DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31C-141

DIST. 8 REGION

W.P. No. 25-77-05

CONT. No. 89-02

W. O. No.

STR. SITE No. 7-53

HWY. No. 33

LOCATION Collins Creek Bridge

No of Pages - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

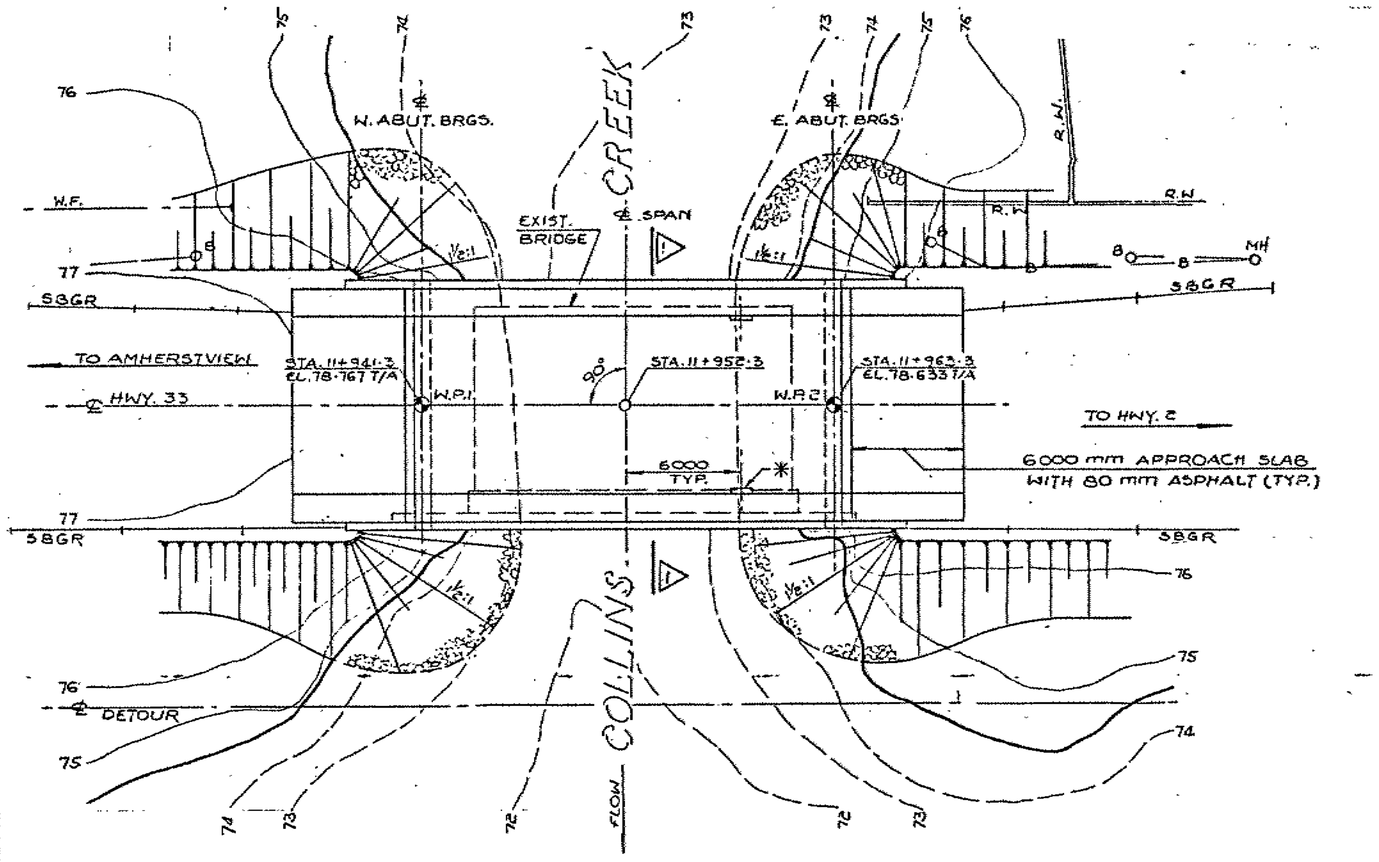
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST. 8
CONT No
WP No 25-77-05

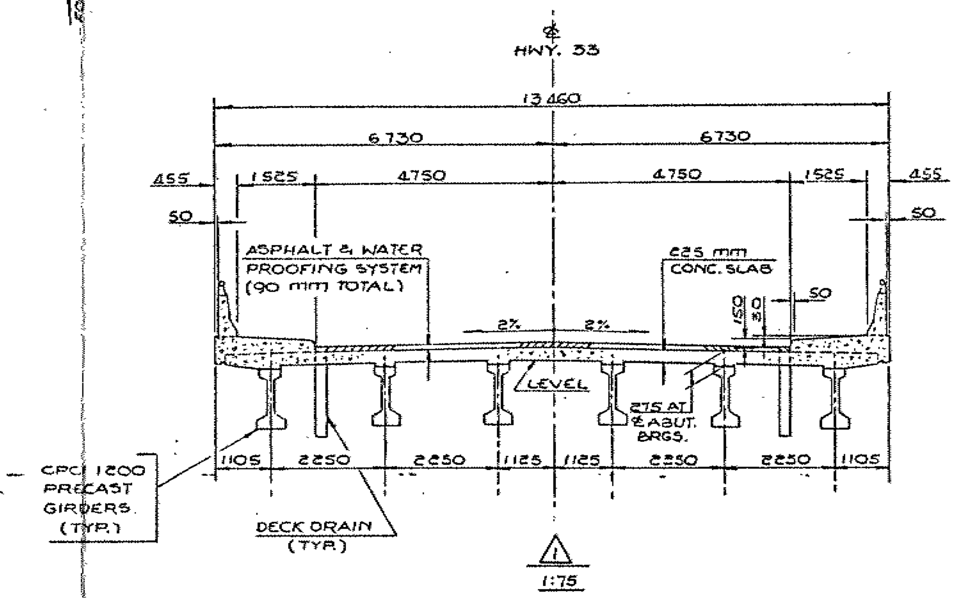
COLLINS CREEK BRIDGE
GENERAL ARRANGEMENT

SHEET



PLAN
1:200

* DECK DRAIN (TYP.)
SEE SS 9-2A



1
1:75

NOTES

CLASS OF CONCRETE

FOOTINGS .... 20 MPa
PRECAST GIRDERS ... 40 MPa
REMAINDER .... 30 MPa

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH THE SUFFIX 'C' DENOTE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS .... 100 ± 25
ABUTMENTS & WINGWALLS
FRONT FACE .... 80 ± 20
BACK FACE .... 70 ± 20
DECK TOP .... 70 ± 20
DECK BOTTOM & SIDES .... 40 ± 10
REMAINDER, UNLESS OTHERWISE NOTED .... 70 ± 20

CONSTRUCTION NOTES

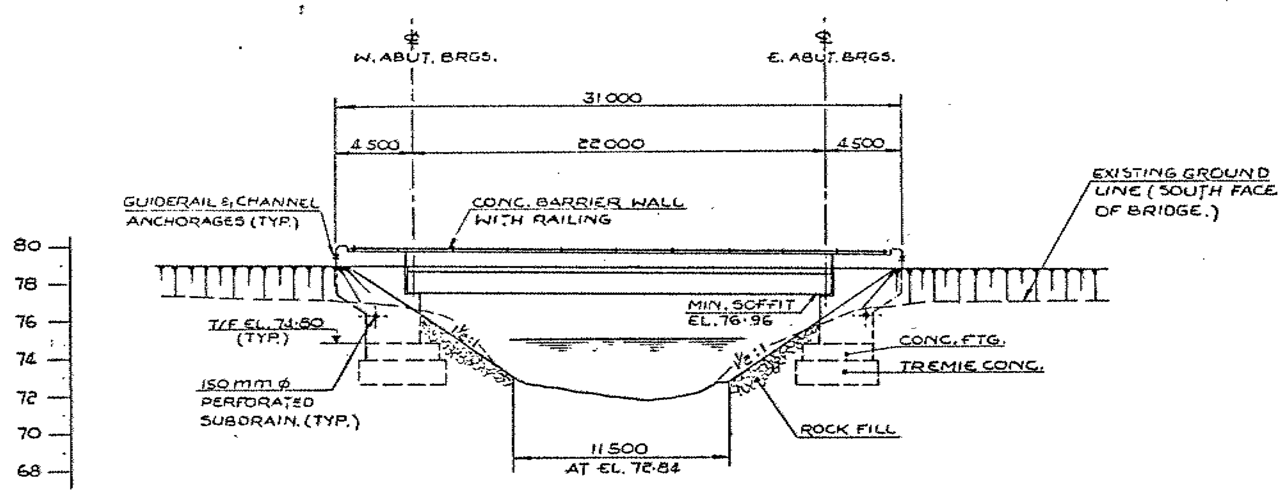
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS, TO A TOLERANCE OF ± 3 mm.

LIST OF ABBREVIATION

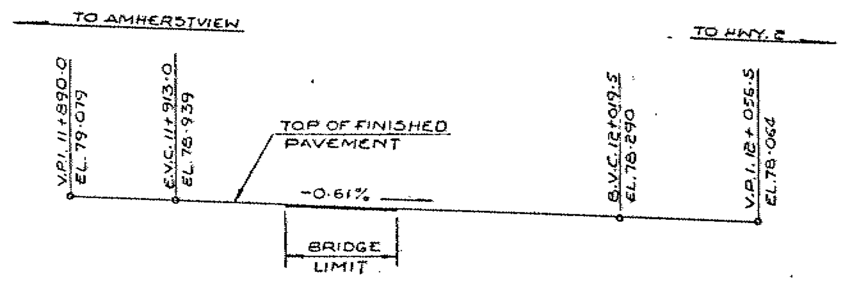
W.P. - WORKING POINT
T/A - TOP OF ASPHALT
T/F - TOP OF FOOTING
B/F - BOTTOM OF FOOTING
F.F. - FRONT FACE
B.F. - BACK FACE
E.F. - EACH FACE
EL. - ELEVATION

LIST OF DRAWINGS

7-53 - 1 GENERAL ARRANGEMENT.
- 2 BORE HOLE LOCATIONS & SOIL STRATA.
- 3 FOOTINGS.
- 4 WEST ABUTMENT.
- 5 EAST ABUTMENT.
- 6 PRESTRESSED GIRDERS & BEARINGS.
- 7 DECK LAYOUT & SCREED ELEVATIONS.
- 8 DECK REINFORCING.
- 9 BARRIER WALL ON SIDEWALK.
- 10 RAILING FOR BARRIER WALL.
- 11 6000 mm APPROACH SLABS.
- 12 AS CONSTRUCTED ELEV. & DIM.
- 13 BRIDGE DATE & SITE NUMBER DATA.
- 14 JOINT ANCHORAGE & ARMORING.
- 15 STANDARD DETAILS.
- 16 QUANTITIES - STRUCTURE.
- 17 QUANTITIES - STRUCTURE.



ELEVATION
1:200



PROFILE OF ℄ OF HWY. 33
N.T.S.

BM EL. 76·306
GEODETIC DATUM
N & W IN N. ROOT
OF 0-7 TWIN WILLOW
23·4 LT. 11+970·0

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	CHECK	LOADING OHBDC - A83	DATE
DRAWING H.N	CHECK	SITE No 7-53	DWG 1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

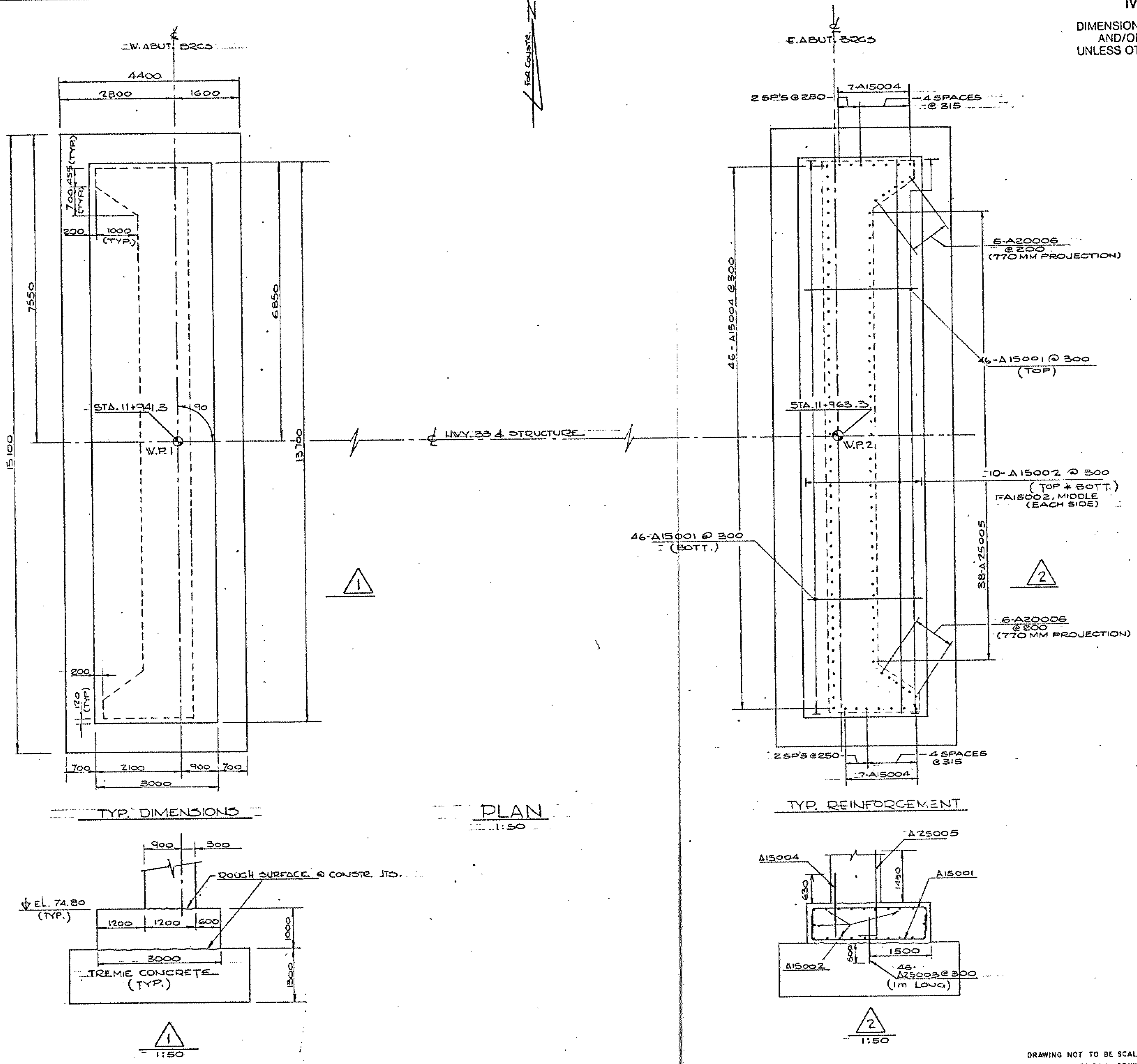
CONT No

WP No 25-77-05

COLLINS CREEK BRIDGE

FOOTINGS

SHEET



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN A.L.	CHECK	LOADING OHBDC-A83	DATE FEB. 87
DRAWING W.V.	CHECK	SITE No 7-53	DWG 3

Sack

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-02

Ontario

Ministry of
Transportation and
Communications

I N D E X

NOTE: The preceding report supersedes all other reports prepared by or for the Ministry in connection with the above-noted project.

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
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
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_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FOR

W.P. 25-77-05; Site 7-53
Collins Creek Bridge
Hwy. 33, District 8, Kingston

INTRODUCTION

This report summarizes the results of a foundation investigation required for the above-noted structure replacement.

The field work was conducted between 85 08 27 and 85 09 11 utilizing a continuous flight auger machine equipped with 82 mm I.D. hollow-stem augers and B core barrels, and a diamond drill equipped with N and B casing and B core barrels.

This work consisted of 4 sampled boreholes.

SITE DESCRIPTION

The site is located in the County of Frontenac, Township of Kingston at the Crossing of Hwy. 33 Line E over Collins Creek.

The limits of this investigation are Sta. 11+915 to Sta. 11+995 (Line E chainage).

According to Chapman and Putnam (1984), the site lies within the 'Napanee Plain' physiographic area. This plain is generally characterized by shallow overburden and numerous limestone outcrops. At this specific site, however, the limestone bedrock has been eroded to form Collins Creek.

The existing crossing of Hwy. 33 over Collins Creek is a 16.8± m long single span bridge. Within the investigation area, the existing grade of Hwy. 33 slopes from elev. 77.2± m at Sta. 11+915, to 76.5± m at Sta. 11+995.

SUBSURFACE CONDISTIONS

General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations (refer to BH #1 to BH #4). The locations and elevations of the boreholes and statigraphical profiles based on the borehole data, are shown on the Borehole Locations & Soil Strate Drawing No. 257705-A. **

The sequence (from the surface downwards) of subsurface materials at the borehole locations is summarized below:

(Boreholes #1 and #2)

Material	Thickness
- Water	0.9 m to 1.5 m
- Gravel and Sand	2.8 m to 3.1 m
- Boulders, Gravel and Sand	3.3 m to 3.8 m
- Limestone Bedrock	-

(Boreholes #3 and #4)

Material	Thickness
- Boulders, Gravel and Sand	2.3 m to 2.7 m
- Gravel and Sand	1.9 m to 3.8 m
- Limestone Bedrock	-

Stratigraphy

Gravel and Sand;
trace/some silt, trace clay
occ. boulders, occ. organics

AT BH # 1 and BH # 2, this material was encountered at the surface of the lake bottom. Its thickness at these locations varies from 2.8 m to 3.1 m.

** NOTE: REFER TO DRAWING # 2 OF THE CONTRACT DRAWINGS.

At BH #3 and BH #4, this material was encountered beneath the Boulders, Gravel and Sand (Rock Fill). Its thickness at these locations varies from 1.9 m to 3.8 m. A 0.7 m thick layer of material containing organics was encountered at the top of the Gravel and Sand deposit at BH #4.

Physical properties of the material, as determined from the results of field and laboratory tests, are summarized below.

	Range	Average	Median
Natural Moisture Content (w)	4.0- 24.0%	11.7%	9.5%

A typical range of grain size distributions is indicated below:

Gravel	51 - 82%
Sand	13 - 51%
Silt	5 - 11%
Clay	1 - 5%

The denseness of the material ranges from very loose to very dense.

Boulders, Gravel and Sand;
trace silt, trace clay,
occ. organic zones

At BH #1 and BH #2, this material was encountered beneath the Gravel and Sand deposit and immediately above the bedrock. Its thickness at these locations varies from 3.3 m to 3.8 m.

At BH #3 and BH #4, this material was encountered at the surface. Its thickness at these locations varies from 2.3 m to 2.7 m.

This material is interpreted as being rock fill. It should be noted that diamond drilling was required to advance boreholes through this fill at a number of locations.

The denseness of this material can be described as loose to very dense.

Bedrock

At the borehole locations, bedrock was encountered at elevations ranging from 66.4 m to 72.3 m.

The bedrock is limestone of the Gull River Formation of the Trenton and Black River Group. For detailed descriptions of the bedrock core recovered, refer to the Description of Rock Core in Table 1 of the Appendix.

Groundwater

At the time of the field investigation, the groundwater elevation at the borehole locations was approximately the same as the prevailing level of Lake Ontario (elev. 75± m).

MISCELLANEOUS

The field work for this project was carried out under the supervision of Mr. I. Richardson, Student Engineer.

The report was written by Mr. D. Dundas, Senior Foundations Engineer, and reviewed by Mr. M. Devata, Chief Foundations Engineer.

The equipment used for the field investigation was owned and operated by Marathon Drilling Co. Ltd.

D.H. Dundas

D.H. Dundas, P.Eng.
Sr. Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

A P P E N D I X

RECORD OF BOREHOLE No 1

METRIC 8

W P 25-77-05 LOCATION Sta. 11 + 943.0 °/s 10.6 m RT ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 08 27 - 28 CHECKED BY D.D.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.8	Water Surface										
0.0	Water						74				
73.3	Lake Bottom										
1.5	Gravel and Sand		1	SS	3						
	Trace/some Silt										
	Trace Clay		2	SS	85		72		○		33 51 11 5
	Occ. boulders, occ. organics										
70.2	Very loose to very dense		3	SS	7						
4.6			4	RC	Rec 0%						
	Boulders, Gravel and Sand		5	RC	Rec 87%		70				
	Trace Silt		6	RC	Rec 17%						
	Trace Clay		7	RC	Rec 50%						
	Occ. Organics		8	RC	Rec 58%		68				
	Very Dense										
66.4			9	RC	Rec 68%						
8.4	weathered						66				
	unweathered										
	Bedrock		10	RC	Rec 100%						
	Limestone										
64.2			11	RC	Rec 68%						
10.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC 9

W P 25-77-05 LOCATION Sta. 11 + 962.0; °/s 11.0 m RT ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 08 28 - 29 CHECKED BY D.D.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.8	Water Surface										
0.0	Water										
73.9	Lake Bottom										
0.9	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, occ. Organics		1	SS	10		74				
71.1	Compact		2	SS	20		72				51 42 5 2
3.7	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics Very Dense		3	RC	Rec 84%						
			4	RC	Rec 20%		70				
			5	RC	Rec 17%						
67.8											
7.0	Bedrock Limestone Unweathered		6	RC	Rec 89%		68				
			7	RC	Rec 96%						
64.4			8	RC	Rec 94%		66				
10.4	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

RECORD OF BOREHOLE No 3

METRIC 10

W P 25-77-05 LOCATION Sta. 11 + 962.7; °/s 3.3 m Lt ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE H.S. Auger, N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 09 11 CHECKED BY D.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
76.9	Ground Surface										
0.0	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics Loose to very dense		1	SS	6	▼	76				
74.2											
2.7	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, Occ.Organics Loose to Compact		2	SS	5		74				
72.3			3	SS	17				o		82 13 (5)
4.6	Bedrock Limestone Unweathered		4	RC	Rec	83%	72				
			5	RC	Rec 93%						
							70				
68.7			6	RC	Rec 79%						
8.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC 10

W P 25-77-05 LOCATION Sta. 11 + 962.7; °/s 3.3 m Lt ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE H.S. Auger, N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 09 11 CHECKED BY D.D.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.9	Ground Surface										
0.0	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics Loose to very dense		1	SS	6	▼	76				
74.2											
2.7	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, Occ.Organics Loose to Compact		2	SS	5		74				
			3	SS	17				○		82 13 (5)
72.3											
4.6	Bedrock Limestone Unweathered		4	RC	Rec	83%	72				
			5	RC	Rec 93%						
			6	RC	Rec 79%		70				
68.7											
8.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC 11

W P 25-77-05 LOCATION Sta. 11 + 941.0; °/s 3.3 m LT. ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE H.S. Auger, N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 09 11 CHECKED BY D.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.9	Ground Surface										
0.0	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics						76				
74.6	Loose to very dense										
2.3	Occ. Organic Zones		1	SS	10		74				53 26 15 6
	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, Occ. Organics		2	SS	5						
			3	SS	11						74 15 8 3
			4	SS	7		72				
70.8	Loose to very dense		5	SS	11						
6.1	Bedrock Limestone Unweathered		6	RC	Rec	63%					
69.1			7	RC	Rec 83%		70				
7.8	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 ◇ 20/10 5 (%) STRAIN AT FAILURE

TABLE 1 DESCRIPTION OF ROCK CORE - W.P. 25-77-05

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	5.6 - 19.6 - 6.9 - 7.4 - 7.7 - 9.3 - 10.2 - 10.8	87 17 50 58 68 100 68	0 17 50 58 24 81 0	5.6 - 8.4 8.4 - 8.8 8.8 - 10.8	Boulders, limestone Limestone, grey, fine grained, moderately weathered, very closely spaced joints Limestone, grey to greenish grey, fine grained, unweathered, medium spaced joints
2	4.4 - 4.9 - 5.3 - 6.2 - 6.8 - 7.7 - 9.0 -10.7	84 20 17 0 89 96 94	0 0 0 0 56 89 89	4.4 - 7.0 7.0 - 10.7	Boulders, limestone Limestone, grey to greenish grey, fine grained, unweathered, medium spaced joints
3	4.5 - 5.0 - 6.5 - 8.1	83 93 79	0 35 48	4.6 - 8.1	Limestone, grey, unweathered, very closely spaced joints (apparently broken by drilling)
4	5.8 - 6.2 6.2 - 7.7	63 83	0 47	5.8 - 6.2 6.2 - 7.7	Boulders Limestone, grey, unweathered, closely to very closely spaced joints (high core loss probably due to drilling)

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION TABLE 1

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 25-77-05 DIST 8
HWY 33 STR SITE 7-53

COLLINS CREEK BRIDGE

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FOUNDATION INVESTIGATION REPORT

FOR

W.P. 25-77-05; Site 7-53
Collins Creek Bridge
Hwy. 33, District 8, Kingston

INTRODUCTION

This report summarizes the results of a foundation investigation required for the above-noted structure replacement.

The field work was conducted between 85 08 27 and 85 09 11 utilizing a continuous flight auger machine equipped with 82 mm I.D. hollow-stem augers and B core barrels, and a diamond drill equipped with N and B casing and B core barrels.

This work consisted of 4 sampled boreholes.

SITE DESCRIPTION

The site is located in the County of Frontenac, Township of Kingston at the Crossing of Hwy. 33 Line E over Collins Creek.

The limits of this investigation are Sta. 11+915 to Sta. 11+995 (Line E chainage).

According to Chapman and Putnam (1984), the site lies within the 'Napanee Plain' physiographic area. This plain is generally characterized by shallow overburden and numerous limestone outcrops. At this specific site, however, the limestone bedrock has been eroded to form Collins Creek.

The existing crossing of Hwy. 33 over Collins Creek is a 16.8± m long single span bridge. Within the investigation area, the existing grade of Hwy. 33 slopes from elev. 77.2± m at Sta. 11+915, to 76.5± m at Sta. 11+995.

SUBSURFACE CONDISTIONS

General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations (refer to BH #1 to BH #4). The locations and elevations of the boreholes and statigraphical profiles based on the borehole data, are shown on the Borehole Locations & Soil Strate Drawing No. 257705-A.

The sequence (from the surface downwards) of subsurface materials at the borehole locations is summarized below:

(Boreholes #1 and #2)

Material	Thickness
- Water	0.9 m to 1.5 m
- Gravel and Sand	2.8 m to 3.1 m
- Boulders, Gravel and Sand	3.3 m to 3.8 m
- Limestone Bedrock	-

(Boreholes #3 and #4)

Material	Thickness
- Boulders, Gravel and Sand	2.3 m to 2.7 m
- Gravel and Sand	1.9 m to 3.8 m
- Limestone Bedrock	-

Stratigraphy

Gravel and Sand;
trace/some silt, trace clay
occ. boulders, occ. organics

AT BH # 1 and BH # 2, this material was encountered at the surface of the lake bottom. Its thickness at these locations varies from 2.8 m to 3.1 m.

At BH #3 and BH #4, this material was encountered beneath the Boulders, Gravel and Sand (Rock Fill). Its thickness at these locations varies from 1.9 m to 3.8 m. A 0.7 m thick layer of material containing organics was encountered at the top of the Gravel and Sand deposit at BH #4.

Physical properties of the material, as determined from the results of field and laboratory tests, are summarized below.

	Range	Average	Median
Natural Moisture Content (w)	4.0- 24.0%	11.7%	9.5%

A typical range of grain size distributions is indicated below:

Gravel	51 - 82%
Sand	13 - 51%
Silt	5 - 11%
Clay	1 - 5%

The denseness of the material ranges from very loose to very dense.

Boulders, Gravel and Sand;
trace silt, trace clay,
occ. organic zones

At BH #1 and BH #2, this material was encountered beneath the Gravel and Sand deposit and immediately above the bedrock. Its thickness at these locations varies from 3.3 m to 3.8 m.

At BH #3 and BH #4, this material was encountered at the surface. Its thickness at these locations varies from 2.3 m to 2.7 m.

This material is interpreted as being rock fill. It should be noted that diamond drilling was required to advance boreholes through this fill at a number of locations.

The denseness of this material can be described as loose to very dense.

Bedrock

At the borehole locations, bedrock was encountered at elevations ranging from 66.4 m to 72.3 m.

The bedrock is limestone of the Gull River Formation of the Trenton and Black River Group. For detailed descriptions of the bedrock core recovered, refer to the Description of Rock Core in Table 1 of the Appendix.

Groundwater

At the time of the field investigation, the groundwater elevation at the borehole locations was approximately the same as the prevailing level of Lake Ontario (elev. 75± m).

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing single span structure carrying Hwy. 33 over Collins Creek with a single span bridge along Hwy. 33 Line E located essentially along the existing C/L. The proposal also involves increasing the grade by up to 2.0± m.

Two foundation problems have been addressed:

1) support for the abutments
2) minimizing the settlement of the approaches.

The recommendations in this report are applicable to the alignment from Sta. 11+915 to Sta. 11+995.

It is also proposed to construct a temporary detour to the south of the existing alignment.

Structure Design

STRUCTURE FOUNDATIONS

Four alternatives are recommended. The alternative which leads to the least expensive design should be adopted.

Alternative 1: Steel H-Piles Driven to Bedrock

The abutments may be supported on 310 HP 110 steel H-piles, equipped with reinforced tips, and driven to bedrock. Please refer to the Record of Borehole Sheets for bedrock elevations at the borehole locations.

Pre-augering will be required to penetrate the bouldery zones. After the piles have been installed, the pre-augered holes should be backfilled with mass concrete placed by tremie methods. It may be necessary to provide casing to prevent cave-in of the pre-augered holes until the

concrete backfill has been placed. These casings may be left in place if desired. In view of these installation difficulties, Alternatives 2, 3 and 4 may be more appropriate for this site.

The following design values are recommended:

Pile Type	Factored Capacity at U.L.S.	Capacity at S.L.S. Type II
310 HP 110	1600 kN per pile	1150 kN per pile

However, the loading should not exceed the structural capacity of the pile.

Alternative 2: Steel Tube Piles Driven to Bedrock

The abutments may be supported on concrete-filled steel tube piles driven to bedrock. Please refer to the Record of Borehole Sheets for bedrock elevations at the borehole locations.

The tube piles should be installed open-ended, as a combination of driving and drilling will be necessary to advance through the bouldery zones. When required, the drilling can be carried out through the tube pile. When the piles have been seated on the bedrock, they should be cleaned out and filled with concrete placed in the dry (after dewatering the liner) or by tremie methods.

The following design values are recommended:

Pile Type	Factored Capacity at U.L.S.	Capacity at S.L.S. Type II
Steel Tube 324 mm x 9.5 mm	1600 kN per pile	1150 kN per pile

However, the loading should not exceed the structural capacity of the pile.

Alternative 3: Reinforced Concrete Caissons on Bedrock

The abutments may be supported on concrete caissons socketed a minimum of 0.15 m into the bedrock. Please refer to the Record of Borehole Sheets for bedrock elevations at the borehole locations.

The caissons may be constructed by advancing a steel liner through the overburden and socketing it into the bedrock. If additional frictional resistance is required, the caisson can be socketed deeper into the bedrock. This operation will require drilling in order to penetrate the boulders and bedrock. After the liner has been cleaned out and the required reinforcing has been installed, the concrete should be placed in the dry (after dewatering the liner) or by tremie methods. The steel liner should remain in place after construction of the caisson has been completed.

The following design values are recommended:

Caisson Diameter	Factored Capacity at U.L.S.	Capacity at S.L.S. Type II
0.76 m	3000 kN per caisson	N/A

If larger diameter caissons are considered, please contact this office for design details.

The capacity at S.L.S. Type II will not govern design as the bedrock will not settle appreciably. However, the structural capacity of the caisson shold not be exceeded, and its safe geotechnical loading should not exceed the U.L.S. values recommended.

Alternative 4: Perched Spread Footings on Rock Fill

The abutments may be supported on spread footings founded within rock fill. For this alternative, the recommendation regarding preloading and surcharging of approach embankments apply (refer to 'APPROACH EMBANKMENTS').

The following design values are recommended:

- Factored Bearing Capacity at U.L.S. = 600 kPa
- Bearing Capacity at S.L.S. Type II = 250 kPa

Even at these recommended loadings, small settlements may occur within the existing material beneath the footing locations and also within the rock fill. If this alternative is selected, the bridge should be designed to accommodate these anticipated settlements.

EARTH PRESSURES CALCULATIONS:

Backfill to structures should consist of granular materials in accordance with MTC Standard Special Provision #121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2 of the O.H.B.D.C.

For design purposes, the physical properties of the backfill are as follows:

Material	ϕ	δ
Granular 'A'	35°	22.0 kN/m^3
Granular 'B'	30°	21.2 kN/m^3
Rock Fill	35°	20.0 kN/m^3

(If lightweight fill is considered for backfill behind abutments, please contact this office for physical properties of lightweight backfill for earth pressure calculation purposes, and for design details).

For structures supported on piles or caissons founded on bedrock, the foundation is considered to be non-yielding, and the at-rest condition applies for calculations of lateral earth pressures.

For structures supported on rock fill, the foundation is considered to be yielding, and the active condition applies for calculations of lateral earth pressures.

SLOPE STABILITY

Final slopes should be 2H:1V or flatter for earth fill, and 1.5H:1V or flatter for rock fill.

Temporary slopes should be 1.5H:1V or flatter.

FROST PROTECTION

For frost protection, 1.5 m of earth cover, or equivalent, is required.

DE-WATERING

De-watering for pile caps and footings should not be required if they are constructed above the prevailing groundwater elevation.

SETTLEMENT

Differential settlements of the proposed abutments will be negligible if they are constructed in accordance with the recommendations provided for Alternatives 1, 2 and 3. For Alternative 4 (spread footings on rock fill), small settlements are anticipated.

SLIDING RESISTANCE

For computation of resistance to lateral forces between the bottom of footings and the rock fill (Alternative 4), the following adhesion values are recommended:

- Factored Capacity at U.L.S. = 0.56
- Unfactored Adhesion Value = 0.70

Approach Embankments

Settlements of up to 0.2 m are anticipated under the proposed loading conditions at the approach embankments.

In order to minimize the effects of this settlement on the completed alignment, preloading and surcharging of the approach embankments between Sta. 11+915 and Sta. 11+995 is recommended. The surcharge should be 1 m above the final grade and extend over the planned limits of the proposed embankments.

The preload period should be a minimum of 6 months. The embankment preload requirements are applicable to the forward direction (including the areas over the proposed abutments) as well as the transverse directions. Although these preload requirements will reduce post-construction settlements (by an estimated 50%), some maintenance may be required due to residual settlements of the approach embankments.

Post construction settlements could be virtually eliminated by using lightweight fill (slag or styrofoam) to construct the approach embankments. This proposal would involve preloading with normal fill, as described above, then subexcavating to the existing grade, and constructing the approach embankments with lightweight fill. The lightweight fill treatment would extend 25± m behind the abutments. If this option is considered, please contact this office for details regarding design and construction. As a preliminary estimate, the following F.O.B. material cost estimates have been determined:

a) pelletized "$^3/_8$" Structural Coarse" slag - $\$39/m^3$
b) pelletized "Old Clinker" slag - $\$36/m^3$
c) air cooled "Open-Graded Pit Run" slag - $\$28/m^3$
d) air-cooled "1" Clear" slag - $\$30/m^3$
e) styrofoam - $\$85/m^3$

To facilitate pile driving, particle sizes in the fill immediately beneath the pile locations should not exceed 75 mm for steel H-piles and 50 mm for steel tube piles.

EROSION PROTECTION:

Where embankments adjacent to the lake/creek are constructed of material other than rock fill, erosion protection, in the form of random rip rap (minimum blanket thickness = 0.6 m) should be placed on the abutment slopesextending from the toe to 0.6 m above the high water level. The rip rap should extend a minimum of 2 m out along the lake/creek bottom.

In a transverse direction, this erosion protection should extend a minimum of 10 m on both sides of the abutments.

DETOUR

It is proposed to construct a temporary detour to the south of the Hwy. 33 alignment. The detour bailey bridge may be founded on rock fill.

The following design values are recommended for the detour alternatives:

- Factored Bearing Capacity at U.L.S. = 600 kPa
- Bearing Capacity at S.L.S. Type II = 250 kPa

Even at these recommended loadings, small settlements of the detour bridge may occur and periodic maintenance may be required.

MISCELLANEOUS

The field work for this project was carried out under the supervision of Mr. I. Richardson, Student Engineer.

The report was written by Mr. D. Dundas, Senior Foundations Engineer, and reviewed by Mr. M. Devata, Chief Foundations Engineer.

The equipment used for the field investigation was owned and operated by Marathon Drilling Co. Ltd.

D. H. Dundas, P. Eng.
Senior Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer

A P P E N D I X

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
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_t	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				k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	e_{max}	1,%	VOID RATIO IN LOOSEST STATE			

TABLE 1 **DESCRIPTION OF ROCK CORE - W.P. 25-77-05**

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	5.6 - 19.6	87	0	5.6 - 8.4	Boulders, limestone
	- 6.9	17	17	8.4 - 8.8	Limestone, grey, fine grained, moderately weathered, very closely spaced joints
	- 7.4	50	50		
	- 7.7	58	58	8.8 - 10.8	Limestone, grey to greenish grey, fine grained, unweathered, medium spaced joints
	- 9.3	68	24		
	- 10.2	100	81		
	- 10.8	68	0		
2	4.4 - 4.9	84	0	4.4 - 7.0	Boulders, limestone
	- 5.3	20	0	7.0 - 10.7	Limestone, grey to greenish grey, fine grained, unweathered, medium spaced joints
	- 6.2	17	0		
	- 6.8	0	0		
	- 7.7	89	56		
	- 9.0	96	89		
	-10.7	94	89		
3	4.5 - 5.0	83	0	4.6 - 8.1	Limestone, grey, unweathered, very closely spaced joints (apparently broken by drilling)
	- 6.5	93	35		
	- 8.1	79	48		
4	5.8 - 6.2	63	0	5.8 - 6.2	Boulders
	6.2 - 7.7	83	47	6.2 - 7.7	Limestone, grey, unweathered, closely to very closely spaced joints (high core loss probably due to drilling)

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

RECORD OF BOREHOLE No 1 METRIC

W P 25-77-05 LOCATION Sta. 11 + 943.0 °/s 10.6 m RT ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 08 27 - 28 CHECKED BY D.D.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.8	Water Surface										
0.0	Water						74				
73.3	Lake Bottom										
1.5	Gravel and Sand Trace/some Silt Trace Clay		1	SS	3						
			2	SS	85		72		○		33 51 11 5
	Occ. boulders, occ. organics										
70.2	Very loose to very dense		3	SS	7						
4.6			4	RC	Rec 0%						
	Boulders, Gravel and Sand		5	RC	Rec 87%		70				
	Trace Silt Trace Clay Occ. Organics		6	RC	Rec 17%						
			7	RC	Rec 50%		68				
	Very Dense		8	RC	Rec 58%						
66.4			9	RC	Rec 68%						
8.4	weathered unweathered						66				
	Bedrock Limestone		10	RC	Rec 100%						
64.2			11	RC	Rec 68%						
10.6	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 25-77-05 LOCATION Sta. 11 + 962.0; °/s 11.0 m RT ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 08 28 - 29 CHECKED BY D.D.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.8	Water Surface										
0.0	Water										
73.9	Lake Bottom										
0.9	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, occ. Organics		1	SS	10		74				
			2	SS	20		72		○		51 42 5 2
71.1	Compact										
3.7	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics Very Dense		3	RC	Rec	84%					
			4	RC	Rec	20%	70				
			5	RC	Rec	17%					
67.8			6	RC	Rec 89%		68				
7.0	Bedrock Limestone Unweathered		7	RC	Rec 96%		66				
64.4			8	RC	Rec 94%						
10.4	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 25-77-05 LOCATION Sta. 11 + 962.7; °/s 3.3 m Lt ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.

DIST 8 HWY 33 BOREHOLE TYPE H.S. Auger, N Casing, B Core COMPILED BY D.D.

DATUM Geodetic DATE 85 09 11 CHECKED BY D.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
76.9	Ground Surface										
0.0	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics Loose to very dense		1	SS	6	▼	76				
74.2											
2.7	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, Occ.Organics Loose to Compact		2	SS	5		74				
			3	SS	17				o		82 13 (5)
4.6	Bedrock Limestone Unweathered		4	RC	Rec	83%	72				
			5	RC	Rec 93%						
68.7			6	RC	Rec 79%		70				
8.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 25-77-05 LOCATION Sta. 11 + 941.0; °/s 3.3 m LT. ℄ Hwy. 33 Line 'E' ORIGINATED BY I.R.
DIST 8 HWY 33 BOREHOLE TYPE H.S. Auger, N Casing, B Core COMPILED BY D.D.
DATUM Geodetic DATE 85 09 11 CHECKED BY D.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.9	Ground Surface										
0.0	Boulders, Gravel and Sand Trace Silt Trace Clay Occ. Organics					▼	76				
74.6	Loose to very dense										
2.3	Occ. Organic Zones		1	SS	10		74		o		S3 26 15 6
	Gravel and Sand Trace/some Silt Trace Clay Occ. Boulders, Occ. Organics		2	SS	5						
			3	SS	11						
			4	SS	7		72		o		74 15 8 3
70.8	Loose to very dense		5	SS	11						
6.1	Bedrock Limestone Unweathered		6	RC	Rec 63%		70				
69.1			7	RC	Rec 83%						
7.8	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

METRIC

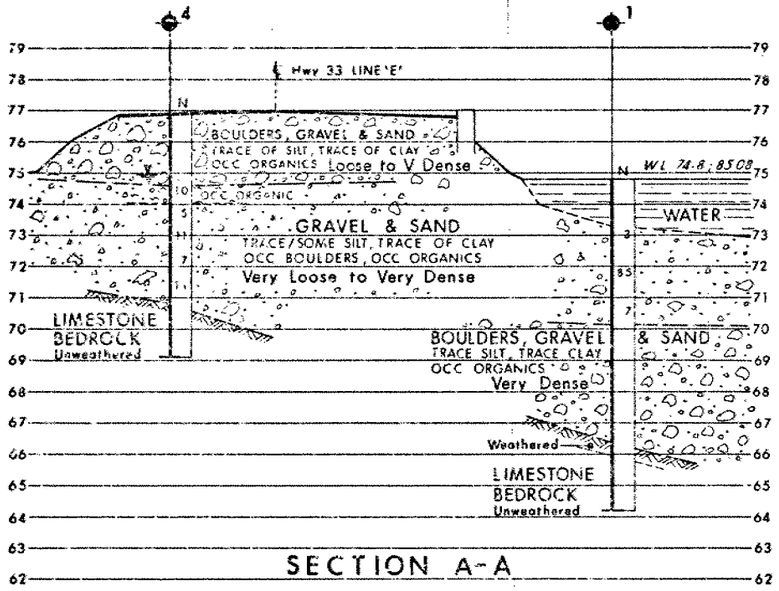
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 25-77-05

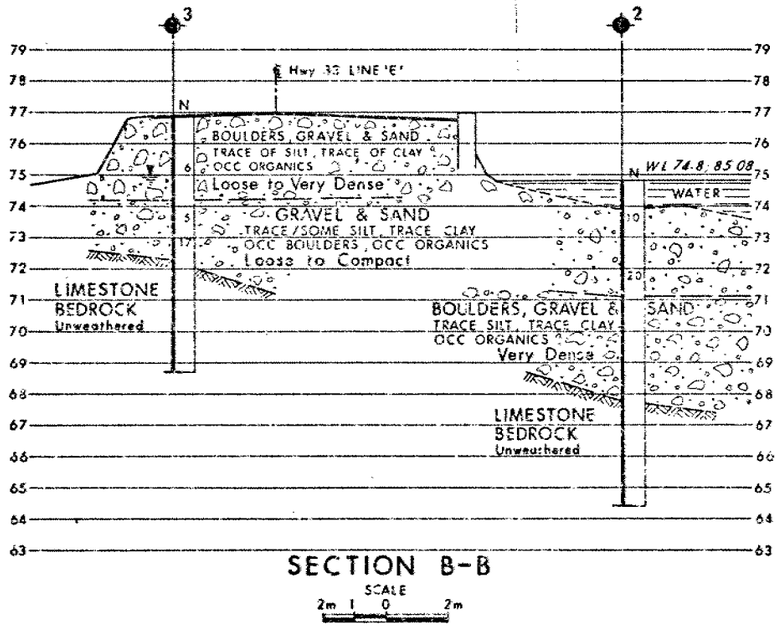
COLLINS CREEK BRIDGE

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

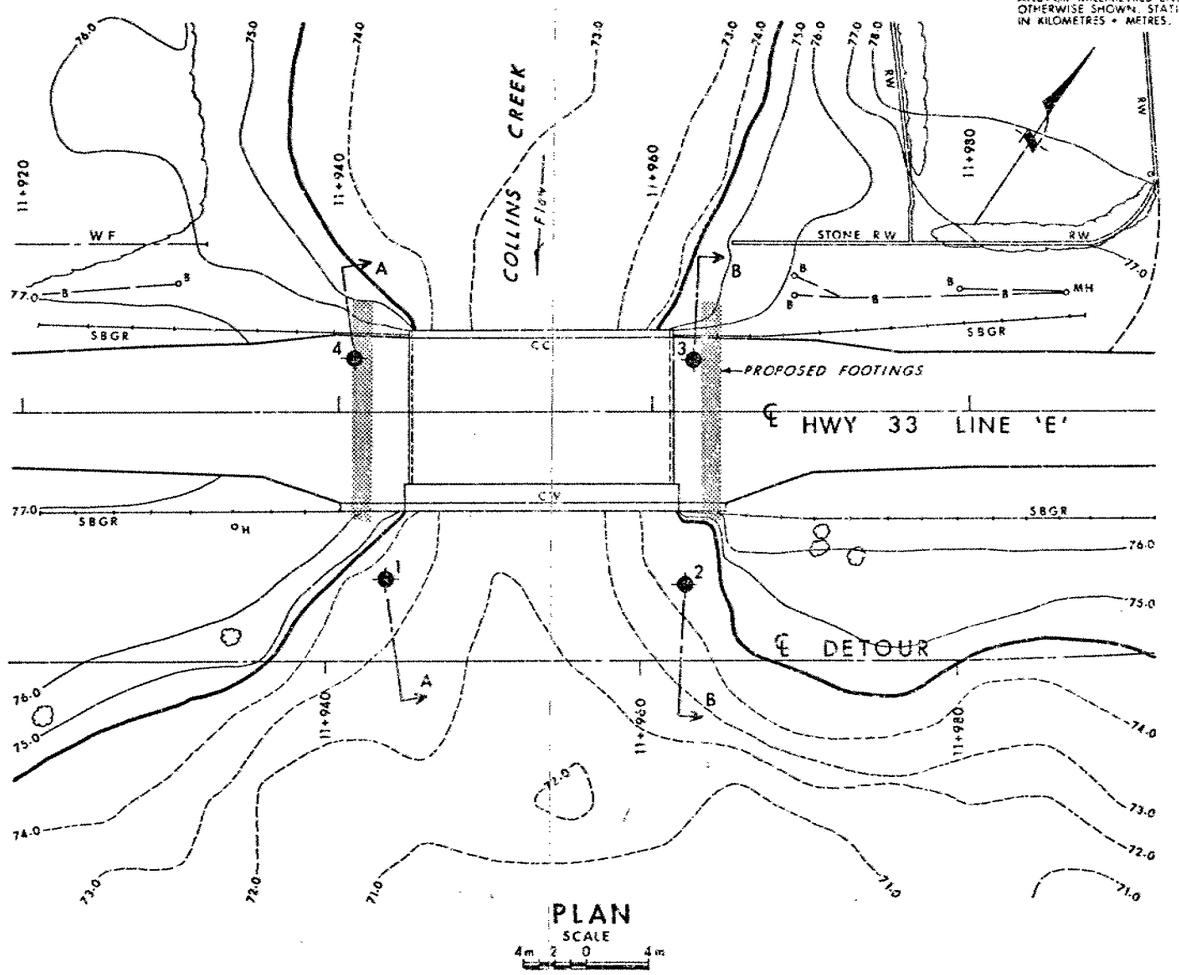


SECTION A-A



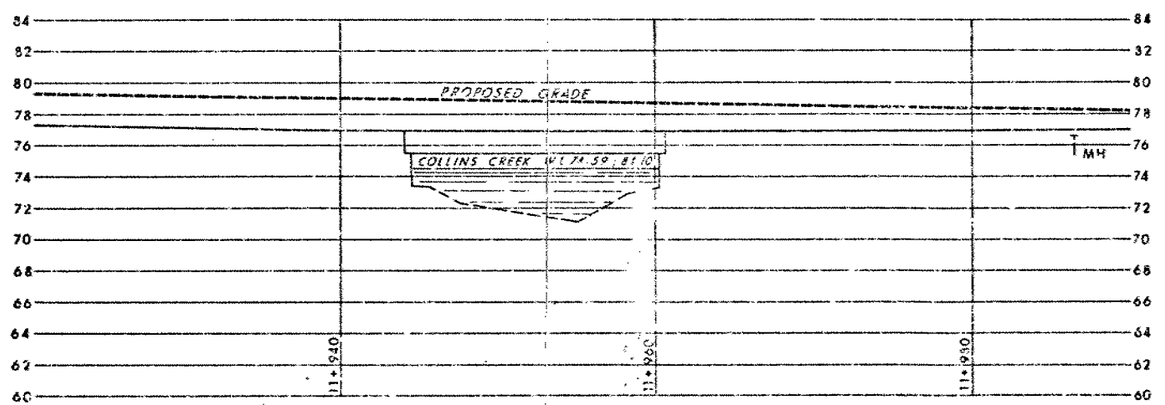
SECTION B-B

SCALE
2m 1 0 2m



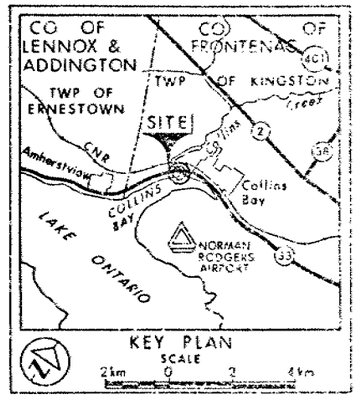
PLAN

SCALE
4m 2 0 4m



℄ PROFILE HWY 33 LINE 'E'

SCALE
4m 2 0 4m



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 1985 08 and 09

No	ELEVATION	STATION	OFFSET
1	74·8	11+943·0	10·6m Rt
2	74·8	11+962·0	11·0m Rt
3	76·9	11+962·7	3·3m Lt
4	76·9	11+941·0	3·3m Lt

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 7012-2 of Form 1120.

REV	DATE	BY	DESCRIPTION

Geocres No 31C-141

HWY No 33			DIST 8
SUBMD D D	CHECKED	DATE 1985 12 16	SITE 7-03
DRAWN	CHECKED	17 REVISED	DWG S7703-A

REF No e-7012-1; 1984 12

provide the space for walkway up to the waterline. This area would be treated with flat stones. The details for the walkway would be finalized by the Planning and Design Section. This detail would have to be shown on the Structural General Arrangement Plans of all three structures when it is finalized.

I am sending you herewith the original tracings of the Loyalist Parkway Aesthetic Consideration for Millhaven Creek Bridge, site 17-102 and Collins Creek Bridge, site 7-53 for inclusion with your contract drawings. The Millhaven Creek Bridge drawing may have to be transferred by photograph to a proper size contract drawing mylar.

The fluting (groove) details shown on the outside face of the barrier walls has dictated the locations of barrier wall construction joints which are as shown on the attached drawings. The construction joint locations are different than what was submitted in your package to the region. Would you please make necessary revisions on your barrier wall drawings resulting from the relocation of construction joints.

We have not finalized the rough texture finish pattern for the exposed faces of the wingwalls yet. However, this detail could be specified in the non-standard special provision when it is finalized.

The Region will look after the similar details and revisions for Parrott's Bay structure.

Q.M. Islam
Q.M. Islam
Senior Structural Engineer

cc R.C. Wycliffe
cc J.W. Reid (Attn: B. Tarini)
cc Ted Phillips
cc S. Ng
cc M. Devata

QMI:tbm

memorandum

Ontario

Tel: 3731

To: Q.M. Islam
Sr. Structural Engineer
Structural Section
Kingston

Date: 1987 04 01

From: Foundation Design Section
Room 315, Central Building

RE: W.P. 25-77-03/04/05
Millhave Creek Bridge, Site 17-102
Parrott's Bay Bridge, Site 17-103
Collins Creek Bridge, Site 7-53
Hwy. 33, District 8, Kingston

Further to your memo dated March 23, 1987, and our telephone conversation of March 31, 1987, following are our recommendations for foundations for the proposed 1 m high above-noted structures:

1) Provided that some differential settlements can be tolerated, especially between the parapet wall and the abutments, the proposed parapet walls may be founded on spread footings.

2) The base of the spread footings should be founded below the depth of frost penetration (1.5 m) on 1 m thick pads of engineered fill.

3) The engineered fill should extend down at a 1 H : 1 V slope from the edge of the footing

4) The engineered fill should consist of:

   a) compacted Granular 'A'

or b) rock fill (with maximum dimension less than 150 mm) if rock fill has been used as backfill to the abutments, and for the immediate approaches.

If there are any questions, please contact this office.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundations Engineer

memorandum

Ontario

Tel: 3731

To: E.C. Lane
Head, Structural Section
Kingston

Date: 1987 03 10

Atten: Q. Islam

From: Foundation Design Section
Room 315, Central Building

RE: W.P. 25-77-03, Millhaven Creek
W.P. 25-77-04, Parrotts Bay
W.P. 25-77-05, Collins Creek
Hwy. 33, District 8 - Kingston

Further to your recent discussions with M. Devata, we have reviewed the foundation requirements for the above-noted three structures. We are satisfied with the recommendations given for Millhaven Creek and Collins Creek.

For Parrotts Bay, we are still of the opinion that the use of tube piles as discussed in the Foundation Report, is the most feasible solution. However, in order to facilitate the installation, the design should involve 450 mm diameter concrete-filled tube piles equipped with driving shoes as per M.T.C. standards. For such a diameter, loads of 2200 kN/pile at the U.L.S. and 1500 kN/pile at the S.L.S. II could be used.

If you require additional information, please do not hesitate to contact this Section.

L. Politano
Project Foundations Engineer

for

M. Devata
Chief Foundations Engineer
(East)

LP/MD/mmj

c.c. Wilin

memorandum

Ontario

Tel: 3282

To: W.L. Lin
Design Engineer
Structural Office
3501 Dufferin Street

Date: 1987 01 02

From: Foundation Design Section
Room 315, Central Building

RE: Collins Creek Bridge
W.P. 25-77-05, Site 7-53
Hwy. 33, District 8, Kingston

This office has reviewed the General Arrangement Drawing 7-53-P1 for the above noted project.

Our comments are as follows:

1) As discussed in our meeting of 86 11 05, the footing excavation should be confined by a cofferdam and tremie concrete should be used to balance the hydrostatic head before continuing with footing construction in the dry.

2) At the NW quadrant of the proposed structure bedrock was encountered at Elev. 71± m, while at the NE quadrant bedrock was encountered at 72± m. The preliminary drawing indicates that the base of the tremie concrete will be at Elev. 72.

   If a portion of the spread footing is founded on bedrock while the remainder is founded on boulders and gravel, there is a possibility of differential settlements occuring. This possibility could be reduced by founding the base of the footing a minimum of 0.3 m above the bedrock if possible either on existing overburden or on a granular pad.

If there are any questions, please contact this office.

D. H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundations Engineer

for

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

DHD/MD/mmj