

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M5-146

DIST. 4 REGION

W.P. No. 47-82-03

CONT. No. 89-90

W. O. No.

STR. SITE No. 10-82-336

HWY. No. Q.E.W.

LOCATION Twin Box Culvert / 14 Mile Creek
(new SE Service Rd.)

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 47-82-03

DIST 4

HWY Q.E.W.

STR SITE 10-82-336

Twin Box Culvert
New SE Service Rd. (Q.E.W.) & 14 Mile Creek

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FOUNDATION INVESTIGATION REPORT

for

Twin Box Culvert
New SE Service Rd. (Q.E.W.) & 14 Mile Creek
W.P. 47-82-03; Site: 10-82-336
District #4 (Burlington)

Introduction

This report contains the results of the foundation investigation carried out at the aforementioned site between 84 08 27 and 84 08 29. The field work consisted of four sampled boreholes and ~~one~~ ^{one} dynamic cone penetration test. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped with 83 mm hollow stem augers and BXL rock coring equipment.

Site Description

The site is located SE of the crossing of Q.E.W. and Third Line Road at 14 Mile Creek in the Town of Oakville. The surrounding terrain is gently rolling and tree covered.

Physiographically the site is located in a region referred to as the South Slope.

Subsurface Conditions

Two different types of deposits were encountered at this site:

- a) Silty clay overburden
- b) Shale bedrock

The boundaries of the different strata, together with the obtained field test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. The stratigraphical sections shown on Drawing No. 478203-A are based upon this information. A description of the different strata encountered is given below.

Overburden

This zone was encountered in all but B.H. #3. The thickness varies from 1.1 m to 3.0 m. The material consists mainly of silty clay with occasional shale fragments. In addition, traces of undecayed organic (roots) substances were also found in the upper about 0.3 m portion of the deposit. The colour of the material is reddish-brown. It is believed that this stratum derived from the underlying shale bedrock.

Standard penetration tests gave 'N' values to vary from 5 to over 100 blows per 30 cm penetration. The lower 'N' values were obtained in the extreme upper zone of the stratum.

The consistency may be classified as firm to hard.

Bedrock

The bedrock was encountered in all boreholes either at ground level or the above described silty clay deposit at the following elevations:

B.H. #1	El. 98.8
#2	El. 96.6
#3	El. 99.5
#4	El. 99.2

The shale bedrock is of the Queenston Formation. The shale is predominantly red in colour containing (about 5%) green siltstone layers. The upper portion of the bedrock is weathered to varying degrees and becomes more sound with depth. For details references should be made to the 'Description of Rock Core' sheet appended to this report. The core description was carried out by Mr. E.R. Magni, M.T.C. Geologist.

Groundwater Conditions

The groundwater level was found to be at or in the vicinity of the creek water level (El. 99.4) at the time (August, 1984) of the field investigation. Seasonal fluctuation of the ground level can be expected.

Discussion and Recommendations

General

It is proposed to construct a new SE Service Road adjacent to Q.E.W. in the vicinity of Third Line. The road will cross 14 Mile Creek by means of twin (3 m x 3 m) box culverts. The proposed invert levels are as follows:

Up-Stream End: El. 98.9

Down-Stream End: El. 98.7

At the present time, the creek bed level is at about El. 99.3, while the profile grade of the Service Road is set at El. 102.8.

Twin Box Culvert

It is recommended that the floor of the culvert be constructed at or below El. 98.1

At this level (El. 98.1) the subsurface material consists either of extremely weathered shale or hard, silty clay deposit containing weathered shale. The allowable bearing capacity of the foundation material is in the order of 400 kPa.

For the purposes of the O.H.B.D.C. the following values are recommended:

Factored Capacity at U.L.S.: 600 kPa
Bearing Capacity at S.L.S. Type II: 400 kPa

The granular backfill requirements should be as outlined on current M.T.C. standards.

For the backfill material, the following parameters are recommended:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.1$

Earth pressure should be computed (assuming 'at rest' condition) as per subsection 6.6.1.2.2 of the code.

The backfill operations should be carried out simultaneously on both sides of the proposed twin culvert. Compaction of the backfill should adhere to Ministry Directive B-131. ('Restriction on use of heavy vibratory equipment behind earth retaining structures' dated 81 11 24).

The concrete of the culvert should be placed 'in the dry'. Should, therefore, the bottom slab and any portion of the walls be located below the prevailing groundwater level an unwatering scheme will be required. Steps also should be taken to prevent any surface water flow into the excavations. The base of the excavation at the foundation level should be covered with a 15 cm thick mass concrete pad within 8 hours of exposure.

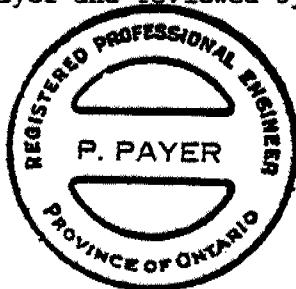
The frost protection requirements in this area is in the order 1.2 m of cover.

Approach Embankments

The profile grade of the new SE Service Road is set at El. 102.8 some 3.5 m above the creek bed level. It is recommended that all surficial organic and/or soft surficial material be removed according to current M.T.C. practices. No stability problems are anticipated for the embankments constructed with 2:1 slopes.

Miscellaneous

The fieldwork for this project was supervised by Mr. T. Miller, Student Engineer. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was prepared by Mr. P. Payer and reviewed by Mr. K.G. Selby.



P. Payer
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby
K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

APPENDIX

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 (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	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
W 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
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	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_{α}	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
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_r	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{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
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ²	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

DESCRIPTION OF ROCK CORE - W.P. 47-82-03

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (M)	% CR*	% RQD*	DEPTH (M)	DESCRIPTION
1	2.49 - 3.97 - 5.49	89.7 98.3	69.0 93.3	2.49 - 3.25	Shale, Queenston, red, slightly weathered, occasional (5%) green siltstone bands about 50 mm wide, closely spaced joints
				3.25 - 5.49	Shale, Queenston, red, unweathered, occasional (5%) green siltstone bands about 50 mm wide, widely spaced joints
2	3.05 - 4.58 - 6.10	83.3 98.3	83.3 98.3	3.05 - 3.30	Assumed core loss
				3.30 - 5.24	Shale, Queenston, red, unweathered, occasional (5%) green siltstone bands about 25 mm wide, widely spaced joints
				5.24 - 6.10	Shale, Queenston, red, moderately weathered, occasional mud seams, occasional (5%) green siltstone bands about 25 mm wide, widely spaced joints
3	2.75 - 4.27 - 5.80	81.7 98.3	75.0 93.3	2.75 - 3.03	Assumed core loss
				3.03 - 5.80	Shale, Queenston, red, unweathered, occasional (5%) green siltstone bands about 50 mm wide, closely spaced joints
4	3.05 - 4.58 - 6.10	93.3 95.0	93.3 95.0	3.05 - 6.10	Shale, Queenston, red, unweathered, occasional (5%) green siltstone bands about 25 to 120 mm wide, widely spaced joints

* CR = CORE RECOVERY; RQD = ROCK QUALITY DESIGNATION

RECORD OF BOREHOLE No 1

METRIC

W P 47-82-03 LOCATION Co-ords. N 4 809 023.6 E 286 855.5 ORIGINATED BY TM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger & BXL Rock Coring COMPILED BY JC
 DATUM Geodetic DATE 84 08 27 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
100.3	Ground Level												
0.0	Silty Clay		1	SS	16								
	Traces of organics												
	occ. shale fragments		2	SS	68								
98.8	Very Stiff to Hard												
1.5	Extremely Weathered												
	Slightly Weathered		4	RC BXL	REC 90%								
	Shale - Weathered												
	Unweathered		5	RC BXL	REC 100%								
94.8	Bedrock												
5.5	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 47-82-03 LOCATION Co-ords. N 4 809 022.5; E 286 837.0 ORIGINATED BY TH
DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger & BXL Rock Coring COMPILED BY JC
DATUM Geodetic DATE 84 08 28 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20					
99.6	Ground Level												
0.0	Silty Clay traces of organics occ. shale fragments Hard Reddish Brown		1	SS	97/25								
			2	SS	60/28								
			4	SS	63/14								
96.6													
3.0	Extensive W. Shale Unweathered to Moderately Weathered Bedrock		5	RC BXL	REC 85%								
			6	RC BXL	REC 100%								
93.5													
6.1	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3

METRIC

W P 47-82-03 LOCATION Co-ords. N 4 809 040.9; E 286 867.1 ORIGINATED BY TH
DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger & BXL Rock Coring COMPILED BY JC
DATUM Geodetic DATE 84 08 28 CHECKED BY [Signature]

SOIL PROFILE		STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE			VALUES	20	40	60	80	100	W _p	W		
99.5	Ground Level		1	SS	11/2	8 cm										
0.0	Extremely Weathered Shale Bedrock		2	SS	80%	8 cm										
	Unweathered		3	RC BXL	REC 83%											
			4	RC BXL	REC 100%											
93.7																
5.8	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



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Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 47-82-03 LOCATION Co-ords. N 4 809 036.5; E 286 833.2 ORIGINATED BY TM
DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger & BXL Rock Coring COMPILED BY JC
DATUM Geodetic DATE 84 08 29 CHECKED BY *Jo*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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					
100.3	Ground Level		1	SS	5		100										
99.2	Silty Clay, trace of organics, occ. shale fragments Firm to Stiff		2	SS	65/25	cm											
1.1	Extremely to Moderately Weathered		3	SS	65/25	cm	98										
	Unweathered Shale Bedrock		4	RC BXL	REC 94%		96										
			5	RC BXL	REC 96%												
94.2																	
6.1	End of Borehole																

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

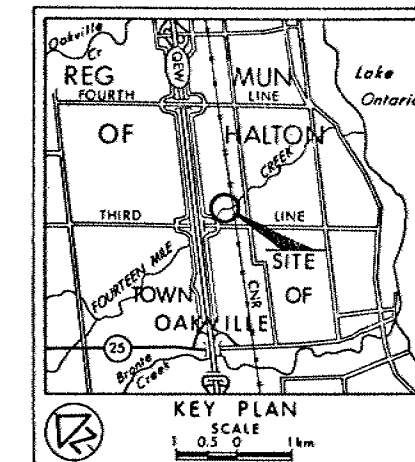
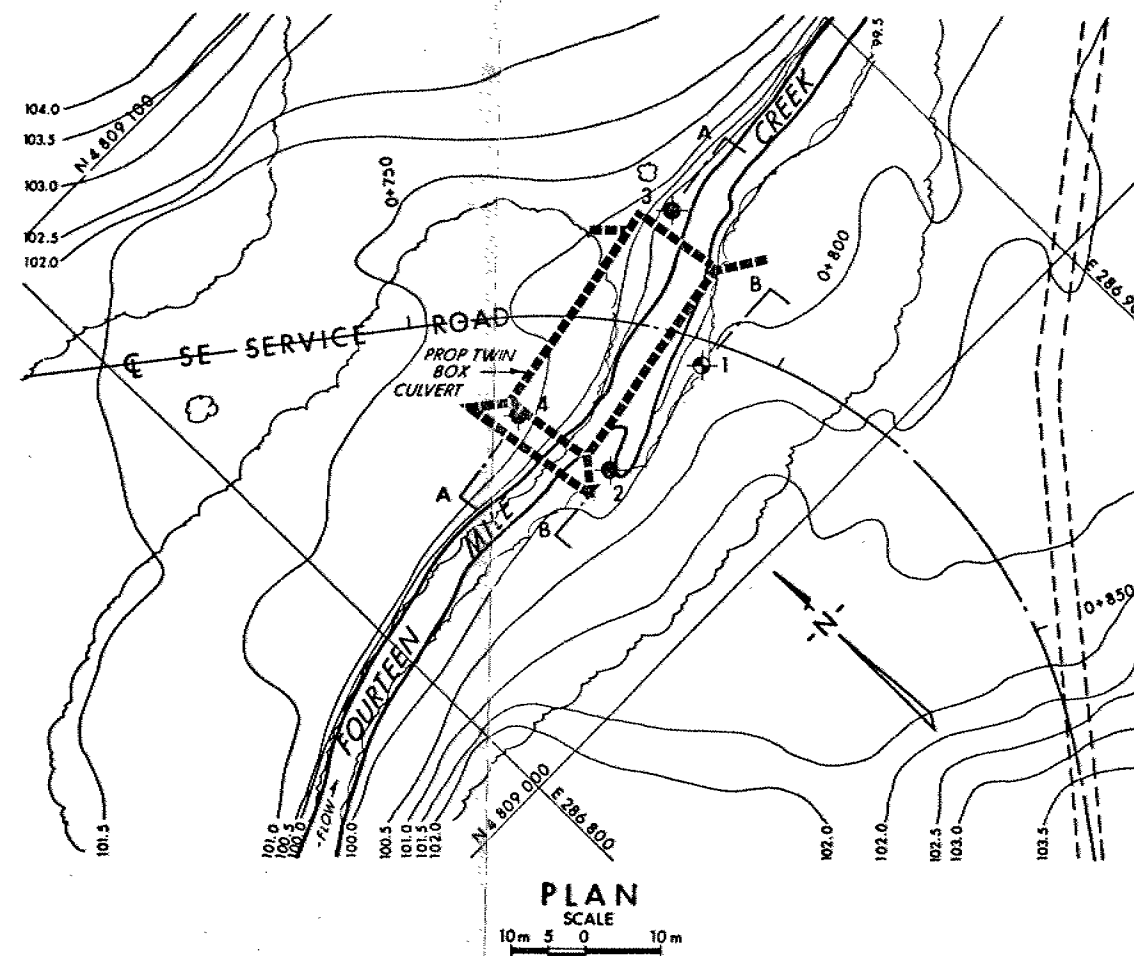
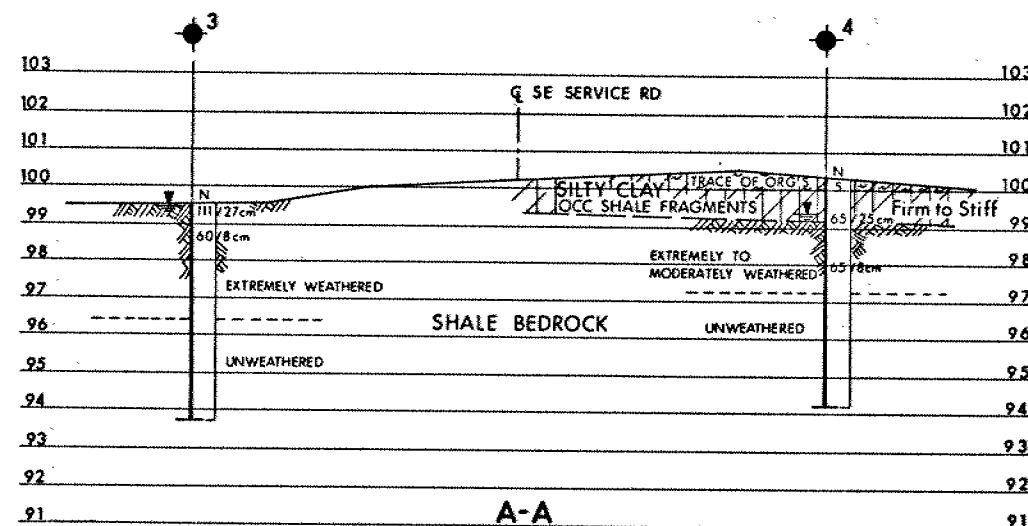
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 47-82-03

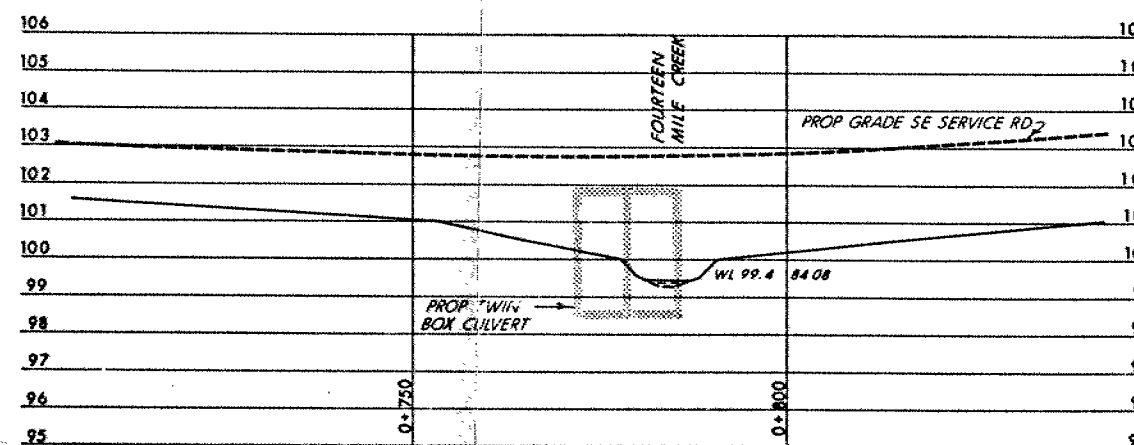
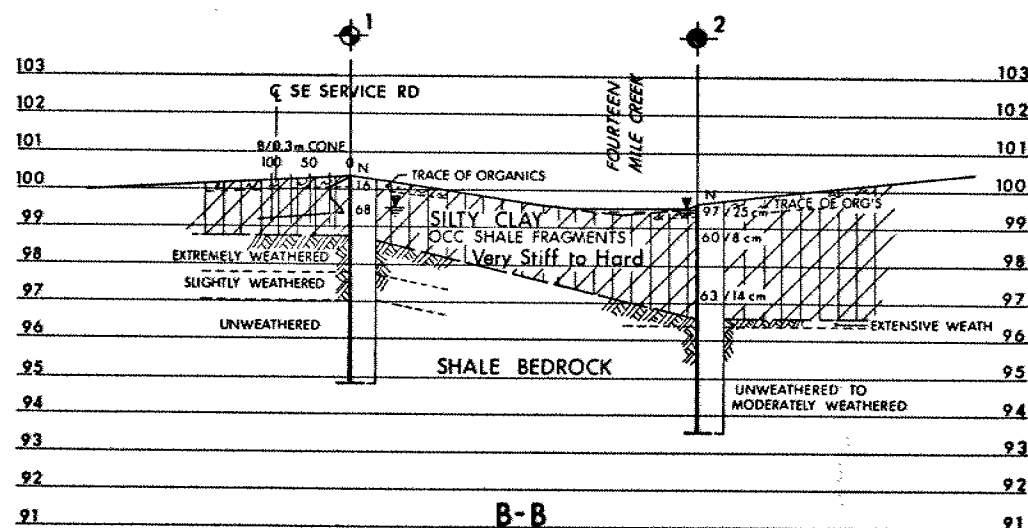
SE SERVICE ROAD
(FOURTEEN MILE CREEK)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



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 84 08



PROFILE SE SERVICE ROAD

SECTIONS

SCALE
4m 2 0 4m Hor
2m 1 0 2m Vert

SCALE
10m 5 0 10m Hor
2m 1 0 2m Vert

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

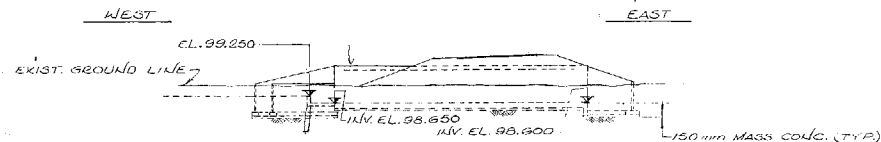
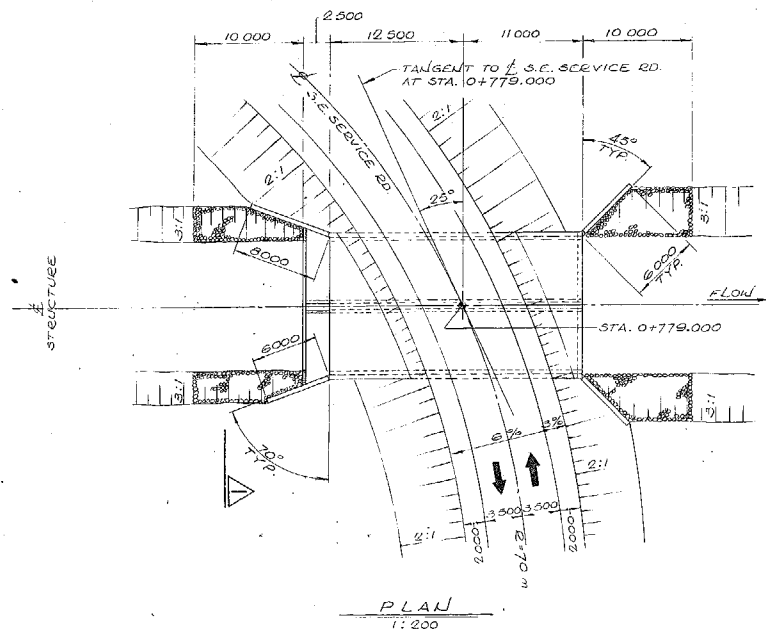
REV	DATE	BY	DESCRIPTION

Geocres No 30M5-146

HWY No	GEW & THIRD LINE	DIST	4
SUBM'D PP	CHECKED	DATE	84 10 15
DRAWN SO	CHECKED	DATE	84 10 15

DWG	478203-A
-----	----------





ELEVATION
1:200

WATER ELEVATION:

NOV. 1983 EL. 99.300
REGULATORY FLOOD EL. 101.920
REGIONAL FLOOD EL. 103.000

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 47-82-03

SOUTHEAST SERVICE RD.
FOURTEEN MILE CREEK
GENERAL ARRANGEMENT



SHEET

NOTES:

CLASS OF CONCRETE:

- CULVERT & RETAINING WALLS----- 30 MPa
- FOOTINGS & ALL OTHER----- 20 MPa

REINFORCING STEEL:

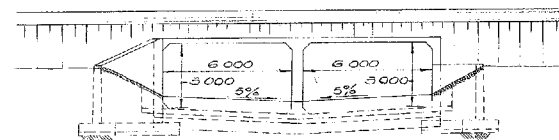
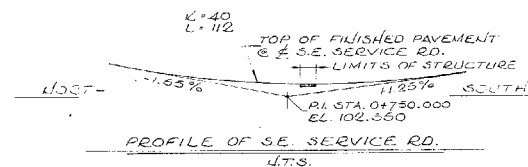
- REINF. STEEL SHALL BE GRADE 400
- BARS MARKED WITH SUFFIX "C" SHALL BE COATED BARS.

CLEAR COVER TO REINF. STEEL:

- FOOTINGS-----100 ± 25
- BOTTOM OF TOP SLAB-----50 ± 10
- REMAINDER-----70 ± 20

· NOTES TO CONTRACTOR:

- NO CONCRETE SHALL BE PLACED IN BOTTOM SLABS, UNTIL THE DEPTH OF THE EXCAVATION AND CHARACTER OF THE FOUNDATION MATERIAL HAVE BEEN APPROVED BY THE ENGINEER.
- FILL SHALL BE PLACED AT BOTH SIDES OF CULVERT SIMULTANEOUSLY.



1 : 106

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE
DESIGN	1.5.4	CHECK	LOADING	JAN 6
DRAWING	3.5	CHECK	SITE No 10-32-532	GWG