

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M5-129

DIST. \_\_\_\_\_ REGION \_\_\_\_\_

W.P. No. 83-TA-26/27

CONT. No. 83-11

W. O. No. \_\_\_\_\_

STR. SITE No. 10-135A

HWY. No. \_\_\_\_\_

LOCATION C.W.R Overhead at  
Ramp 403 E/W

No. of PAGES -       

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. \_\_\_\_\_

REMARKS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS DISTRICT OF YORK

METRIC

DIST. 4  
CONT No  
WP No 83-74-27

SHEET

C.N.R. OVERHEAD  
AT RAMP 403 E/W  
GENERAL ARRANGEMENT

MCCORMICK RANKIN  
CONSULTING ENGINEERS

DIMENSIONS ARE IN MILLIMETRES  
UNLESS OTHERWISE SHOWN.  
ELEVATIONS, COORDINATES, CURVE  
AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES.

### GENERAL NOTES:

#### CLASS OF CONCRETE

DECK	55 MPa
PIER COLUMNS	55 MPa
ABUTMENTS, WINGWALLS & BARRIER WALLS	50 MPa
REMAINDER	20 MPa

#### REINFORCING STEEL GRADE

GRADE 400  
COATED BARS TO HAVE A SUFFICIENT

#### COVER TO REINFORCING STEEL

FOOTINGS	100 mm
ABUTMENTS, WINGWALLS & PIERS	80 mm
DECK	50 mm TOP 30 mm BOTTOM
REMAINDER AS NOTED ON DWGS	

#### CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING  
THE BEARING SEATS DEAD LEVEL TO THE  
SPECIFIED ELEVATIONS WITH A TOLERANCE OF  $\pm 3$  mm.  
EXISTING STRUCTURE TO BE REMOVED PRIOR TO  
CONSTRUCTION OF THIS STRUCTURE.

### LIST OF DRAWINGS

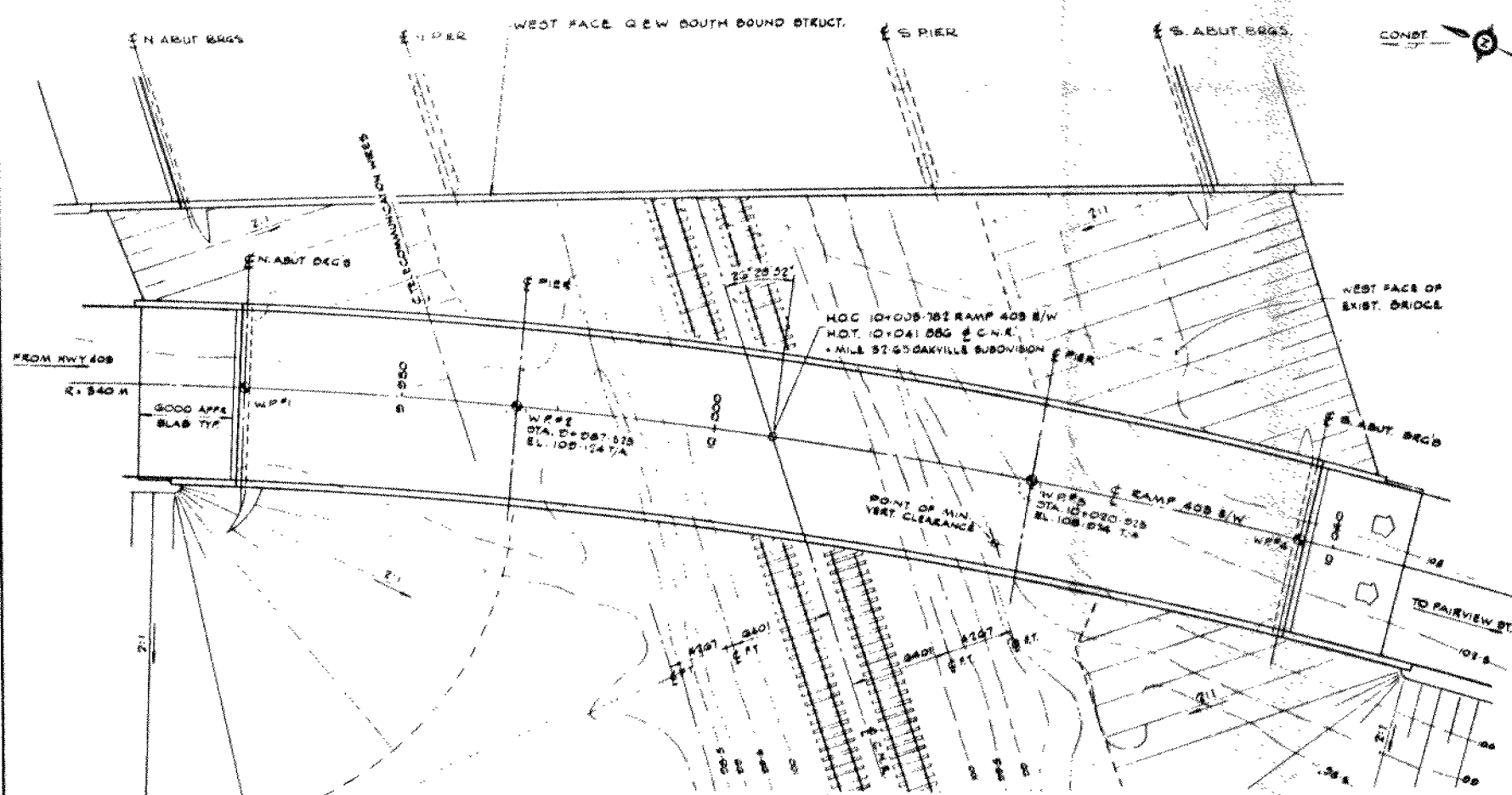
1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION & SOIL STRADA
3. FOUNDATION LAYOUT
4. NORTH ABUTMENT
5. SOUTH ABUTMENT
6. PIERS
7. DECK LAYOUT
8. LONGITUDINAL CABLE DETAILS
9. TRANSVERSE CABLE DETAILS
10. DECK REINFORCING
11. ANCHORAGE REINFORCING DETAILS
12. BARRIER WALL
13. APPROACH SLABS
14. AS CONSTRUCTED ELEV AND DIMENSIONS
15. BRIDGE DATE AND SITE DATA
16. STANDARDS
17. ELECTRICAL EMBEDDED WORK
18. ELECTRICAL STANDARDS

### CONCRETE QUANTITIES (FOR LUMP SUM TENDER ITEMS)

1. PIERS	45 m <sup>3</sup>
2. ABUTMENT & WINGWALLS	118 m <sup>3</sup>
3. PRESTRESSED CONCRETE DECK	781 m <sup>3</sup>
4. BARRIER WALLS	42 m <sup>3</sup>
5. APPROACH SLABS	32 m <sup>3</sup>

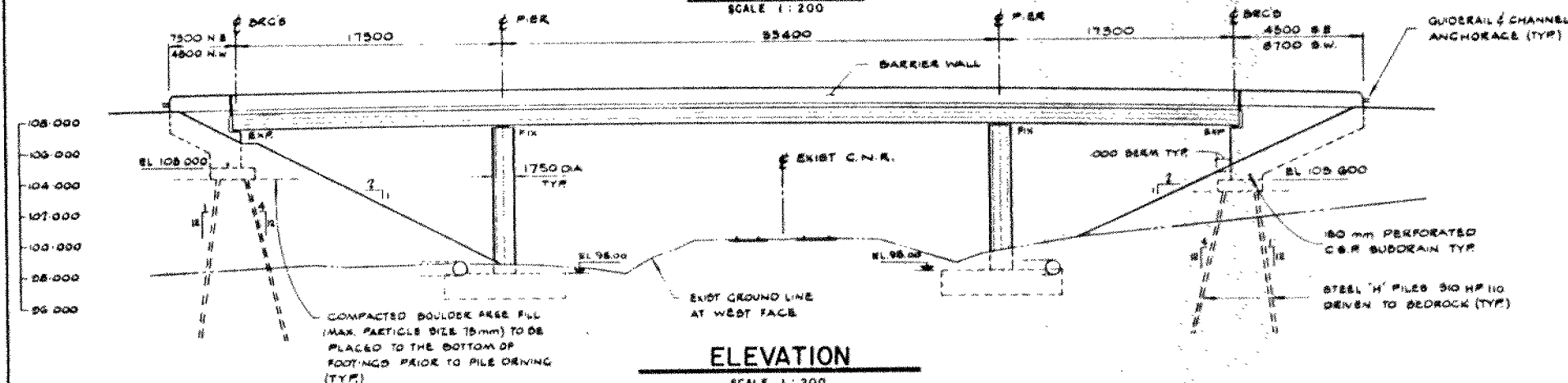


REVISIONS	DATE	BY	DESCRIPTION
DESIGN	J. L. CHECK	R. S.	LOADING CHBDC-A-79
DRAWING	B. J. CHECK	R. S.	SITE No. 10-1358
			DWG



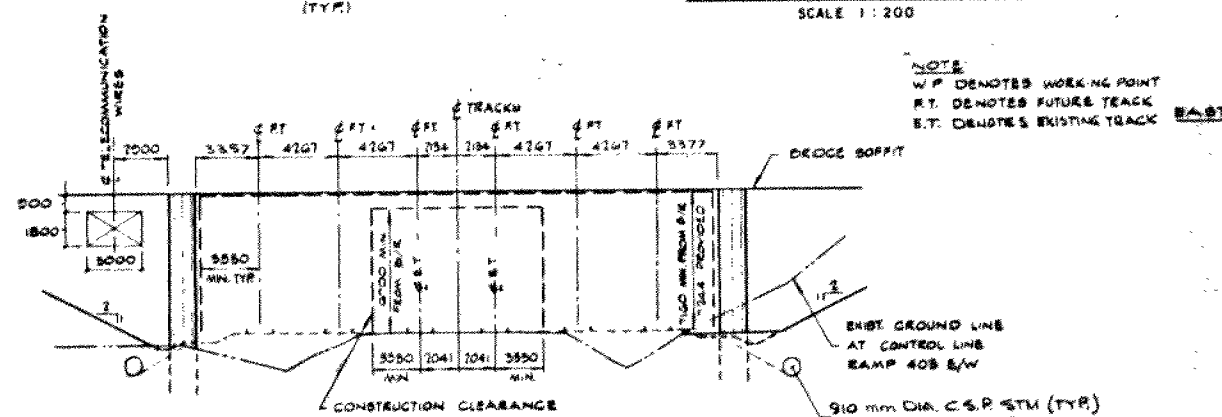
PLAN

SCALE 1:200



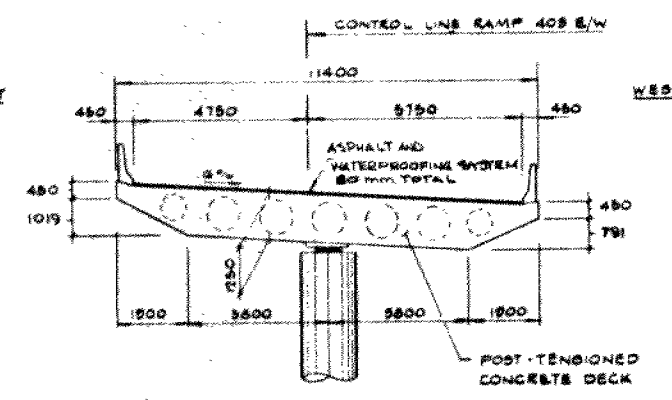
ELEVATION

SCALE 1:200



CLEARANCE DIAGRAM

SCALE 1:200



SECTION

SCALE 1:100

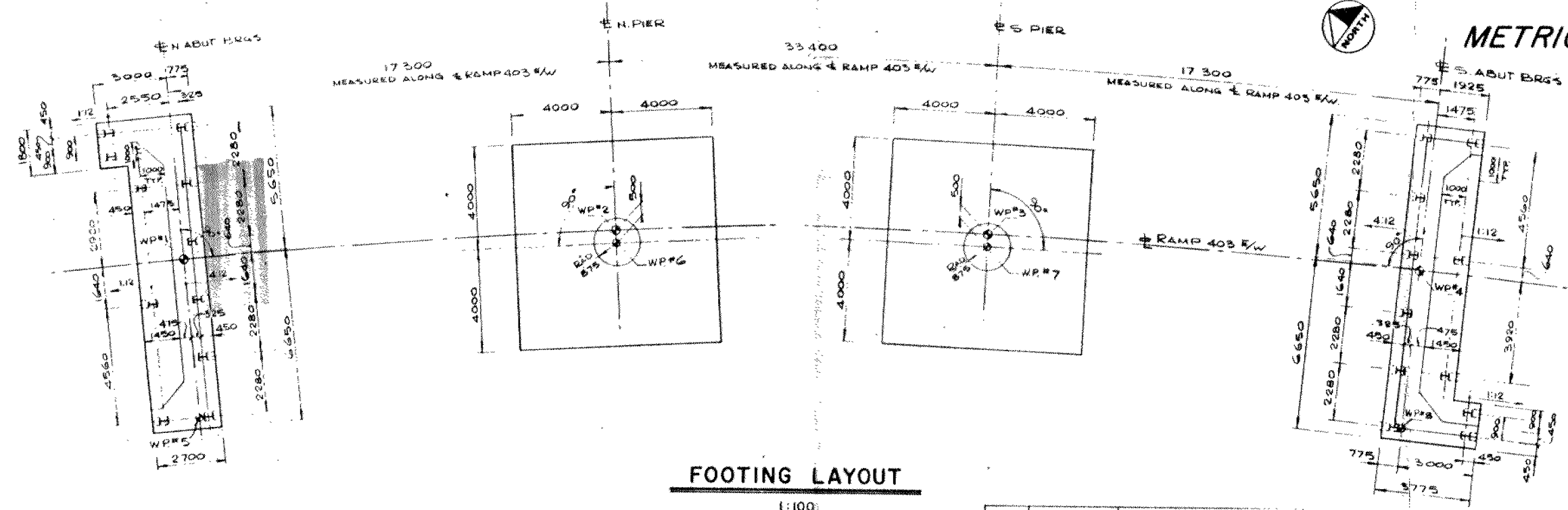
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

DIST. 4  
CONT No  
WP No 83-74-27

403 RAMP OVERHEAD  
AT C.N.R.  
FOUNDATION LAYOUT

SHEET

McCORMICK RANKIN  
CONSULTING ENGINEERS

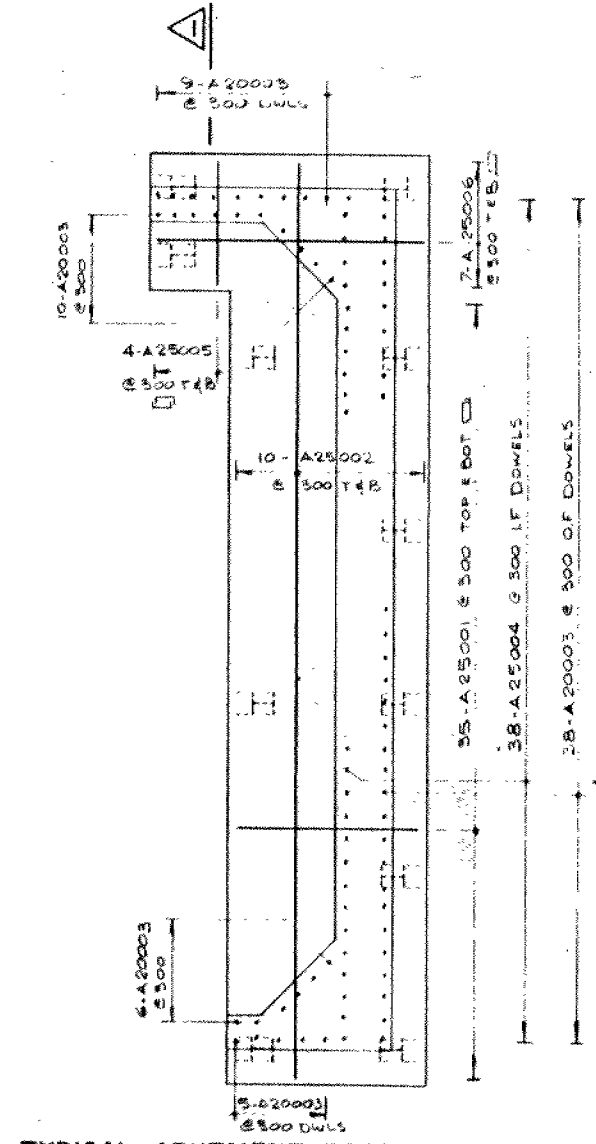


FOOTING LAYOUT  
1:100

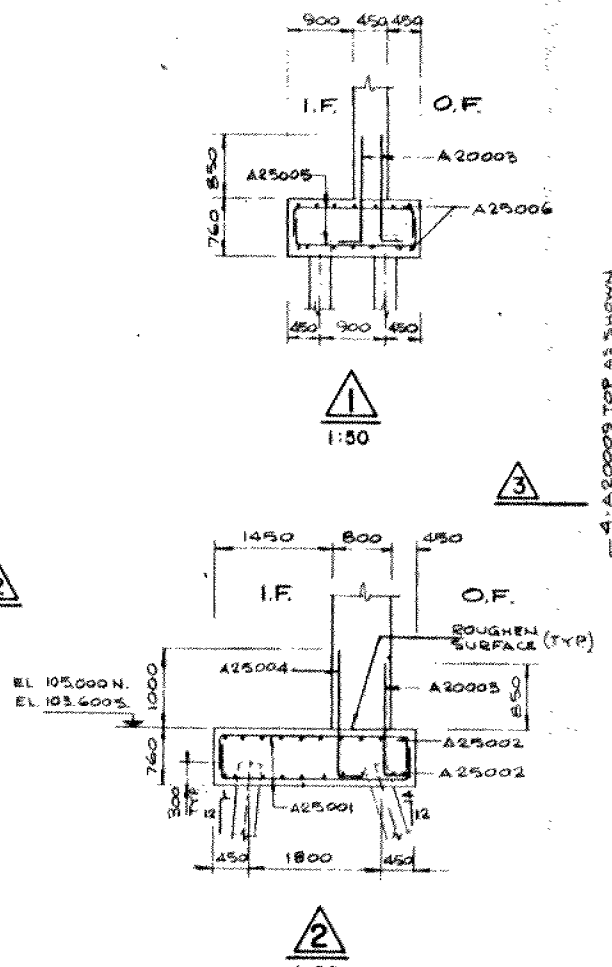
- NOTES:
- PILES TO BE 310HP 110 STEEL PILES DRIVEN TO BEDROCK.
  - PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTH BELOW THE CUT-OFF ELEV.
  - PILE LAYOUT DIMENSIONS ARE TO BE MEASURED AT THE UNDERSIDE OF FOOTINGS.
  - DESIGN LOAD:  
FACTORED CAPACITY AT U.L.S. = 1600 KN  
CAPACITY AT S.L.S. TYPE II = 1150 KN
  - O.F. DENOTES OUTSIDE FACE  
I.F. DENOTES INSIDE FACE
  - PILE TIP SHALL BE REINFORCED ACCORDING TO CD-3301.

W.P.	STATION	CO-ORDINATES	
		NORTHING	EASTING
#1	9+970.225	4798750.951	278213.395
#2	9+987.525	4798734.442	278218.624
#3	10+020.925	4798701.953	278226.317
#4	10+038.225	4798684.871	278229.038
#5	9+970.225	4798748.907	278207.535
#6	9+987.525	4798734.303	278218.144
#7	10+020.925	4798701.862	278225.825
#8	10+038.225	4798684.052	278223.892

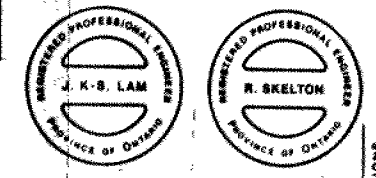
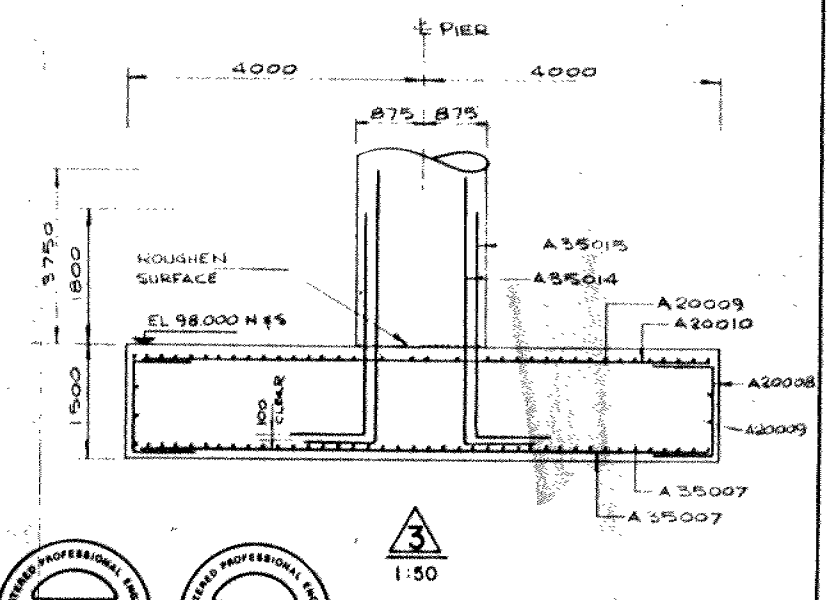
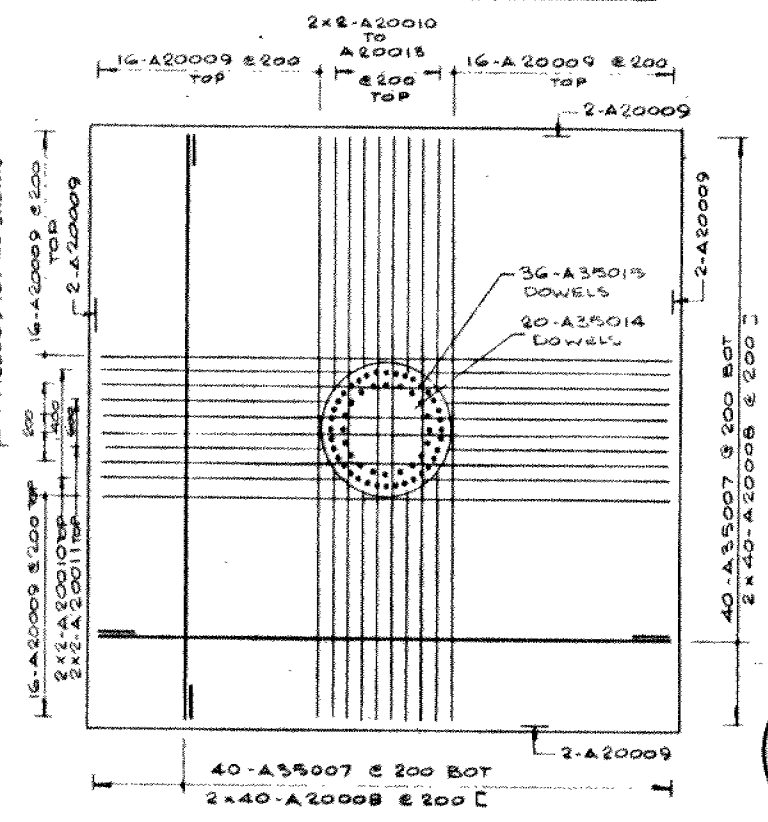
PILE DATA				
LOC	BATTER	QTY	LENGTH	CUT-OFF ELEV.
NABUT	4:12	6	17.5m	104.54
	1:12	5	17.0m	104.54
SABUT	4:12	6	16.0m	103.14
	1:12	5	15.5m	103.14



TYPICAL ABUTMENT FOOTING REINFORCING  
1:50



TYPICAL PIER FOOTING REINFORCING  
1:50



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	J.L.	CHECK	G.D. LOADING CHBDC-A-79 DATE 9/81
DRAWING	W.C.D.	CHECK	J.L. SITE N40-135 B DWG 3

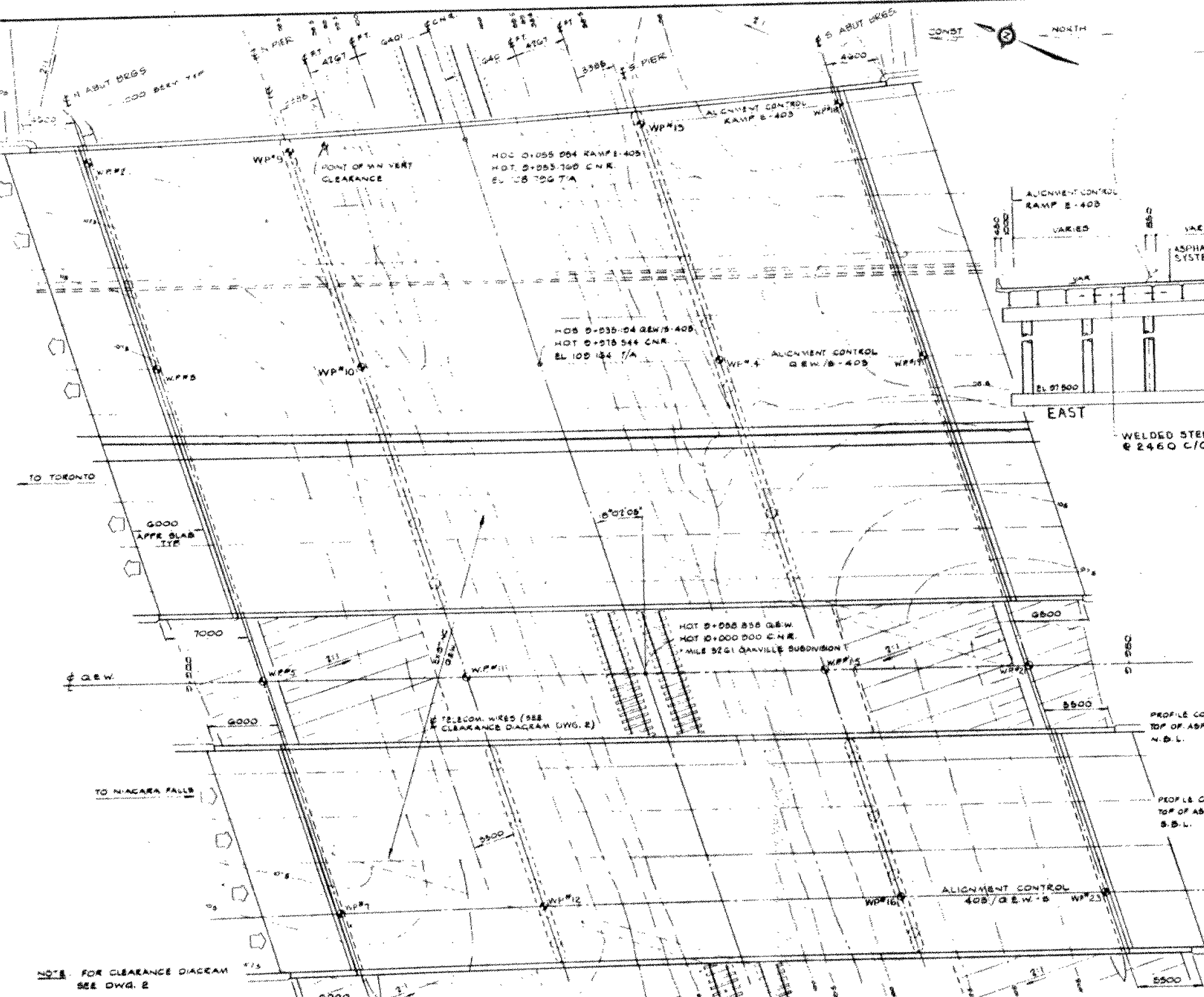
DIST. 4  
CONT No  
WP No 83-74-26

C.N.R. OVERHEAD  
AT Q.E.W.  
GENERAL ARRANGEMENT

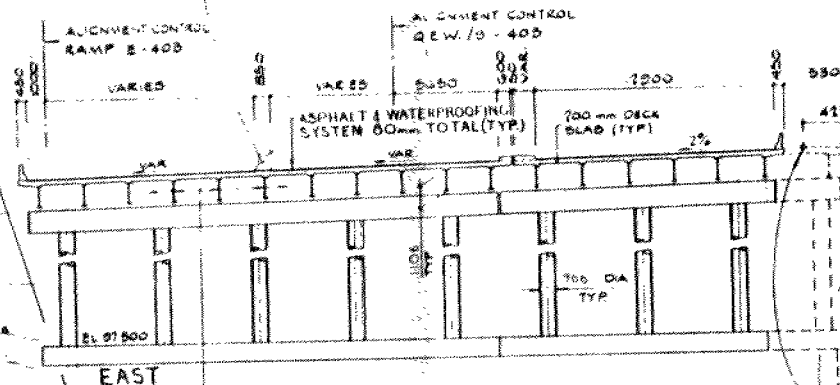
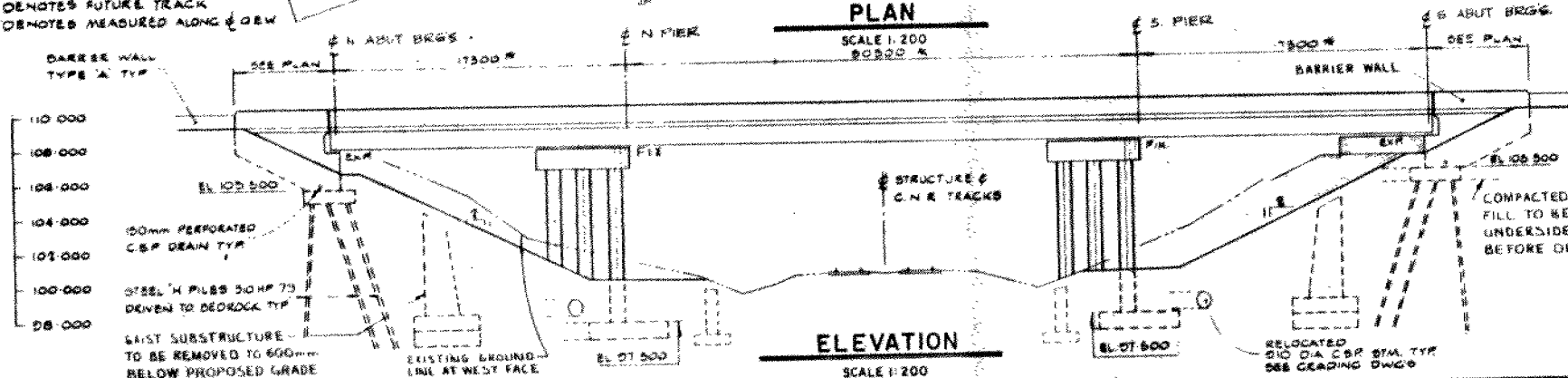
SHEET

**MCCORMICK RANKIN**  
CONSULTING ENGINEERS

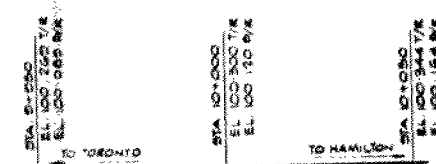
**METRIC**  
DIMENSIONS ARE IN MILLIMETRES  
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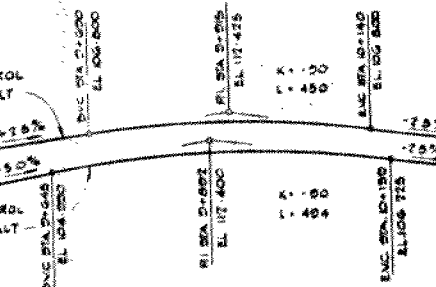
NOTE: FOR CLEARANCE DIAGRAM  
SEE DWG. 2  
W.P. DENOTES WORKING POINT  
F.T. DENOTES FUTURE TRACK  
\* DENOTES MEASURED ALONG Q.E.W.



**SECTION**  
SCALE 1:200



**PROFILE OF C.N.R.**  
(RUNNING EDGE OF NORTH RAIL)  
N.T.S.



**PROFILE OF Q.E.W.**  
N.T.S.

CONCRETE QUANTITIES		
(CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS)		
	NBL	SBL
CONCRETE IN ABUTMENTS & WINGWALLS	228m <sup>3</sup>	121m <sup>3</sup>
CONCRETE IN PIERS	207m <sup>3</sup>	99m <sup>3</sup>
CONCRETE IN DECK	586m <sup>3</sup>	267m <sup>3</sup>
CONCRETE IN BARRIER WALL	43m <sup>3</sup>	43m <sup>3</sup>
CONCRETE IN APPROACH SLAB	127m <sup>3</sup>	55m <sup>3</sup>
STRUCTURAL STEEL QUANTITY	255 TONNES	120 TONNES

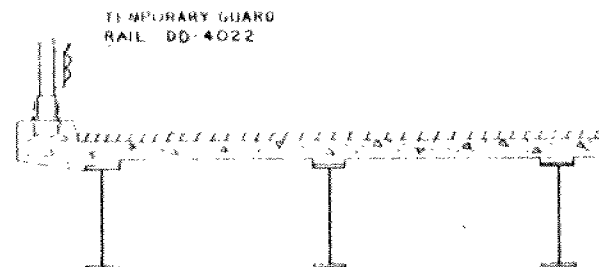
**GENERAL NOTES:**  
CLASS OF CONCRETE  
FOOTINGS 20 MPa  
REMAINDER 30 MPa  
REINFORCING STEEL GRADE  
GRADE 400  
COATED BARS HAVE A SUFFIX 'C'  
COVER TO REINFORCING STEEL  
FOOTINGS & PIER COLUMNS 100 mm  
ABUTMENTS & WINGWALLS 101 mm  
DECK 75 mm TOP 40 mm BOT.  
REMAINDER AS SHOWN ON DRAWINGS  
**CONSTRUCTION NOTES:**  
THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF 3 mm.

- LIST OF DRAWINGS**
- 1 GENERAL ARRANGEMENT
  - 2 CONSTRUCTION STAGES
  - 3 RAIL PROTECTION & CLEARANCE
  - 4 SITE PLAN & BOREHOLE LOCATION DATA
  - 5 FOUNDATION LAYOUT STAGE II
  - 6 FOUNDATION LAYOUT STAGE III
  - 7 ROADWAY PROTECTION DETAILS
  - 8 NORTH ABUTMENT STAGE II
  - 9 SOUTH ABUTMENT STAGE II
  - 10 NORTH ABUTMENT STAGE III
  - 11 SOUTH ABUTMENT STAGE III
  - 12 WINGWALLS STAGE II
  - 13 WINGWALLS STAGE III
  - 14 PIERS STAGE II
  - 15 PIERS STAGE III
  - 16 BEARING DETAILS
  - 17 GIRDER DETAILS I
  - 18 GIRDER DETAILS II
  - 19 GIRDER DETAILS III
  - 20 DECK REINFORCING & SCREED ELEV. STAGE II
  - 21 DECK REINFORCING & SCREED ELEV. STAGE III NBL
  - 22 DECK REINFORCING & SCREED ELEV. STAGE III SBL
  - 23 BARRIER WALLS
  - 24 APPROACH SLABS
  - 25 AS CONSTRUCTED ELEV. & DIMEN.
  - 26 BRIDGE DATE & SITE NUMBER DATA
  - 27 STANDARDS
  - 28 STANDARDS
  - 29 ELECTRICAL EMBEDDED WORK
  - 30 ELECTRICAL STANDARDS
  - 31 TO 44 EXISTING Q.E.W. STRUCTURE DRAWINGS

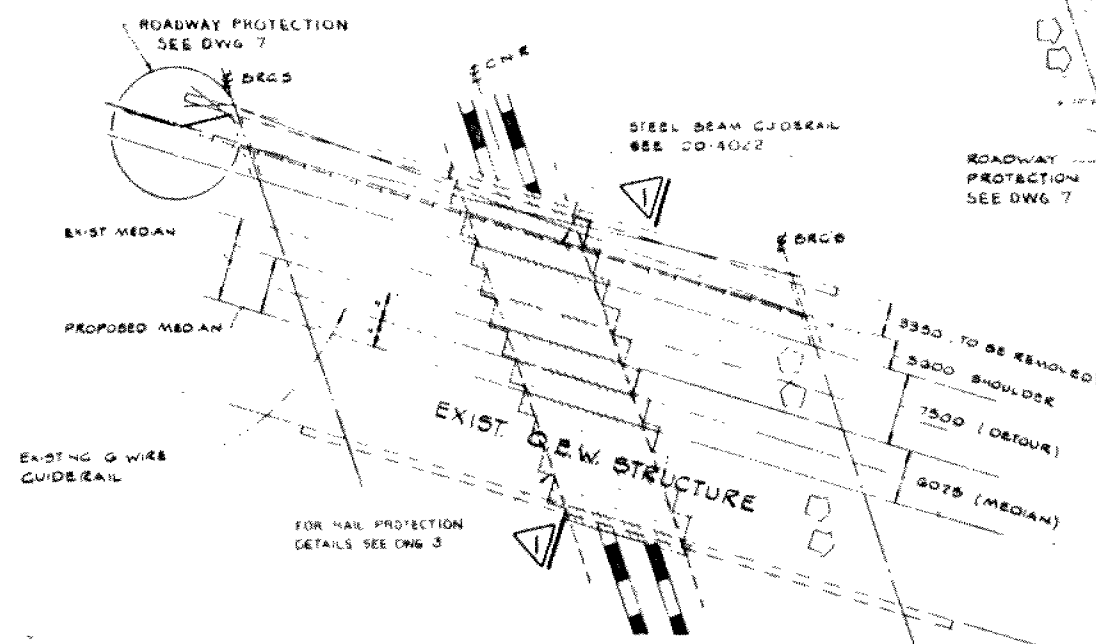


DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN	J.L.	CHECK R.S. LOADING CHBDC A-79 DATE SEPT 91
DRAWING	B.J.A.	CHECK R.S. SITE No 10-135A DWG 1

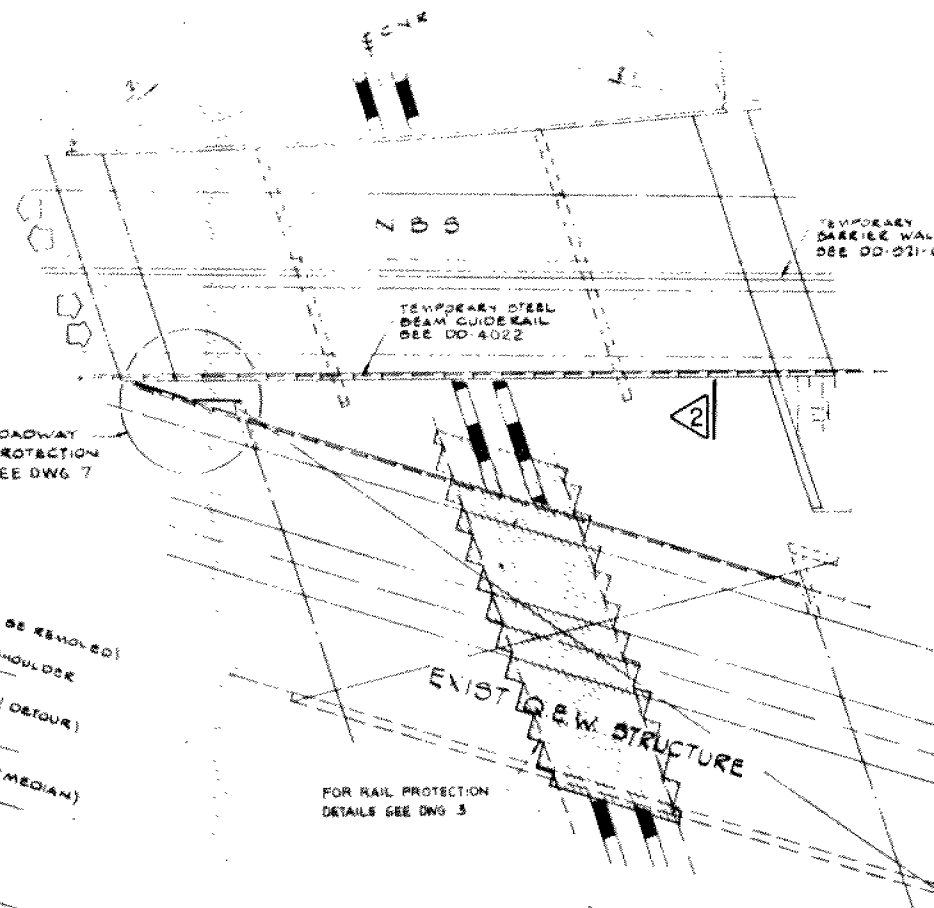


**SECTION 2**  
SCALE 1:40



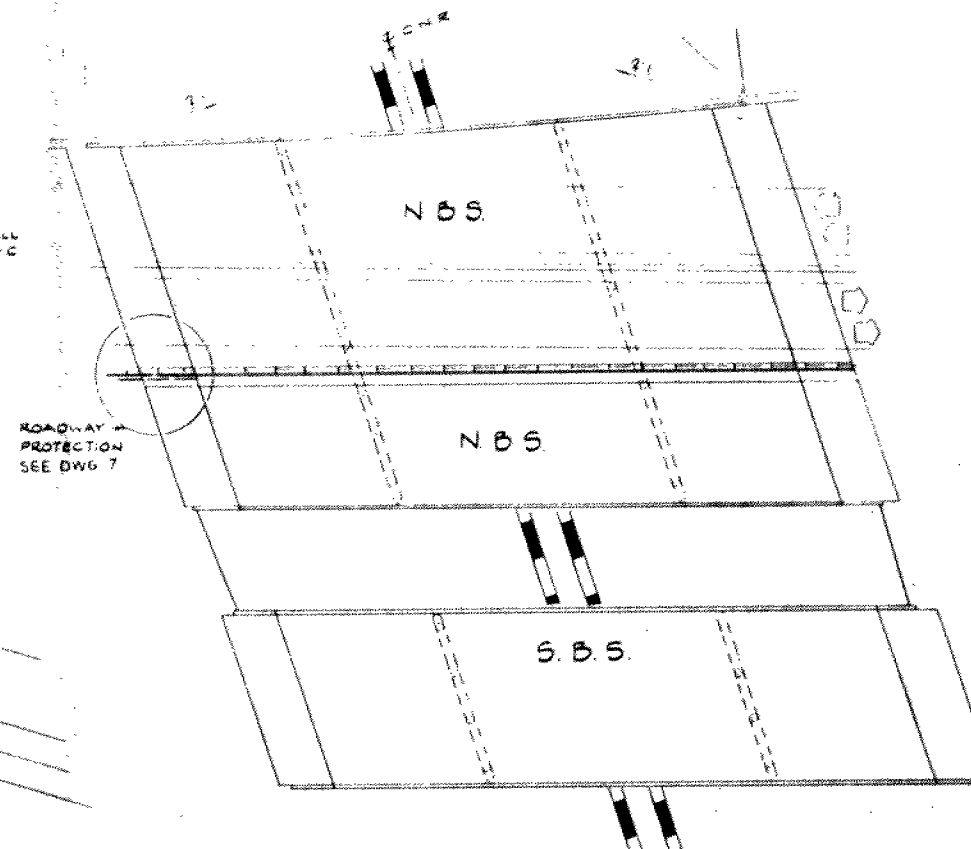
**STAGE I**

- DETOUR NORTH BOUND LANES ON EXISTING STRUCTURE
- INSTALL TEMPORARY GUIDERAIL ON EXISTING STRUCTURE AND INSTALL ROADWAY PROTECTION
- REMOVE PART OF EXISTING STRUCTURE DECK & NORTH EAST WINGWALL



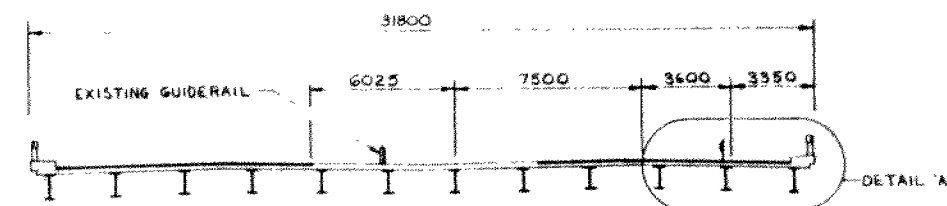
**STAGE II**

- CONSTRUCT EAST PORTION OF NORTH BOUND STRUCTURE INCLUDING APPROACHES
- UPON COMPLETION, DETOUR NORTH BOUND & SOUTH BOUND G.W. ONTO NORTH BOUND STRUCTURE
- REMOVE REMAINDER OF EXISTING STRUCTURE

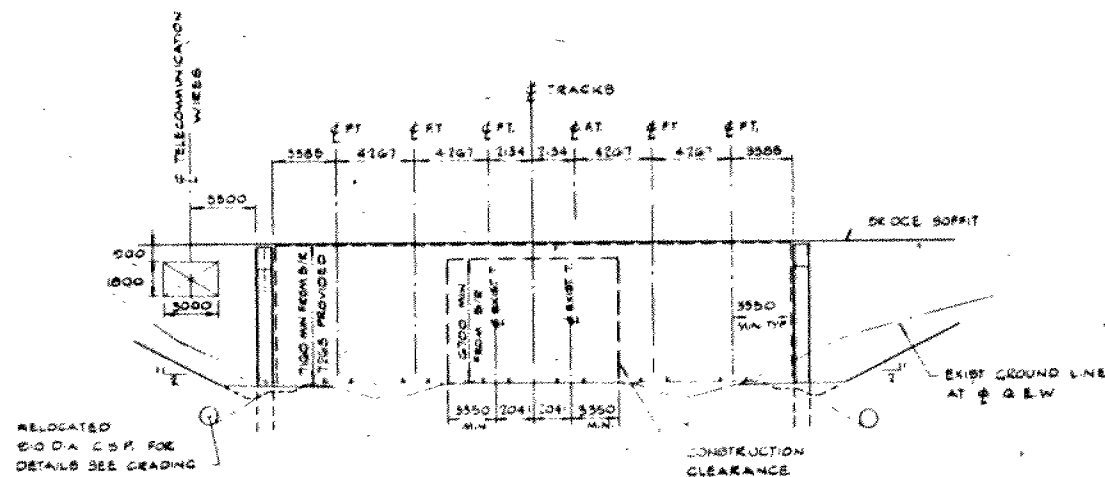


**STAGE III**

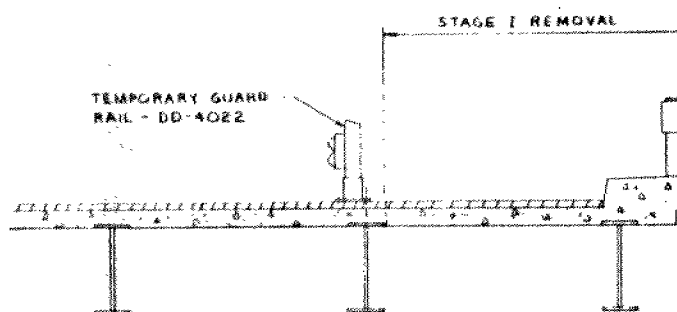
- CONSTRUCT SOUTH BOUND STRUCTURE AND WEST PORTION OF NORTH BOUND STRUCTURE



**SECTION 1**  
SCALE 1:150



**CLEARANCE DIAGRAM**  
SCALE 1:200



**DETAIL 'A'**  
SCALE 1:40

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

DIST. 4  
CONT No  
WP No 83-74-26

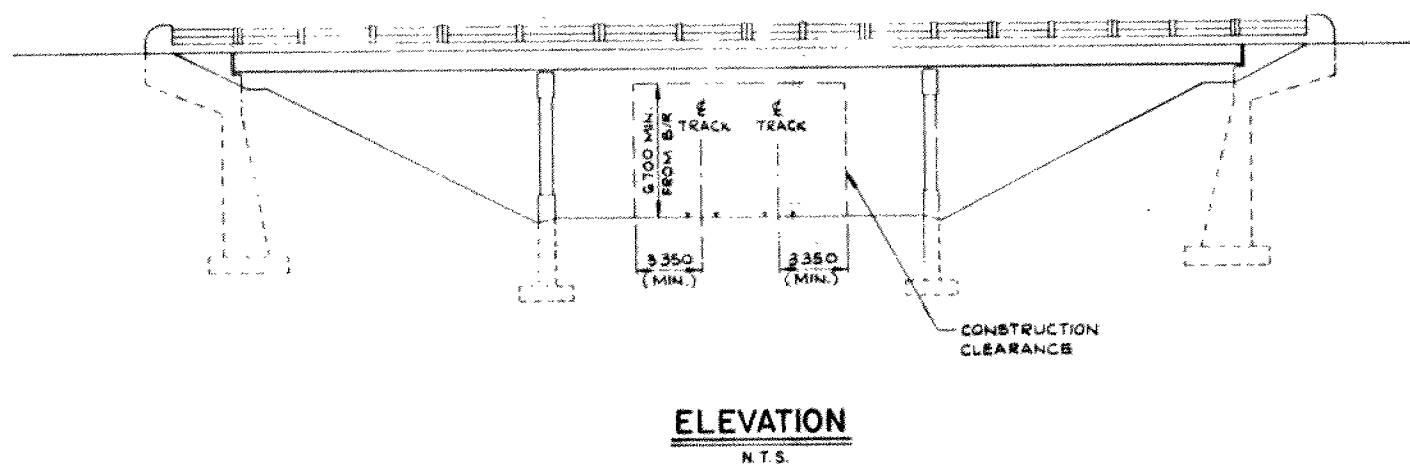
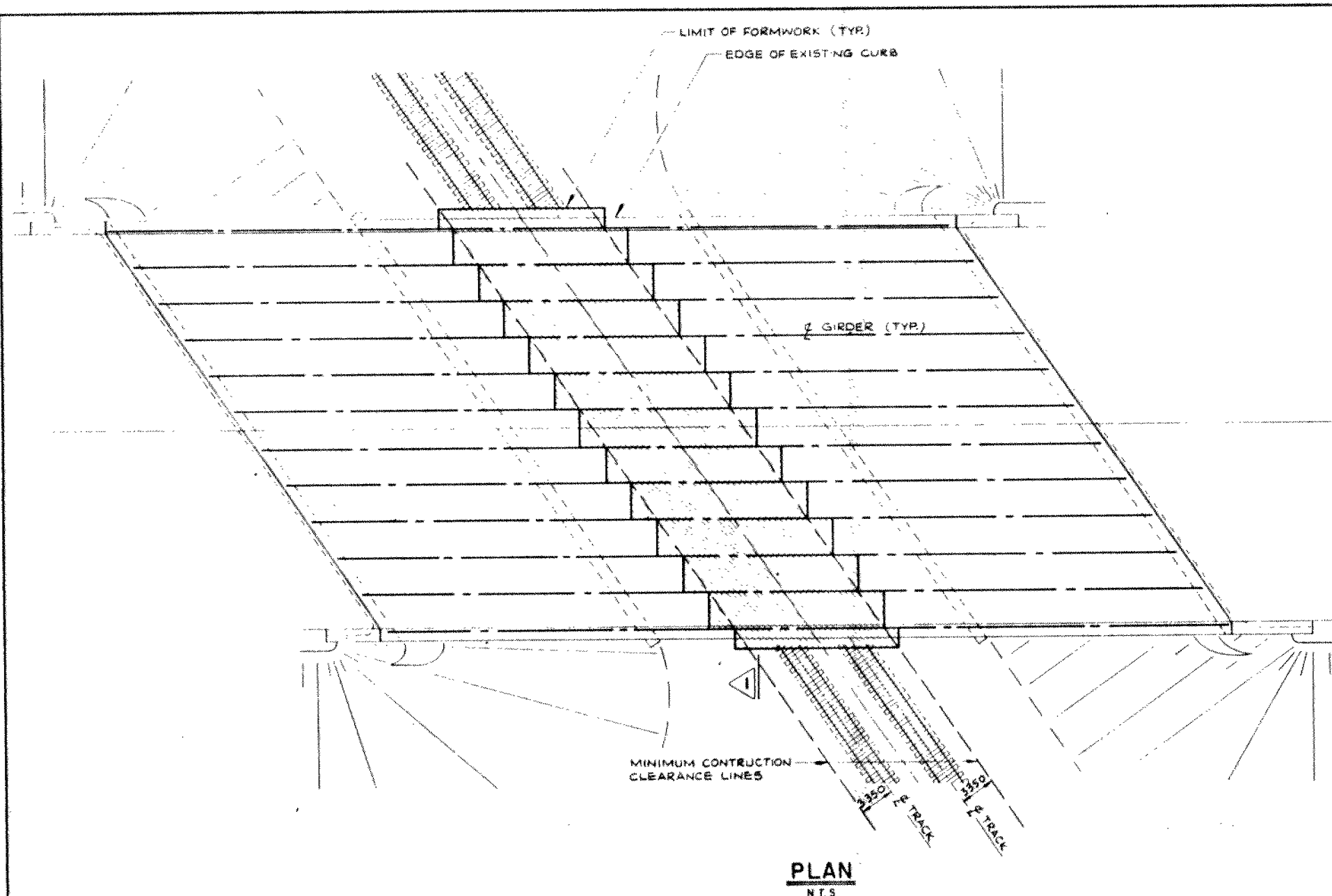
C.N.R. OVERHEAD  
AT Q.E.W.  
CONSTRUCTION STAGES

SHEET

**MCCORMICK RANKIN**  
CONSULTING ENGINEERS



REVISIONS	DATE	BY	REVISION	DESCRIPTION
DESIGN	J.L.	CHECK	R.S.	LOADING OHBDC-A-79 DATE SEPT 83
DRAWING	B.J.A.	CHECK	R.S.	SITE No 10-135A DWS 2



**METRIC**

DIMENSIONS ARE IN MILLIMETRES  
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AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES.

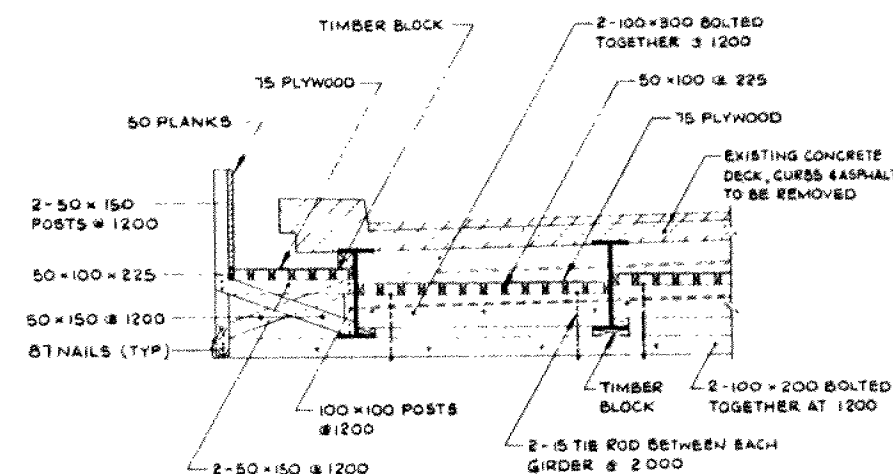
DIST. 4  
CONT No  
WP No 83-74-26

C.N.R. OVERHEAD  
AT O.E.W.  
RAIL PROTECTION & CLEARANCE



SHEET

**MCCORMICK RANKIN**  
CONSULTING ENGINEERS



**NOTE**

1 RAIL PROTECTION SHALL BE STAGED IN ACCORDANCE WITH THE CONSTRUCTION STAGES SHOWN ON DWG. 2



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	T.W.	CHECK	J.L.
DRAWING	J.W.B.	CHECK	R.S.
LOADING OHBDC-A-74 DATE SEPT 81			
SITE No 10-136A DWG 5			





# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - II



Ministry of  
Transportation and  
Communications

INDEX

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3	Soil Classification System
4- 52	Foundation Investigation Reports For
<i>30M 5-129</i> --	W.P. 83-74-26, Site: 10-135A C.N.R. Overhead at Q.E.W.
	W.P. 83-74-27, Site: 10-135B C.N.R. Overhead at Ramp 403 E/W
<i>30M 5-128</i>	W.P. 83-74-24, Site: 10 Rambo-Hager Creek Culvert Extension
	and
<i>30M 5-132</i> --	W.P. 83-74-25, Site: 10-319 Fairview Street - Q.E.W. Overpass



## EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

# EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)					GRP SYMB	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA		
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μm "LARGEST" PARTICLE IS 3 TIMES "THE SMALLEST" PARTICLE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE			GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESES.	DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm). COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:  LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GM, GC, SM, SC  BORDERLINE CASES REQ. USE OF DUAL SYMBOLS	
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES			
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES			
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES			
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES			SW	WELL GRADED SANDS, GRAVELLY SANDS: LITTLE OR NO FINES			FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			SP	POORLY GRADED SANDS, GRAVELLY SANDS: LITTLE OR NO FINES			
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES			
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES			
						IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μm				
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μm "LARGEST" PARTICLE IS ABOUT "THE SMALLEST" PARTICLE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR	GIVE TYPE, NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES	FOR UNDISTURBED SOILS AND INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, POSITION & DRAINAGE CONDITIONS	
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM	CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS			
			SLIGHT TO MEDIUM	SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS			
		LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MH	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS			
			HIGH	NONE	MEDIUM TO HIGH	CH	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY			
			SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	OH	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY			
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS			
			HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS			
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY			
			READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE				PE			PEAT & OTHER HIGHLY ORGANIC SOILS
			HIGHLY ORGANIC SOILS							

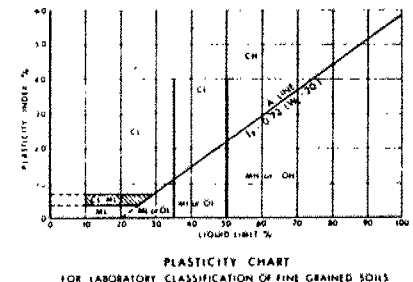
$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4	
$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3	
NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
ATTERBERG LIMITS BELOW A-LINE, OR $I_p$ LESS THAN 4	ABOVE A-LINE WITH $I_p$ BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH $I_p$ GREATER THAN 7	
$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6	
$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3	
NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
ATTERBERG LIMITS BELOW A-LINE OR $I_p$ LESS THAN 4	ABOVE A-LINE WITH $I_p$ BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH $I_p$ GREATER THAN 7	

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

PLASTICITY INDEX %

LIQUID LIMIT %

PLASTICITY CHART  
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS



BINARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER.

## FOUNDATION INVESTIGATION REPORT

FOR

W.P. 83-74-26, Site: 10-135A  
C.N.R. Overhead at Q.E.W.

W.P. 83-74-27, Site: 10-135B  
C.N.R. Overhead at Ramp 403 E/W

W.P. 83-74-24, Site: 10  
Rambo-Hager Creek Culvert Extension

District 4, Hamilton

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1. INTRODUCTION

Peto MacCallum Ltd. was authorized by The Ministry of Transportation and Communications, Agreement No. 4242-9080-106 to carry out a geotechnical investigation at the sites for the proposed C.N.R. overhead structures at Q.E.W. and Hwy. 403W - Fairview Street Ramp and the Rambo-Hager Creek Culvert Extension in Burlington, Ontario.

## 2. FIELD WORK

A total of eight (8) boreholes were initially scheduled at Sites 10-135A and B, for the proposed grade separation structures. Three (3) of these holes were scheduled to be drilled through the approach embankment from above the present bridge structure. However, due to spacial limitations as well as traffic and safety constraints, which would require closure of the inside Q.E.W. lanes, two (2) of these boreholes were relocated to natural grade under the existing bridge beside the C.N.R. tracks and the other deleted. Consequently, no information is available concerning the nature and engineering properties of the approach embankment fill. Therefore, a total of seven (7) boreholes, boreholes 1 to 7, were drilled at the site for the C.N.R./Q.E.W. and C.N.R./Ramp 403 E/W grade separation structures.

Two (2) holes, boreholes 8 and 9, were drilled at the site for the Rambo-Hager Creek culvert extension.

The field work was carried out during the period of November 18 to 22, 1980 and January 7 and 8, 1981. The holes were drilled at the locations shown on (Sheets No. 228, 257 and 189 of the contract drawings).\* The boreholes were extended to a depth of 6.55 to 17.34 m below existing grade, using a CME-55 drillrig equipped with continuous flight solid stem and hollow stem augers and rock coring capabilities, supplied and operated by a specialist drilling contractor.

\* Added by M.T.C.

Representative samples of the overburden were obtained at frequent intervals, using a conventional split spoon sampler in conjunction with standard penetration tests. Relatively undisturbed samples of the cohesive soils encountered at the site were recovered in thin walled shelly tubes. The undrained shear strength of the silty clay till was assessed by conducting pocket penetrometer tests on the recovered samples. BXL core samples of the bedrock at the bridge site were recovered.

The groundwater conditions in the open boreholes were closely monitored during and on completion of drilling. Two (2) piezometers at the proposed C.N.R./Q.E.W. bridge site, and one (1) piezometer at the proposed culvert extension site were installed and monitored to determine the stabilized groundwater conditions. Details of the piezometer installations are described on the appended, Record of Borehole No's. 1, 5 and 8.

The field work was supervised throughout by a member of our engineering staff who directed the drilling and sampling operations, documented the soil and bedrock stratigraphy encountered, monitored the groundwater condition in the open boreholes, detailed the piezometer installations and cared for the recovered samples.

The location and ground surface elevation at the boreholes were established in the field by Peto MacCallum Ltd. The following geodetic benchmarks, provided by The Ministry of Transportation and Communications, were used as reference for vertical control:

BM: Cut cross on south concrete retaining wall of culvert under C.N.R. tracks. 112.0 m left of STATION 9+913.8. Approximately 100 m east of Q.E.W./C.N.R. bridge. Elevation: 99.986.

BM: Nail and washer in east root of 0.35 m Ø ash tree. 10.0 m left of STATION 11+190.0. Elevation: 87.746.

### 3. LABORATORY TESTING PROGRAMME

All of the recovered samples were brought to our laboratory for detailed visual examination and routine testing to confirm field visual classifications. In addition, the following tests were conducted:

Moisture Content on all samples

Four (4) - Atterberg Limits, Table I

Three (3) - Unconfined Triaxial Compression  
Table II

Two (2) - pH and Sulphate Content of Soil  
Samples, Table III

One (1) - pH and Sulphate Content of Ground-  
water Sample, Table IV

Five (5) - Grain Size Analysis, Figure No's.  
1 to 3.



#### 4. SITE DESCRIPTION AND GEOLOGY

The site for the proposed grade separation structures and culvert extension are generally flat and fairly well drained. A light vegetative cover of small bushes and grass has developed over the surface.

The development areas are located near the northern edge of the Lake Iroquois Plain, which is typified by a fine to silty fine sand veneer.

Bedrock consists of red Queenston Shale. Drift thickness is generally less than 15 m thick and comprises generally glacial till deposits. Very often, the basal portion of the overburden is distinctly red in colour from large amounts of incorporated Queenston Shale.

## 5. SUBSURFACE SOILS AND GROUNDWATER CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the field work including soil and rock classifications, inferred stratigraphy, standard penetration "N" values, the results of field and laboratory undrained shear strength testing, groundwater observations in the open boreholes and installed piezometers, laboratory moisture content determinations and Atterberg Limit test results. (Refer also to Sheets No. 228, 257 and 189 of the contract drawings.)\*

The stratigraphy at the bridge site generally comprises relatively thin surficial fills, topsoil and sand layers, a major hard silty clay till deposit extending to about 8.2 to 10.2 m below grade underlain by very dense sand/silt till overlying Queenston Shale, at approximately 11.6 to 13.6 m depth.

At the Rambo-Hager Creek extension site, the stratigraphy is generally similar, except the major silty clay till deposit is interlayered with very dense sandy silt till.

A summarized account of the major stratigraphic units is presented below:

\* Added by M.T.C.

- 5.1\* W.P. 83-74-26, Site: 10-135A  
C.N.R. Overhead at Q.E.W. (Sheet No. 228 of the contract drawings)  
W.P. 83-74-27, Site: 10-135B  
C.N.R. Overhead at Ramp 403E/W (Sheet No. 257 of the contract drawings)

5.1.1 FILL AND TOPSOIL

A 1.37 m thick fill layer generally comprising firm clayey silt and silty clay was encountered near the C.N.R. tracks in boreholes 2 and 6. Local 300 mm thick silty clay fill and mixed fill deposits were noted at the surface in boreholes 3 and 7.

A topsoil layer, 130 to 300 mm in thickness, was encountered surficially in boreholes 4 and 5 and under the fill layer in borehole 7.

5.1.2 SAND

A loose to compact silty sand unit was contacted generally over the site. This unit was encountered surficially in borehole 1, and under the topsoil or fill layers in boreholes 2, 3, 6 and 7. The layer is 0.33 to 1.38 m thick and was penetrated at 0.84 to 2.07 m below grade, near elevation 96.51 to 97.78.

Moisture content in the sand varies between about 8 to 18%.

\* Added by M.T.C.

### 5.1.3 SILTY CLAY TILL

A major, generally hard, heavily over-consolidated silty clay till deposit was contacted in all of the testholes under the topsoil or sand layer some 0.13 to 2.07 m below grade near elevation 96.51 to 98.54. Two typical gradation curves are shown in Figure No. 1, appended.

The moisture content in the clay varies between about 7 to 18%, but typically ranges between approximately 11 to 14%. The liquid and plastic limits of two representative samples are 24 and 32, and 15 and 16 respectively, indicating a low plasticity.

The major clay till unit was not penetrated in boreholes 2, 3, 4 and 6 at the termination depth of 6.55 m, but was penetrated in boreholes 1, 5 and 7 at the 8.23 to 10.21 m depth, elevation 88.18 on the west side of the bridge and 90.44 on the east side.

### 5.1.4 SANDY SILT TILL AND SILTY SAND TILL

Dense to very dense reddish brown sandy silt till and silty sand till (typical gradation, Figure No. 2), were encountered below the major clay till unit in boreholes 1, 5 and 7. In the west portion of the site, the granular till unit was contacted at about 10.1 and 10.2 m below grade, near elevation 88.2 and 88.4, in boreholes 1 and 7 respectively, while in the east section, borehole 5, contact was at about the 8.2 m depth

at approximate elevation 90.4. The moisture content in about 8 to 11%. This unit was not penetrated in borehole 7.

#### 5.1.5 BEDROCK

Red Queenston Shale bedrock was contacted under the sand/silt till unit in the two deep boreholes 1 and 5 at 13.56 and 11.58 m, elevation 84.68 and 87.09 respectively. Based on detailed visual examination of the recovered core samples, the top approximately 1.8 and 0.9 m of the shale bedrock in boreholes 1 and 5 respectively, is weathered, becoming sound below this depth. The shale is generally of poor quality in the weathered zone, and of fair to good quality in the sound zone.

#### 5.1.6 GROUNDWATER CONDITIONS

The groundwater conditions observed in the testholes and piezometers indicate a variable groundwater regime at the site. Groundwater which was encountered in the surficial pervious materials in the holes drilled within the railway right-of-way, boreholes 2 and 6, is considered to be perched.

Boreholes 1, 3 and 4, which were terminated in the silty clay till layer remained dry during and upon completion of drilling. The piezometer installed in borehole 1, has also remained dry.

Groundwater was encountered in boreholes 1A, 5, 5A and 7, which contacted the basal sand/silt till. The piezometer installed in the basal till in borehole 5, shows that the stabilized groundwater level at the time of the investigation is at elevation 94.01.

5.2\* W.P. 83-74-24, Site: 10  
Rambo-Hager Creek Culvert Extension (Sheet No. 189 of the  
contract drawings)

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#### 5.2.1 SUBSOIL CONDITIONS

The surficial stratigraphy at this site comprises a thin veneer of silty clay fill (borehole 9) and compact silty sand to 1.37 and 1.52 m depth (boreholes 8 and 9 respectively). Underlying the sand layer, interlayered generally hard silty clay till (typical gradation shown on Figure No. 3, appended), and very dense sandy silt till units were encountered and was penetrated at the 7.01 m depth, near elevation 81.39 and 81.29 (boreholes 8 and 9, respectively) where layered silt and weathered shale and shale bedrock were contacted.

#### 5.2.2 GROUNDWATER CONDITIONS

Borehole 9 was open and dry at the conclusion of drilling, while the groundwater level in borehole 8 at the conclusion of drilling was near elevation 81.3. The piezometric level in borehole 8 is stabilizing near elevation 85.95.

\* Added by M.T.C.

Note: The preceding contract report is a copy of the factual data relating to subsurface conditions prepared for The Ministry of Transportation and Communications by Peto MacCallum Ltd., for the above-noted projects.

Pavement & Foundation Design Section

83 04 12



## APPENDIX

# RECORD OF BOREHOLE No 1 8-1A

Metric

W P 83-74-26' & 27' LOCATION Co-ords. 4,798,674 N; 278,215 E ORIGINATED BY M.R.  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Rock Core COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 & January 7, 1981 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
98.24																	
0.00	Sand, fine to medium, silty, trace of clay.		1	SS	13		98										
96.87	Compact Brown		2	SS	27												
1.37	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		3	TW	PH		96										
	Hard Brown Greyish Brown		4	SS	36												
			5	SS	29		94										
			6	TW	PH												
			7	SS	26												
			8	SS	55		92										
			9	SS	60		90										
			10	SS	56												
88.18							88										
10.00	Sand, fine to coarse, silty, some gravel. (Glacial Till)		11	SS	58												
	Very dense reddish Brown		12	SS	60/80 mm		86										
84.68																	
13.56	Bedrock Shale		13	SS	100/80 mm		84										
	Red Weathered Sound		14	RC	100%												R.Q.D.=18%
			15	RC	100%		82										R.Q.D.=70%
30.90																	
17.34	End of Borehole																
Notes:			Borehole 1A														
Borehole 1			BH 1A was drilled adjacent to BH 1 on Jan. 7/81 and was terminated at 17.34 m. 0 to 7.52 m unsampled 1 hour after SS 13. Water at elevation 92.69.														
Upon completion of augering no cave, no water in open borehole.																	
Piezometer installed at elevation 92.14 Seal at elev. 95.8																	
Water																	
Date Elevation																	
Nov. 22/80 Dry																	
Nov. 24/80 Dry																	
Dec. 1/80 Dry																	

+3, x5; Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 2

Metric

W P 83-74-26' & 27' LOCATION Co-ords. 4,798,730 N; 278,248 E. ORIGINATED BY W.J.  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 22, 1980 CHECKED BY *AK*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
99.35																	
100	Fill-sandy gravel.																
97.98	Fill-clayey silt, trace of sand & gravel, occ. shale fragments. Reddish Brown		1	SS	7									○			
1.37	Firm		2	SS	5										○		
97.28	Sand, fine to coarse		3	SS	35										○		
2.07	trace silt & gravel		4	SS	39										○		
	Loose Dark Gray		5	SS	36										○		
	Silty clay, some sand, trace of gravel, occ. silt inclusions		6	SS	38										○		
	(Glacial Till)		7	SS	49										○		
	Hard Brown Grayish Brown		8	SS	40										○		
92.80	red weathered shale layers and fragments below 5.2 m																
6.55	End of Borehole																
<p>Note:</p> <p>Upon completion of augering cave at elevation 97.83, water at elevation 97.95.</p> <p>Stabilised ground- water level not established.</p>																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15 ± 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 3

Metric

W P 83-74-26 & 27 - LOCATION Co-ords. 4,798,730 N; 278,285 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
98.19	Fill-silty clay, trace of sand, fine to coarse silty, trace of clay & gravel. Brown		1	SS	14												
97.89	Compact		2	SS	19												
1.68	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		3	SS	34												
	V. stiff to Hard		4	SS	33												
	Brown		5	SS	25												
	Greyish		6	SS	37												
	Brown		7	SS	41												
	occ. red weathered shale fragments below 3.7 m		8	SS	32												
91.64	End of Borehole																
6.55	Note: Upon completion of drilling no cave, no water in open borehole. Stabilised ground-water level not established.																

+3, x<sup>3</sup>. Numbers refer to  
Sensitivity

20  
15 ÷ 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 4

Metric

W P 83-74-26. & 27 LOCATION Co-ords. 4,798,764 N; 278,298 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 CHECKED BY JMK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
98.06																
97.76	Topsoil		1	SS	29											
300	Silty clay, sand, trace of gravel, occasional silt inclusions.  (Glacial Till) Hard Brown  Grayish Brown		2	SS	24											
			3	SS	30											
			4	TH	PH											
			5	SS	36											
			6	SS	31											
			7	SS	30											
91.51			8	SS	40											
6.55	End of Borehole															
	Note: Upon completion of augering no cave, no water in open borehole.  Stabilised ground- water level not established.															

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

# RECORD OF BOREHOLE No 5 & 5A

Metric

W P 83-74-26 & 27 LOCATION Co-ords 4,798,811 N; 278,285 E. ORIGINATED BY W.J.  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Rock Core COMPILED BY TLB  
DATUM Geodetic DATE November 22, 1980 & January 8, 1981 CHECKED BY *SK*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
98.67														
130	Topsoil		1	SS	21		98							
	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		2	SS	42									4 18 50 28
	Hard Brown		3	SS	33		96							
	Greyish Brown		4	SS	32									
			5	SS	35									
			6	SS	53		94							
			7	SS	52									6 22 47 25
			8	SS	48		92							
90.44			9	SS	65									
8.2	Sandy silt, some gravel, occ. cobble, trace of clay (Glacial Till)		10	SS	72/150 mm		90							
	Very Reddish Dense Brown		11	SS	88		88							28 28 40 4
87.09	occasional wet sand seams													*no recovery
11.58	Bedrock Shale		12	SS	100/25 mm									R.Q.D.=0%
	Weathered Red Sound		13	BXL Rec	100%		86							R.Q.D.=68%
			14	RC	100%									R.Q.D.=93%
			15	RC	92%		84							
83.28	End of Borehole													
15.39	Note: Borehole 5 BH 5 drilled on Nov. 22/80, was terminated at 11.13 m. After sample 10, borehole dry. Upon completion of augering cave at elevation 88.92 and water at elevation 90.07. Piezometer installed at elevation 88.92 Seal at elev. 93.79.  Date                      Water Elevation Nov. 22/80              93.79 Nov. 24/80              94.04 Dec. 1/80                94.01				Borehole 5A BH 5A was drilled adjacent to BH 5 on Jan. 8/81 and was terminated at 15.39 m. 0 to 12.19 m unsampled. After SS 12 water at elevation 89.83.									

+3, x5: Numbers refer to Sensitivity

20  
15 ÷ 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 6															Metric		
W P 83-74-26 & 27		LOCATION Co-ords. 4,798,760 N; 278,259 E.										ORIGINATED BY NJ					
DIST 4 HWY Q.E.W.		BOREHOLE TYPE Solid Stem Auger										COMPILED BY TLB					
DATUM Geodetic		DATE November 22, 1980										CHECKED BY <i>MLK</i>					
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
99.05	Fill-silty clay, some sand & gravel, pockets of reddish-brown soil. Soft to firm.		1	SS	4		98										
97.68	1.37 Sand, fine to coarse, silty, some gravel, trace of clay.		2	SS	16												
1.83	1.83 Compact Brown Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		3	SS	41												
			4	SS	50		96										
			5	SS	42												
			6	SS	44		94										
			7	SS	40												
92.50	Hard Greyish Brown occ. red weathered shale fragments below 5.2 m		8	SS	58												
6.55	End of Borehole Note: After sample 2, water at elevation 97.58. Upon completion of augering no cave, water at elevation 96.00 in open borehole.  One hour later water at elevation 98.26.  Stabilized ground-water level not established.																



# RECORD OF BOREHOLE No 7

Metric

W P 83-74-26. & 27. LOCATION Co-ords. 4,798,729 N; 278,212 E. ORIGINATED BY WJ  
DIST 4 HWY Q.E.W BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 20, 1980 CHECKED BY *AK*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
98.62	Fill-mixed silty clay, sand & gravel some organics. Br. and reddish brown.		1	SS	14								
	Topsoil		2	SS	13								
	Silty fine sand, trace of gravel. Loose to compact Brown		3	TW	PH								
	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		4	SS	30								
	Very stiff Brown to hard Greyish Brown		5	SS	26								
			6	SS	30								
			7	SS	43								
			8	SS	50								
	occasional red weathered shale fragments below 3.66 m		9	SS	48								
			10	SS	70								
98.41	Sand, fine to coarse silty, some gravel with coarse sand seams. (Glacial Till)												
10.21	Dense Reddish Br.												
87.49			11	SS	40								
11.13	End of Borehole												
<p><b>Note:</b> After sample 10, no water in open borehole. Upon completion of augering, cave at elevation 88.26, and water at elevation 92.98. Nov. 22, 1980 water at elevation 93.18.</p>													

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

# RECORD OF BOREHOLE No 8

Metric

W P 83-74-24 LOCATION Co-ords. 4,797,767 N; 279,085 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 19, 1980 CHECKED BY RK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60	80	100		
88.40	Silty fine sand, trace of clay.		1	SS	27														
87.03	Compact Brown Silty clay, some sand, trace of gravel		2	SS	26														
1.37	(Glacial Till)																		
85.76	V. silty clay, trace of hard brown		3	SS	55														
2.64	Sandy silt, some gravel, trace of clay.		4	SS	68														
84.74	(Glacial Till)																		
3.66	V. Dense Reddish Silty clay, some sand, trace of gravel		5	SS	54														
83.22	(Glacial Till)																		
5.18	Hard Grayish Brown Silt, trace of fine sand & clay.		6	SS	44														
82.61	(Glacial Till)																		
5.79	V. Dense Gray Silt, some fine sand & gravel, trace of clay.		7	SS	81/230 mm														
81.39	(Glacial Till)																		
7.01	V. Dense Reddish Brown		8	SS	50/130 mm														
80.68	(Glacial Till)																		
7.72	Layered silt and weathered shale. Brown V. Dense and Red		9	SS	50/130 mm														
	End of Borehole																		
<p>Note:</p> <p>Upon completion of augering water at elevation 81.27 inside hollow stem augers.</p> <p>Piezometer installed at elevation 80.78 Seal at elev. 81.70</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Water Elevation</th> </tr> </thead> <tbody> <tr> <td>Nov. 24/80</td> <td>85.95</td> </tr> <tr> <td>Dec. 1/80</td> <td>85.95</td> </tr> </tbody> </table>														Date	Water Elevation	Nov. 24/80	85.95	Dec. 1/80	85.95
Date	Water Elevation																		
Nov. 24/80	85.95																		
Dec. 1/80	85.95																		

# RECORD OF BOREHOLE No 9

Metric

W P 83-74-24 LOCATION Co-ords. 4,797,740 N; 279,122 E. ORIGINATED BY MR  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
 DATUM Geodetic DATE November 19, 1980 CHECKED BY JK

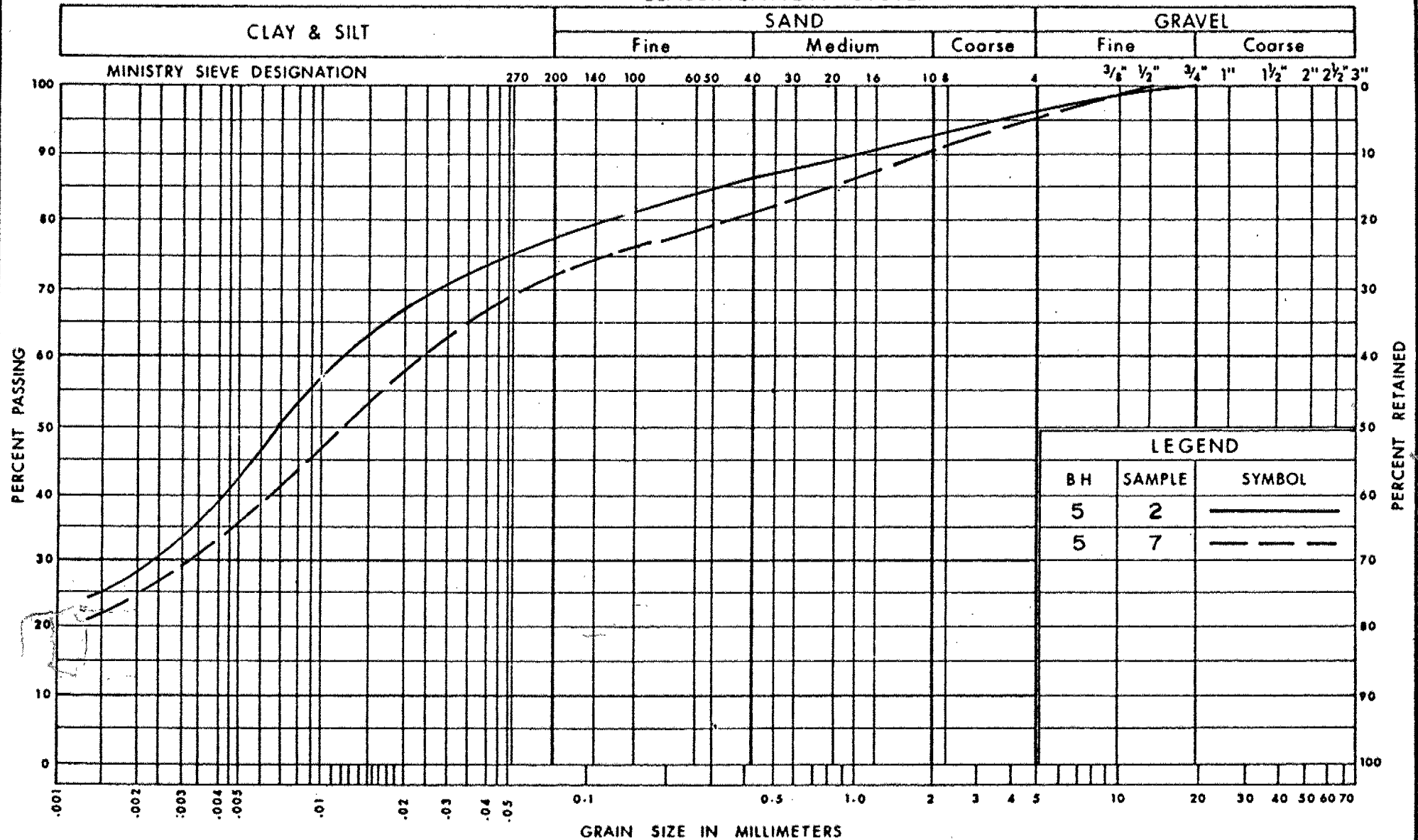
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
88.30	Fill-silty clay, trace of clay																
300	Silty fine sand, trace of clay		1	SS	11												
86.78	Compact Brown Silty clay, some sand, trace of gravel (Glacial Till)		2	SS	21												
1.52	Stiff Brown to to hard Greyish Br		3	SS	41												
85.40	Sandy silt, trace of clay & gravel (Glacial Till)		4	SS	62												
2.90	Dense Reddish Br		5	SS	57												
84.64	Silty clay, some sand, trace of gravel (Glacial Till)		6	SS	82												
3.66	Hard Reddish Br		7	SS	150 mm												
81.29	Shale Bedrock		8	SS	50/0 mm												
7.01	Weathered Red		9	SS	50/0 mm												
79.13	End of Borehole																
9.17	<p>Note:</p> <p>Upon completion of augering no cave, no water in open borehole.</p> <p>Stabilized ground- water level not established.</p>																

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## UNIFIED SOIL CLASSIFICATION SYSTEM



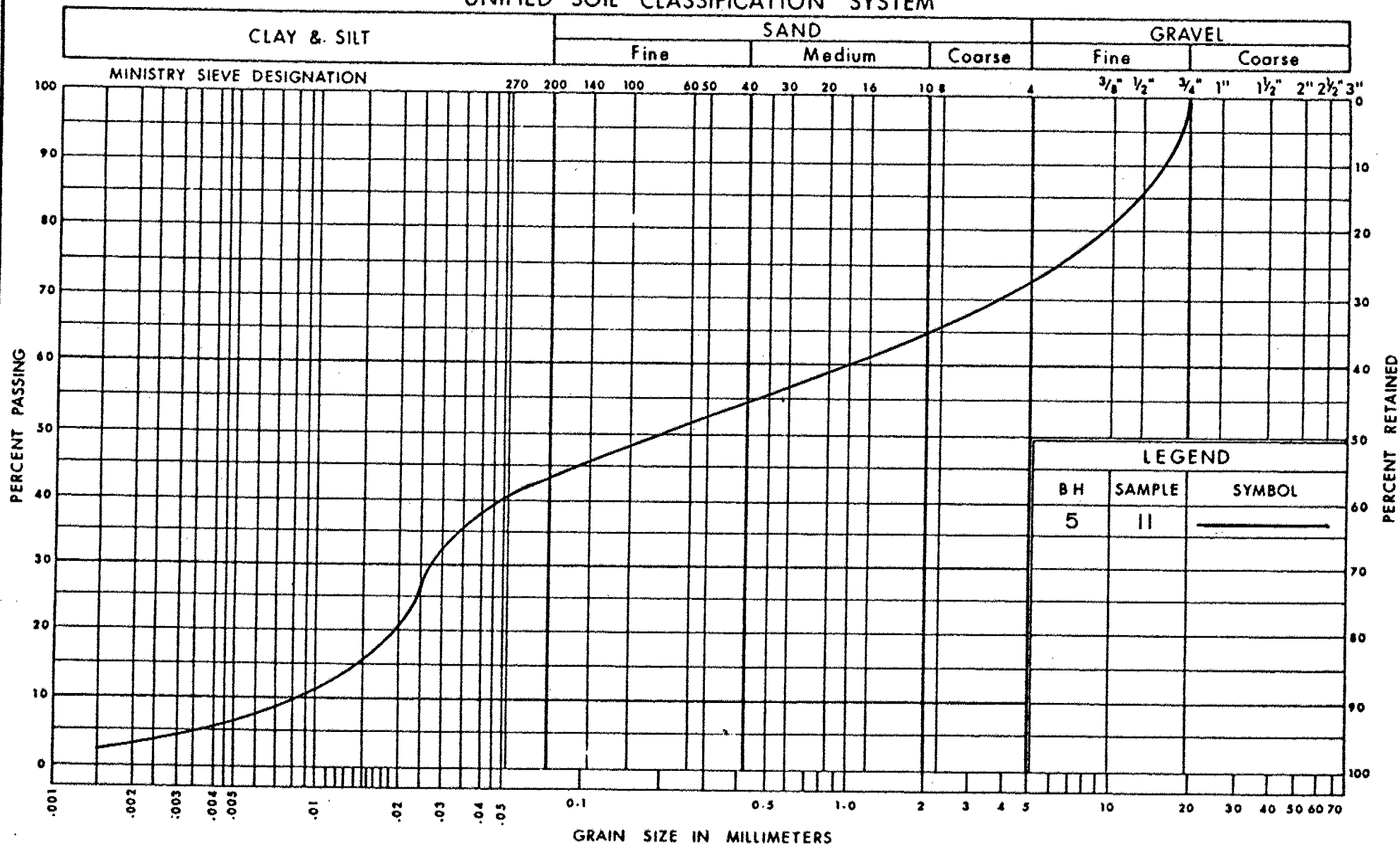
Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY**  
SOME SAND, TRACE OF GRAVEL

FIG No 1

W P 83-74-26 &amp; 27

## UNIFIED SOIL CLASSIFICATION SYSTEM



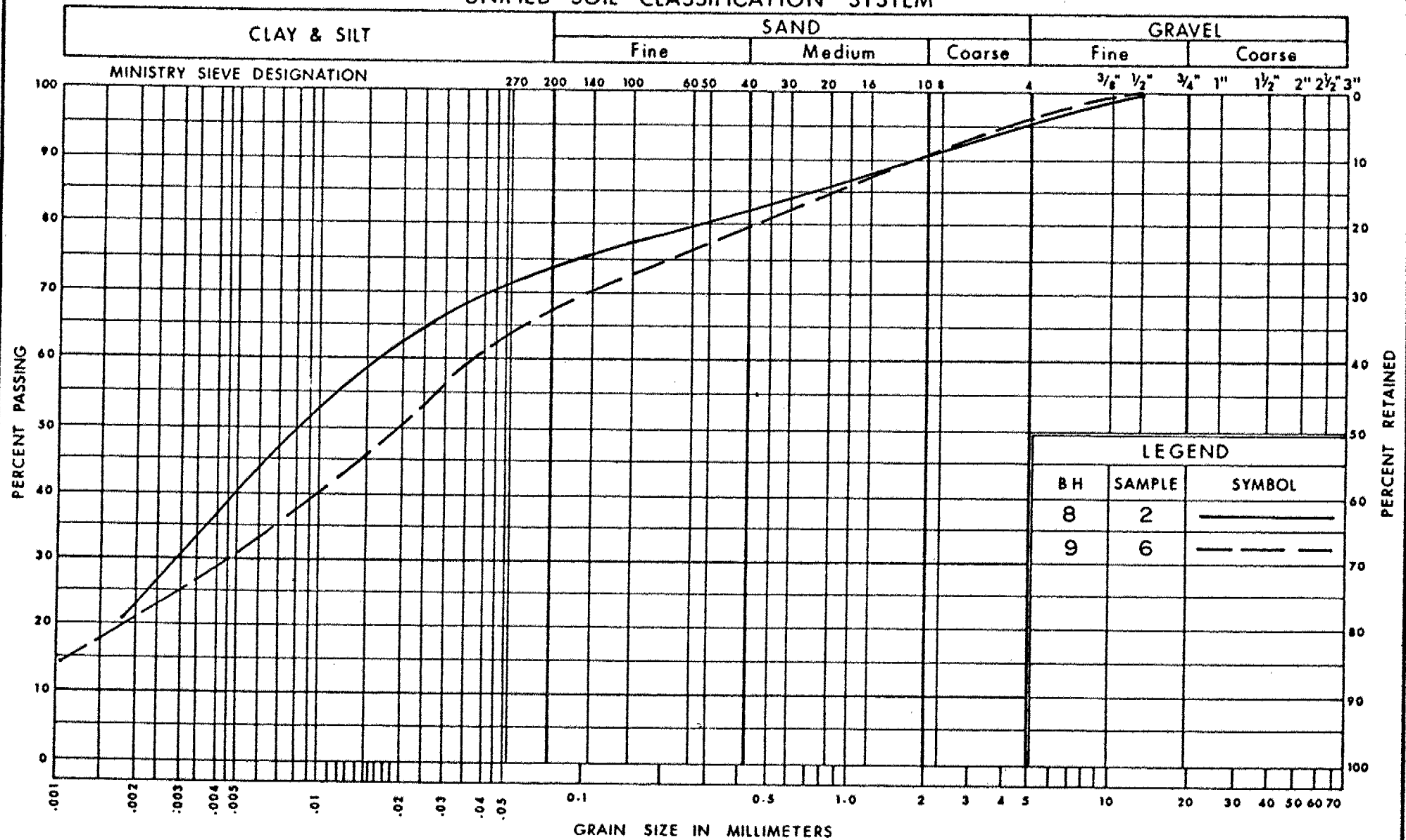
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SANDY SILT  
SOME GRAVEL, TRACE OF CLAY

FIG No 2

W P 83-74-26 127

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY**  
SOME SAND, TRACE OF GRAVEL

FIG No 3

W P 83-74-24

TABLE I

ATTERBERG LIMIT TEST RESULTS

PROPOSED C.N.R. OVPFHEADS AT Q.E.W. AND HWY 403W - FAIRVIEW STREET RAMP  
 RAMBO-HAGER CREEK CULVERT EXTENSION  
 BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>SAMPLE NO.</u>	<u>DEPTH (m)</u>	<u>NATURAL WATER CONTENT (w) %</u>	<u>LIQUID LIMIT (<sup>w</sup>L)</u>	<u>PLASTIC LIMIT (<sup>w</sup>p)</u>	<u>PLASTICITY INDEX (<sup>I</sup>p)</u>	<u>REMARKS</u>
5	2	1.52 - 1.98	14.4	32	16	16	Silty Clay
5	7	5.33 - 5.79	11.3	24	15	9	Silty Clay
8	2	1.52 - 1.98	6.5	29	16	13	Silty Clay
9	6	4.57 - 5.03	11.9	25	13	12	Silty Clay



TABLE II  
LABORATORY UNCONFINED COMPRESSION TEST RESULTS

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

BOREHOLE NO.	SAMPLE NO.	DEPTH (m)	NATURAL WATER CONTENT	UNIT WEIGHT		VOID RATIO (e)	DEGREE OF SATURATION	FAILURE STRAIN ( $\epsilon_f$ ) (%)	SHEAR STRENGTH ( $\tau_f$ ) (kPa)	REMARKS
			(w) (%)	WET ( $\gamma$ ) (t/m <sup>3</sup> )	DRY ( $\gamma_d$ ) (t/m <sup>3</sup> )		( $S_r$ ) (%)			
1	6	4.57-5.03	11.7	2.23	2.00	0.35	90	4	160	Suspect sample disturbance.
4	4	3.05-3.51	14.3	2.18	1.91	0.41	93	11	290	
7	3	2.29-2.74	13.9	2.18	1.92	0.41	91	2.5	460	

JOB NO. 80F300

TABLE III  
pH VALUE AND SULPHATE CONTENT OF SOIL SAMPLES

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>SAMPLE NO.</u>	<u>DEPTH (m )</u>	<u>pH VALUE</u>	<u>SULPHATE CONTENT % as SO<sub>4</sub></u>	<u>RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE</u>
6	3	2.29-2.74	7.9	0.01	Negligible
8	5	3.81-4.27	8.0	0.01	Negligible

TABLE IV  
pH VALUE AND SULPHATE CONTENT OF WATER SAMPLES

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>DEPTH (m)</u>	<u>pH VALUE</u>	<u>SULPHATE CONTENT ppm as SO<sub>4</sub></u>	<u>RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE</u>
2	1.44	7.0	325	Positive

## FOUNDATION INVESTIGATION REPORT

FOR

W.P. 83-74-25, Site: 10-319  
Fairview Street - Q.E.W. Overpass  
District 4, Hamilton

---

1. INTRODUCTION

Morton & Partners Limited has been retained by The Ministry of Transportation and Communications to carry out a foundation investigation at the site of the proposed Fairview Street - Q.E.W. Overpass, Site 10-319, W.P. 83-74-25 in Burlington, Ontario.

This report summarizes the results of this investigation. Sections 2 to 6 inclusive provide factual information.

## 2. SITE

The site is located near the north east corner of the present intersection of the Q.E.W. and Plains Road in Burlington, Ontario, as shown on (Sheet No. 204 of the contract drawings).\*

The site is relatively flat, at about elevation 96, and is crossed by existing Maple Avenue. An existing building, known as the Tien Kui Inn, and its parking lot occupy part of the site.

\* Added by M.T.C.

### 3. SITE GEOLOGY AND GEOMORPHOLOGY

The proposed highway structure is located within a low terrace of land formed as a wide depositional beach in glacial Lake Iroquois. The shore cliff (or strand line) of this glacial feature lies some 1.2 km northwest from the site location, immediately on the north and northwest side of Provincial Highway 403. The offshore edge of the wide, glacial lake and beach (in the strand flat) is located along the edge of present-day Lake Ontario (and Hamilton Harbour), some 2.0 km southeastward.

Surficial sediments accumulated on the wide strand flat comprise rather uniformly graded fine to coarse, slightly silty sands. Scattered gravel and small rock fragments occur throughout these sands, probably transported offshore by ice floating away from the former shoreline beach and confining small cliff in Queenston Shale or Halton Till. The Halton Till unit of late Pleistocene age is found to underlie the strand flat sediments at about 4.15 m depth.

Evidence of interstadial deposition prior to formation of the Halton Till is provided by several of the boreholes, by existence of a substratum of finely stratified (varved?) clayey silt to silty clay. This "clay" in turn possesses a basal layer about 0.75 m thick of water bearing clayey beach deposit of silty sand and gravel, in which the gravel tends to comprise now-weathered fragments of red shale from the underlying bedrock. The presence of this coarse, basal sediment below an upwards fining lacustrine sedimentary stratum confirms that the lake water in which it was

sedimented was transgressive and not regressive.

Bedrock at about 12 to 13 m depth (about elevation 85) comprises essentially horizontally bedded red shale or mudstone of the Queenston Formation, of Upper Ordovician Age.

The depth/level of intersection recorded in the boreholes corresponds very closely with the general bedrock subcrop position indicated in Ontario Geological Map 2034, though it must be noted that it is our experience that very rapid lateral changes in bedrock level of 3 to 5 m do occur in the Burlington area, due to the existence of narrow former creek beds eroded into the shale and filled with interstadial and glacial sediment. No such rapid change in bedrock level appears to exist between the 8 boreholes of this specific study, but we understand on the basis of field comments with adjacent project investigators, that changes may occur within the total confines of the intended interchanges.

Seismic risk in the Lake Ontario-Lake Erie fringe is noted as Level 1. The possibility of seismically-induced consolidation or liquefaction of the uppermost stratum of loose to dense uniform sand is therefore considered remote.

#### 4. FIELD WORK

The field work for this investigation was carried out during the period of November 18 to 26, 1980 inclusive, and consisted of eight detailed boreholes at the locations shown on (Sheet No. 204 of the contract drawings).\* The boreholes were advanced with a power auger using solid stem or hollow stem augers.

Samples were taken using a split spoon driven by the Standard Penetration Test method. Bedrock was core drilled using a BXL core barrel. All samples were shipped to our laboratory for further examination and testing. Samples remaining after testing will normally be stored for a period of three months following the date of this report and then discarded, unless other instructions are received.

Unsealed piezometers were installed in two boreholes to determine the current groundwater level, as well as to facilitate future observations.

Elevations referred to in this report are metric and relative to a temporary benchmark, supplied by M.T.C., and consisting of a nail in the root of the seventh of a row of Maple trees along Maple Avenue, east of the existing restaurant. The benchmark is geodetic and reported to be at elevation 96.139 m.

\* Added by M.T.C.



## 5. SOIL CONDITIONS

The soil strata and the range of elevations between which they occur at the borehole locations are listed below:

<u>Soil Type</u>	<u>Approximate Range of Elevation</u>
Fill	between 97 and 94
Sand	between 96 and 92
Clay, Silt with Sand and trace of Gravel (Glacial Till)	between 93 and 87
Clay and Clayey Silt	between 89 and 85
Sand and Gravel	between 86 and 85
Bedrock	between 86 and 85
(Ground level at the site varies between about elevations 96 and 97.)	

The detailed soil conditions and their extent, groundwater levels and the results of laboratory testing are shown on the attached "Record of Borehole" sheets. Estimated stratigraphical profiles, based on these data, are shown on (Sheet No. 204 of the contract drawings).\*

The various soil types are briefly described in the following paragraphs.

\* Added by M.T.C.

## 5.1 FILL

Fill was encountered in most boreholes and consists generally of loose, fine to sometimes medium and coarse, sand, locally mixed with gravel. It is generally somewhat organic and, although otherwise relatively clean, occasionally clayey and mixed with foreign material such as brick, cinder and wood pieces.

It should be noted that, as the fill is relatively clean, the boundary between the fill and the underlying sand is not always clearly defined and, consequently, the boundaries shown on the "Record of Borehole" sheets may be approximate.

The relative density of the fill is variable, as indicated by the "N" values, which ranged from 8 to 43 blows per 0.3 m. The higher values may be due to obstructions and, in general, the relative density of the fill is considered to range from loose to compact.

## 5.2 SAND

The fill is underlain by a stratum of brown sand. As a water-lain deposit, it exhibits considerable variations in gradation both in the horizontal and vertical direction. In general, the sand is fairly uniformly fine with a tendency to become less uniform and coarser with depth. The gravel content in some boreholes became noticeably greater near the bottom of the stratum.

Grainsize analyses were carried out on all samples of the sand from Borehole 1, and the results are shown on the "Record of Borehole" sheets. The envelope of the grain size distribution curves is shown in Figure 1. It should be noted that the envelope probably covers the finer sizes, but not the coarser sizes across the site.

"N" values obtained in the stratum ranged from 5 to greater than 100, with a median value of 34 blows per 0.3 m, indicating its variable, but generally compact to dense, nature. It should be noted that the lower values were invariably obtained in the upper part of the stratum.

### 5.3 CLAY, SILT WITH SAND AND TRACE OF GRAVEL (GLACIAL CLAYEY TILL)

Beneath the sand, in all boreholes, is a glacial deposit, generally with a clayey silt to clay matrix, but occasionally very silty with little or no clay. Cobble or boulder sizes were not encountered, but they are likely to exist within the stratum.

"N" values obtained within the stratum ranged from 38 to over 100 blows per 0.3 m, with a median value of 61, indicating a hard consistency.

### 5.4 CLAY AND CLAYEY SILT

Beneath the above glacial deposit, in all boreholes, is a stratum of stratified silty clay and clayey silt. The "N" value obtained in this deposit ranged from 39 to 75 blows per 0.3 m, with a median value of 52, indicating a hard consistency.

### 5.5 SAND AND GRAVEL

Underlying the clay in most and possibly all boreholes is a stratum of sand and gravel. As the stratum is relatively shallow and, because of its frequent clay and weathered shale content, difficult to distinguish from the underlying weathered rock, its boundaries were difficult to define.

The "N" values obtained in this stratum are relatively low, but probably influenced by temporary excess hydrostatic pressure during sampling.

### 5.6 BEDROCK

Bedrock was core drilled in Boreholes 1 and 2, and assumed to have been reached in all boreholes following practical refusal to further penetration. The bedrock consists of reddish brown, generally horizontally bedded, Queenston Shale of Upper Ordovician Age. The upper part of the shale is moderately to heavily weathered, but the core recovery in Boreholes 1 and 2, combined with the depth at which refusal to augering was met elsewhere, suggest that the weathered part of the rock is not extensive and of the order of 1 m.

## 6. GROUNDWATER

During drilling, free water was encountered in the upper sand in all boreholes. This water level did not appreciably change during or after the drilling operations. Consequently, unsealed piezometers were used to observe the groundwater conditions likely to be encountered during construction.

The groundwater level stabilized very quickly following completion of the boreholes, but appeared to be subject to precipitation. During the period of investigation, the groundwater level fluctuated between elevations 94.0 and 94.5 across the site.

The piezometers referred to above were installed in Boreholes 1 and 2 only; i.e. on opposite ends of the proposed structure. They were capped and should be usable for future observation, if required.

Note: The preceding contract report is a copy of the factual data relating to subsurface conditions prepared for The Ministry of Transportation and Communications by Morton and Partners Limited for the above-noted project.

## APPENDIX

## RECORD OF BOREHOLE No 1

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+218.56 - 33.1 Rt ORIGINATED BY \_\_\_\_\_  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid and hollow stem auger, BXL core COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 80-11-18 & 19 CHECKED BY \_\_\_\_\_

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

**+3, x5 : Numbers refer to Sensitivity**

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 2

METRIC

W P 83-74-25 (site 10-319) LOCATION CHAINAGE 10+292.36 - 23.5 Lt ORIGINATED BY \_\_\_\_\_  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid and hollow stem augers, BXL Core COMPILED BY \_\_\_\_\_  
DATUM Geodetic DATE 80-11-20 & 21 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
95.8	0.0 Fill, sand with gravel, clayey parts. Brown to dark brown		1	SS	29												
93.8	2.0 Sand, bedded fine to coarse with gravel, trace of silt, compact to dense. Brown		2	SS	16		94										
			3	SS	47												
			4	SS	26												
92.5			5	SS	55												
	3.3 Mixture of silty clay to clayey silt and sand, trace of gravel (Glacial till) Hard Light grey brown to grey		6	SS	74		92										
			7	SS	63												
			8	SS	41												
			9	SS	>100		90										
			10	SS	100												
			11	SS	93												
			12	SS	100		88										
87.6	8.2 Clayey silt interbedded with clay Hard Grey		13	SS	75												
86.2			14	SS	46												
	9.6 Sand, gravel with clay (Glacial till) Dense Reddish Brown		15	SS	40		86										
85.0			16	SS	>100												
10.8	Shale Weathered Bedrock Sound		17	RC BXL	65%		84										
83.5																	
12.3	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 3

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+217.06 - 24.2 Lt ORIGINATED BY \_\_\_\_\_  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 80-11-21 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
96.2														
0.0	Fill, sand, trace of gravel and clay Reddish brown		1	SS	43									
94.1			2	SS	22									
2.1	Sand, bedded, fine to medium, trace of gravel and silt Loose to dense Brown		3	SS	11									
92.3			4	SS	60									
3.9	Mixture of silty clay to clayey silt and sand, trace of gravel (Glacial till) Hard Light grey brown to grey		5	SS	53									
			6	SS	>100									
			7	SS	82									
			8	SS	56									
88.4			9	SS	54									
7.8	Clayey silt interbedded with clay Hard Grey		10	SS	50									
86.1			11	SS	49									
10.1	Shale Bedrock Weathered													
84.7														
11.5	End of Borehole Refusal to auger on assumed sound bedrock													

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

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 4

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+292.76 - 34.5 Rt  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger  
 DATUM Geodetic DATE 80-11-24

ORIGINATED BY

COMPILED BY

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
96.1								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%)						
								PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>						
0.0	Fill, silty sand Reddish brown		1	SS	10		96							
94.0			2	SS	9		94							
2.1	Sand, fine to medium, sandy gravel at bottom Compact to dense. Brown		3	SS	24		94							
92.8			4	SS	96		92							
3.3	Mixture of silty clay to clayey silt and sand with some gravel (Glacial till) Hard Light grey brown to grey		5	SS	54		92							
			6	SS	52		90							
			7	SS	61		90							
			8	SS	46		88							
88.4			9	SS	50		88							
7.7	Clayey silt interbedded with clay Hard Grey		10	SS	52		86							
86.0							86							
10.1 85.4	Probably weathered Shale													
10.7	End of Borehole Refusal to sampler on assumed sound bedrock													

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

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 5

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+291.36 - 23.5 Rt  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger  
DATUM Geodetic DATE 80-11-24  
ORIGINATED BY  
COMPILED BY  
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
95.9								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%)						
								10	20	30				
0.0	Fill, silty sand Reddish brown		1	SS	8									
94.1			2	SS	9									
1.8	Sand, bedded fine to coarse to sandy gravel Dense to very dense Brown		3	SS	45									
92.2			4	SS	74									
3.7	Mixture of silty clay to clayey silt and sand, trace of gravel (Glacial till) Hard Light gray brown to gray		5	SS	38									
			6	SS	55									
			7	SS	61									
			8	SS	74									
87.4			9	SS	68									
8.5	Clayey silt interbedded with clay Hard Grey		10	SS	54									
85.3														
10.6	Sand & Gravel (Till)		11	SS	54									
84.5	Weathered Shale													
11.4	End of Borehole Refusal to auger on assumed sound bedrock													

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 6

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+217.06 - 6.5 Rt  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger  
 DATUM Geodetic DATE 80-11-25  
 ORIGINATED BY  
 COMPILED BY  
 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
97.1								20 40 60 80 100							
0.0	Fill (?)														
96.4															
0.7	Sand, bedded, fine to medium with trace of gravel, with layers of sandy gravel. Loose to very dense. Reddish brown to brown		1	SS	7		96								
			2	SS	5										
			3	SS	100										
			4	SS	60		94								
			5	SS	64										
92.5	Mixture of silty clay to clayey silt and sand, trace of gravel (Glacial till)  Hard  Light grey brown to grey		6	SS	59		92								
4.6			7	SS	66										
			8	SS	90		90								
			9	SS	90										
88.5	Clayey silt interbedded with clay  Hard Grey		10	SS	53		88								
8.6															
86.2	Sand & Gravel (Till)  Weathered Shale		11	SS	100		86								
10.9															
84.8	End of Borehole Refusal to auger on assumed sound bedrock						84								
12.3															

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 7

METRIC

W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+297.06 - 2.6 Rt ORIGINATED BY \_\_\_\_\_  
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 80-11-25 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
95.8																	
0.0	Fill, silty sand and clayey silt																
94.7	Dark Brown		1	SS	14												
1.1	Sand, bedded, fine to medium, layers of sandy gravel. Compact to very dense. Reddish brown to brown		2	SS	12												
			3	SS	55												
92.5			4	SS	57												
3.3	Mixture of silty clay to clayey silt and sand, trace of gravel (Glacial till) Hard		5	SS	60												
	Light grey brown to grey		6	SS	49												
			7	SS	53												
			8	SS	54												
			9	SS	69												
86.8																	
9.0	Clayey silt interbedded with clay		10	SS	55												
85.4	Hard Grey																
10.4	Sand & Gravel (Till)		11	SS	51												
84.4	Weathered Shale																
11.4	End of Borehole Refusal to auger on assumed sound bedrock																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 8

METRIC

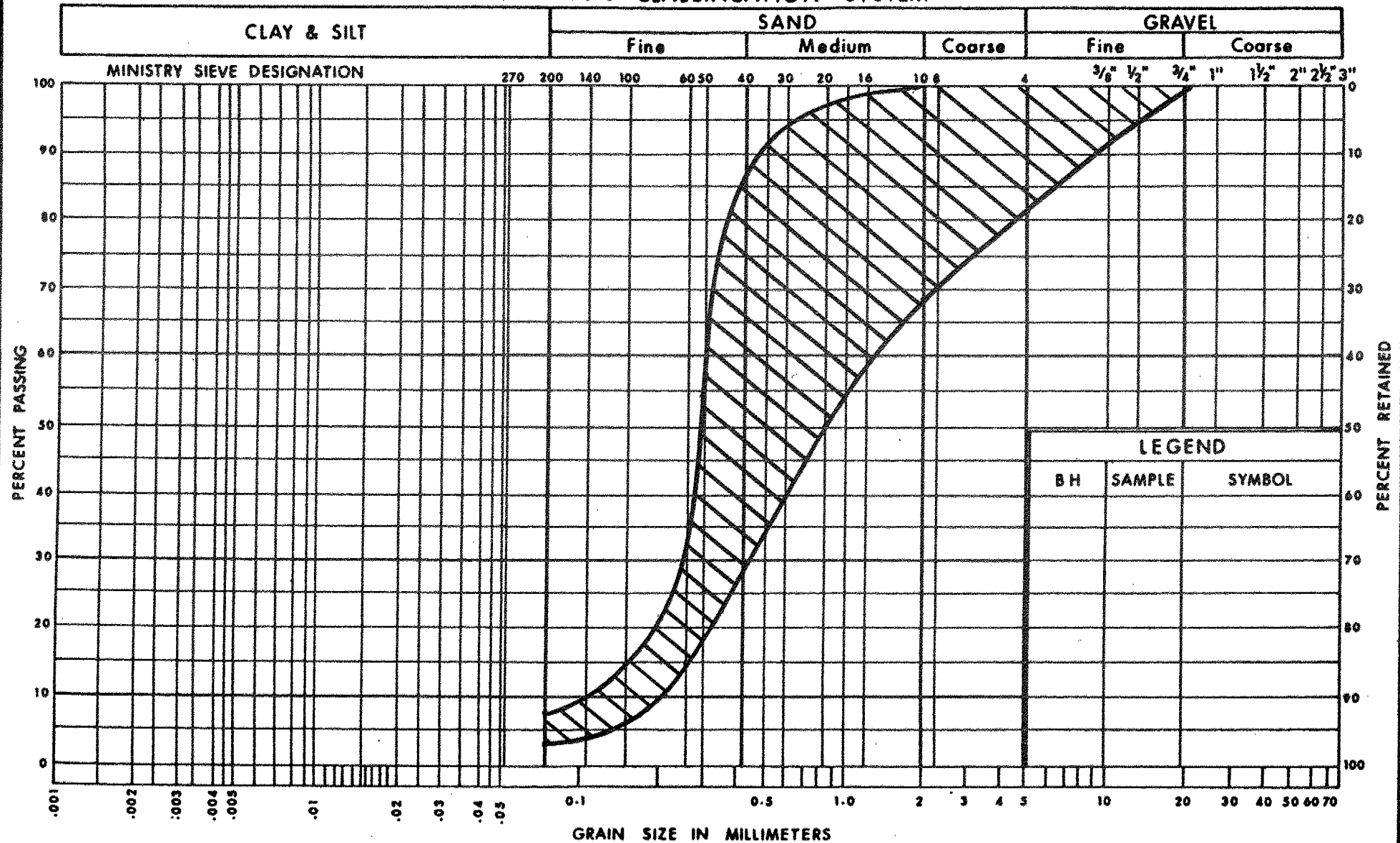
W P 83-74-25 (Site 10-319) LOCATION CHAINAGE 10+219.06 - 9.5 Lt  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow stem auger  
DATUM Geodetic DATE 80-11-26  
ORIGINATED BY  
COMPILED BY  
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
95.9								SHEAR STRENGTH					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL x LAB VANE									
0.0	Sand, bedded fine to medium, trace of gravel and silt. Layer of sandy gravel at bottom. Compact to dense. Reddish brown to brown.		1	SS	12		94										
			2	SS	>100												
			3	SS	15												
92.5			4	SS	34		92										
3.4	Mixture of silty clay to clayey silt and sand trace of gravel (Glacial till). Hard. Light grey brown to grey.		5	SS	52												
			6	SS	67												
			7	SS	79		90										
			8	SS	60												
87.9			9	SS	61		88										
8.0	Clayey silt interbedded with clay. Hard. Grey.		10	SS	40		86										
85.8																	
10.1	Sand & Gravel (Till)																
84.8	Weathered Shale		11	SS	>100												
11.1	End of Borehole. Refusal to auger on assumed sound bedrock.						84										

+3, x5: Numbers refer to Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10

# UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of  
Transportation and  
Communications**

## GRAIN SIZE DISTRIBUTION

(ENVELOPE)

FIG No 1

W P 83-74-25

SITE 10-319

GEOECHANICAL INVESTIGATION  
C.N.R. OVERHEAD AT Q.E.W.  
SITE 10-135A, W.P. 83-74-26R  
C.N.R. OVERHEAD AT HWY. 403W-  
FAIRVIEW STREET RAMP  
SITE 10-135B, W.P. 83-74-27R  
RAMBO-HAGER CREEK CULVERT EXTENSION  
SITE 10, W.P. 83-74-24  
DISTRICT 4, BURLINGTON, ONTARIO



PETO MacCALLUM LTD.

45 BURFORD RD., HAMILTON, ONTARIO L8E 3C6  
CONSULTING ENGINEERS



GEOTECHNICAL INVESTIGATION  
C.N.R. OVERHEAD AT Q.E.W.  
SITE 10-135A, W.P. 83-74-26R  
C.N.R. OVERHEAD AT HWY. 403W -  
FAIRVIEW STREET RAMP  
SITE 10-135B, W.P. 83-74-27R  
RAMBO-HAGER CREEK CULVERT EXTENSION  
SITE 10, W.P. 83-74-24  
DISTRICT 4, BURLINGTON, ONTARIO.

FOR

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(HEAD OFFICE:- 165 CARTWRIGHT AVE., TORONTO M6A 1V5 (416) 789-4105)

Job No. 80 F 300

January 26, 1981

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

Attention: Mr. K. Selby, P.Eng.  
Senior Foundation Engineer

Gentlemen:

Re: Geotechnical Investigation  
C.N.R. Overhead at Q.E.W.  
Site 10-135A, W.P. 83-74-26R  
C.N.R. Overhead at Hwy. 403W -  
Fairview Street Ramp,  
Site 10-135B, W.P. 83-74-27R  
Rambo-Hager Creek Culvert Extension  
Site 10, W.P. 83-74-24  
District 4, Burlington, Ontario

We are pleased to present our final report for the geotechnical investigation carried out for the proposed grade separation structures and culvert extension referenced above, as authorized in Agreement No. 4242-9080-106.

Our preliminary comments and recommendations concerning construction of the two structures were presented in our report dated December 29, 1980.



MEMBER OF THE ASSOCIATION OF CONSULTING ENGINEERS OF CANADA

The attached report provides complete details of the field and laboratory work carried out, the soils rock and ground-water conditions encountered at the two development sites and foundation recommendations.

The stratigraphy encountered at the bridge site generally comprises relatively thin surficial fills, topsoil and sand layers, a major hard silty clay till deposit extending to about 8.2 to 10.2 m below grade underlain by very dense sand/silt till overlying Queenston shale bedrock at approximately 11.6 to 13.6 m depth. At the Rambo-Hager Creek Extension site the stratigraphy is generally similar except the major silty clay till is interlayered with very dense sandy silt till.

Subsurface conditions are quite favourable for the use of conventional spread footings to support the proposed bridge structures. However, due to construction and other constraints, various alternative foundation schemes, which are particularly applicable to supporting the abutments are discussed. These include supporting footings on an engineered fill, drilled caissons or driven piles as summarized below:

<u>Foundation Type</u>	<u>Founding Material</u>	<u>Founding Elevation</u>	<u>Bearing Capacity</u>
Spread Footings	Silty Clay Till	96.5	400 kPa
Spread Footings	Well Compacted Granular fill	Nominal Depth	175 kPa
Drilled Caisson	Silty Clay Till	94	1200 kPa
Concrete filled steel pipe pile	Sand/Silt Till	88	*980 kN for 324 mm (12.75 in.) O.D. X 7.1 mm (0.281 in.) wall thickness  *1070 kN for 324 mm (12.75 in.) O.D. X 7.9 mm (0.312 in.) wall thickness
Steel "H" Pile	Shale Bedrock	83 to 85	Structural capacity of section

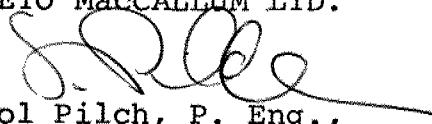
\*Capacity based on 20 MPa concrete strength. A 300 kN increase in pile capacity may be achieved by utilizing 30 MPa compressive strength concrete.

The report presents parameters for design of abutment walls and approach embankment and discusses problems that might be encountered during the bridge construction including safe construction slopes, bracing requirements and ground-water control.

At the Rambo-Hager Creek culvert extension site, two methods of extending the existing culvert are discussed and compared. It is more feasible from a geotechnical viewpoint to extend the existing structure by constructing a 3 cell box culvert and relocating the inlet at the new upstream location, as it would involve shallower excavation, a minimum of groundwater control and in general, less materials handling and relatively straightforward construction.

We trust that this report satisfies your requirements and thank you for the opportunity to be of service to the Ontario Ministry of Transportation and Communications. If you have any questions, or if any point in the report requires clarification, please do not hesitate to call our office.

Yours very truly,  
PETO MacCALLUM LTD.

  
Sol Pilch, P. Eng.,  
Chief Geotechnical Engineer.

TLB/SP/rf

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### LABORATORY TEST RESULTS

TABLE I - Atterberg Limit Test Results  
TABLE II - Laboratory Unconfined Compression Test Results  
TABLE III - pH Value and Sulphate Content of Soil Samples  
TABLE IV - pH Value and Sulphate Content of Water Sample

FIGURE NO'S 1 to 3 - Grain Size Distribution

RECORD OF BOREHOLE SHEETS

BOREHOLE LOCATION PLAN AND SOIL STRATA

## 1. INTRODUCTION

Peto MacCallum Ltd. was authorized by The Ministry of Transportation and Communications, Agreement No. 4242-9080-106 to carry out a geotechnical investigation at the sites for the proposed C.N.R. overhead structures at Q.E.W. and Hwy. 403W - Fairview Street Ramp and the Rambo-Hager Creek Culvert Extension in Burlington, Ontario.

The subject project constitutes part of the overall Q.E.W. reconstruction from Lockhardt Road northerly to Brant Street.

A summary of the proposed development plans and construction sequence was provided in a copy of The Ministry of Transportation and Communications internal memorandum to Mr. K. G. Selby, Senior Foundation Engineer, dated October 14, 1980, and accompanying Drawings 1123-912 and 913. The development plans were subsequently discussed in the meeting of November 10, 1980.

The proposed C.N.R. overhead at Q.E.W. will be a twin structure (one to carry north bound traffic and the other south bound traffic) with three spans of about 20 m - 30 m - 20 m. Stage construction is planned, involving firstly, construction of the east portion of the east bridge. This would allow for construction clear of the existing Q.E.W. Traffic will then be detoured over the newly constructed east deck section so that the present bridge can be removed and the remaining deck cross-section completed.

The proposed superstructure will be of steel girders and therefore no falsework will be required over the C.N.R.

We understand that both sections of the proposed twin structure will be widened in 10+ years to suit ultimate expansion of the Q.E.W.

The new C.N.R./Hwy. 403W - Fairview Street Ramp will have similar spans as the proposed twin structure. No future deck widening is anticipated for this bridge.

It is noteworthy that the site for the present C.N.R./Q.E.W. bridge was investigated in 1955 by our predecessors, Racey, MacCallum and Associates Limited, and the results presented in report No. S-500-505/55 T91-1.

Due to realignment, the north Q.E.W. lanes will be located over the present inlet structure of the Rambo-Hager Creek diversion channel. Extension of the existing culvert will be required to accommodate the new Q.E.W. and two alternatives are being considered. The first involves extending the existing structure with a 3 cell concrete box culvert and reconstructing the inlet at the new location some 30 m upstream. The other possibility consists of removing the existing drop structure, extending the 3 cell culvert and reconstructing the new drop and inlet structures at the new upstream location.

The purpose of this investigation is to determine the subsurface soils and groundwater conditions at the proposed construction sites and based on this information to comment on and provide geotechnical engineering recommendations pertinent to the design and construction of the proposed C.N.R. overhead structures at Q.E.W. and Hwy. 403W - Fairview Street Ramp and the Rambo-Hager Creek culvert extension.



A preliminary report dated December 29, 1980, was provided following completion of the initial field work, which summarizes the subsurface conditions and geotechnical recommendations for the two projects.

## 2. FIELD WORK

The results of the previous investigation by Racey, MacCallum and Associates Limited at the bridge site, indicated that a competent silty clay till layer extends over the development area, which has the capacity to support relatively heavy loads. The scope of the present investigation was established cognizant of the subsurface information available at the site.

A total of eight (8) boreholes were initially scheduled at Sites 10-135A and B, for the proposed grade separation structures. Three (3) of these holes were scheduled to be drilled through the approach embankment from above the present bridge structure. However, due to spacial limitations as well as traffic and safety constraints which would require closure of the inside Q.E.W. lanes, two (2) of these boreholes were relocated to natural grade under the existing bridge beside the C.N.R. tracks and the other deleted. Consequently, no information is available concerning the nature and engineering properties of the approach embankment fill. Therefore, a total of seven (7) boreholes, boreholes 1 to 7, were drilled at the site for the C.N.R./Q.E.W. and C.N.R./Hwy. 403W grade separation structures.

Two (2) holes, boreholes 8 and 9, were drilled at the site for the Rambo-Hager Creek culvert extension.

The field work was carried out during the period of November 18 to 22, 1980 and January 7 and 8, 1981. The

holes were drilled at the locations shown on the appended Plan. The boreholes were extended to a depth of 6.55 to 17.34 m below existing grade, using a CME-55 drillrig equipped with continuous flight solid stem and hollow stem augers and rock coring capabilities, supplied and operated by a specialist drilling contractor.

Representative samples of the overburden were obtained at frequent intervals using a conventional split spoon sampler in conjunction with standard penetration tests. Relatively undisturbed samples of the cohesive soils encountered at the site were recovered in thin walled shelly tubes. The undrained shear strength of the silty clay till was assessed by conducting pocket penetrometer tests on the recovered samples. BXL core samples of the bedrock at the bridge site were recovered.

The groundwater conditions in the open boreholes were closely monitored during and on completion of drilling. Two (2) piezometers at the proposed C.N.R./Q.E.W. bridge site, and one (1) piezometer at the proposed culvert extension site were installed and monitored to determine the stabilized groundwater conditions. Details of the piezometer installations are described on the appended, Record of Borehole No's 1, 5 and 8.

The field work was supervised throughout by a member of our engineering staff who directed the drilling and sampling operations, documented the soil and bedrock stratigraphy encountered, monitored the groundwater condition in the open boreholes, detailed the piezometer installations and cared for the recovered samples.

The location and ground surface elevation at the boreholes were established in the field by Peto MacCallum Ltd.

The following geodetic benchmarks, provided by The Ministry

of Transportation and Communications were used as reference for vertical control:

BM: Cut cross on south concrete retaining wall of culvert under C.N.R. tracks. 112.0 m left of STATION 9+913.8. Approximately 100 m east of Q.E.W./C.N.R. bridge. Elevation: 99.986.

BM: Nail and washer in east root of 0.35 m Ø ash tree. 10.0 m left of STATION 11+190.0. Elevation: 87.746.

### 3. LABORATORY TESTING PROGRAMME

All of the recovered samples were brought to our laboratory for detailed visual examination and routine testing to confirm field visual classifications. In addition, the following tests were conducted:

- Moisture Content on all samples
- Four (4) - Atterberg Limits, Table I
- Three (3) - Unconfined Triaxial Compression, Table II
- Two (2) - pH and Sulphate Content of Soil Samples, Table III
- One (1) - pH and Sulphate Content of Ground-water Sample, Table IV
- Five (5) - Grain Size Analysis, Figure No's 1 to 3.

### 4. SITE DESCRIPTION AND GEOLOGY

The site for the proposed grade separation structures and culvert extension are generally flat and fairly well

drained. A light vegetative cover of small bushes and grass has developed over the surface.

The development areas are located near the northern edge of the Lake Iroquois Plain, which is typified by a fine to silty fine sand veneer.

Bedrock consists of red Queenston Shale. Drift thickness is generally less than 15 m thick and comprises generally glacial till deposits. Very often the basal portion of the overburden is distinctly red in color from large amounts of incorporated Queenston Shale.

## 5. SUBSURFACE SOILS AND GROUNDWATER CONDITIONS

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

The stratigraphy at the bridge site generally comprises relatively thin surficial fills, topsoil and sand layers, a major hard silty clay till deposit extending to about 8.2 to 10.2 m below grade underlain by very dense sand/silt till overlying Queenston shale at approximately 11.6 to 13.6 m depth.

At the Rambo-Hager Creek extension site, the stratigraphy is generally similar except the major silty clay till deposit is interlayered with very dense sandy silt till.

A summarized account of the major stratigraphic units are presented below:

5.1 SITES 10-135A AND B,  
C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W -  
FAIRVIEW STREET RAMP

5.1.1 FILL AND TOPSOIL

A 1.37 m thick fill layer generally comprising firm clayey silt and silty clay was encountered near the C.N.R. tracks in boreholes 2 and 6. Local 300 mm thick silty clay fill and mixed fill deposits were noted at the surface in boreholes 3 and 7.

A topsoil layer, 130 to 300 mm in thickness was encountered surficially in boreholes 4 and 5 and under the fill layer in borehole 7.

5.1.2 SAND

A loose to compact silty sand unit was contacted generally over the site. This unit was encountered surficially in borehole 1, and under the topsoil or fill layers in boreholes 2, 3, 6 and 7. The layer is 0.33 to 1.38 m thick and was penetrated at 0.84 to 2.07 m below grade, near elevation 96.51 to 97.78.

Moisture content in the sand varies between about 8 to 18%.

5.1.3 SILTY CLAY TILL

A major, generally hard, heavily over-consolidated silty clay till deposit was contacted in all of the testholes under the topsoil or sand layer some 0.13 to 2.07 m below grade near elevation 96.51 to 98.54. Two typical gradation curves are shown in Figure No. 1, appended.

The moisture content in the clay varies between about 7 to 18% but typically ranges between approximately 11 to 14%. The liquid and plastic limits of two representative samples are 24 and 32, and 15 and 16 respectively indicating a low plasticity.

The major clay till unit was not penetrated in boreholes 2, 3, 4 and 6 at the termination depth of 6.55 m, but was penetrated in boreholes 1, 5 and 7 at the 8.23 to 10.21 m depth, elevation 88.18 on the west side of the bridge and 90.44 on the east side.

#### 5.1.4 SANDY SILT TILL AND SILTY SAND TILL

Dense to very dense reddish brown sandy silt till and silty sand till (typical gradation, Figure No. 2) were encountered below the major clay till unit in boreholes 1, 5 and 7.

In the west portion of the site, the granular till unit was contacted at about 10.1 and 10.2 m below grade, near elevation 88.2 and 88.4, in boreholes 1 and 7 respectively, while in the east section, borehole 5, contact was at about the 8.2 m depth at approximate elevation 90.4.

The moisture content is about 8 to 11%. This unit was not penetrated in borehole 7.

#### 5.1.5 BEDROCK

Red Queenston Shale bedrock was contacted under the sand/silt till unit in the two deep boreholes 1 and 5 at 13.56 and 11.58 m, elevation 84.68 and 87.09 respectively.

Based on detailed visual examination of the recovered core samples, the top approximately 1.8 and 0.9 m of the shale bedrock in boreholes 1 and 5 respectively, is weathered, becoming sound below this depth. The shale is generally of poor quality in the weathered zone and of fair to good quality in the sound zone.

#### 5.1.6 GROUNDWATER CONDITIONS

The groundwater conditions observed in the testholes and piezometers indicate a variable groundwater regime at the site. Groundwater which was encountered in the surficial pervious materials in the holes drilled within the railway right-of-way, boreholes 2 and 6, is considered to be perched.

Boreholes 1, 3 and 4, which were terminated in the silty clay till layer remained dry during and upon completion of drilling. The piezometer installed in borehole 1, has also remained dry.

Groundwater was encountered in boreholes 1A, 5, 5A and 7 which contacted the basal sand/silt till. The piezometer installed in the basal till in borehole 5, shows that the stabilized groundwater level at the time of the investigation is at elevation 94.01.

### 5.2 SITE 10, RAMBO-HAGER CREEK CULVERT EXTENSION

#### 5.2.1 SUBSOIL CONDITIONS

The surficial stratigraphy at this site comprises a thin veneer of silty clay fill (borehole 9) and compact silty sand to 1.37 and 1.52 m depth (boreholes 8 and 9 respectively). Underlying the sand layer, interlayered generally hard silty clay till (typical gradation shown on Figure No. 3, appended) and very dense sandy silt till units were encountered and was penetrated at the 7.01 m depth, near elevation 81.39 and 81.29 (boreholes 8 and 9, respectively) where layered silt and weathered shale and shale bedrock were contacted.

### 5.2.2 GROUNDWATER CONDITIONS

Borehole 9 was open and dry at the conclusion of drilling while the groundwater level in borehole 8 at the conclusion of drilling was near elevation 81.3. The piezometric level in borehole 8 is stabilizing near elevation 85.95.

## 6. ENGINEERING CONSIDERATIONS

### 6.1 C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W. - FAIRVIEW STREET RAMP

#### 6.1.1 FOUNDATION ALTERNATIVES

The soils and groundwater conditions at the site are quite favourable for the use of conventional spread footings. However, due to construction constraints, including spacial limitations, traffic considerations and the existing 10 m high fill embankment, an alternate deep foundation system may be considered, especially to support the abutments. The final support system will be dictated by economics and may comprise any one or combination of several alternate geotechnically feasible schemes described below:

##### 6.1.1.1 Spread Footings

The proposed bridge structures may be supported on conventional spread footings founded in the native hard silty clay till layer and proportioned using a net allowable bearing capacity of 400 kPa. The surface elevation of the competent bearing material varies somewhat across the site from about minimum elevation 96.5 to maximum elevation 97.5. The founding level should be established during construction cognizant of the normal requirement for frost protection (1.2 m of earth cover) and the variation in surface elevation of the bearing material. For preliminary



design purposes it may be assumed that footings are founded at elevation 96.5.

Settlement of footings founded in the silty clay till unit is expected to comprise primarily elastic compression in the clay stratum which should occur immediately following load application. Long-term consolidation settlement of the heavily over-consolidated silty clay till layer is expected to be negligible. It is estimated that the magnitude of the immediate elastic settlement will not be greater than 15 mm.

It may be possible to support the abutment footings in the existing approach fill. However, as pointed out earlier, determination of the pertinent properties of the existing approach fill material was not possible at this time as drilling would require closure of one of the Q.E.W. traffic lanes. As such, design recommendations for this alternative are not available unless additional drilling is carried out in the approach embankment.

The abutment may also be supported on relatively shallow spread footings founded within the approach embankment providing granular substitution of the existing approach fill material below the footing and provision of a structural fill in the widened portion of the embankment is carried out in accordance with standard MTC construction procedures. The footings may then be designed for an allowable bearing capacity of 175 kPa. Further comments in regards to site preparation prior to structural fill placement are presented later in the text.

Anticipated maximum settlement of footings in the engineered fill is about 25 mm. The majority of this settlement should occur during the construction period.

#### 6.1.1.2 Drilled Caissons

Should construction constraints dictate, drilled caissons may be used to support the proposed bridges. An allowable end bearing capacity of 1200 kPa may be used for design of caissons founded in the hard silty clay till layer. The caisson should be embedded to a depth equal to at least 4 times the caisson diameter, into the silty clay till layer. The anticipated founded level is near elevation 94 but depends on the diameter of the caisson. Downhole inspection is recommended to ensure the hole is properly cleaned out of all disturbed material and to verify the competency of the founding surface.

Groundwater is not expected to pose any undue problems since the augering will be within the relatively impervious clay till layer.

Additional comments regarding the caisson installation operations are presented in the following section.

#### 6.1.1.3 Driven Piles

Alternatively, either concrete filled closed end steel pipe or steel "H" piles may be used to support the bridge structure.

It is anticipated that driven steel pipe piles will reach practical refusal near elevation 87 on the west side of the bridge and 89 on the east side of the bridge in the very dense sand/silt till layer with an average founding elevation across the structure of 88. Relatively high driving resistance is expected during installation through the hard silty clay till and therefore a heavy pile section is recommended.

Working loads of 980 and 1070 kN are suggested for concrete filled pipe piles 324 mm (12.75 in.) O.D. with wall thickness of 7.1 and 7.9 mm (0.281 and 0.312 in.) respectively, filled with 20 MPa compressive strength concrete. An increase of 300 kN in pile capacity may be achieved by utilizing 30 MPa compressive strength concrete.

Steel "H" piles driven to practical refusal in the shale bedrock are suitable for developing the full structural capacity of the section.

The borehole information indicates that the bedrock surface generally dips from east to west, from about elevation 87.1 to 84.7 in boreholes 1 and 5 respectively. It is anticipated that the steel "H" piles will meet refusal between elevation 83 to 85 across the bridge structure.

In this regard, it should be pointed out that the steel "H" piles founded in the Queenston Shale are known to "relax" following driving. Therefore, it is recommended that the piles are redriven after a waiting period of at least 3 days. The indicated refusal depth takes this mechanism into consideration.

It is expected that the majority of any settlement which the deep foundation support system experiences will be limited to elastic compression of the structural member.

The characteristics of the approach fills have not been established as noted previously and consequently, additional drilling will be required in order to provide comments regarding installation of caissons/driven piles through the fill.

The "H" pile tip should be reinforced with welded steel plates or rock points to minimize damage during driving through the very dense basal till and bedrock.

A minimum spacing of 3 times the pile diameter is recommended between individual members.

Piles should be driven using a hammer with a minimum rated energy of 40 kJ/blow. The capacity of the pile should be confirmed during installation using the Hiley's Formula.

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

#### 6.1.1.4 Design Considerations

Although the magnitude of settlement of the various stages of the proposed twin bridge construction would be similar (assuming equivalent loading and foundations are used to support each stage), the settlement of the initial east portion of the easterly bridge will essentially be completed prior to commencement of the second stage of this bridge. Accordingly, the planned structure should be designed to accommodate the differential settlement at the junction of the staged segments, cognizant of the type or combination of types of support systems that are adopted. Overlapping of stress bulbs from adjacent shallow foundations is not expected to affect the performance of the structure.

Differential settlement will not be of concern in the C.N.R./Hwy. 403W structure as stage construction is not programmed on this bridge.

It may be prudent to construct the foundations for the ultimate bridge widening at this time, so as to minimize the excavation, bracing requirements or duplication of work during construction of the future bridge deck. In this regard, negligible settlement should be expected in these "pre-built foundations" as the full load will not be imposed until construction of the future addition.

Further, cognizant of the favourable subsurface conditions at this site, a single span structure with conventional "closed" abutments supported on spread footings may be considered as an alternative to the proposed three span bridge structure.

### 6.1.2 ABUTMENTS

Both closed and open ended type abutments are feasible depending on spacial limitations and the bridge design chosen. Abutment walls should be designed to resist the unbalanced lateral forces acting on the wall. In this regard, provided that standard practice is followed involving the provision of free-draining granular backfill and the installation of weepholes or weeping tiles behind the wall to prevent the build-up of hydrostatic pressures as well as the mobilization of the passive pressures in front of the wall, the following design parameters are recommended:

Earth pressure coefficient at rest,  $k_0 = 0.5$   
if the wall is rigid and unyielding.

Earth pressure coefficient,  $k = 0.33$   
if some movement of the top of the wall is permitted.

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

Friction angle between footing and hard silty clay  
till,  $\delta = 22^\circ$ .

Friction angle between footing and well compacted  
granular fill,  $\delta = 24^\circ$ .

Passive earth pressure coefficient,  $k_p = 3.0$   
assuming granular backfill in front of wall.

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

### 6.1.3 APPROACH EMBANKMENT

The proposed construction will involve realignment and widening of the existing approach. Anticipated maximum height of the approach fill is some 10 m.

Prior to construction of the fill embankment (or structural fill), all topsoil, existing fills and obviously deleterious materials should be sub-excavated and the exposed surface proof-rolled to ensure at least 95% Standard Proctor maximum dry density.

We recommend longitudinal and transverse slopes of 2 horizontal to 1 vertical for the approach embankment. Provided suitable borrow material is employed and MTC standard construction procedures are observed, we do not anticipate any slope or base stability problems, as exemplified by the satisfactory performance of the existing approach embankment. Conventional slope protection involving seeding or sodding should be observed to control erosion due to surface runoff.

#### 6.1.4 CONSTRUCTION AND GROUNDWATER CONTROL

Staged construction is planned as described in the previously referenced memorandum.

Construction will be carried out within the area of the existing approach embankment as well as in areas unaffected by the present embankment. We do not expect that the different stress history in these areas will affect the overall performance of the finished structure.

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

Construction slopes should be cut at 1 horizontal to 1 vertical, subject to geotechnical inspection.

It will be necessary to support the existing or new approach fill slopes during the various stages of construction if excavation encroaches within a line drawn at 1 horizontal to 1 vertical through the crest of the embankment. In accordance with this requirement, construction of the engineered

fill to support the abutments of the various stages of the proposed structure will require partial removal of the existing approach embankment and bracing the remaining portion of the embankment in order to maintain the integrity of the Q.E.W.

One advantage of supporting the abutments on piles/caissons is that the approach fill widening can be constructed to abut the existing embankment, and then the piles/caissons can be installed through the fill slope. This method would involve a minimum of braced construction slopes.

Groundwater should not pose any special problems. Local nuisance seepage or surface runoff that enters the construction area should be readily handled by conventional sump pumping.

## 6.2 RAMBO-HAGER CREEK CULVERT EXTENSION

### 6.2.1 GENERAL

Two methods of extending the existing culvert are under consideration as described in the Introduction. For the purposes of this report, Alternative A, refers to the extension of the existing structure with a 3 cell concrete box culvert and relocating the inlet some 30 m upstream. Alternative B, refers to the method involving extending the present pipe culvert and reconstructing the inlet and drop structures at the new upstream location.

### 6.2.2 EXCAVATION AND GROUNDWATER CONTROL

The invert of the proposed 3 cell box culvert extension, Alternative A, is similar to the existing channel invert, i.e. near elevation 85.5. Installation will generally require relatively minor excavation in the existing channel

where construction slopes of 1 horizontal to 1 vertical are recommended, but should be flattened if concentrated seepage zones and sloughing of the slopes in the granular soils develop.

The groundwater level was stabilizing near elevation 86, near the invert level. Accordingly, if construction of Alternative A is carried out during the drier months, only minor amounts of water should be encountered and conventional sump pumping should prove adequate.

Alternative B, may be achieved by open cut methods. The trench excavation would be about 8 m deep and will be carried out for the most part within hard/very dense overburden materials and weathered shale bedrock. Large hydraulic earth moving equipment will be required to excavate expeditiously the material. Construction slopes of 1 horizontal to 1 vertical in the upper 2 m and 1 horizontal to 2 vertical in the remainder of the trench are recommended, subject to geotechnical inspection.

Excavation will be taken down below the groundwater table. Several testpits should be put down at the site prior to construction to assess the quantity of water to be handled and the most suitable means of dewatering.

Tunnelling may be used to connect the existing pipes to the new drop structure. We understand that the existing concrete pipes were installed by this method and groundwater posed somewhat of a problem. It is anticipated that tunnelling will require difficult and complex construction techniques since a variety of cohesive and granular overburden materials and weathered shale bedrock will be encountered.

Consequently, we favour the open cut method over tunnelling as we believe this method will pose less of a construction problem as well as being more economical.



### 6.2.3 BEARING CAPACITY AND BEDDING REQUIREMENT

Support of the proposed new structures in both Alternatives A and B is not expected to be of concern, since the insitu materials below the invert level of the various components are capable of supporting a load of 400 kPa.

A levelling course of at least 150 mm of Granular "A" material compacted to 95% Standard Proctor maximum dry density is recommended under precast culvert sections. Cast-in-place concrete structures may be supported directly on the native soil.

### 6.2.4 BACKFILL AND WALL DESIGN

All backfill under the proposed roadway should be compacted to at least 95% Standard Proctor maximum dry density in uniform thin lifts to minimize settlement that would be detrimental to the performance of the pavement structure.

The backfill behind the walls of the proposed concrete box culvert extension and inlet structure, should comprise free-draining granular material to facilitate placement and compaction operations in the relatively confined space.

Earth pressure coefficient at rest,  $k_0 = 0.5$  (assuming rigid unyielding wall) and bulk unit weight  $\gamma = 21.2 \text{ kN/m}^3$  are recommended for design of the walls. In addition, the walls should be designed to resist the full hydrostatic water pressure and the surcharge due to the soil cover over the culvert and traffic loading.

Bulk fill over the box culvert (Alternative A) and in the relatively deep open cuts in Alternative B, may comprise the excavated materials, which based on our experience and general knowledge of similar types of soils are quite suitable for reuse on this project.

### 6.2.5 ENGINEERING DISCUSSION

Extending the existing culvert with a 3 cell concrete box culvert and relocating the inlet upstream of the existing structure is more feasible than Alternative B from a geotechnical viewpoint. This would involve relatively shallow excavation and a minimum of groundwater control. Alternative B would involve deeper excavations, more materials handling and would probably encounter more severe groundwater problems.


### 6.3 ANCILLARY CONSIDERATIONS

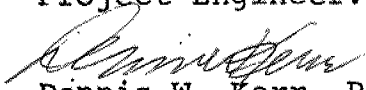
At the site for the proposed bridges, the results of chemical test of one soil sample (Table III) indicate a negligible degree of soluble sulphate attack on buried concrete structure, while the results of the test on a groundwater sample (Table IV) show that a positive relative degree of attack is to be expected. It is possible that the relatively high soluble sulphate concentration measured in the groundwater sample obtained at shallow depths in Borehole 2 is a result of water seeping through the railway ballast. Additional testing should be carried out prior to final design to confirm the potential for soluble sulphate attack.

The chemical test on a soil sample from the Rambo-Hager Creek culvert extension site (Table III) also indicates a negligible degree of soluble sulphate attack.

Reference is made to The Canadian Standard Association, CSA Standard A23 and The Canadian Building Digest, CBD-136 dated April 1971 for recommendation regarding the type of cement required.

PETO MacCALLUM LTD.

  
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TLB/DWK/rf



LABORATORY TEST RESULTS

JOB NO. 80F300

TABLE I  
ATTERBERG LIMIT TEST RESULTS  
PROPOSED C.N.R. OVERHEADS AT O.E.W. AND HWY 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>SAMPLE NO.</u>	<u>DEPTH (m)</u>	<u>NATURAL WATER CONTENT (w) %</u>	<u>LIQUID LIMIT (<sup>w</sup><sub>L</sub>)</u>	<u>PLASTIC LIMIT (<sup>w</sup><sub>p</sub>)</u>	<u>PLASTICITY INDEX (<sup>I</sup><sub>p</sub>)</u>	<u>REMARKS</u>
5	2	1.52 - 1.98	14.4	32	16	16	Silty Clay
5	7	5.33 - 5.79	11.3	24	15	9	Silty Clay
8	2	1.52 - 1.98	6.5	29	16	13	Silty Clay
9	6	4.57 - 5.03	11.9	25	13	12	Silty Clay

JOB NO. 80F300

TABLE II  
LABORATORY UNCONFINED COMPRESSION TEST RESULTS

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

BOREHOLE NO.	SAMPLE NO.	DEPTH (m)	NATURAL WATER CONTENT (w) (%)	UNIT WEIGHT WET ( $\gamma$ ) (t/m <sup>3</sup> )	DRY ( $\gamma_d$ ) (t/m <sup>3</sup> )	VOID RATIO (e)	DEGREE OF SATURATION ( $S_r$ ) (%)	FAILURE STRAIN ( $\epsilon_f$ ) (%)	SHEAR STRENGTH ( $\tau_f$ ) (kPa)	REMARKS
1	6	4.57-5.03	11.7	2.23	2.00	0.35	90	4	160	Suspect sample disturbance.
4	4	3.05-3.51	14.3	2.18	1.91	0.41	93	11	290	
7	3	2.29-2.74	13.9	2.18	1.92	0.41	91	2.5	460	

JOB NO. 80F300

TABLE III  
pH VALUE AND SULPHATE CONTENT OF SOIL SAMPLES

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>SAMPLE NO.</u>	<u>DEPTH (m )</u>	<u>pH VALUE</u>	<u>SULPHATE CONTENT % as SO<sub>4</sub></u>	<u>RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE</u>
6	3	2.29-2.74	7.9	0.01	Negligible
8	5	3.81-4.27	8.0	0.01	Negligible

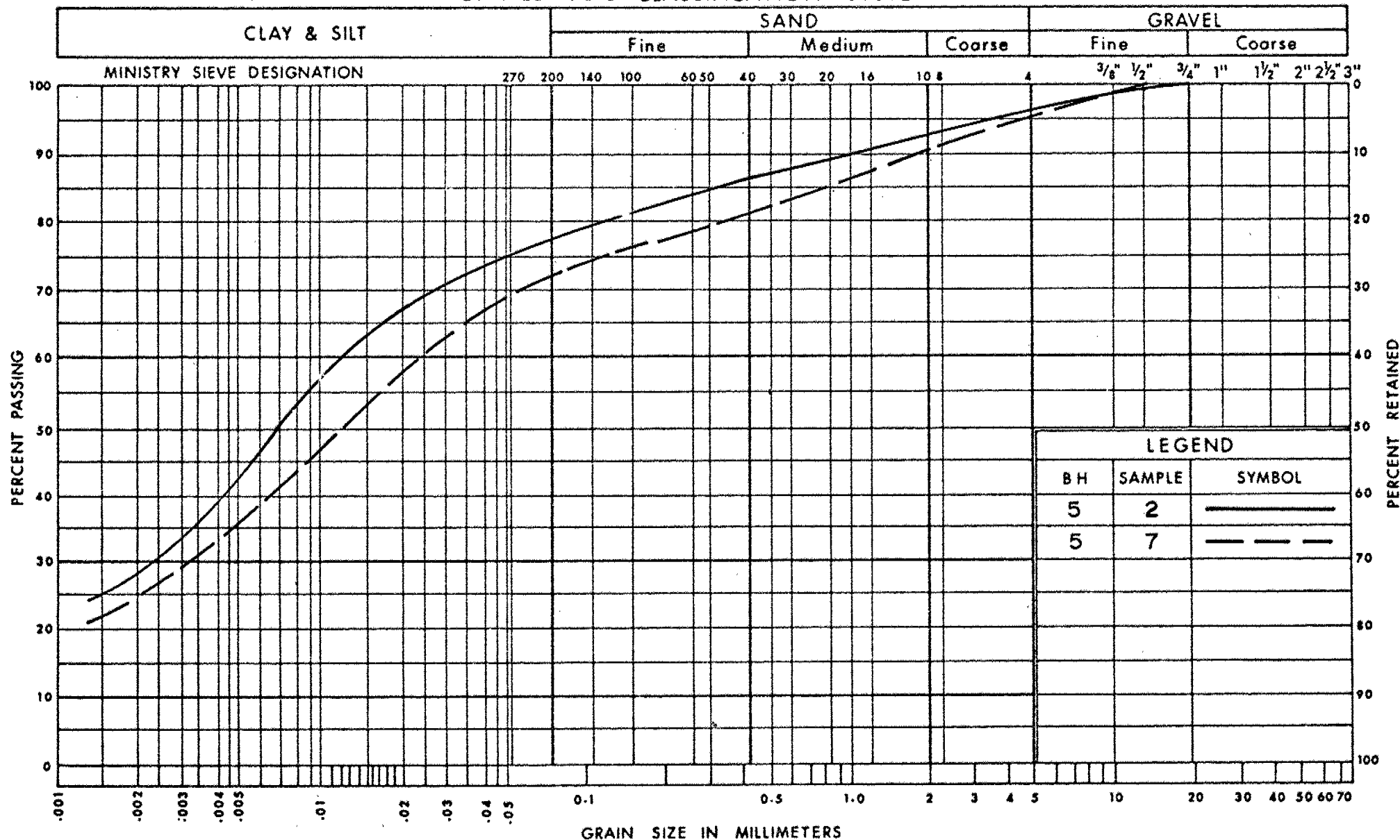
JOB NO. 80F300

TABLE IV  
pH VALUE AND SULPHATE CONTENT OF WATER SAMPLES

PROPOSED C.N.R. OVERHEADS AT Q.E.W. AND HWY. 403W - FAIRVIEW STREET RAMP  
RAMBO-HAGER CREEK CULVERT EXTENSION  
BURLINGTON, ONTARIO.

<u>BOREHOLE NO.</u>	<u>DEPTH (m)</u>	<u>pH VALUE</u>	<u>SULPHATE CONTENT ppm as SO<sub>4</sub></u>	<u>RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE</u>
2	1.44	7.0	325	Positive

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY  
SOME SAND, TRACE OF GRAVEL

FIG No 1

W P 83-74-26R &amp; 27R



## UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY &amp; SILT

SAND

GRAVEL

Fine

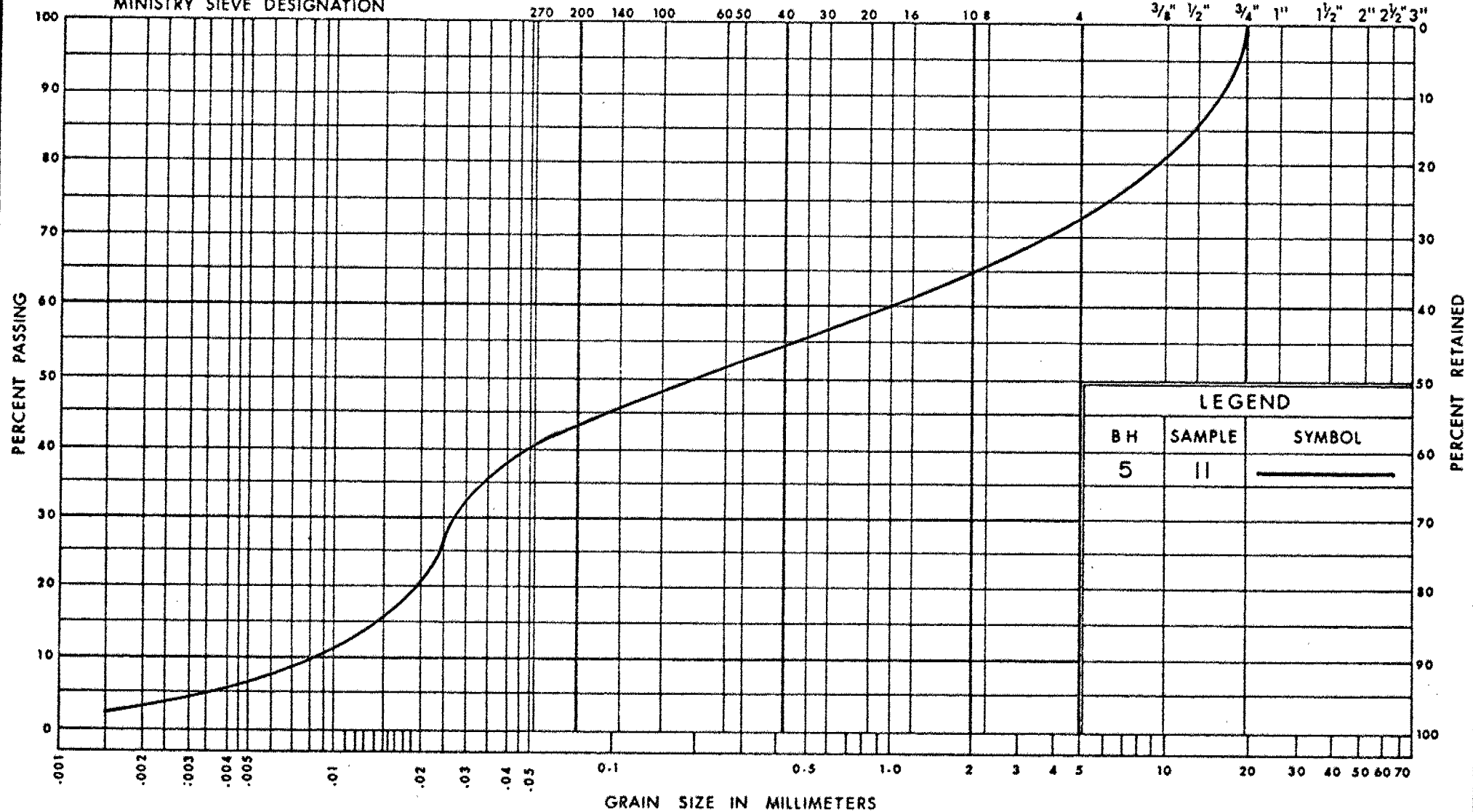
Medium

Coarse

Fine

Coarse

MINISTRY SIEVE DESIGNATION



## LEGEND

BH

SAMPLE

SYMBOL

5

11



Ontario

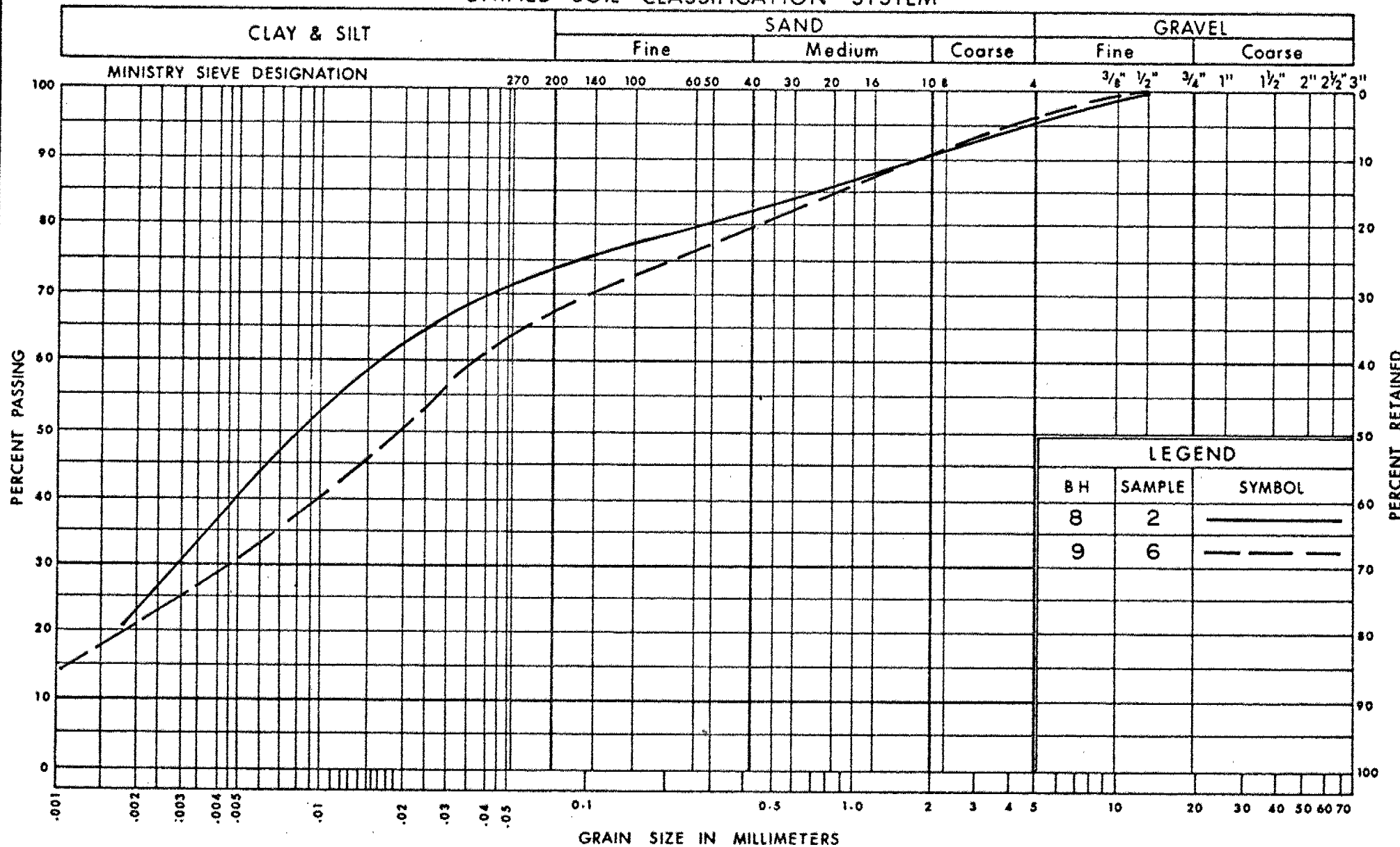
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SANDY SILT  
SOME GRAVEL, TRACE OF CLAY

FIG No 2

W P 83-74-26R &amp; 27R

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY  
SOME SAND, TRACE OF GRAVEL

FIG No 3

W P 83-74-24

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{VO}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kN/m^3$	SEEPAGE FORCE
$\gamma'$	$kN/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLES

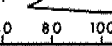


Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 1 & 1A

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,674 N; 278,215 E ORIGINATED BY M.R.  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Rock Core COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 & January 7, 1981 CHECKED BY DLK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
								SHEAR STRENGTH									
98.24																	
0.00	Sand, fine to medium, silty, trace of clay. Compact Brown		1	SS	13												
96.87	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till) Hard Brown Greyish Brown		2	SS	27												
1.37			3	TW	PH												
			4	SS	36												
			5	SS	29												
			6	TW	PH												
			7	SS	26												
			8	SS	55												
			9	SS	60												
			10	SS	56												
88.18																	
10.00	Sand, fine to coarse, silty, some gravel. (Glacial Till)		11	SS	58												
	Very dense reddish Brown		12	SS	60/80 mm												
84.68																	
13.56	Bedrock Shale		13	SS	100/80 mm												
	Red Weathered Sound		14	BXL RC	Rec 100%											R.Q.D.=18%	
			15	BXL RC	Rec 100%											R.Q.D.=70%	
30.90																	
17.34	End of Borehole																
Note: Borehole 1 BH 1 drilled on Nov. 18/80 was terminated at 6.55 m. Upon completion of augering no cave, no water in open borehole. Piezometer installed at elevation 92.14 Seal at elev. 95.8  Water Date                      Elevation Nov. 22/80              Dry Nov. 24/80              Dry Dec. 1/80                Dry			Borehole 1A BH 1A was drilled adjacent to BH 1 on Jan. 7/81 and was terminated at 17.34 m. 0 to 7.62 m unsampled 1 hour after SS 13. Water at elevation 92.69.														

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



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## RECORD OF BOREHOLE No 2

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,730 N; 278,248 E. ORIGINATED BY W.J.  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 22, 1980 CHECKED BY *AK*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40	60	80	100					
99.35																	
100	Fill-sandy gravel.																
97.98	Fill-clayey silt, trace of sand & gravel, occ. shale fragments. Reddish Brown		1	SS	7		98										
97.28	Sand, fine to coarse trace silt & gravel. Dark Grey		2	SS	5												
2.07	Silty clay, some sand, trace of gravel, occ. silt inclusions (Glacial Till)		3	SS	35												
	Hard Brown		4	SS	39		96										
	Greyish		5	SS	36												
	Brown		6	SS	38		94										
	red weathered shale layers and fragment below 5.2 m		7	SS	49												
22.80			8	SS	40												
6.55	End of Borehole																
<p>Note: Upon completion of augering cave at elevation 97.83, water at elevation 97.95.  Stabilised ground- water level not established.</p>																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5  
(%) STRAIN AT FAILURE



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 3

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,730 N; 278,285 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
98.19	Fill-silty clay, trace of sand. Brown		1	SS	14		98										
97.89	Sand, fine to coarse silty, trace of clay & gravel. Brown		2	SS	19		96										
96.51	Compact. Brown		3	SS	34												
1.68	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		4	SS	33												
	V. stiff to Hard Brown Greyish Brown		5	SS	25		94										
	occ. red weathered shale fragments below 3.7 m		6	SS	37												
			7	SS	41												
91.64			8	SS	32		92										
6.55	End of Borehole																
	Note: Upon completion of drilling no cave, no water in open borehole. Stabilised ground-water level not established.																

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 4

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,764 N; 278,298 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 18, 1980 CHECKED BY MR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT $\Sigma$					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
28.06																
27.76	Topsoil		1	SS	29											
300	Silty clay, sand, trace of gravel, occasional silt inclusions.  (Glacial Till) Hard Brown  Greyish Brown		2	SS	24											
			3	SS	30											
			4	TW	PH											
			5	SS	36											
			6	SS	31											
			7	SS	30											
91.51			8	SS	40											
6.55	End of Borehole															
	Note:  Upon completion of augering no cave, no water in open borehole.  Stabilised ground- water level not established.															



## Metric

[illegible]

+3, x5: Numbers refer to Sensitivity



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# RECORD OF BOREHOLE No 6

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,760 N; 278,259 E. ORIGINATED BY WJ  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 22, 1980 CHECKED BY WJ

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
99.05																
0.00	Fill-silty clay, some sand & gravel, some pockets of red soil. Soft to medium brown		1	SS	4											
97.68	Hard Greyish Brown		2	SS	16											
1.37	Sand, fine to coarse, silty, some gravel, trace of clay.		3	SS	41											
1.83	Compact Brown (Glacial Till)		4	SS	50											
			5	SS	42											
			6	SS	44											
	Hard Greyish Brown		7	SS	40											
	Occ. red weathered shale fragments		8	SS	58											
92.50	below 5.2 m															
6.55	End of Borehole Note: After sample 2, water at elevation 97.58. Upon completion of augering no cave, water at elevation 96.00 in open borehole. One hour later water at elevation 98.26.  Stabilized ground- water level not established.															

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\pm$  5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 7

Metric

W P 83-74-26R & 27R LOCATION Co-ords. 4,798,729 N; 278,212 E. ORIGINATED BY WJ  
DIST 4 HWY Q.E.W BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 20, 1980 CHECKED BY MK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60
98.62	Fill-mixed silty clay, sand & gravel some organics. Br. and reddish brown.		1	SS	14										
80	Topsoil		2	SS	13										
510	Silty fine sand, trace of gravel. Loose to compact Brown		3	TW	PH										
840	Silty clay, some sand, trace of gravel, occ. silt inclusions. (Glacial Till)		4	SS	30										
	Very stiff Brown/ to hard Greyish Brown		5	SS	26										
			6	SS	30										
			7	SS	43										
			8	SS	50										
	occasional red weathered shale fragments below 3.66 m		9	SS	48										
			10	SS	70										
88.41	Sand, fine to coarse silty, some gravel with coarse sand seams. (Glacial Till)														
10.21	Dense Reddish Br.														
27.49															
11.13	End of Borehole														
<p><b>Note:</b></p> <p>After sample 10, no water in open borehole.</p> <p>Upon completion of augering, cave at elevation 88.26, and water at elevation 92.98.</p> <p>Nov. 22, 1980 water at elevation 93.18.</p>															

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 8

Metric

W P 83-74-24 LOCATION Co-ords. 4,797,767 N; 279,085 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.L.B  
DATUM Geodetic DATE November 19, 1980 CHECKED BY *DK*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100	SHEAR STRENGTH kPa			WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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+3, x5: Numbers refer to  
Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10



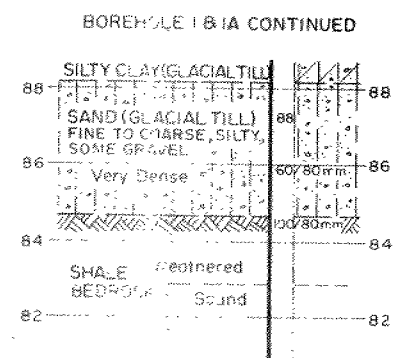
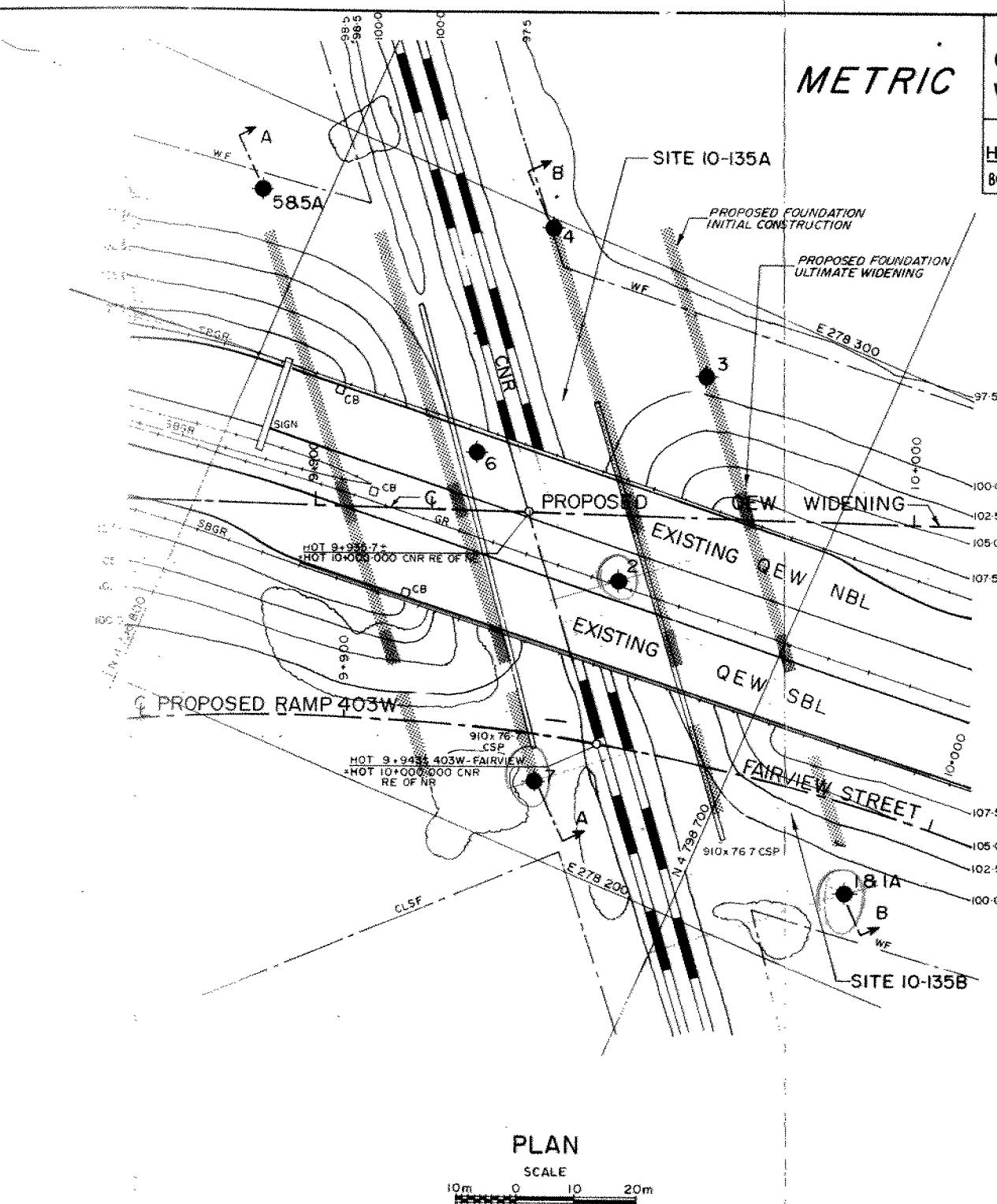
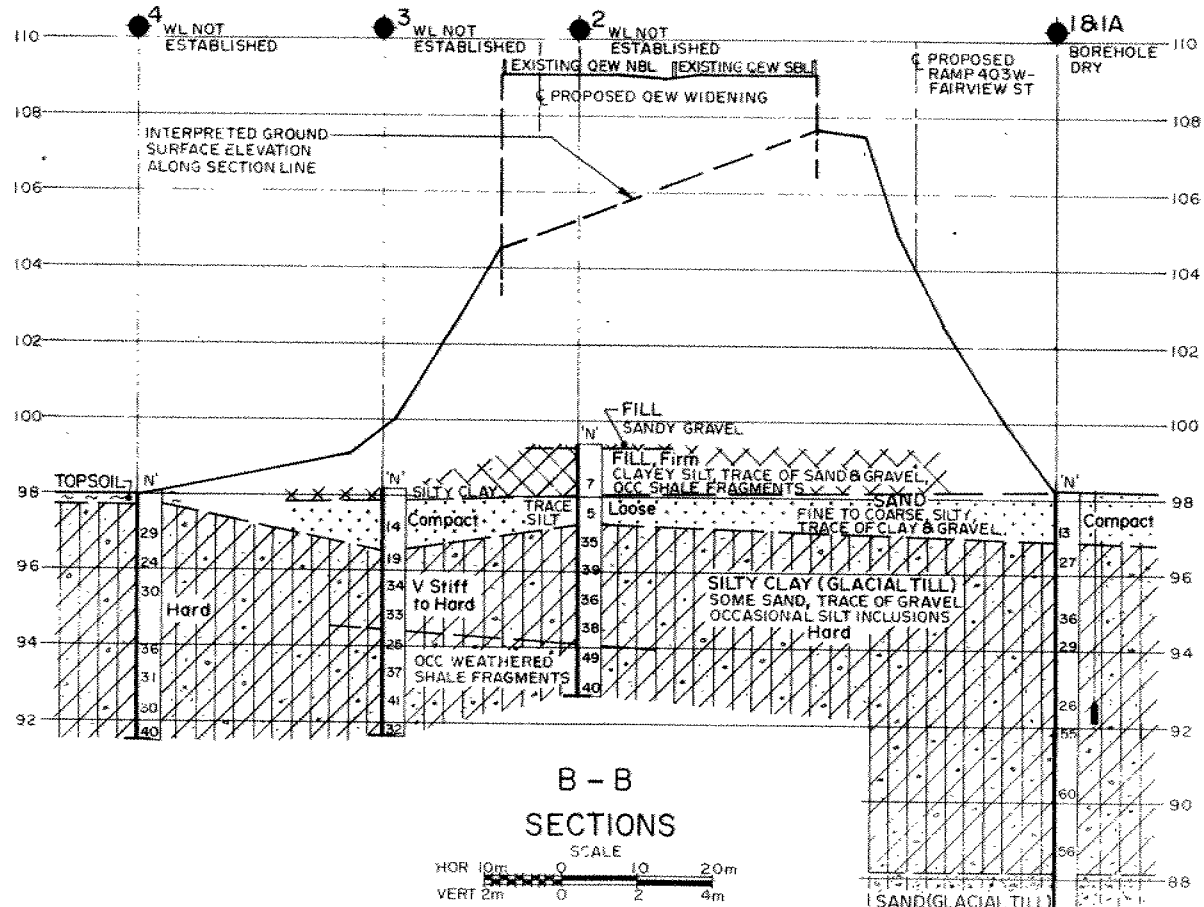
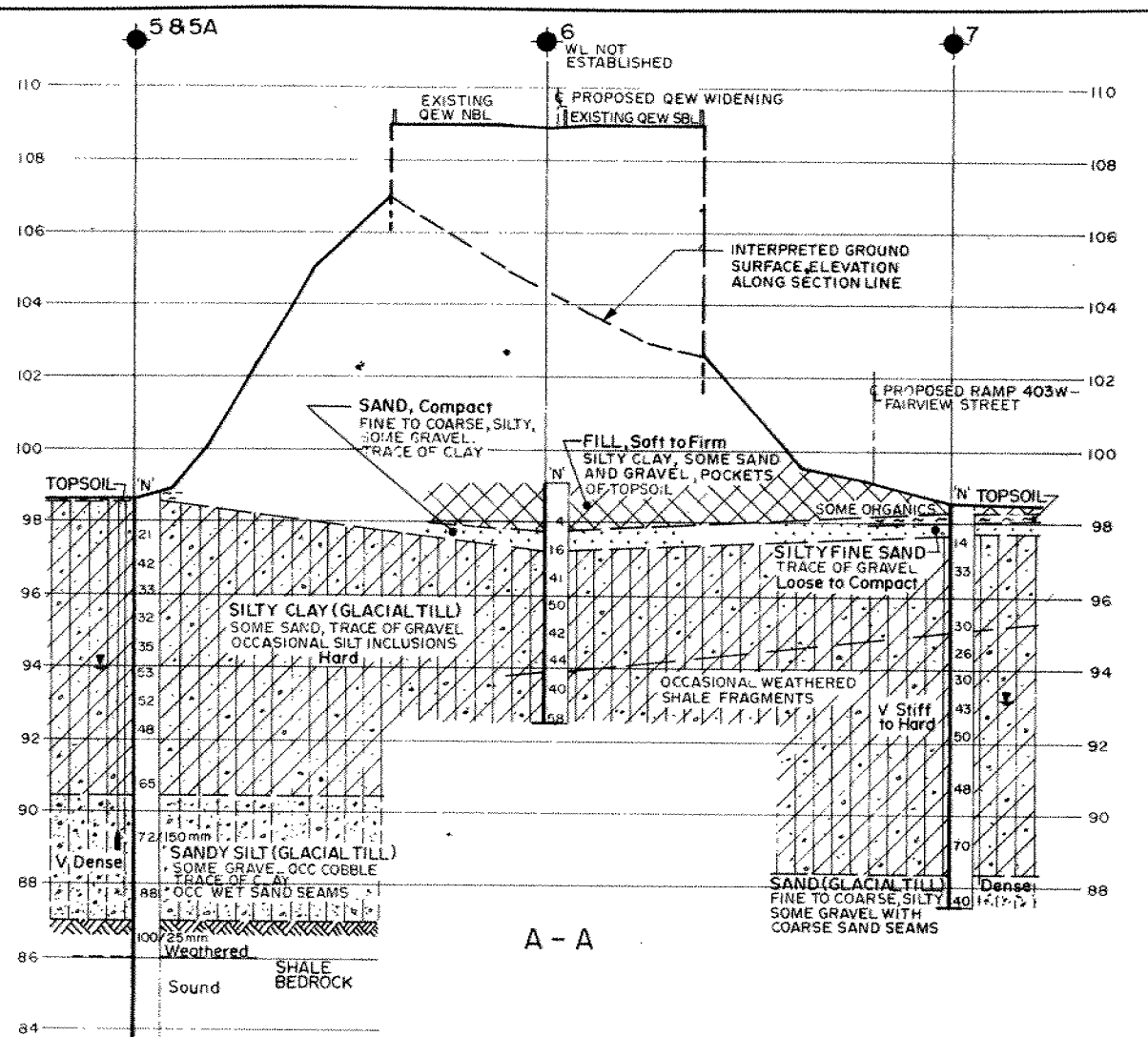
# RECORD OF BOREHOLE No 9

Metric

W P 83-74-24 LOCATION Co-ords. 4,797,740 N; 279,122 E. ORIGINATED BY MR  
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TLB  
DATUM Geodetic DATE November 19, 1980 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
88.30	0.00 Silty-silty clay, little sand. Brown						88										
300	0.30 Silty fine sand, trace of clay. Brown		1	SS	11												
86.78	1.52 Compact Brown		2	SS	21												
	1.52 Silty clay, some sand, trace of gravel. (Glacial Till)		3	SS	41		86										
85.40	2.90 V. stiff Brown to to hard Greyish Br.		4	SS	62												
84.64	3.66 Silty silt, trace of clay & gravel. (Glacial Till)		5	SS	57		84										
	3.66 Dense Reddish Br.		6	SS	82												
	Silty clay, some sand, trace of gravel. (Glacial Till)		7	SS	25/150 mm		82										4 28 46 22
81.29	Hard Reddish Br.		8	SS	50/0 mm		80										
79.13	7.01 Shale Bedrock		9	SS	50/0 mm												
9.17	End of Borehole																
<p>Note: Upon completion of augering no cave, no water in open borehole.</p> <p>Stabilized ground- water level not established.</p>																	

BOREHOLE LOCATION PLAN AND SOIL STRATA



*METRIC*

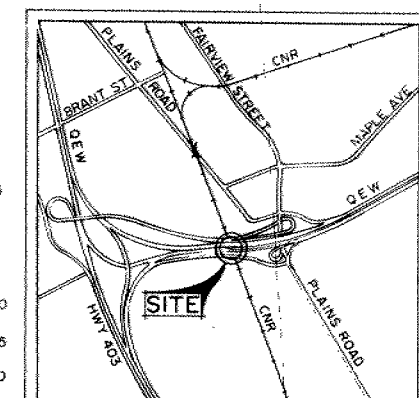
CONT No  
WP No 83-74-268  
27

CNR OVERHEADS AT QEW &  
HWY 403 W-FAIRVIEW ST RAMP  
BORE HOLE LOCATIONS & SOIL STRATA








SHEET

PETO MacCALLUM LTD.



KEY PLAN  
SCALE  
1 km 0.5 0 1 km

### LEGEND

- |   |  |
|---|--|
|    | Bore Hole                                |
|    | Dynamic Cone Penetration Test (Cone)     |
|    | Bore Hole & Cone                         |
| N   | Blows/0.3m (Std Pen Test, 475 J/blow)    |
| CONE  | Blows/0.3m {60° Cone, 475 J/blow}        |
|  | WL at time of investigation NOV-DEC 1980 |
|  | PIEZOMETER                               |

No	ELEVATION	CO ORDINATES	
		NORTH	SOUTH
181A	98 24	4 798 674	278 215
2	99 35	4 798 730	278 248
3	98 19	4 798 730	278 285
4	98 06	4 798 764	278 298
585A	98 67	4 798 811	278 285
6	99 05	4 798 760	278 259
7	98 62	4 798 729	278 212

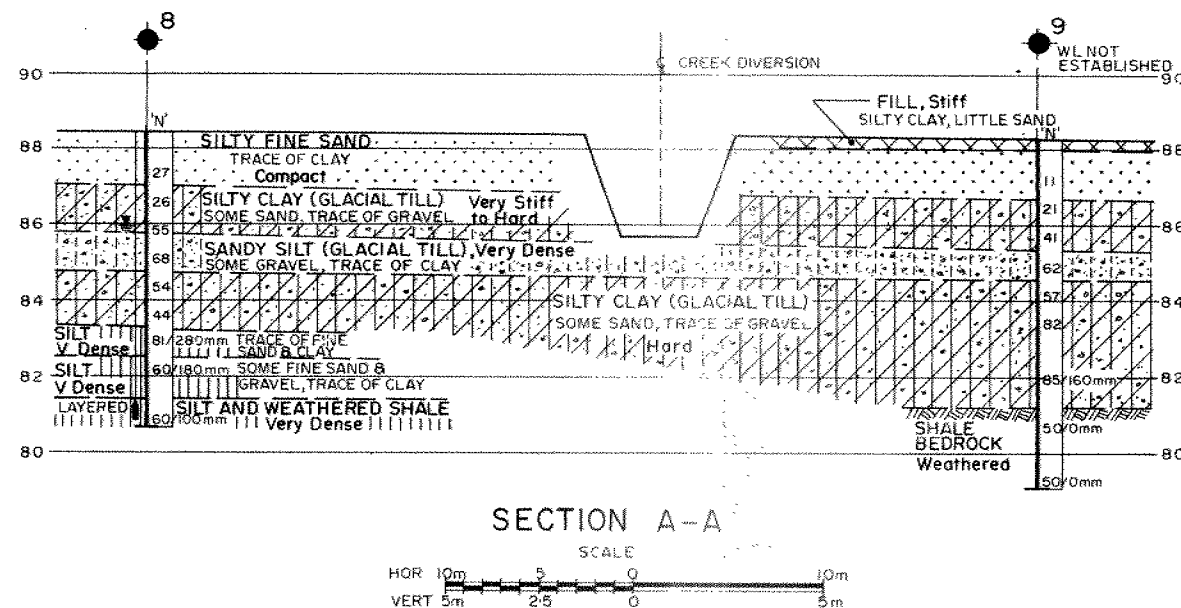
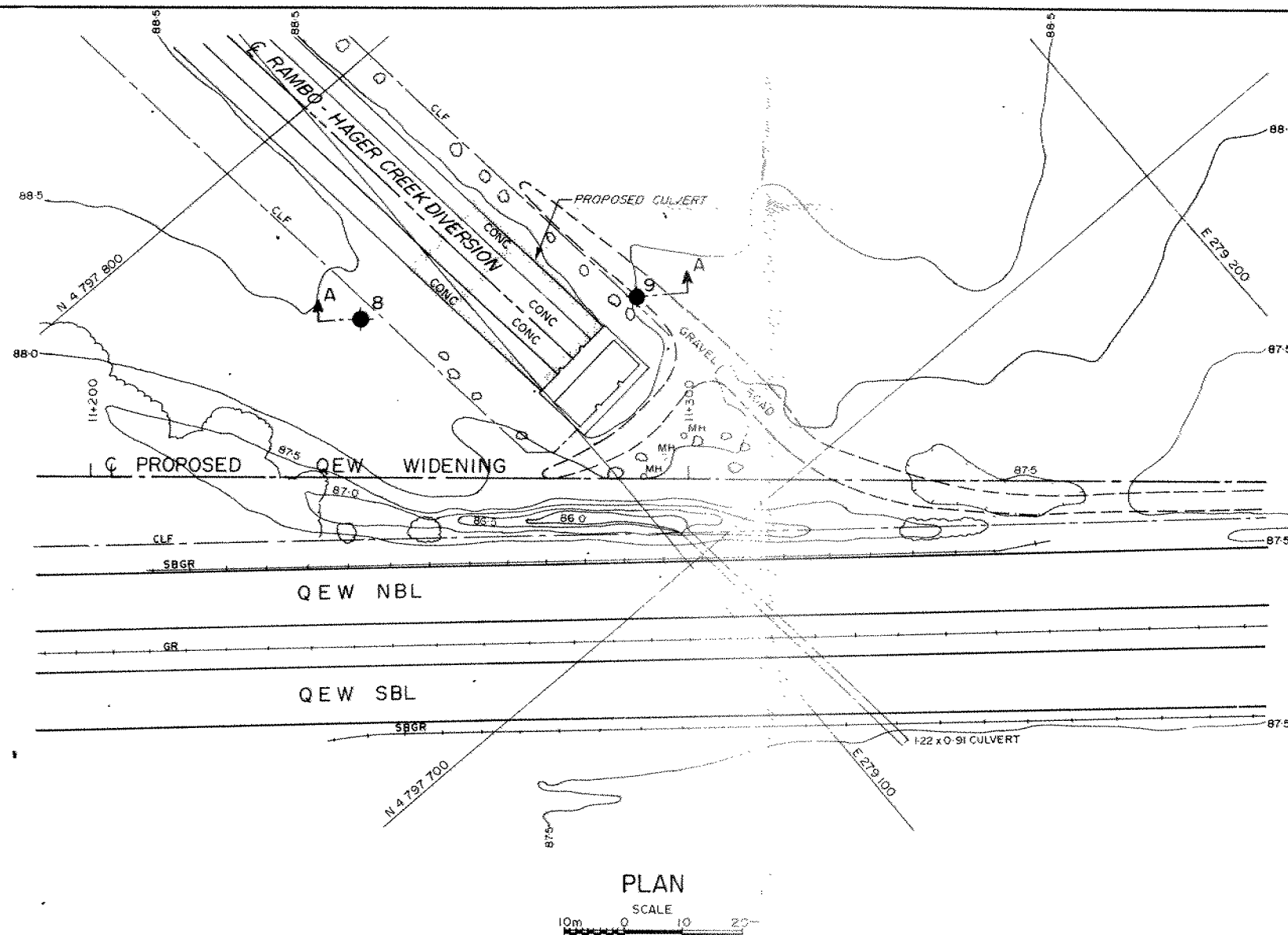
**NOTE**

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

<b>REVISIONS</b>			
	<b>DATE</b>	<b>BY</b>	<b>DESCRIPTION</b>

Geocres No

HWY No QEW	DIST	4
SUBM'D TLB CHECKED	DATE 1981 0: 16	SITE 10-35A & B
DRAWN KK CHECKED	APPROVED	DWG 83-426 & 27-A



METRIC

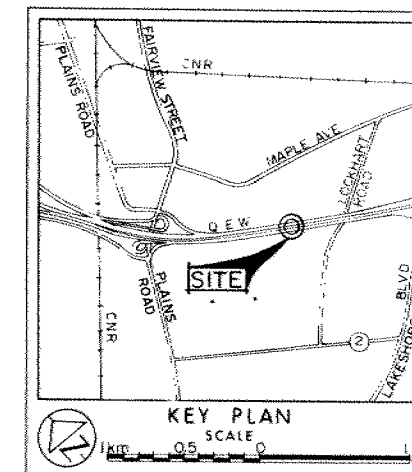
CONT No  
WP No 83-74-24

RAMBO-HAGER CREEK  
CULVERT EXTENSION  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

PETO MacCALLUM LTD.



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation NOV-DEC 1980
- PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
8	88.40	4 797 767	279 085
9	88.30	4 797 740	279 122

NOTE

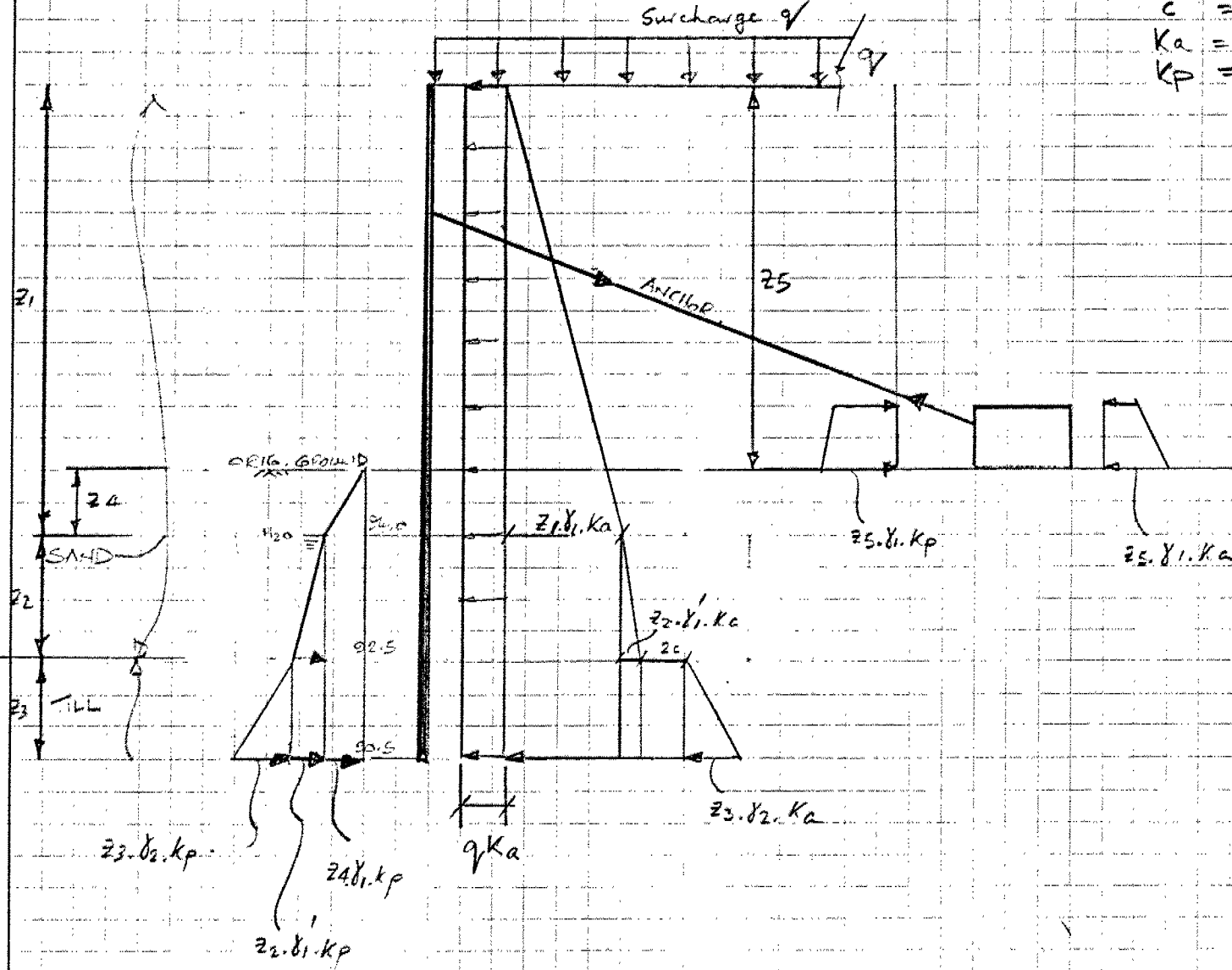
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No	
HWY No QEW	DIST 4
SUBM'D T/LB	CHECKED DATE 1981 01 16 SITE 10
DRAWN K	CHECKED J-6 APPROVED DWG 837424-A



consulting engineers



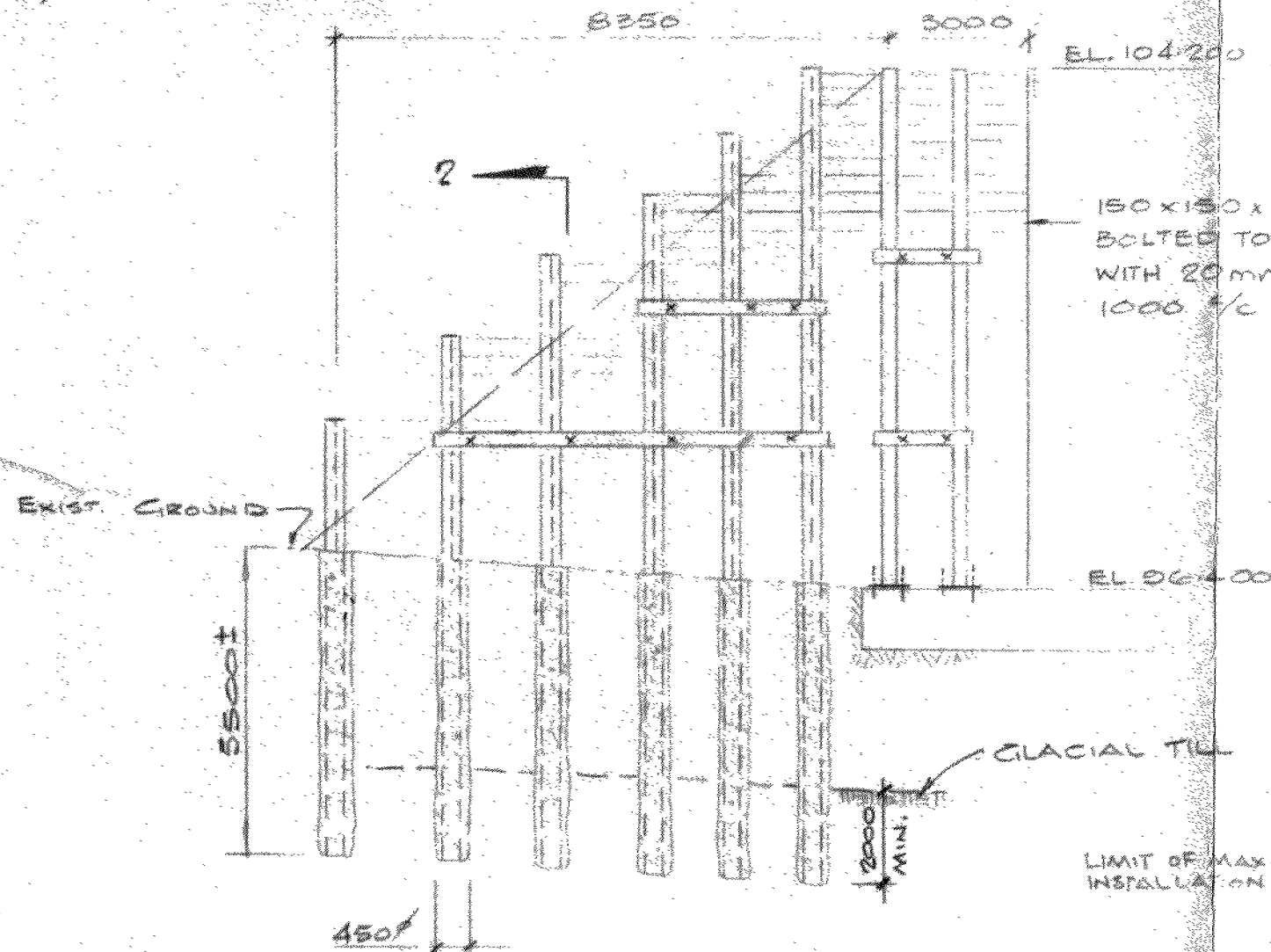
$$\begin{aligned} q &= 2 \text{ ft Surcharge} \\ \gamma_1 &= 130 \text{ p.c.f.} \\ \phi &= 30^\circ \\ \gamma_2 &= 140 \text{ p.c.f.} \\ c &= 8,000 \text{ p.s.f.} \\ K_a &= 0.35 \\ K_p &= 3.0 \end{aligned}$$

# DESIGN CRITERIA

$\gamma = 20 \text{ KN/m}^3$   $K_a = 0.35$   $K_p = 3.0$   
600 mm LIVE LOAD SURCHARGE

## NOTES:

- PILES 310 HP 110
- CONCRETE STRENGTH 20 MPa
- GRANULAR BACKFILL BEHIND SHORING
- 50 mm HARDWOOD LAGGING
- ANCHORS TO BE 26 mm  $\phi$  DYWIDAG OR 2/16 STRANDS

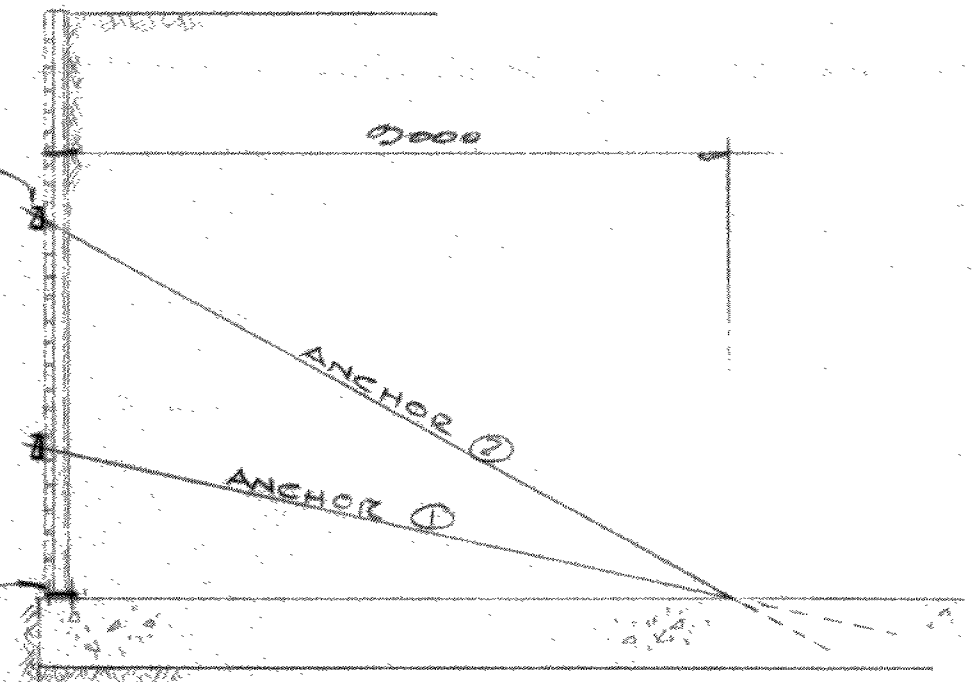


ELEVATION  
11100

FAIRVIEW STREET  
SHORING DETAILS  
W.P. 83-74-25

C200x17 WALER TYP.

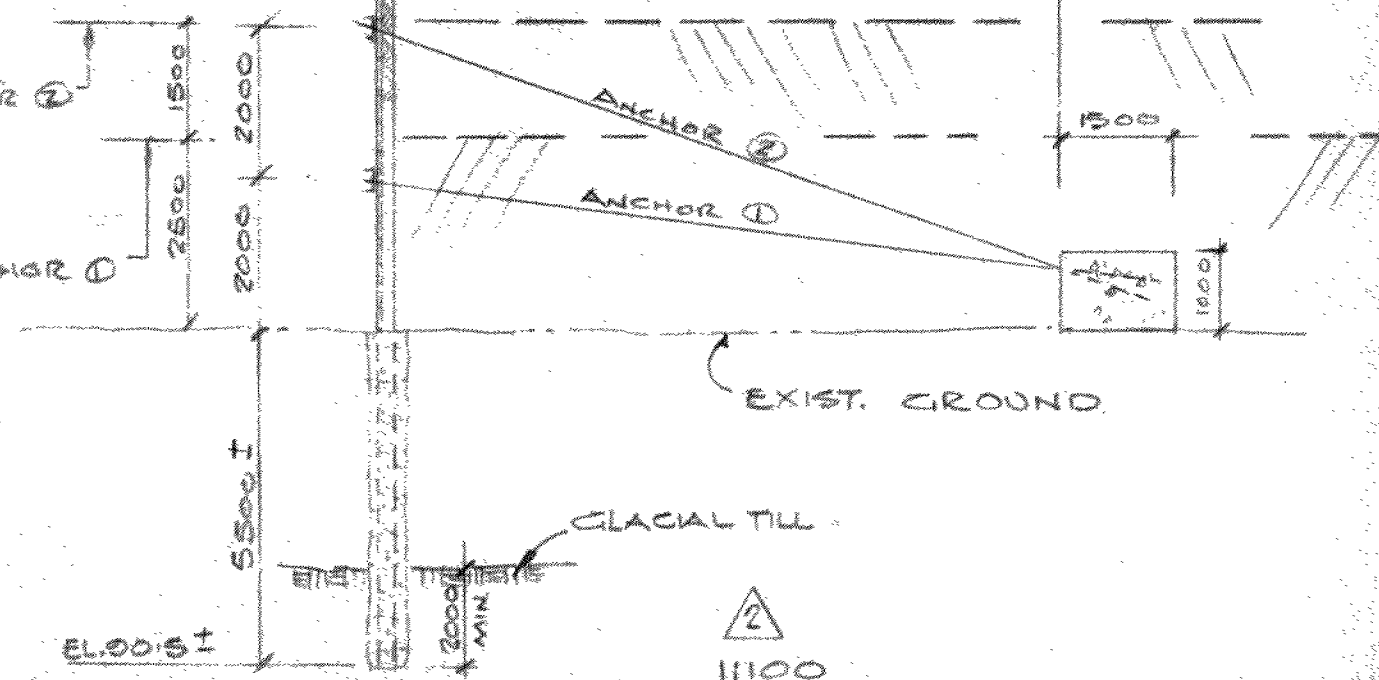
BOLTED  
CONNECTION



1  
11100

LIMIT OF MAX. FILL FOR  
INSTALLATION OF ANCHOR 2

LIMIT OF MAX. FILL FOR  
INSTALLATION OF ANCHOR 1



2  
11100



# PETO MacCALLUM LTD.

45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3C6

CONSULTING ENGINEERS

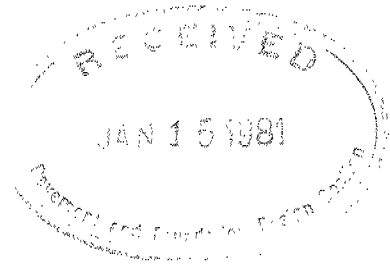
(416) 561-2231

(HEAD OFFICE:- 165 CARTWRIGHT AVE., TORONTO M6A 1V5 (416) 789-4105)

Job No. 80 F 300

January 7, 1981.

Ministry of Transportation &  
Communications,  
Highway Engineering Division,  
1201 Wilson Avenue,  
Room 234,  
Central Building,  
Downsview, Ontario.  
M3M 1J8



Attention: Mr. K. G. Selby, P. Eng.

Re: Grade Separation Structures at  
QEW and Hwy. 403W - Fairview Ramp,  
Site No. 10-135A, WP 83-74-26R,  
Site No. 10-135B, WP 83-74-27R,  
Burlington, Ontario.

Gentlemen:

Further to our recent preliminary report regarding this project dated December 29, 1980 and my subsequent conversations with your Mr. T. Kazmierowski regarding the need for additional confirmatory drilling relative to the installation of a driven pile foundation system, this letter is written to advise you that the supplementary field work is scheduled to be carried out on January 7, 1981.

You may recall from our discussions prior to commencement of this project that we conducted the original foundation investigation in 1955 for the bridge structure presently at the site. The subsurface information available in our files for this study was used as a basis for laying out the field program for the present project. Considering the excellent subsurface conditions for shallow foundations encountered initially and confirmed during the current work, it was decided that a considerable economic advantage could be realized by terminating the testholes at a depth shallower than that required to completely define the subsurface conditions for a deep foundation system. Additional confirmatory



drilling relative to a deep foundation system could be carried out following completion of the preliminary design should design and construction constraints dictate.

The supplementary field work currently planned will involve coring approximately 6 m of the bedrock. As this was not included in our original terms of reference, an additional cost will be incurred.

It should also be noted that the basis of payment for this work defined in the contract provided for our signature in late December is different from the standard contract form provided during our initial meeting with you on November 10, 1980 (redefinition of payroll cost, mark-up factor and charge-out rates for principals). Consequently, our estimated cost for this project contained in our letter of November 14, 1980 has not been prepared in accordance with the contract. Please advise what we should do to correct this situation.

We look forward to any questions you may have regarding the contents of this letter.

Yours very truly,  
PETO MacCALLUM LTD.

Dennis W. Kerr, P. Eng.,  
Regional Geotechnical Engineer.

DWK/rf