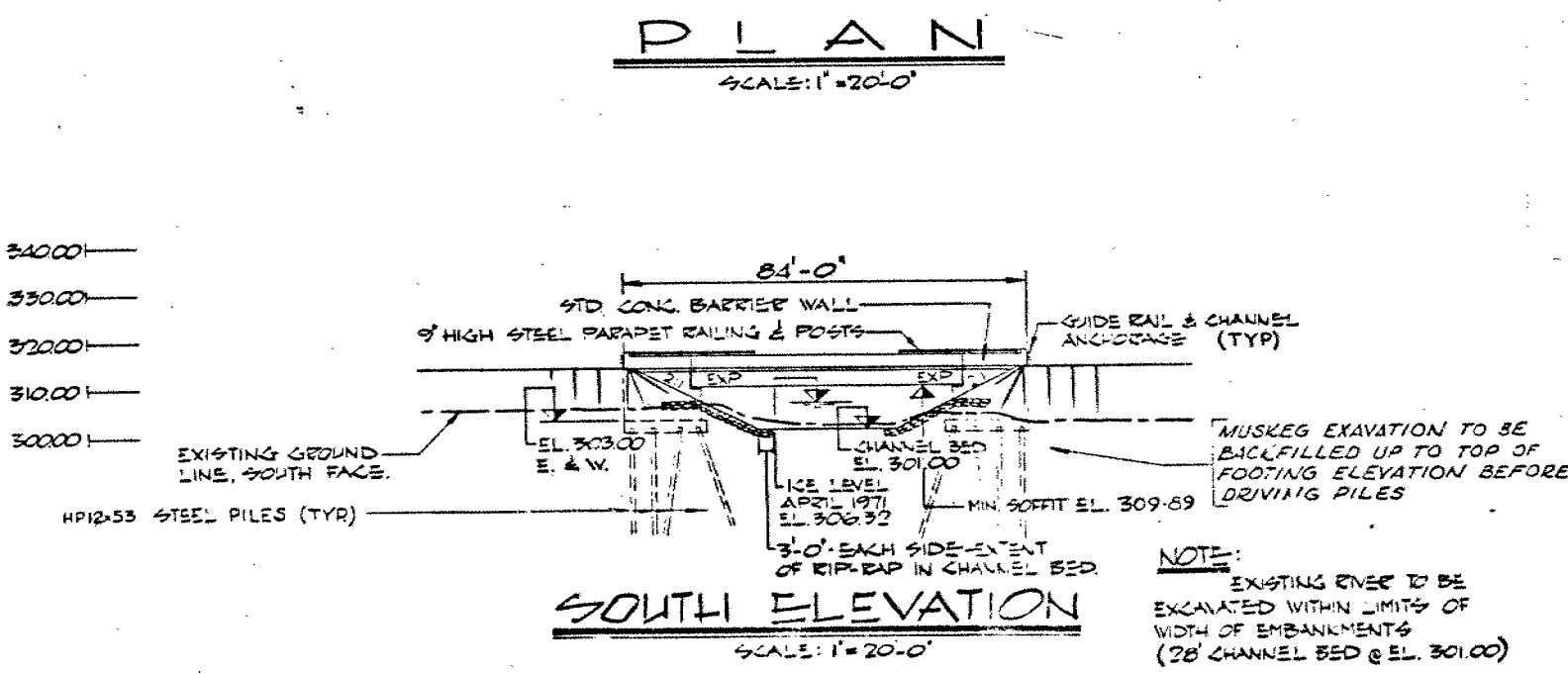
**FUNCTIONS OF SKEW ANGLE**

7° 30' 00"

SIN	0.1305262
COS	0.9914449
TAN	0.1316525
SEC	1.0086289



- NOTES**
- CLASS OF CONCRETE
    - DECK & BARRIER WALLS — 4000 PSI.
    - PRESTRESSED GIRDS & APPR. SLABS — 5000 PSI.
    - REMAINDER — 3000 PSI.
  - CLEAR COVER ON REINFORCING STEEL
    - FOOTINGS & ABUTMENTS — 3"
    - DECK TOP — 2"
    - DECK BOTTOM — 1 1/2"
    - BARRIER WALLS — 1 1/2"
    - (UNLESS NOTED OTHERWISE ON DWS.)
  - CONSTRUCTION NOTES
    - THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 1/8"
    - NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED
  - CONCRETE QUANTITIES
    - CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS:
    - CONCRETE IN ABUTMENTS & CHANNELS — 124 CUYDS.
    - CONCRETE IN DECK & DIAPHRAGMS — 66 CUYDS.
    - CONCRETE IN BARRIER WALLS — 15 CUYDS.
    - CONCRETE IN APPROACH SLABS — 113 CUYDS.



**TO BE USED FOR ESTIMATING PURPOSES ONLY**

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS  
ONTARIO

**CARP RIVER BRIDGE (E.B.L.)**  
6.5 MI. WEST OF HWY. 7

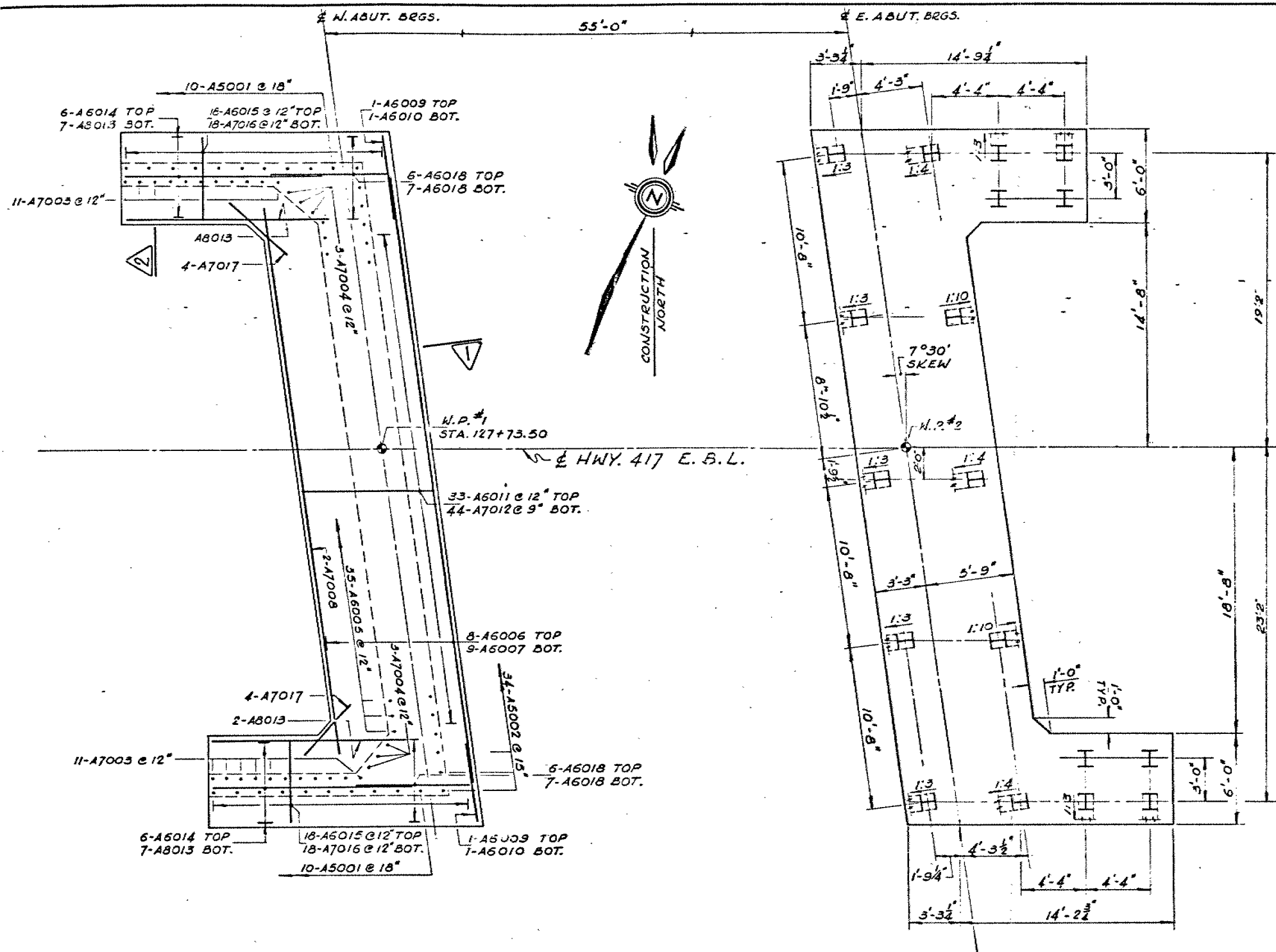
KING'S HIGHWAY No. 417 (E.B.L.) DIST. No. 9  
CO. E.B.L. MUNICIPALITY OF OTTAWA-CARLETON  
TWP. MARCH LOT 2 CON. 1

GENERAL LAYOUT

APPROVED: [Signature] DATE: 3-2-80

DESIGN: [Signature] CHECK: [Signature]  
DRAWING: [Signature] CHECK: [Signature]  
DATE: [Signature] LOADING: [Signature]

CONTRACT No. [Signature]  
DRAWING No. D7075-1



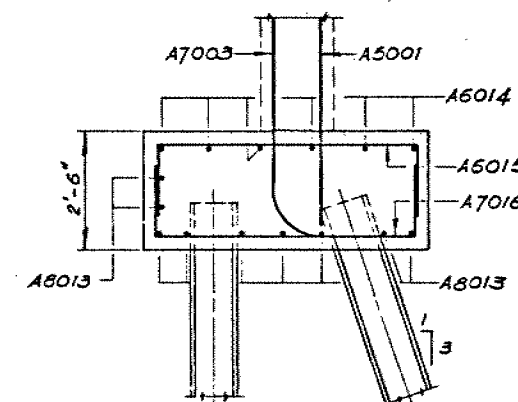
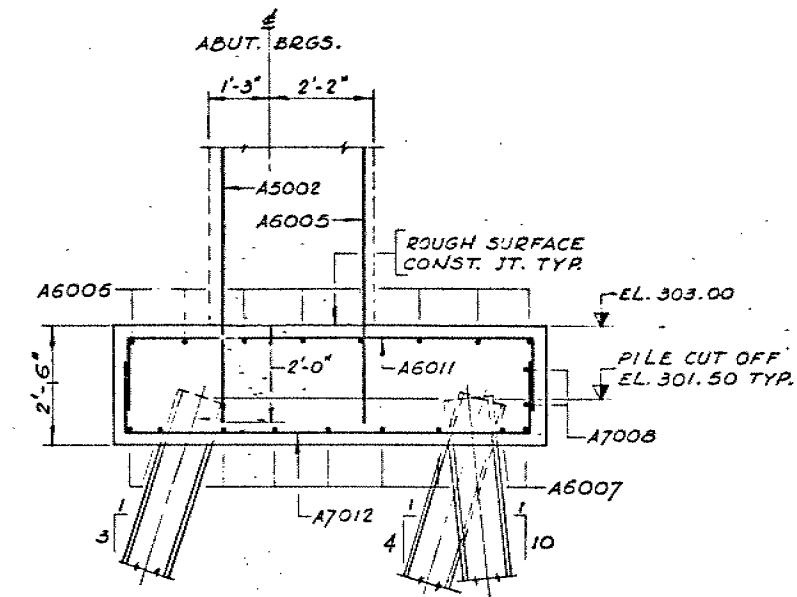
## FOUNDATION LAYOUT

SCALE: 1/2 IN. = 1 FT.

PILE DATA			
LOCATION	N <sup>o</sup>	LENGTH	TYPE
N. ABUT.	18	65'-0"	HP12x53
E. ABUT.	18	65'-0"	HP12x53

### NOTES:

- DIMENSIONS, REINF. & PILE LAYOUT SIMILAR FOR EAST & WEST ABUT. FOOTINGS.
- WEST ABUT. PILES TO BE DRIVEN TO BEDROCK AS DIRECTED BY THE ENGINEER
- EAST ABUT. PILES TO BE DRIVEN IN ACCORDANCE WITH STD. 553-II
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
- PILE DESIGN LOAD 70 T. PER PILE
- TIPS OF PILES AT EAST ABUT. TO BE REINFORCED IN ACCORDANCE WITH STD. 553-I
- THIS DWG. TO BE READ IN CONTINUATION WITH DWG. DT075-4



TO BE USED  
FOR ESTIMATING  
PURPOSES ONLY

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS  
ONTARIO

CARP RIVER BRIDGE (E.B.L.)

6.5 MILES. WEST OF HWY. 7

KING'S HIGHWAY No. 417 (E.B.L.) DIST. No. 9

CO. 553, MUNICIPALITY OF OTTAWA-CARLETON

TWP. MARCH LOT 2 CON. 1

FOUNDATION LAYOUT

APPROVED: [Signature] DATE: 5-22-77 W.P. No. 553-74-01

CONTRACT No. [Blank]

DESIGN: A.C.O. CHECK: [Blank]

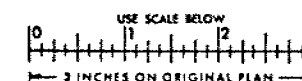
DRAWING: S.S. CHECK: [Blank]

DATE: 5-22-77 LOADING: [Blank]

D7075-3



FOR REDUCED PLAN





Department of Transportation and Communications  
XXXXXXXXXXXXXXXXXXXX

Mr. C. S. Grebski,  
Structural Engineer,  
Design Services Branch,  
West Building, Downsview.

Foundations Office,  
Design Services Branch,  
Central Building, Downsview.

January 5, 1972.

Carp River Bridge, 6.5 Miles West of Hwy. #7,  
W.P. #435-64-01, Site #3-290  
W.P. #435-64-02, Site #3-290  
Hwy. #417, District No. 9

71-11-051

We have reviewed the final bridge drawings for the above-mentioned sites and submit the following comments:

1. In our Foundation Report submitted on September 9, 1971, we recommended that the allowable loads should be reduced by 15% in view of the anticipated negative skin friction forces.
2. The east abutment piles for the EBL structure may not penetrate to the rock due to the presence of dense glacial till deposit immediately above the bedrock surface. Hence, the pile lengths for this abutment should be modified according to recommendations made in our report.
3. In our opinion the piles for the west abutment of WBL structure appear to be 5 to 7 feet longer than necessary.

SAA/ao

cc: Foundations Files  
Documents

For:

*Shahen Ahmad*

S. A. Ahmad,  
Project Foundation Engineer,  
M. Devata,  
Supervising Foundation Engineer.