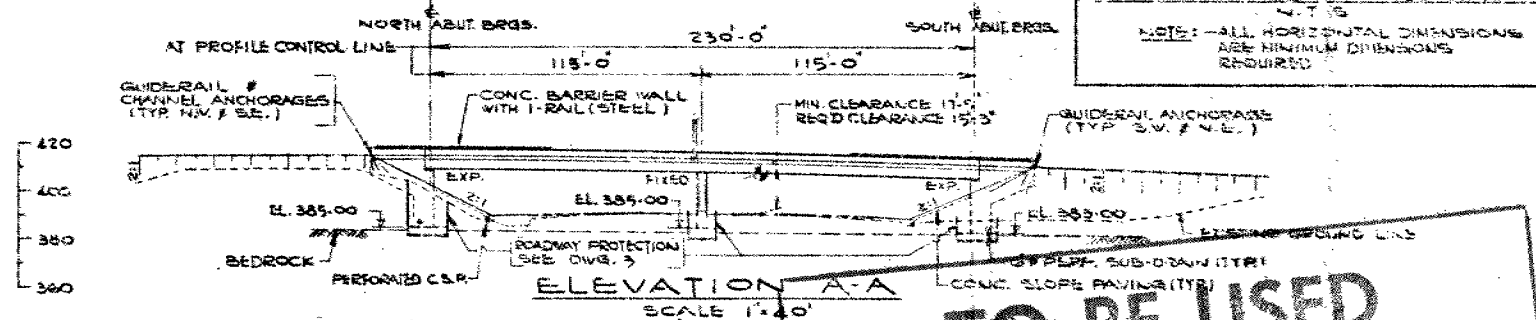
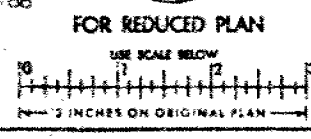
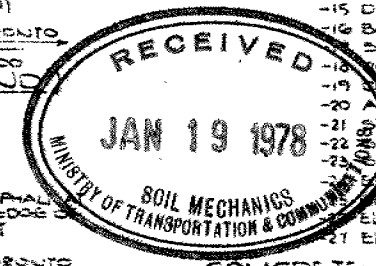
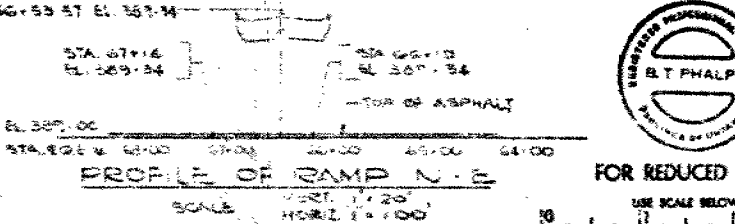
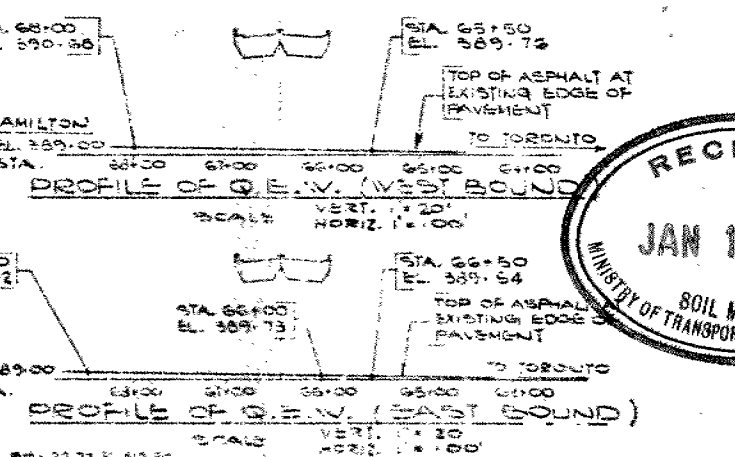
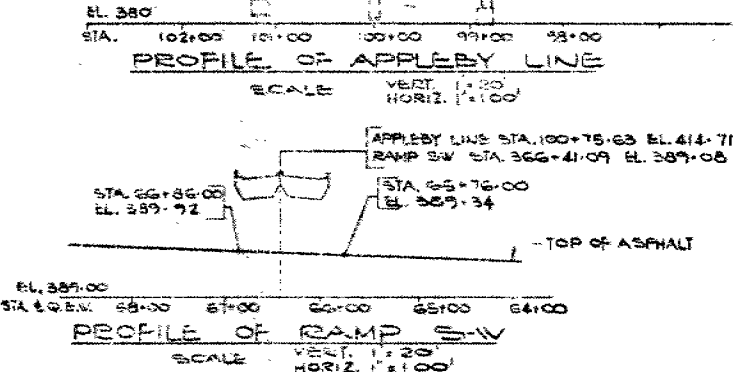
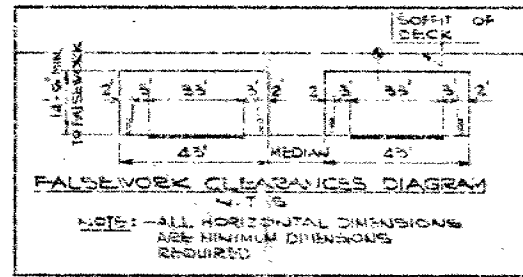
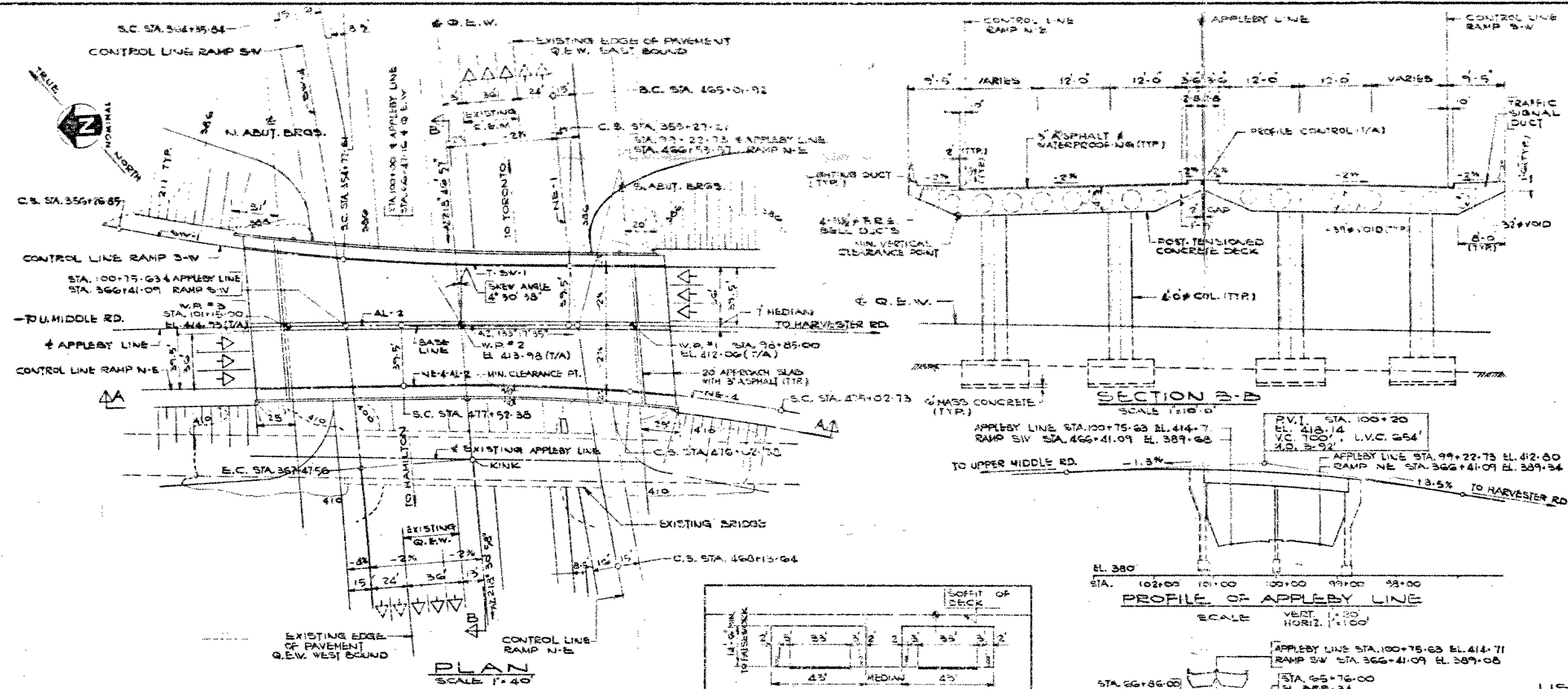
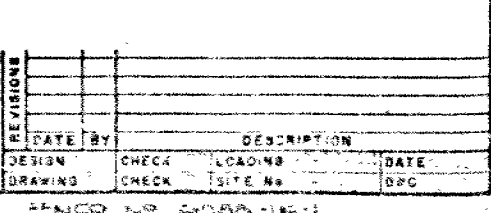
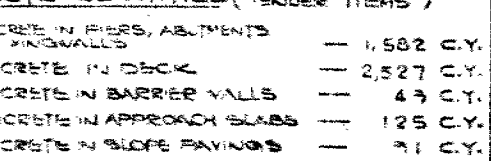
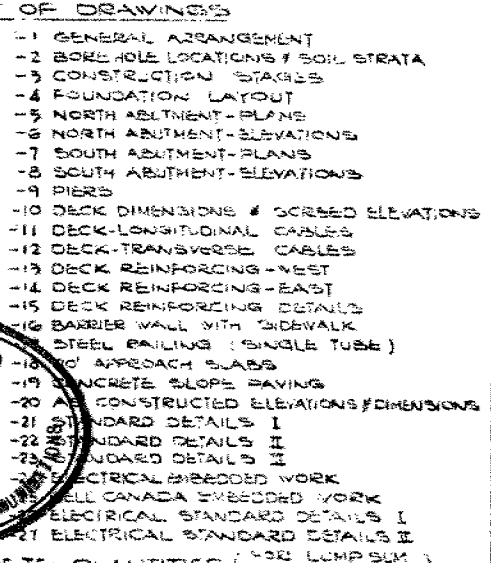
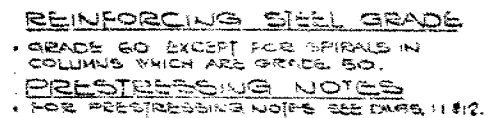
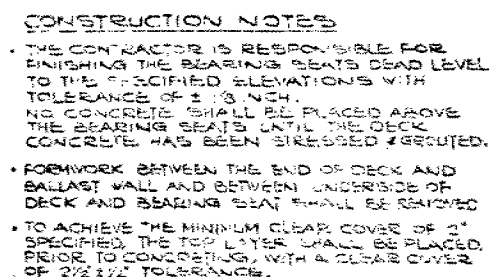
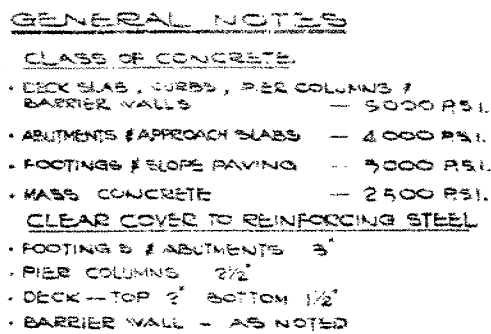


G.I.-30 SEPT. 1976

REMARKS: _____



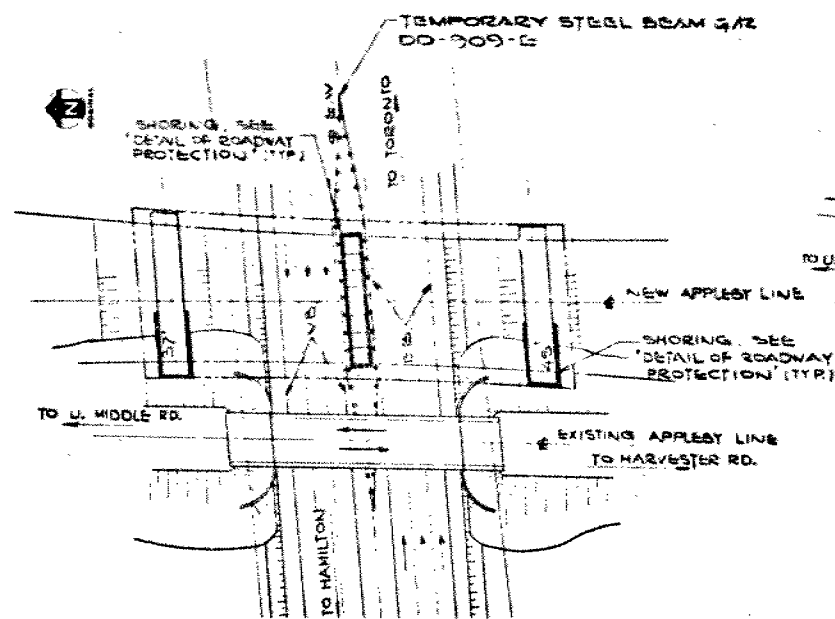
	STATION	CO. ORDINATES	
		NORTH	EAST
AMPLEST LINE	B.C. 37 + 21.64	76134.424	26914.239
	99 + 22.73	762350.258	27697.092
	I.D. 100 + 00.00	762403.437	27641.026
	100 + 15.63	762459.117	27585.607
	E.C. 106 + 32.03	762356.381	27130.982
RAMP S-W	C.S. 35 + 27.81	761382.502	27726.011
	B.C. 39.4 + 77.61	761438.368	27614.293
	C.S. 35.4 + 26.85	761604.461	27529.714
	B.C. 36.4 + 35.84	762624.566	27701.545
	36.4 + 11.09	762458.17	27465.087
B.C. 36.7 + 47.56	762375.594	27521.064	
RAMP N-E	B.C. 44.9 + 01.82	762470.918	27708.904
	46.8 + 38.91	761350.258	27671.092
	C.S. 46.8 + 19.64	762171.799	27607.245
	B.C. 47.9 + 02.73	762717.142	27755.700
	F.S. 47.6 + 02.38	762726.535	27642.972
B.C. 47.7 + 52.18	762400.240	27586.673	

RAMP SURVEY DATA									
#	Δ	D	R	T	L	E			
SW-1	27.42	5'00.00	145.96	74.72	100.00	2.43			
SW-4	6'4.04	2'00.00	264.78	120.00	100.00	3.245			
SPIRAL DATA									
#	LS	Δ	OS	Δ	OS	Δ	OS	Δ	OS
1-SW-1	75.000	3.4570	2.222	50.000	5.0000				

RAMP N-E									
CURVE DATA									
	A	B	C	R	T	L	E		
NE-1	3	404	20000	2364.79	56.03	91.722	1.215		
NE-4	5	534.46	20000	261.95	47.55	99.659	1.302		

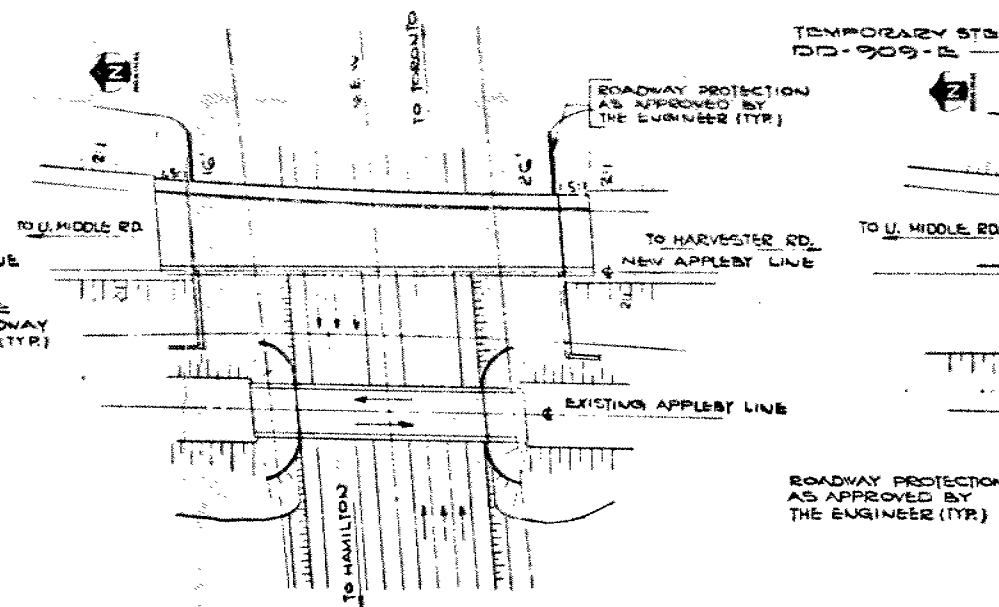
SPIRAL DATA									
	A	B	C	R	T	L	E		
NE-4AL-2	50	000	4	42.35	56.02	99.680	200000	3	10.96

TO BE USED
FOR ESTIMATING
PURPOSES ONLY



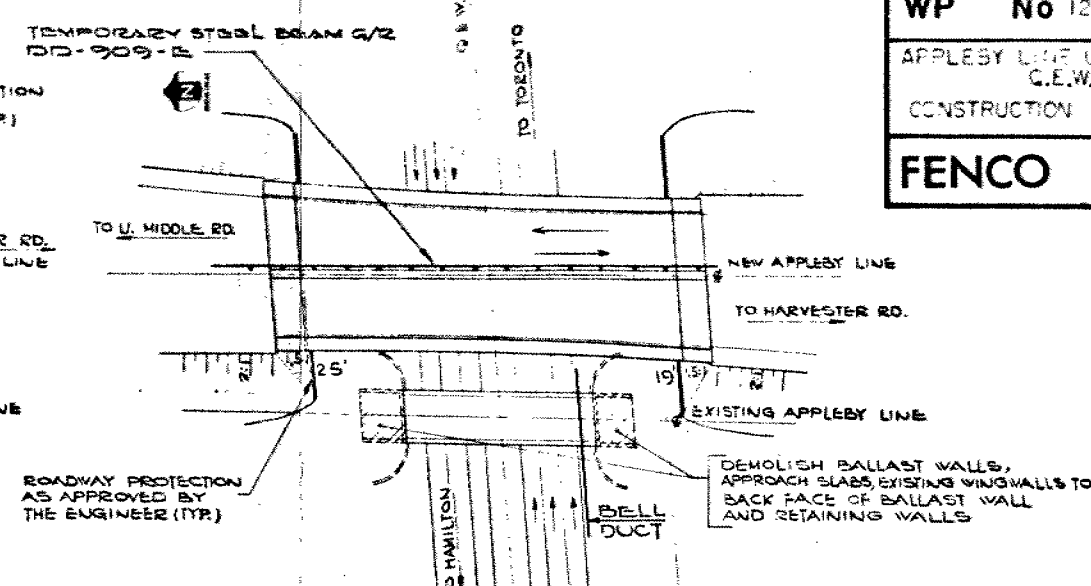
STAGE I-A

PLACE ROADWAY PROTECTION AND CONSTRUCT FOOTINGS, ABUTMENTS AND PIERS FOR BOTH HALVES OF NEW BRIDGE.
 CONSTRUCT SUPERSTRUCTURE FOR EAST HALF.
 Q.E.W. TRAFFIC UNCHANGED
 APPLEBY LINE TRAFFIC UNCHANGED



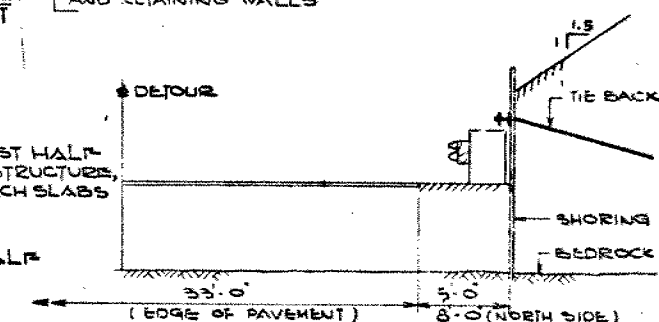
STAGE I-B

PLACE ROADWAY PROTECTION APPROACH FILL AND APPROACH SLABS ON EAST SIDE.
 Q.E.W. TRAFFIC UNCHANGED
 APPLEBY LINE TRAFFIC UNCHANGED

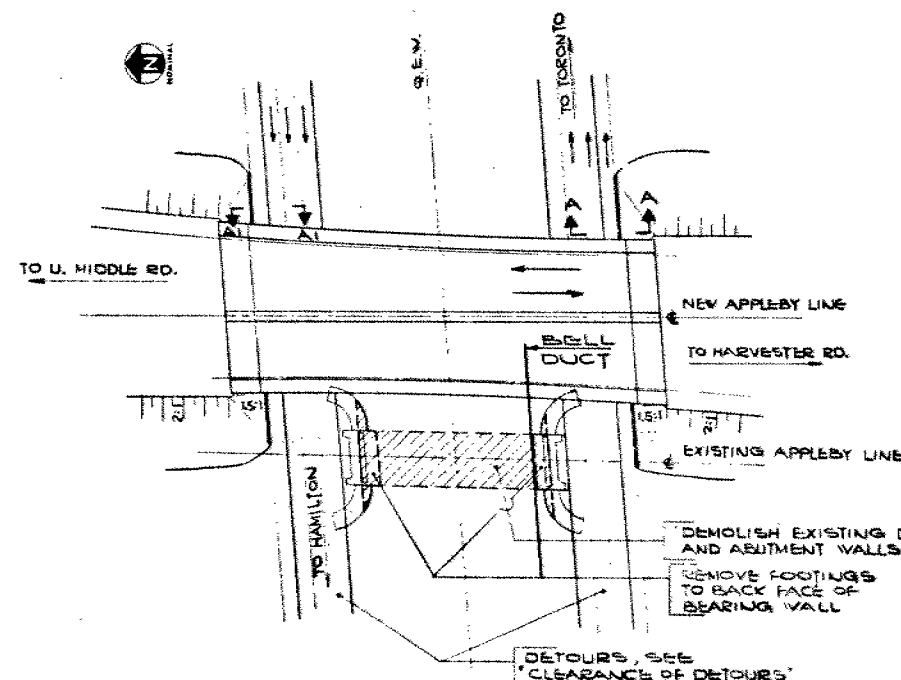


STAGE II

SWITCH APPLEBY LINE TRAFFIC TO EAST HALF OF NEW STRUCTURE. CONSTRUCT SUPERSTRUCTURE, PLACE APPROACH FILL AND APPROACH SLABS FOR WEST HALF OF BRIDGE.
 Q.E.W. TRAFFIC UNCHANGED
 APPLEBY LINE TRAFFIC ON EAST HALF OF NEW BRIDGE.

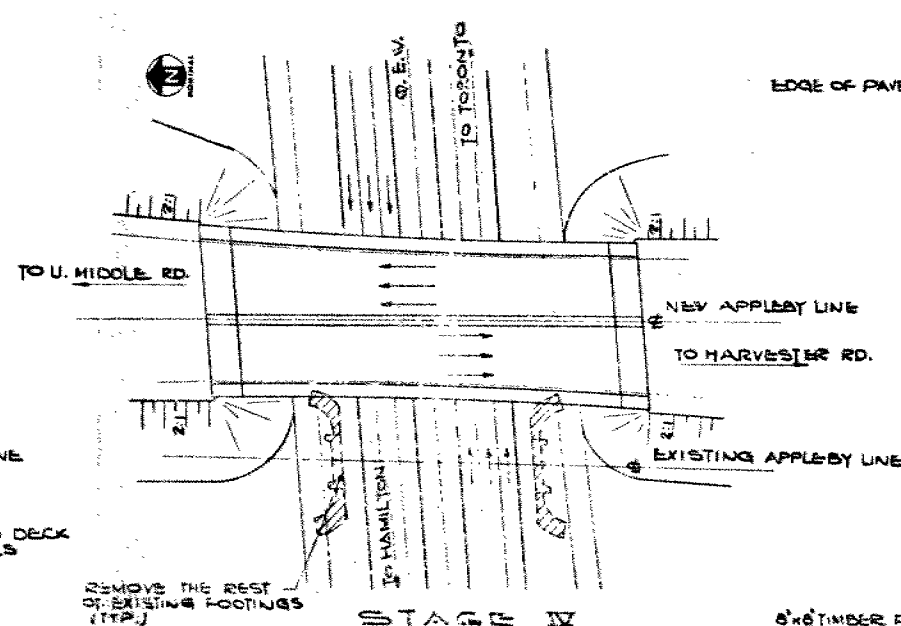


SECTION A-A
 SECTION A-A, SIMILAR EXCEPT AS NOTED
 SCALE 1/4" = 1'-0"



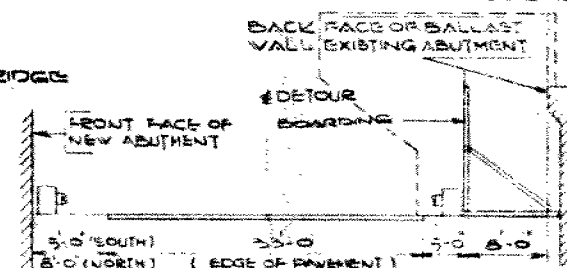
STAGE III

1. DETOUR Q.E.W. TRAFFIC
 2. DEMOLISH REMAINDER OF EXISTING BRIDGE
 Q.E.W. TRAFFIC ON DETOUR
 APPLEBY LINE TRAFFIC ON EAST HALF OF NEW BRIDGE.

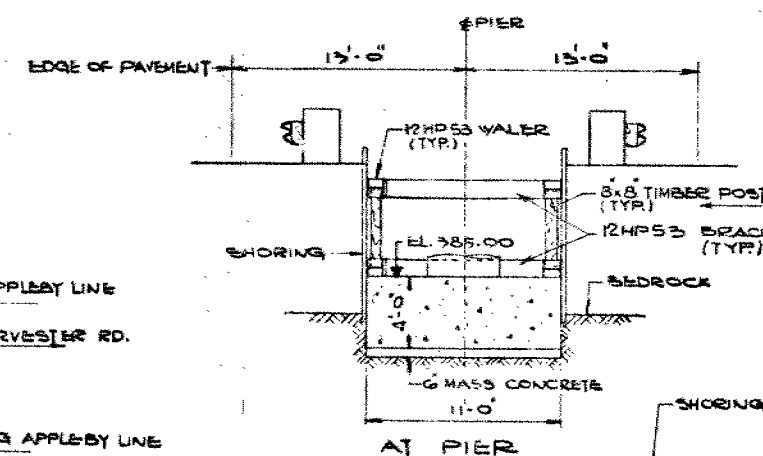


STAGE IV

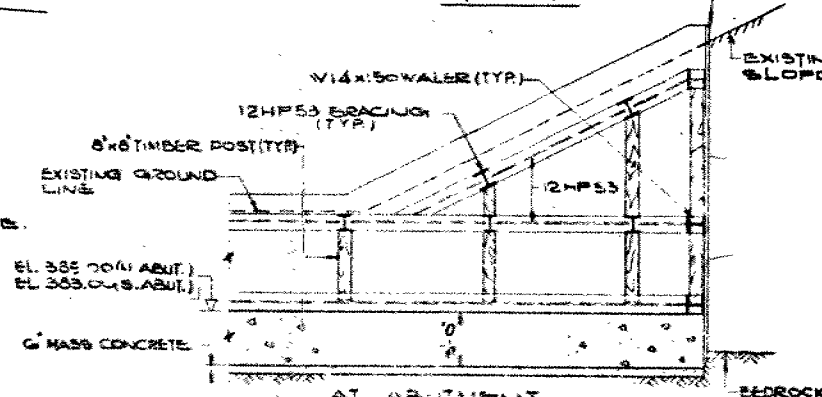
1. SWITCH BACK Q.E.W. TRAFFIC TO Q.E.W.
 Q.E.W. TRAFFIC ON Q.E.W.
 APPLEBY LINE TRAFFIC ON NEW BRIDGE.



CLEARANCE OF DETOURS
 SCALE 1/4" = 1'-0"



AT PIER



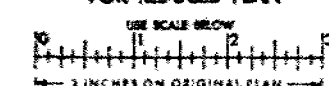
AT ABUTMENT

SUGGESTED DETAILS OF ROADWAY PROTECTION

NOTES:

- FOR GENERAL NOTES SEE DWG. 1
- FOR TRAFFIC STAGES SEE SHEET
- DURING DEMOLITION OF THE DECK THE PAVEMENT ON THE Q.E.W. SHALL BE PROTECTED AGAINST DAMAGE, BY MEANS OF A SAND AND/OR TIMBER BLANKET AS APPROVED BY THE ENGINEER.
- FOR ALIGNMENT OF DETOURS SEE SHEET

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION	DATE



INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3- 13	Foundation Investigation Report Culvert at Sta. 57+10 and Structure at Appleby Line W.P.s 125-66-08/09

NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

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

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

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

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

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

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

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

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

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

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

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

FIELD SAMPLING

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

EARTH PRESSURE TERMS

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

INDEX PROPERTIES

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

STRENGTH PARAMETERS

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

HYDRAULIC TERMS

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

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

FOUNDATION INVESTIGATION REPORT

For

Culvert at Sta. 57+10 and
Structure at Appleby Line
Q.E.W. District 4 (Hamilton)
W.P.s 125-66-08/09

INTRODUCTION

This report contains the results of a foundation investigation covering the Appleby Line Q.E.W. interchange structure, and a culvert at Sta. 57+10.

Fieldwork consisted of 8 dynamic cone penetration tests, and 8 sampled boreholes advanced during the period February 24th to March 3rd, 1977, utilizing a CME 55 auger machine mounted on a muskeg vehicle. All boreholes were advanced employing solid augers. Four of these boreholes were cased with BX casing, and BXL rock core samples were attained.

SITE DESCRIPTION

Appleby Line crosses the Q.E.W. on a flyover approximately 2.6 miles west of the Highway 25 Q.E.W. interchange. The Q.E.W. in this area consists of 6 traffic lanes with a paved median and median barrier. It is paralleled by North and South Service Roads, which veer away from the Q.E.W. to intersect Appleby Line some 800 to 900 feet north and south of the Highway.

The surrounding area is in the process of being converted from agricultural to industrial uses. Appleby Line is flanked by industrial development both north and south of the Highway.

The ground surface is generally flat with a gentle slope to the southeast. Exceptions to this flat topography are the minor stream channels in the area, and a shore cut cliff paralleling the Q.E.W. a third of a mile to the south.

SUBSURFACE CONDITIONS

General

Subsoil consists of a shallow deposit of clayey silt overlying shale bedrock. Deposit boundaries are shown in the Record of Borehole Sheets, which are contained in the Appendix of this report. The locations and elevations of the borings are shown on Sheets Nos. 79 and 118 of the Contract Drawings.

Subsoil

The subsoil consists of a shallow deposit of red clayey silt ranging in depth from 4 to 7 feet. It has a stiff to hard consistency with Standard Penetration 'N' values ranging from less than 10 to in excess of 80 blows per foot. Moisture content varies from 8 to 20 percent.

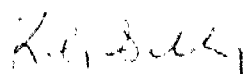
The approach fills for the existing Appleby Line flyover have been overbuilt so that they encroach on the proposed abutment locations for the new structure. These fills consist primarily of clayey silt but do contain some pieces of shale. Standard Penetration tests carried out on the fill material indicated a stiff to hard consistency with 'N' values ranging from 8 to 39 blows per foot. Moisture content varies between 15 and 20 percent. Dynamic cone penetration tests were carried out at two locations in the fill with the cone penetrating to the base of the fill in both cases.

Bedrock

Queenston shale bedrock underlies the clayey silt overburden. It is generally red in colour but contains harder greenish shaley limestone bands, which are generally less than 2 inches in thickness. The shale shows evidence of severe weathering at the surface but improves in quality with depth.

Groundwater

Groundwater was encountered in the shale at elevation 376 to 378 some 8 to 12 feet below the ground surface.



K.G. Selby, P. Eng.
Senior Foundations Engineer

May 28, 1980

APPENDIX

RECORD OF BOREHOLE NO 1

WP 125-66-08 & 09 LOCATION Co-ords. N 15 763 195; E 928 085 ORIGINATED BY JM
 DIST 4 HWY Q.E.W. BORING DATE March 2, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, BX Casing, BXL Core & Cone Test CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
386.9	Ground Level													
6.0	Clayey Silt		1	SS	28									
381.9	Stiff to Hard		2	SS	100	6"								
5.0	Queenston Shale		3	SS	100	3"								
	Bedrock, Severely		4	SS	82									
	to Moderately													
	Weathered		6	SS	100	3"								
			7	SS	100	2 1/2"								
			8	SS	100	1"								
361.9			9	BXL RC	85% Rec									
25.0	End of Borehole													
	Note: Water Level not Established													

RECORD OF BOREHOLE NO. 3

WP 125-66-08 & 09

LOCATION Co-ords. N 15 763 263; E 928 230

ORIGINATED BY JM


DIST 4 HWY 4 QEN

BORING DATE March 3, 1977

COMPILED BY JM

DATUM Geodetic

BOREHOLE TYPE Solid Augers & Cone Test

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES		20	40	60	80	100	w_p	w	w_L		
384.2	Ground Level															
0.0	Clayey Silt		1	SS	21	380							o			
379.2	Stiff to Hard		2	SS	100	7"							o			
5.0	Queenston Shale		3	SS	100	3"							o			
	Bedrock		4	SS	100	3"										
	Severely to		5	SS	100	4"										
	Moderately Weathered		6	SS	100	1"										
366.7			7	SS	50	0"										
17.5	End of Borehole															
	Note: Water Level not Established															

RECORD OF BOREHOLE NO 4

WP 125-66-08 & 09

LOCATION Co-ords N 15 763 116; E 928 296

ORIGINATED BY JM

DIST 4 HWY QEW

BORING DATE March 3, 1977

COMPILED BY JM


DATUM Geodetic

BOREHOLE TYPE Solid Augers & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P — W — W_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
385.9	Ground Level													
0.0	Clayey Silt Stiff to Hard		1	SS	8									
378.9			2	SS	9									
4.0	Queenston Shale Bedrock Severely to Moderately Weathered		3	SS	100	6"								
			4	SS	32									
			5	SS	100	6"								
368.3			6	SS	153	9" 370								
17.6	End of Borehole		7	SS	100	1"								

RECORD OF BOREHOLE No 6

WP 125-66-08 & 09 LOCATION Co-ords N 15 763 109; E 928 416 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE March 1, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, BX Casing BXL Core & Cone Test CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
380.4	Ground Level					380										
0.0	Clayey Silt															
376.4	Stiff to Hard		1	SS	57											
4.0	Queenston Shale		2	SS	75	3"										
	Bedrock		3	SS	100	5"										
	Severely to Moderately Weathered		4	BXL RC	70% Rec	370										
366.1																
14.3	End of Borehole															
	Note: Water Level not Established															

RECORD OF BOREHOLE NO 7

WP 125-66-08 & 09

LOCATION Co-ords N 15 762 446; E 927 514

ORIGINATED BY JM

DIST 4 HWY QEW

BORING DATE February 25, 1977

COMPILED BY JM

DATUM Geodetic

BOREHOLE TYPE Solid Augers & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
410.4	Ground Level															
0.0	Fill					410										
	Clayey Silt with Shale pieces		1	SS	12											
	Stiff to Hard		2	SS	8											
			3	SS	14											
			4	SS	12											
			5	TW	PH											
			6	SS	16											
388.4	Clayey Silt		7	SS	10											
22.0	Stiff to Hard		8	SS	85											
384.4	Queenston Shale		9	SS	100/6"											
26.0	Bedrock		10	SS	100/4"											
	Severely to		11	SS	50/1"											
	Moderately Weathered		12	SS	100/3"											
370.1	End of Borehole					370										
40.3	Note: Water Level not Established															

RECORD OF BOREHOLE NO 8

WP 125-66-08 & 09 LOCATION Co-ords N 15 762 540; E 927, 596 ORIGINATED BY JM
 DIST 4 HWY QFW BORING DATE February 24, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Auger, B Casing BXL Core & Cone Test CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
387.4	Ground Level															
0.0	Clayey Silt															
383.4	Stiff to Hard		1	SS	24											
4.0	Queenston Shale		2	SS	100	6"										
	Bedrock		3	SS	100	5"										
	Severely to		4	SS	100	4"										
	Moderately Weathered		5	AS	100	3"										
			6	SS	100	3"										
			7	SS	80	3"										
362.8			8	BXL	100%											
				RC												
24.6	End of Borehole															

RECORD OF BOREHOLE NO 9

WP 125-66-08 & 09
DIST 4 HWY QEW
DATUM Geodetic

LOCATION Co-ords N 15 762 262; E 927 684
BORING DATE February 28, 1977
BOREHOLE TYPE Solid Augers & Cone Test

ORIGINATED BY JM
COMPILED BY JM
CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N VALUES		20	40	60	80	100	W_P	W	W_L		
411.7	Ground Level					410										
0.0	Fill															
	Clayey Silt with Shale pieces		1	SS	10											
	Stiff to Hard		2	SS	39	400										
			3	SS	12											
			4	SS	22											
			5	SS	18											
			6	SS	11	390										
387.7			7	SS	19											
24.0	Clayey Silt		8	SS	17											
383.7	Stiff to Hard		9	SS	150	10"										
28.0	Queenston Shale		10	SS	165	380										
	Bedrock		11	SS	100	3"										
	Severely to		12	SS	75	4"										
	Moderately					370										
	Weathered		13	SS	100	4"										
366.4																
45.3	End of Borehole															
	Note: Water Level not Established															

RECORD OF BOREHOLE NO 10

WP 125-66-08&09 LOCATION Co-ords N 15 762 354; E 927 757 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE March 1, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, B Casing BXL Core & Cone Test CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
387.0	Ground Surface															
0.0	Clayey Silt															
382.0	Stiff to Hard		1	SS	31											
5.0	Queenston Shale Bedrock Severely to Moderately Weathered		2	SS	91	380										
			3	SS	105/4"											
			4	SS	106/4"											
			5	SS	106/3"											
			6	SS	106/2"											
			7	SS	106/3"	370										
360.5			8	BXL RC	95% rec.											
26.5	End of Borehole Note: Water Level not Established															

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 125-66-09

DIST 4

HWY QEW

STR SITE 10-148

The Structure and Culvert
at Appleby Line Interchange

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FOUNDATION INVESTIGATION REPORT
For

The Structure and Culvert at Appleby Line Interchange
W.P. 125-66-09, Site 10-148
QEW, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation covering the Appleby Line QEW interchange structure, and two proposals for increasing the capacity of a concrete culvert located some 1000 feet east of Appleby Line.

Fieldwork consisted of 8 dynamic cone penetration tests, and 8 sampled boreholes advanced during the period February 24th to March 3rd 1977, utalizing a CME 55 auger machine mounted on a muskeg vehicle. All boreholes were advanced employing solid augers. Four of these boreholes were cased with BX casing, and BXL rock core samples were attained.

SITE DESCRIPTION

Appleby Line crosses the QEW on a flyover approximately 2.6 miles west of the Highway 25 QEW interchange. The QEW in this area consists of 6 traffic lanes with a paved median and median barrier. It is paralleled by North and South Service Roads, which veer away from the QEW to intersect Appleby Line some 800 to 900 feet north and south of the Highway.

The surrounding area is in the process of being converted from agricultural to industrial uses. Appleby Line is flanked by industrial development both north and south of the Highway.

The ground surface is generally flat with a gentle slope to the southeast. Exceptions to this flat topography are the minor stream channels in the area, and a shore cut cliff paralleling the QEW a third of a mile to the south.

SUBSURFACE CONDITIONS

General

Subsoil consists of a shallow deposit of clayey silt overlying shale bedrock. Deposit boundaries are shown in the Record of Borehole Sheets,

which are contained in the Appendix of this report. The locations and elevations of the borings are shown on Drawings numbered 1256609-A and 1256609-B.

Subsoil

The subsoil consists of a shallow deposit of red clayey silt ranging in depth from 4 to 7 feet. It has a stiff to hard consistency with Standard Penetration 'N' values ranging from less than 10 to in excess of 80 blows per foot. Moisture content varies from 8 to 20 percent.

The approach fills for the existing Appleby Line flyover have been overbuilt so that they encroach on the proposed abutment locations for the new structure. These fills consist primarily of clayey silt but do contain some pieces of shale. Standard Penetration tests carried out on the fill material indicated a stiff to hard consistency with 'N' values ranging from 8 to 39 blows per foot. Moisture content varies between 15 and 20 percent. Dynamic cone penetration tests were carried out at two locations in the fill with the cone penetrating to the base of the fill in both cases.

Bedrock

Queenston shale bedrock underlies the clayey silt overburden. It is generally red in colour but contains harder greenish shaley limestone bands, which are generally less than 2 inches in thickness. The shale shows evidence of severe weathering at the surface but improves in quality with depth.

Groundwater

Groundwater was encountered in the shale at elevation 376 to 378 some 8 to 12 feet below the ground surface.

DISCUSSIONS AND RECOMMENDATIONS

Discussion

It is proposed that Appleby Line cross the QEW on a 6 lane 2 span structure with each span approximately 115 feet in length. The vertical curvature of the proposed grade for Appleby Line is eccentric so that the highest point is located north of the QEW where the fill height will be approximately 28 feet. The new interchange structure will be located east of the existing structure.

The construction of the interchange will require changes in the drainage pattern through stream channelization and the increasing of the capacity of an existing culvert located some 1000 feet east of Appleby Line. This increased capacity will be achieved either by replacing the existing concrete culvert with a larger one or by extending the existing one and twinning it.

Structure Foundations

Centre pier: The centre pier should be supported by a spread footing founded in the shale bedrock at elevation 381. The maximum allowable design loading is 10 tons per square foot. Resistance to sliding may be calculated assuming a coefficient of friction of .45.

Shale bedrock will deteriorate rapidly on exposure to the elements. For this reason a 6 inch layer of mass concrete should be placed in the bottom of the footing excavation within 3 hours of their being excavated to grade.

Abutments: Abutments perched in the approach fills may be supported on steel H-piles with reinforced tips driven into the weathered shale bedrock. These piles may be loaded to the allowable structural capacity of the section chosen. The estimated tip elevation for piles in both the north and south abutment is 376±.

If full height abutments are required, they may be supported by spread footings founded in the shale bedrock. Recommendations for this case are the same as for the centre pier with a maximum design loading of 10 tons per square foot for footings founded at elevation 380 for the south abutment, and 382 for the north abutment.

Approach Fills

No stability problems are anticipated with the approach fills if slopes of 2 horizontal to 1 vertical are employed. In areas where new fill will be placed against the existing approach fills the topsoil should be removed, and the slopes benched in accordance with standard DD 414.

Culvert Footings

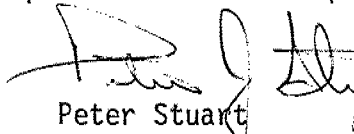
Any new concrete culvert or culvert extensions may be supported on spread footings in the shale bedrock with a design loading of up to 10 tons per square foot. The footings must be founded 4 feet below the invert elevations to provide for frost protection.

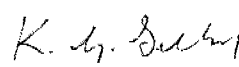
Miscellaneous

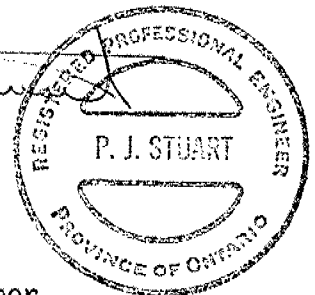
No dewatering problems are anticipated due to the relatively impervious nature of the subsoil. Any seepage into the footing excavations may be removed by pumping from sumps.

All footings or pile caps should be protected against frost action by a minimum 4 feet of cover.

All fieldwork was conducted under the supervision of John Murray, Student Technician who also aided in the preparation of this report.


Peter Stuart
Project Engineer


K.G. Selby
Supervising Engineer



PS/KGS/lf
April, 1977

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 125-66-09 LOCATION Co-ords. N 15 763 195; E 928 085 ORIGINATED BY JM
 DIST 4 HWY Q.E.W. BORING DATE March 2, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, BX Casing, BXL Core & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L	
386.9	Ground Level														
0.0	Clayey Silt		1	SS	28										
381.9	Stiff to Hard		2	SS	100	6"									
5.0	Queenston Shale Bedrock, Severely to Moderately Weathered		3	SS	100	3"									
			4	SS	82										
			6	SS	100	3"									
			7	SS	100	2 1/2"									
			8	SS	100	1"									
361.9			9	BXL RC	85% Rec.										
25.0	End of Borehole Note: Water Level not Established														

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 125-66-09 LOCATION Co-ords. N 15 763 263; E 928 230 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE March 3, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers & Cone Test CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W $W_P \quad W \quad W_L$ WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
384.2	Ground Level													
0.0	Clayey Silt													
379.2	Stiff to Hard		1	SS	21	380								
5.0	Queenston Shale		2	SS	100	7"								
	Bedrock		3	SS	100	3"								
	Severely to		4	SS	100	3"								
	Moderately Weathered		5	SS	100	4"								
366.7			6	SS	100	1"								
			7	SS	50	0"								
17.5	End of Borehole													
	Note: Water Level not Established													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 125-66-09 LOCATION Co-ords N 15 763 116; E 928 296 ORIGINATED BY JM
DIST 4 HWY QEW BORING DATE March 3, 1977 COMPILED BY JM
DATUM Geodetic BOREHOLE TYPE Solid Augers & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
385.9	Ground Level															
0.0	Clayey Silt Stiff to Hard		1	SS	8											
378.9			2	SS	9											
4.0	Queenston Shale Bedrock Severely to Moderately Weathered		3	SS	100	6"										
			4	SS	32											
			5	SS	100	6"										
368.3			6	SS	153	9"370										
			7	SS	100	1"										
17.6	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 125-66-09 LOCATION Co-ords N 15 763 109; E 928 416 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE March 1, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, BX Casing BXL Core & Cone Test CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
380.4	Ground Level					380				
0.0	Clayey Silt									
376.4	Stiff to Hard		1	SS	57					
4.0	Queenston Shale		2	SS	75	3"				
	Bedrock		3	SS	100	5"				
	Severely to Moderately Weathered		4	BXL RC	70% Rec	370				
366.1										
14.3	End of Borehole									
	Note: Water Level not Established									

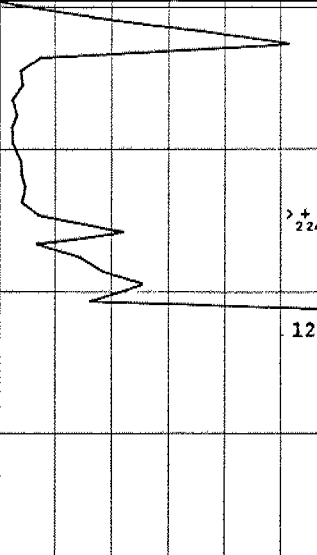
OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 125-66-09 LOCATION Co-ords N 15 762 446; E 927 514 ORIGINATED BY JM
DIST 4 HWY QEW BORING DATE February 25, 1977 COMPILED BY JM
DATUM Geodetic BOREHOLE TYPE Solid Augers & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w WATER CONTENT % w_p w w_L 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
410.4	Ground Level						SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000							
0.0	Fill Clayey Silt with Shale pieces Stiff to Hard		1	SS	12	410								
			2	SS	8									
			3	SS	14									
			4	SS	12									
			5	TW	PH									
			6	SS	16									
388.4	Clayey Silt		7	SS	10	390								
22.0	Stiff to Hard		8	SS	85									
384.4			9	SS	100/6"									
26.0	Queenston Shale Bedrock Severely to Moderately Weathered		10	SS	100/4"380									
			11	SS	50/2"									
370.1			12	SS	100/3"370									
40.3	End of Borehole Note: Water Level not Established													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 125-66-09 LOCATION Co-ords N 15 762 540; E 927, 596 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE February 24, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Auger, B Casing EXL Core & Cone Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
387.4	Ground Level									
0.0	Clayey Silt									
383.4	Stiff to Hard		1	SS	24					
4.0	Queenston Shale		2	SS	100	6"				
	Bedrock		3	SS	100	5"				
	Severely to		4	SS	100	4"				
	Moderately Weathered		5	AS						
			6	SS	100	3"				
			7	SS	80	3"				
						370				
362.8			8	BXL	100%					
24.6	End of Borehole			RC						

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 9

WP 125-66-09 LOCATION Co-ords N 15 762 262; E 927 684 ORIGINATED BY JM
DIST 4 HWY QEW BORING DATE February 28, 1977 COMPILED BY JM
DATUM Geodetic BOREHOLE TYPE Solid Augers & Cone Test CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L	
411.7	Ground Level														
0.0	Fill					410									
	Clayey Silt with Shale pieces		1	SS	10										
	Stiff to Hard		2	SS	39	400									
			3	SS	12										
			4	SS	22										
			5	SS	18										
			6	SS	11	390									
387.7	Clayey Silt		7	SS	19										
24.0	Stiff to Hard		8	SS	17										
383.7	Queenston Shale		9	SS	150	10"									
28.0	Bedrock		10	SS	165	380									
	Severely to Moderately Weathered		11	SS	100	3"									
			12	SS	75	1/2"									
366.4			13	SS	100	4"									
45.3	End of Borehole														
	Note: Water Level not Established														

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 10

WP 125-66-09 LOCATION Co-ords N 15 762 354; E 927 757 ORIGINATED BY JM
 DIST 4 HWY QEW BORING DATE March 1, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Solid Augers, B Casing BXL Core & Cone Test CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
387.0	Ground Surface													
0.0	Clayey Silt													
382.0	Stiff to Hard		1	SS	31									
5.0	Queenston Shale Bedrock Severely to Moderately Weathered		2	SS	91									
			3	SS	105/4"									
			4	SS	100/4"									
			5	SS	100/3"									
			6	SS	100/2"									
			7	SS	100/3"									
360.5			8	BXL RC	95% rec.									
26.5	End of Borehole Note: Water Level not Established													

OFFICE REPORT ON SOIL EXPLORATION

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS :-

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

TYPE OF SAMPLE

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

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

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

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

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

GENERAL

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

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

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

FOUNDATIONS

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

SLOPES

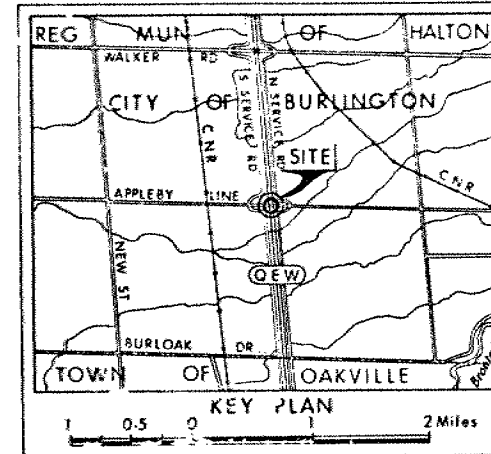
H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

CONT No
WP No 125-66-09



APPLEBY LINE
(2.6 Miles West of Hwy 25)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- "N" Blows/ft (Std Pen Test 350ft lbs energy)
- CONC Blows/ft (60° Cone, 350ft lbs energy)
- Wt at time of investigation Feb 1977
- Wt Not Established in Bore Holes 7, 9 and 10

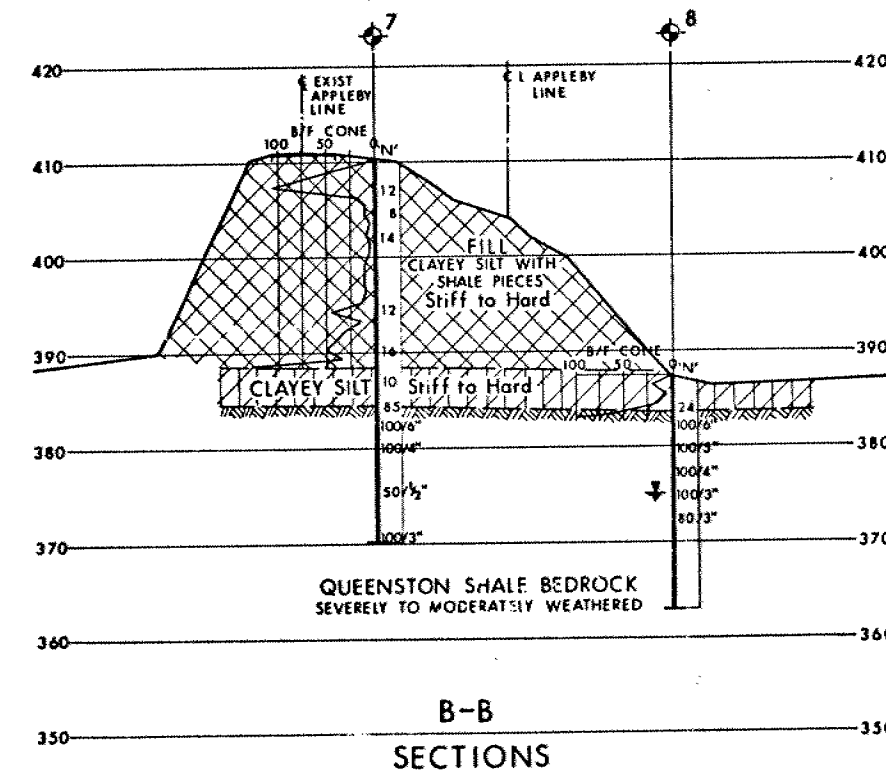
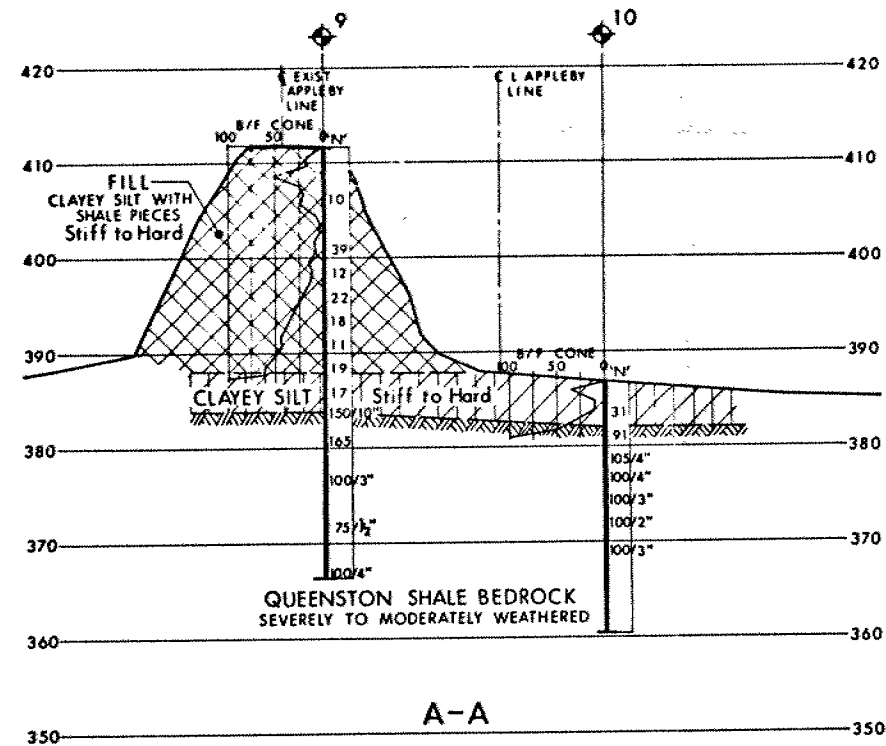
No	ELEVATION	CO-ORDINATES NORTH	EAST
7	410.4	15 762 446	927 514
8	387.4	15 762 540	927 596
9	411.7	15 762 262	927 684
10	387.0	15 762 354	927 757

-NOTE-

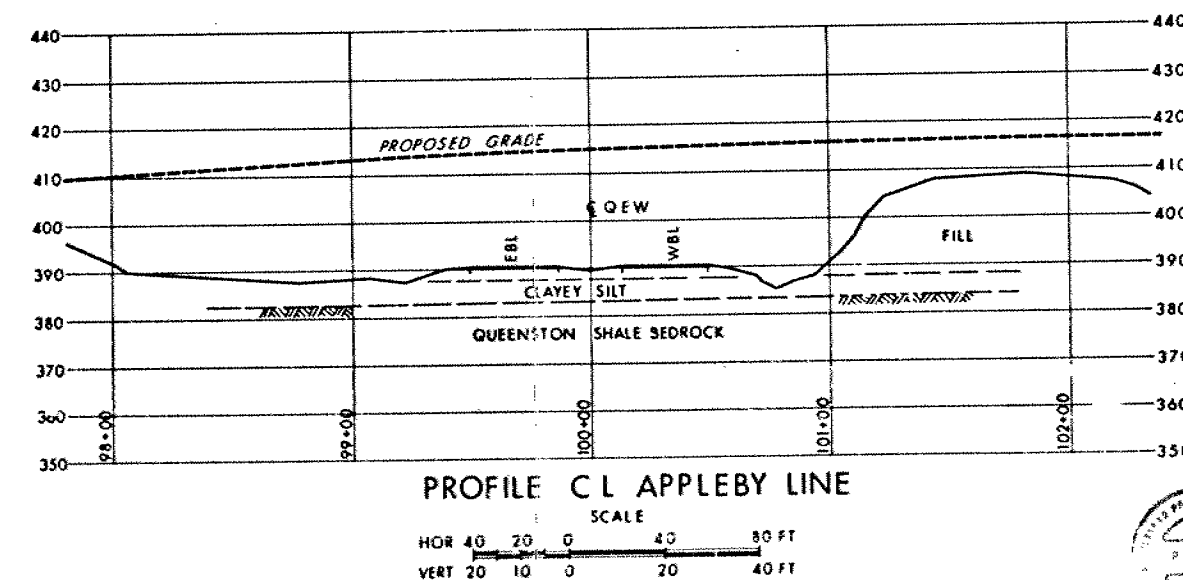
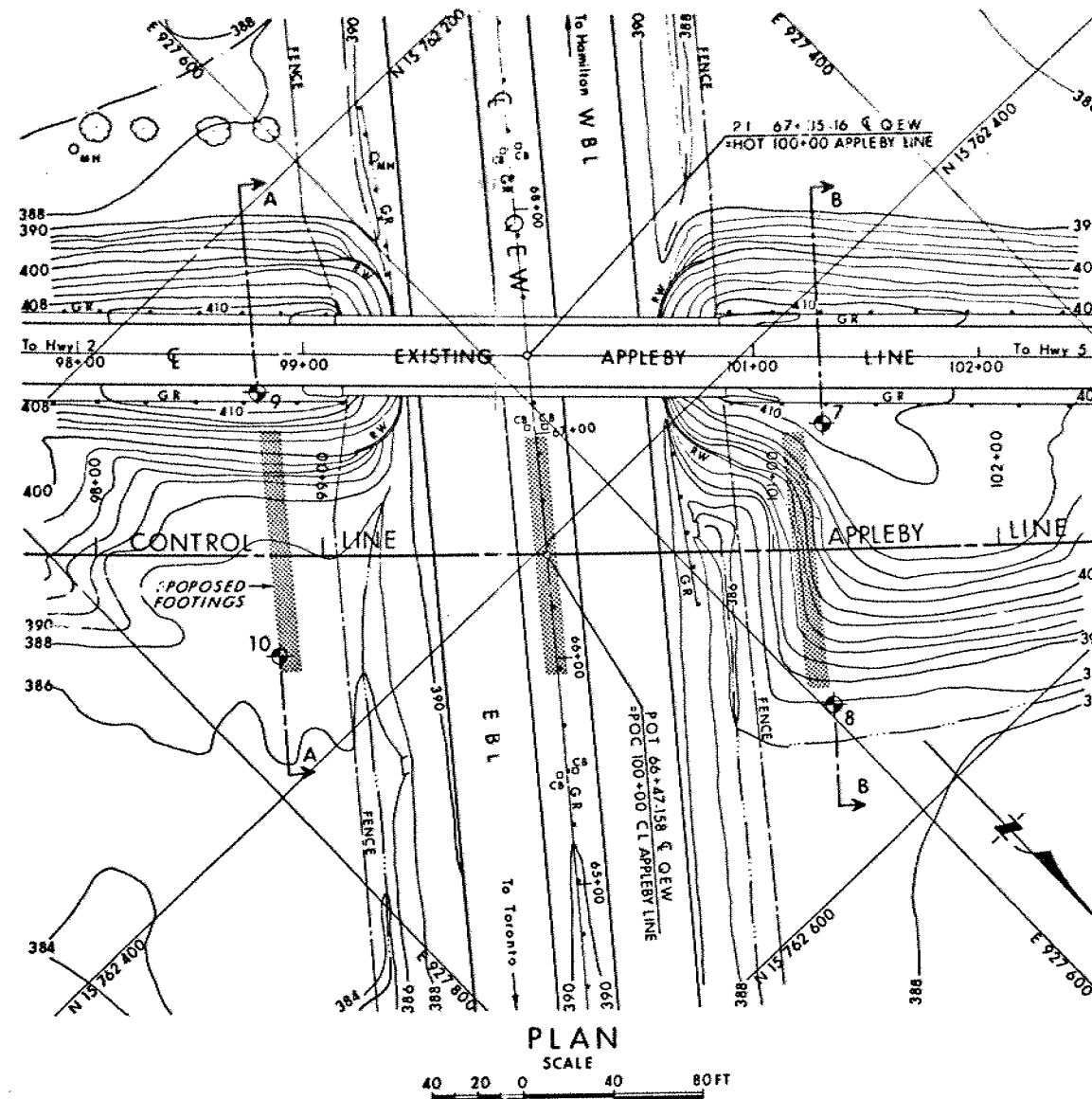
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

HWY No. QEW
SHEET 3 M CHECKED DATE April 14, 1977 SHEET 10-148
DRAWN BY CHECKED APPROVED DWG 1256609-A



HOR 40 20 0 40 80 FT
VERT 10 5 0 10 20 FT

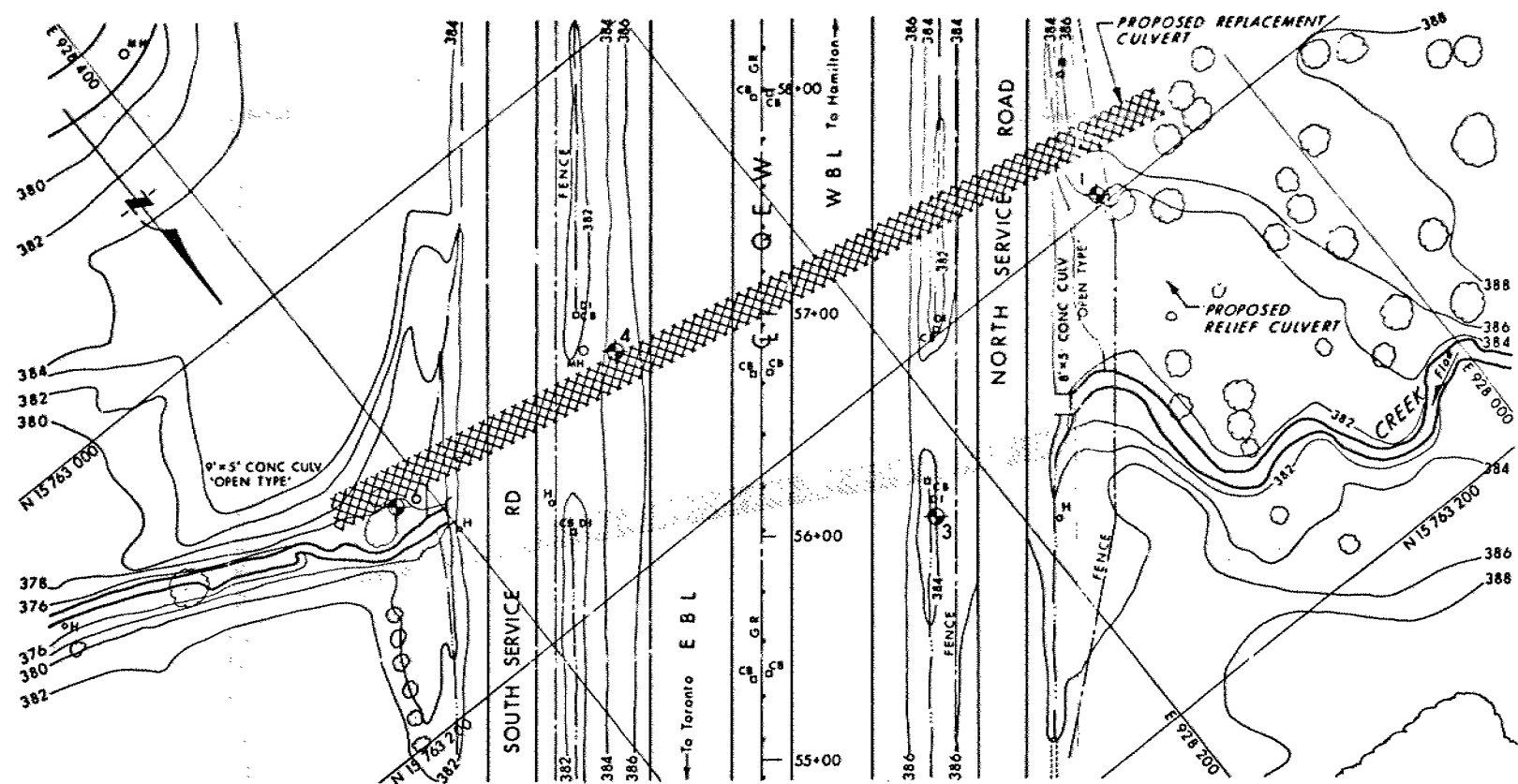


PROFILE C-L APPLEBY LINE

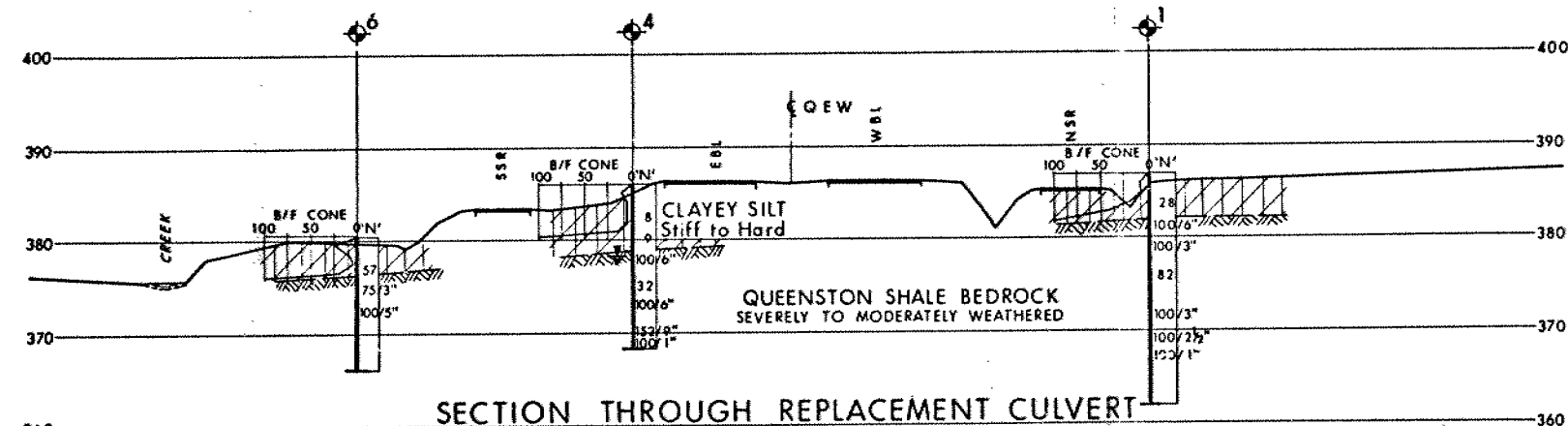
HOR 40 20 0 40 80 FT
VERT 20 10 0 20 40 FT



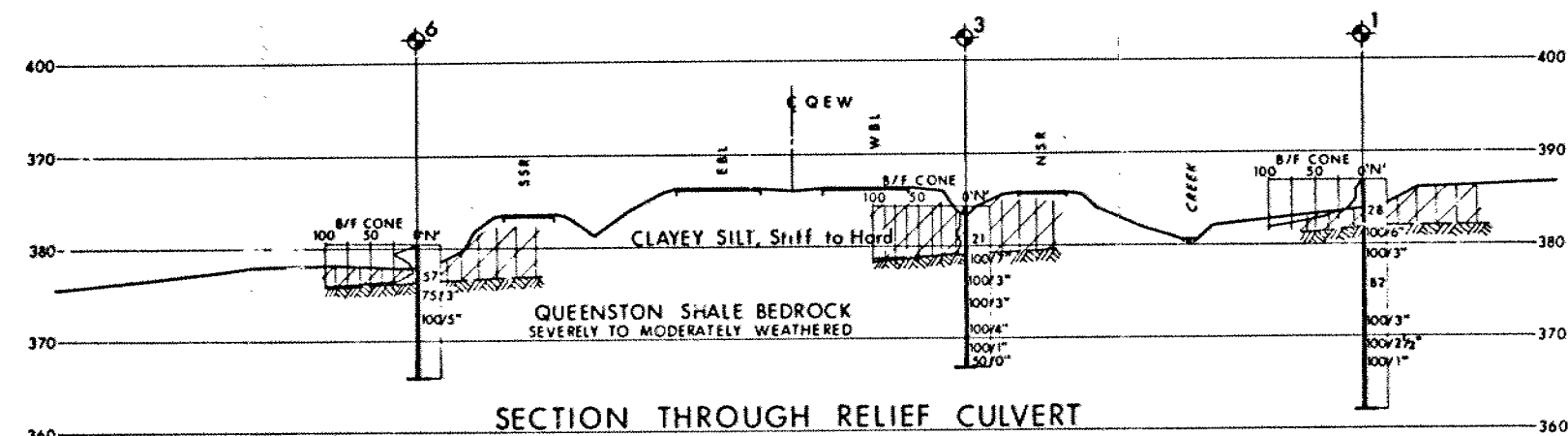
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO



PLAN SCALE
40 20 0 40 80 FT



SECTION THROUGH REPLACEMENT CULVERT



SECTION THROUGH RELIEF CULVERT

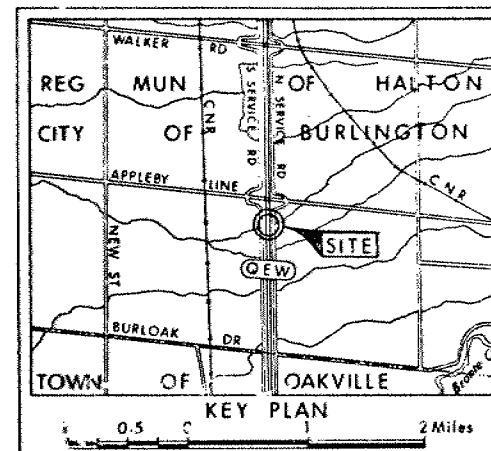
SCALE
HOR 40 20 0 40 80 FT
VERT 10 5 0 10 20 FT

CONT No
WP No 125-66-09



PROPOSED CULVERT
(APPROX 1000 FT EAST OF APPEBY LINE)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W/L at time of investigation Mar 1977
- W/L Not Established in Bore Holes 1, 3 and 6

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	386.9	15 763 195	928 085
3	384.2	15 763 263	928 230
4	385.9	15 763 116	928 296
6	380.4	15 763 109	928 416

-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

HWY No QEW
S. B. W. D. J. M. CHECKED DATE April 15, 1977
C. B. W. D. J. M. CHECKED DATE April 15, 1977

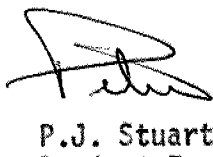

Mr. W. Lin, Design Engineer
Central Section
Structural Office
West Building, Downsview

Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

78 02 08

Re: Appleby Line Underpass
W.P. 125-66-09, Site 10-148
QEW, District 4, Hamilton

A review of the final bridge Drawings 1 and 3 for this project shows the soil mechanics related portion of the design of the structure itself to be adequate. The roadway protection scheme, however, appears incomplete and open to misinterpretation.

 
P.J. Stuart
Project Engineer

For: K.G. Selby
Supervising Engineer

KGS/PJS/gs

cc: Files/

C.S. Grebski
Structural Design Engineer
Structural Office, Downsview

Soil Mechanics Section
Engineering Materials
West Building, Downsview

Mr. M. Lin
Regional Structural Design Engineer

77 07 19

Appleby Line Underpass
W.P. 126-66-09, Site 10-148
Hwy. QEW, District 4, Hamilton

A review of the preliminary bridge plan for the above site leads to the following comment. The founding of the abutments on spread footings on bedrock will necessitate a roadway protection scheme if it is desired to maintain traffic on Appleby Line during the construction of the adjacent abutment footings.



P. Stuart
Project Engineer

PS/kr

cc: Files ✓
Record Services

Mr. G.C.E. Burkhardt
Regional Structural Planning Eng.
Central Region

Engineering Materials Office
Soil Mechanics Section
West Bldg.

R.A. Jeffries

77 03 29

Appleby Line Underpass
W.P. 125-66-09, Site 10-148
QEW, District 4

A foundation investigation has been carried out covering the above structure and two proposals for a culvert crossing the QEW some 1000 feet to the east. This memorandum contains a brief outline of subsurface conditions as well as preliminary foundation recommendations. A detailed foundation report will be produced at a later date.

Subsoil consists of a shallow deposit of clayey silt ranging from 4 to 7 feet in depth. It overlies red Queenstone shale bedrock which is weathered at the surface but gradually improves in quality with depth. The approach fills for the existing Appleby Line structure, which are composed primarily of clayey silt, cover parts of the proposed abutment footing areas.

Groundwater was encountered at elevations ranging from 375 to 378.

RECOMMENDATIONS

The structure may be supported on spread footings founded in the shale bedrock at elevation 378 with a maximum design load of 10 tons per square foot. Resistance to sliding may be calculated assuming a coefficient of friction of .45. A 6 inch layer of mass concrete should be placed in the bottom of the footing excavations within 3 hours of their being dug to grade to prevent deterioration of the exposed shale.

Alternately, perched abutments may be supported on steel H-piles with reinforced tips driven into the weathered shale bedrock. These piles may be loaded to their allowable structural capacity. Estimated tip elevations for the piles are 376 \pm for both the north and south abutment.

No stability problems are anticipated if 2:1 slopes are employed.

The culvert should be founded on spread footings. Its proposed invert elevations are 379 \pm for the inlet and 376 \pm for the outlet. Four feet of cover will be necessary to provide frost protection for the footings, placing them at 375 \pm for the inlet and 372 \pm for the outlet. At these elevations the shale bedrock will carry a design load of up to 10 tons per square foot.

Peter J. Stuart
Project Engineer

For: K.G. Selby
Supervising Engineer

KGS/PJS/bp

cc: J. Anderson
R. Fitzgibbon
C.S. Grebski
Files
Record Services