

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 317-95

DIST. 9 REGION

W.P. No. 45-71-02

CONT. No. 80-47

W. O. No.

STR. SITE No. 15-10

HWY. No. 511

LOCATION Clyde River Bridge

No. of PAGES -

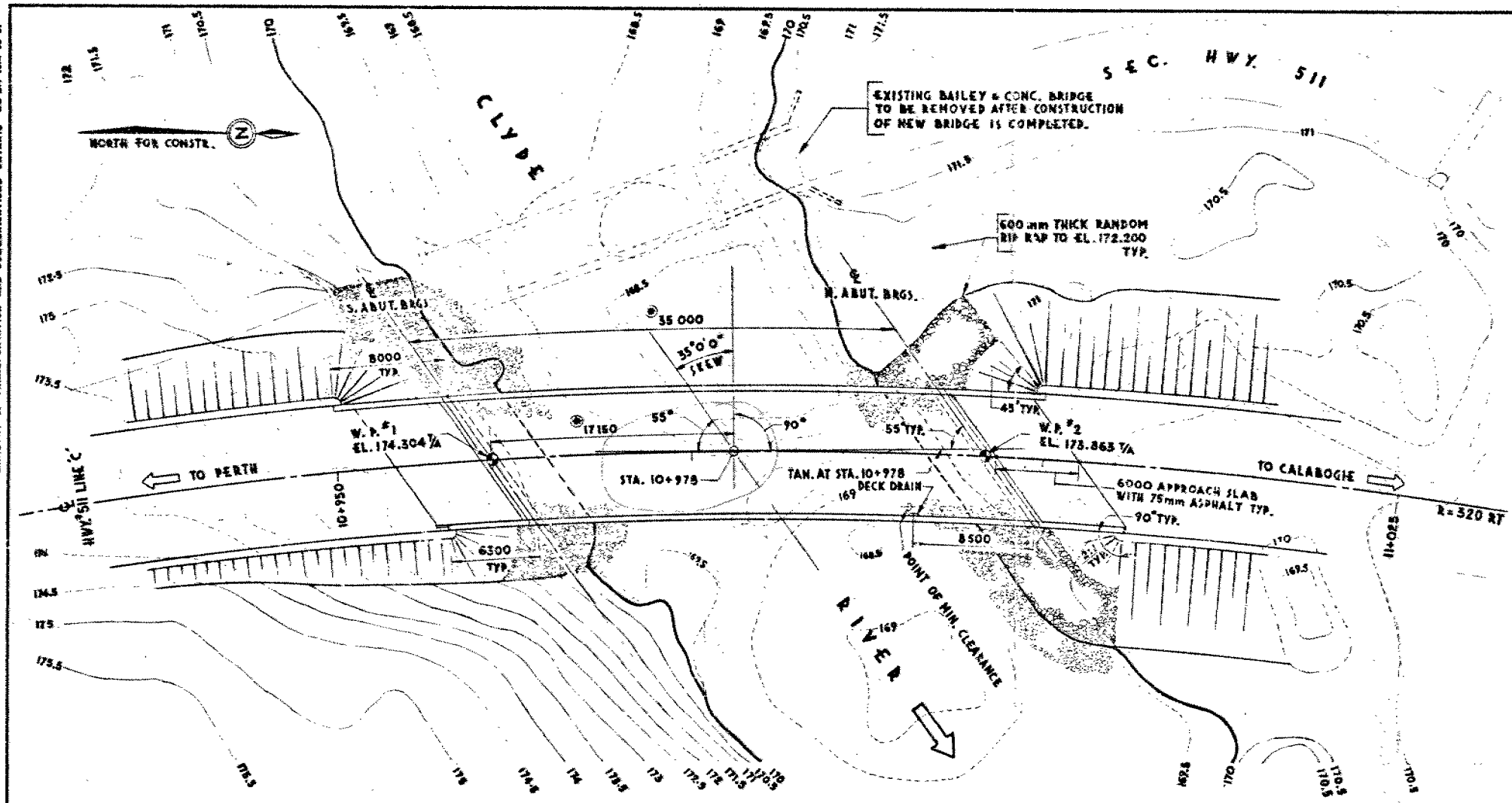
=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

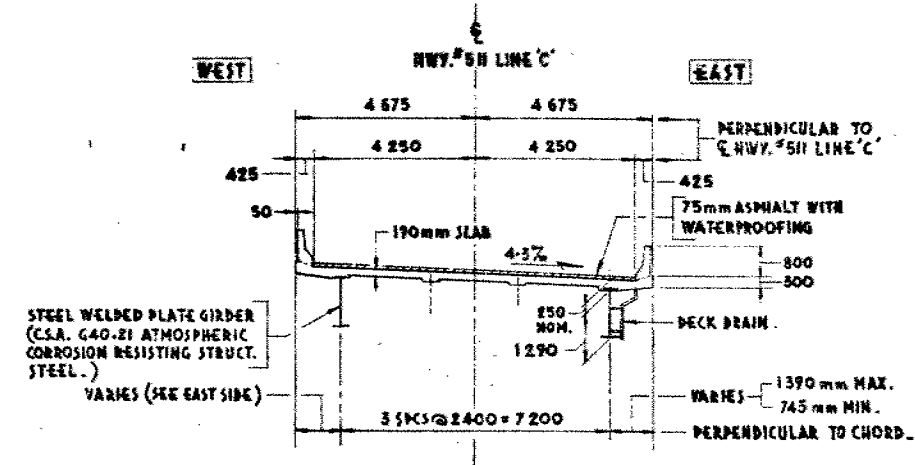
# METRIC

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



**P L A N**  
SCALE 1:200

- NOTES**
- W.P. DENOTES WORKING POINT.
  - 1/2 DENOTES TOP OF ASPHALT WEARING SURFACE.
  - MEASURED ALONG C HWY. 511 LINE 'C'.



**TYP. DECK SECT.**  
SCALE 1:100

## NOTES

**CLASS OF CONCRETE**

DECK & BARRIER WALLS . . . . . 30 MPa.

REMAINDER . . . . . 20 MPa.

**REINFORCING STEEL**

GRADE 400

BAR MARK WITH SUFFIX 'C' DENOTES COATED BAR.

**CLEAR COVER TO REINF. STEEL** mm

FOOTINGS & ABUTMENTS . . . . .	75
DECK TOP . . . . .	50
DECK BOTTOM . . . . .	40
BARRIER WALLS . . . . .	40
APPROACH SLABS . . . . .	50
AND/OR AS NOTED ON DRAWINGS.	

**CONSTRUCTION NOTES**

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ±3 mm.

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

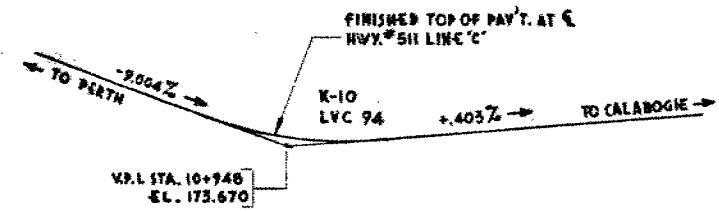
TO ACHIEVE THE MINIMUM CLEAR COVER OF 50 SPECIFIED AT TOP OF DECK, THE TOP LAYER OF REINFORCEMENT SHALL BE PLACED PRIOR TO CONCRETING, WITH A CLEAR COVER OF 55±15 mm TOLERANCE.

**CONCRETE QUANTITIES**

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONC. LUMP SUM TENDER ITEMS.

1- CONCRETE IN ABUTMENTS AND BARRIER WALLS . . . . .	112 m³
2- CONCRETE IN DECK . . . . .	73 m³
3- CONCRETE IN BARRIER WALLS . . . . .	19 m³
4- CONCRETE IN APPROACH SLABS . . . . .	26 m³

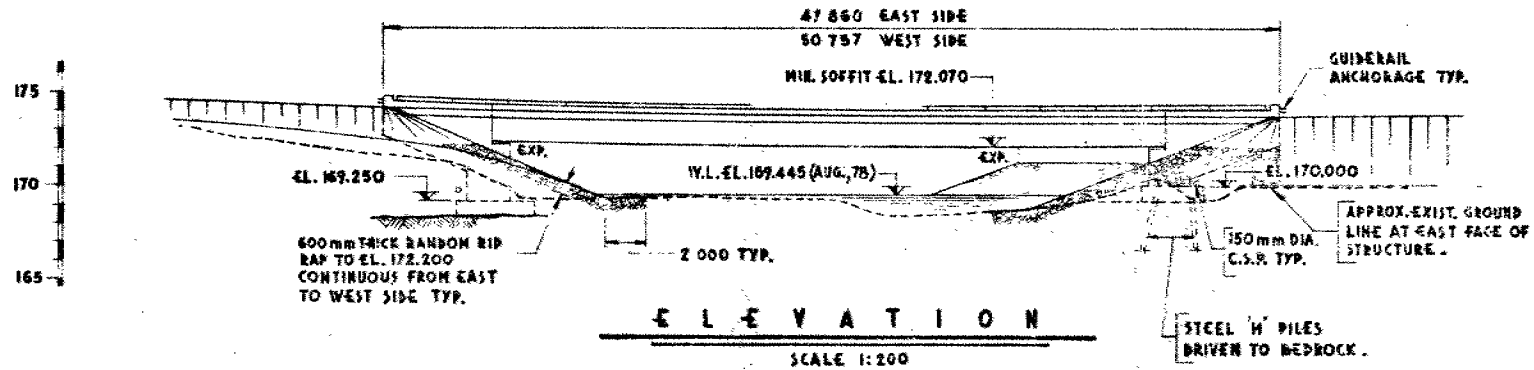
**STRUCTURAL STEEL QUANTITY . 50 TONNES**



**PROFILE OF HWY. 511 LINE 'C'**  
N.T.S.

## LIST OF DRAWINGS

- 15-10-1 GENERAL PLAN.
- 2 BOREHOLE LOCATION & SOIL STRATA.
- 3 FOUNDATION LAYOUT & REINF.
- 4 SOUTH ABUTMENT
- 5 NORTH ABUTMENT
- 6 STRUCTURAL STEEL & BEARINGS
- 7 DECK
- 8 BARRIER WALL
- 9 RAILING FOR BARRIER WALL
- 10 6000 APPROACH SLAB
- 11 STANDARD DETAILS I
- 12 STANDARD DETAILS II
- 13-15 AS CONSTRUCTED ELEV. & DIM.



**ELEVATION**  
SCALE 1:200

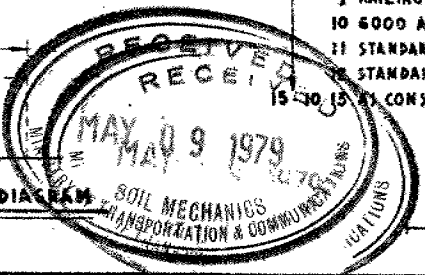
G.B.M. 135-G EL 192.189

C.R. RY. (ABANDONED) LARGE CONCRETE BOX CULVERT, 1.61 Km NORTH OF STATION AND AT 39.43 Km FROM RENFREW, THE FURTHER NORTH OF TWO CULVERTS 7.62 m APART, BOLT IN NORTH END OF WEST FACE.

QUAD 45076 SW LINE 52

FLOWER STATION

**NAVIGATION CLEARANCE DIAGRAM**  
(AFTER CONSTRUCTION)  
N.T.S.



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

**REVISIONS**

DATE	BY	DESCRIPTION
DESIGN	R.A. CHECK	LOADING M3 20-44 DATE APR 78
DRAWING	G.C. 15-DECK 2/78	SITE No 15-10 DWG 1



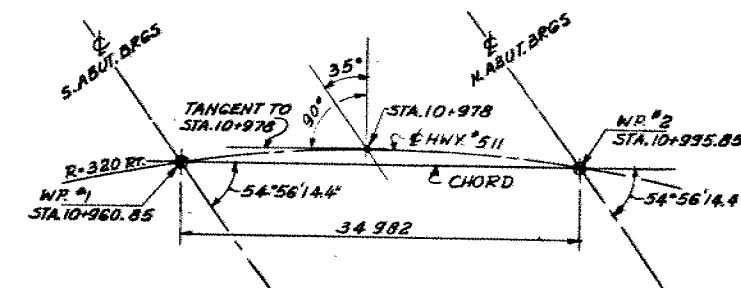
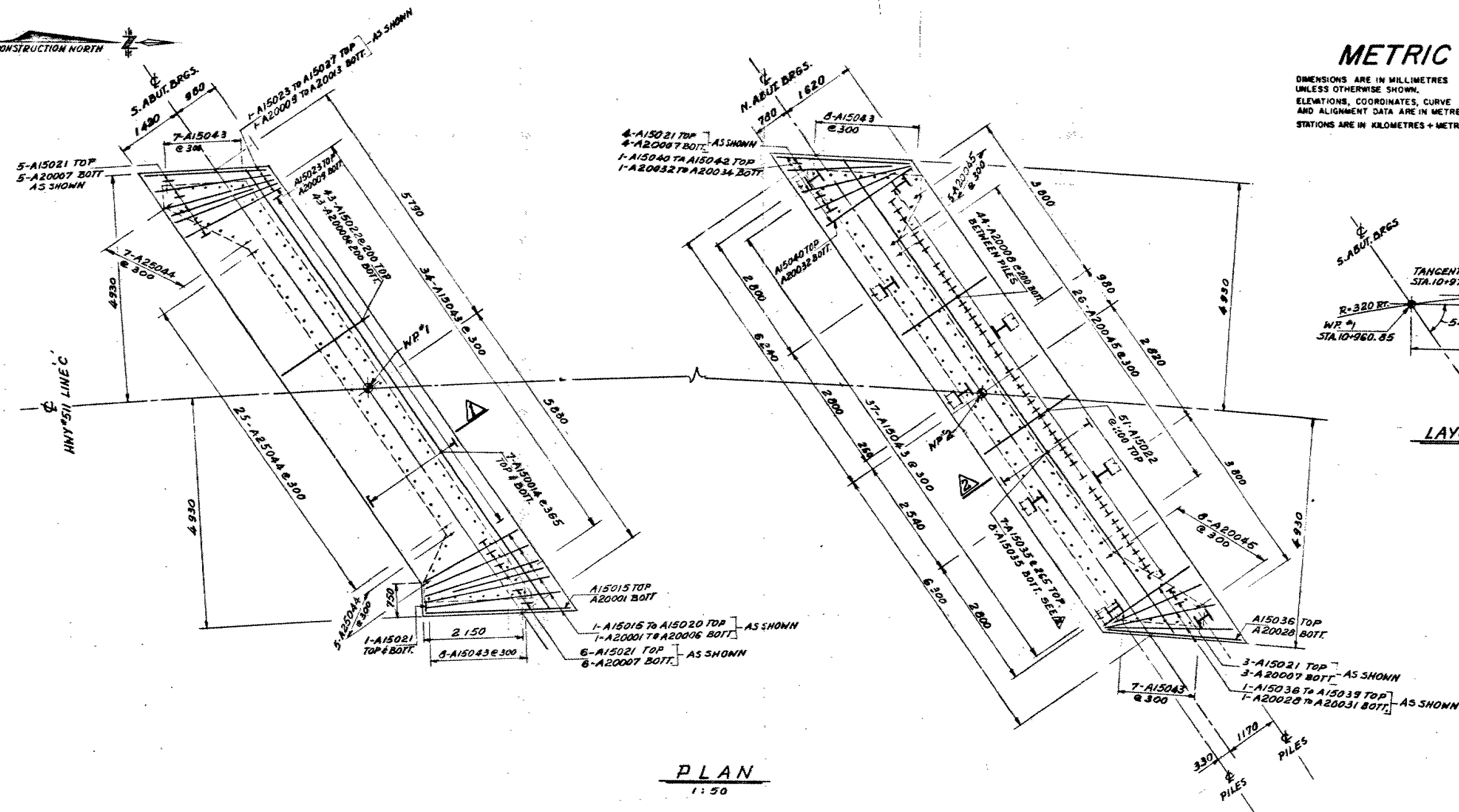
**METRIC**

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

CONT No  
WP No 45-71-02

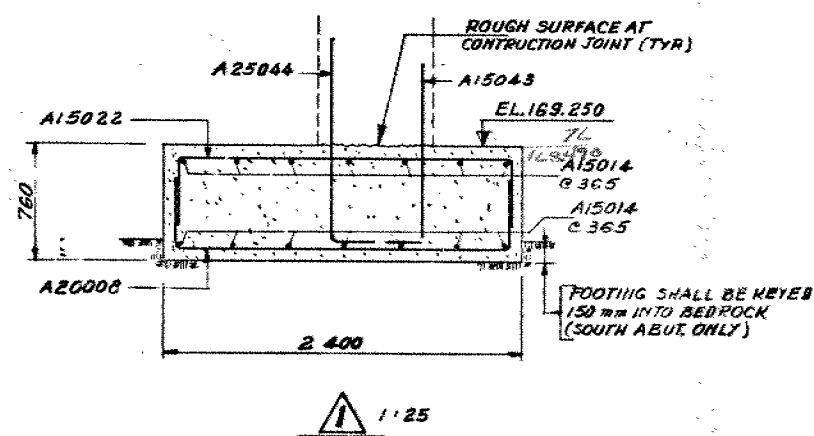
CLYDE RIVER BRIDGE  
1 Km North of Brightside  
FOUNDATION LAYOUT & REIN.

SHEET

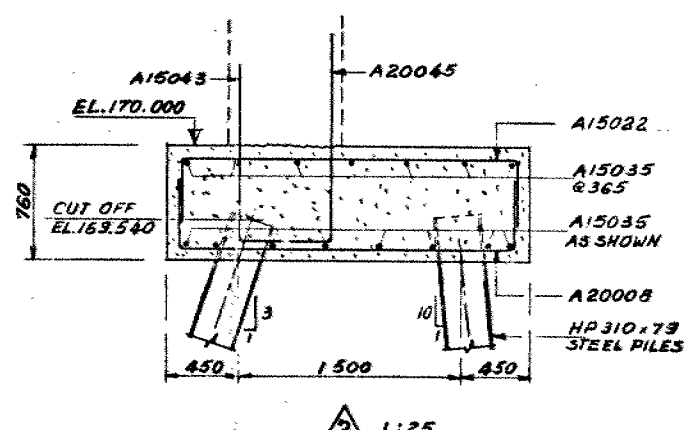


LAYOUT OF WORKING POINTS  
N.T.S.

PLAN  
1:50



1:25



2:25

PILE DATA			
LOCATION	TYPE	No. REID	LENGTH
NORTH ABUT.	HP 310 x 79	9	4.250

**NOTES**

- PILE SPACINGS TO BE MEASURED AT UNDERSIDE OF FOOTING
- PILES TO BE DRIVEN TO BEDROCK
- PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF

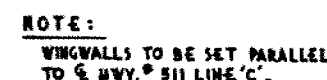
THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWINGS 4 & 5



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

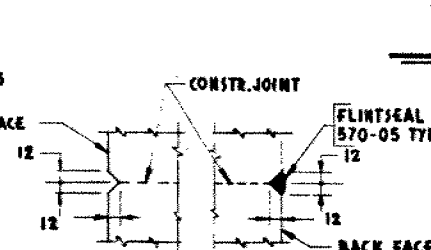
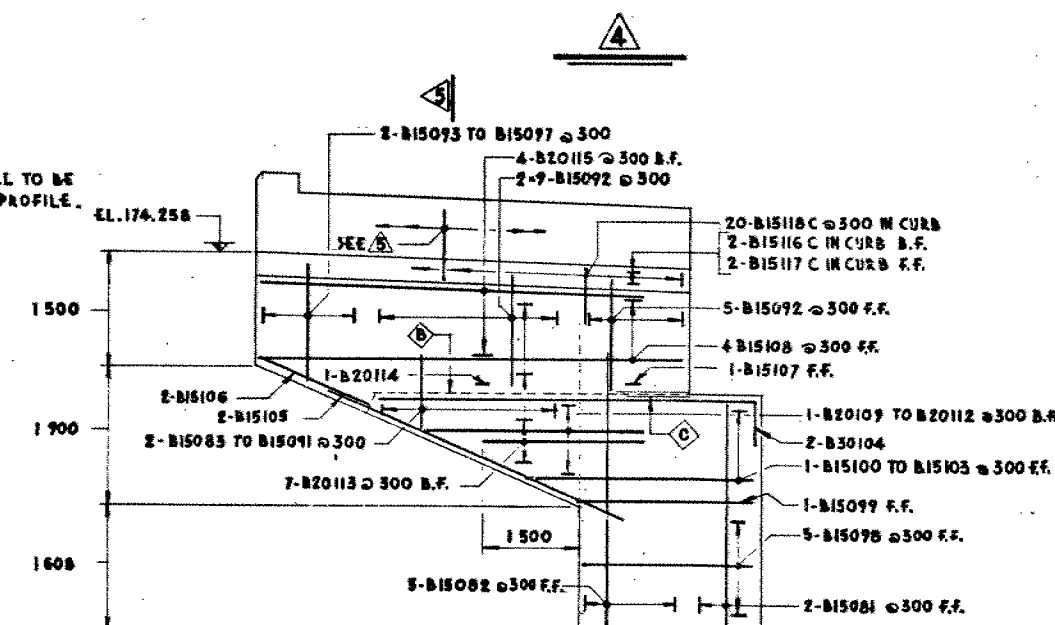
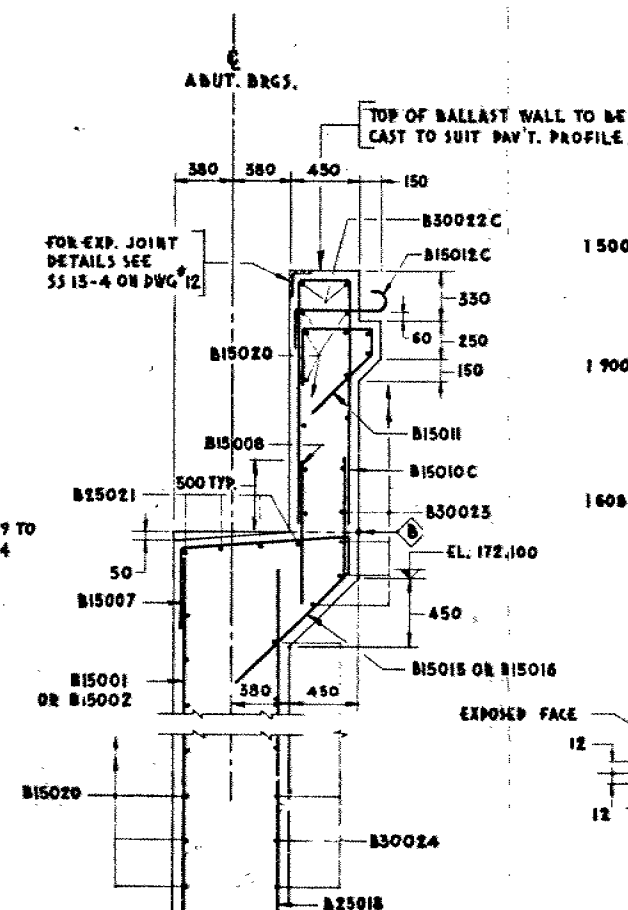
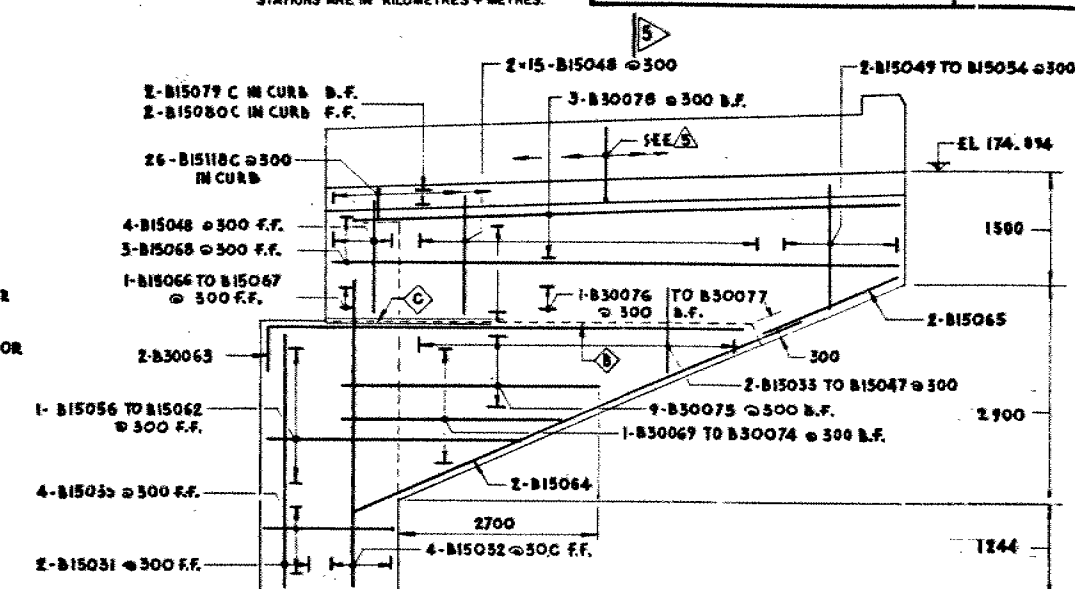
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	2.1.81	CHECK	LOADING H.S. 20-44 DATE 2/2/79
DRAWING	7.2.81	CHECK	DATE 7/2/79
			SITE No 15-10 DWG-3

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



FOR BARRIER WALL  
DETAILS & REINF.  
SEE DWG "B."

500  
150 50  
800  
75  
25  
B15079 C OR  
B15116 C  
300  
B15080 C OR  
B15117 C  
50  
B30078 OR  
B20115  
B30075 OR  
B20115  
B15048 TO B15054 OR  
B15092 TO B15097  
B15068 OR  
B15108  
450  
S 1:25



- F.F. DENOTES FRONT FACE.
- B.F. DENOTES BACK FACE.
- SCALE 1:50 UNLESS OTHERWISE NOTED.

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS				
	DATE	BY	DESCRIPTION	
	DESIGN R.A.	CHECK	LOADING W320-44-	DATE
	DRAWING C.C.	CHECK <i>W.P.</i>	SITE No 15-10	DWG A

## INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3- 12	Foundation Investigation Report Clyde River Bridge W.P. 45-71-02

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:** 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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

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

### PHYSICAL PROPERTIES OF SOIL

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

## FOUNDATION INVESTIGATION REPORT

For

Clyde River Bridge  
1 Kilometre North of Brightside  
W.P. 45-71-02, Site 15-10  
Hwy. 511, District 9, Ottawa

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INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. Field-work was carried out during August 16 and 17, 1978 and consisted of 4 sampled boreholes and 6 dynamic cone penetration tests. The borings were advanced to depths of up to 4.9 metres below the existing ground surface by hollow stem augering. In addition, bedrock was proven in each of the sampled boreholes by obtaining up to 3.5 metres of BX size rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of Clyde River and Hwy. 511 some 1000 metres north of Brightside in the County of Lanark, Township of Darling.

The topography in the site vicinity is rough. Land use in the area may be described as rural residential with single residences established immediately south of the river and to the east and west of the highway. North of the river, pasture is located west of the highway, whereas east of the highway the terrain is bush covered.

Above this crossing the Clyde River drains numerous small lakes with a total catchment area some 600 square kilometers to the west of the highway. The water level at the time of the foundation investigation was about at elevation 170 metres with a depth of water of 0.3 to 0.6 metres. The creek banks are approximately 1 metre high and almost vertical on the north side and are in the order of 5 metres high to the south with slopes as steep as 2 horizontal to 1 vertical. The creek bed is strewn with sand, cobbles and boulders up to 1 metre in size.

The existing structure is comprised of a bailey bridge, center span, 20.9 m, with two concrete slab end spans, 6.6 m each. The proposed crossing is located some 10 to 25 metres east of the existing crossing.

Physiographically, the site is located within the region known as the Canadian Shield. This area is characterized by shallow till deposits and rock ridges.

### SUBSOIL CONDITIONS

#### General

Subsoil conditions across the site are somewhat variable. North of the river the surficial deposit is composed of 2.4 metres of very soft to firm organic silt with sand overlying 1.2 metres of very stiff clayey silt. Immediately below this clayey silt deposit north of the river and extending from the ground surface south of the river is a compact to very dense granular deposit composed of sand with some gravel having a total thickness up to 2.7 metres. Adjacent to the highway this surficial granular stratum is overlain by up to 2.3 metres of well compacted roadway fill material composed of sand, some gravel and occasional cobbles. Immediately below the sand and gravel stratum is bedrock; gneiss bedrock to the south of the river, dolomitic limestone bedrock to the north of the river.

The boundaries between the various soil strata and bedrock are shown on the Record of Borehole Sheets. The locations and elevations of the borings, together with 1 stratigraphical profile and 2 stratigraphical sections based on the borehole data, are shown on Contract Drawing No. 15-10-2.

Following is a brief description of the encountered subsoil and bedrock types.

#### Fill

This deposit was encountered in 1 borehole put down south of the river adjacent to the highway and extending from the ground surface to a depth of 2.3 metres. The fill material is comprised of sand, some gravel with occasional cobbles. In addition,



exposed boulders, up to 0.5 metres in size, were observed within the face of the forward southeast approach slopes. The results of grain size distribution testing performed on representative samples obtained from this fill material are shown on Figure 1 in envelope form. Based on the results of Standard Penetration Test 'N' values of 5 to 18 blows per foot, it is estimated that the fill material has undergone a moderate compactive effort.

#### Organic Silt With Some Sand

This cohesive deposit was encountered in the two borings put down north of the river and extending from the ground surface to a depth of 2.4 metres below the ground surface. The stratum is composed of dark brown to black organic silt with some sand.

Based on Standard Penetration Test 'N' values ranging from 3 to 12 blows per foot this cohesive deposit is estimated to have a very soft to firm consistency.

#### Clayey Silt

This cohesive deposit was encountered in both sampled borings put down north of the river immediately below the stratum of organic silt with some sand. The thickness of this stratum is estimated to be 1.2 metres and is comprised of grey clayey silt. The results of Atterberg limit testings are as follows (2 samples tested).

	Borehole #3 Sample #3	Borehole # Sample #
Natural Moisture Content (W) %	25	29
Liquid Limit (W <sub>L</sub> ) %	24	29
Plastic Limit (W <sub>p</sub> ) %	19	19
Plasticity Index (I <sub>p</sub> ) %	5	10

The limit testing indicates that the material is inorganic of low plasticity (CL to CL-ML zone).

The consistency of the deposit is estimated to be very stiff based on the Standard Penetration Test results of 11 and 14 blows per foot.

### Sand, Some Gravel

This granular deposit was encountered in all borings; south of the river it extends from the ground surface, whereas north of the river it is located immediately below the cohesive clayey silt stratum. The thickness varies from 0.9 to 2.7 metres and the material is comprised of sand with some gravel. The results of grain size distribution testing on samples from this deposit are shown in envelope form on Figure 1 in the Appendix.

Standard Penetration Testing gave 'N' values generally ranging from 14 to 58 blows per foot which indicates a compact to very dense relative density.

### Bedrock

Bedrock was proven in the four sampled boreholes by obtaining 1.5 to 3.5 metres of BX size rock core; elsewhere the bedrock surface was taken to be at the point of refusal to the cone test. Bedrock was encountered immediately below the sand with some gravel deposit at a depth of 2.7 to 5.4 metres below the ground surface which corresponds to an elevation of 164.8 to 169.4. The bedrock surface appears to be undulating and sloping slightly down to the north.

The type of the bedrock varies across the site; north of the river the bedrock is dolomitic limestone; south of the river the bedrock is gneiss.

The gneiss bedrock is grey to pink in colour and hard to medium texture with foliation at 45°. In one particular location the upper 0.7 metres of the gneiss bedrock appears to be in a weathered state with a corresponding RQD value of 40%; elsewhere the gneiss bedrock is generally sound with RQD values as high as 97%.

The dolomitic limestone (marble) bedrock is white grey in colour, coarse texture, hard, and partly weathered in zones of vugs and mineralization. The upper 1.4 to 1.6 metres of this bedrock contains some zones about 0.3 metres thick which are in a somewhat weathered state. Below these zones the rock is in a generally good condition with corresponding RQD values of 75 to 90%.

### Groundwater Conditions

The groundwater level was determined by measuring in the open boreholes. The measurements indicate that the groundwater varies between 0.6 and 2.4 metres below the ground surface which corresponds to elevation 169.4 to 170.3. The free water in Clyde River was at about elevation 170 during the field investigation. From the observations it is apparent that the groundwater has a very gentle gradient down to the river.

*M. MacLean*

M. MacLean, P. Eng.  
Project Foundations Engineer



*M. Devata*

M. Devata, P. Eng.  
Senior Foundations Engineer

## APPENDIX



Ministry of  
Transportation  
Construction

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

9

RECORD OF BOREHOLE No 1

METRIC

W P 45-71-02 LOCATION Sta. 10+951.0 o/s 1.5 m Lt. E Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *CP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100				
172.74	Ground Surface														
0.0	Fill, Sand, Some Gravel Occasional Cobble		1	SS	5										9 59 31 1
170.45			2	SS	18										
2.29	Sand, Some Gravel Compact to Very Dense		3	SS	14										2 64 (34)
168.24			4	SS	58										RQD = 40%
4.50	Gneiss Bedrock Weathered Sound		5	BX RC	Rec 79%										RQD = 97%
165.57			6	BX RC	Rec 100%										
7.17	End of Borehole														

RECORD OF BOREHOLE No 2

METRIC

W P 45-71-02 LOCATION Sta. 10+960.4 o/s 4.5 m Rt. E Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *CP*

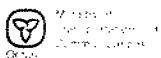
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100				
171.35	Ground Surface														
0.0	Sand, Some Gravel Compact		1	SS	30										14 55 23 8
168.68			2	SS	16										36 59 (5)
2.67	Gneiss Bedrock Sound		3	BX RC	Rec 100%										RQD = 90%
167.22															
4.13	End of Borehole														

+3, x5: Numbers refer to Sensitivity

20  
15  
10

5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



## RECORD OF BOREHOLE No 3

METRIC

W P 45-71-02 LOCATION Sta. 10+993.8 o/s 6.0 m Lt. & Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 17 CHECKED BY *SP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
170.77	Ground Surface													GR SA SI CL
0.0	Organic Silt Some Sand Very Soft to Firm		1	SS	3		170.00							
168.33			2	SS	9									
2.44	Clayey Silt Very Stiff		3	SS	14									5 2 78 15
167.11			4	SS	40									35 45 (20)
3.66	Sand, Some Gravel Compact to Very Dense		5	SS	40/0.15 m									
165.83			6	BX RC	Rec 100%		165.00							RQD = 71%
4.94	Dolomitic Limestone Bedrock Sound Weathered Sound		7	BX RC	Rec 100%									RQD = 80%
162.75														
8.02	End of Borehole													

## RECORD OF BOREHOLE No 4

METRIC

W P 45-71-02 LOCATION Sta. 11+000.4 o/s 4.0 m Rt. & Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *SP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
170.32	Ground Surface													GR SA SI CL
0.0	Organic Silt Some Sand Very Soft to Firm		1	SS	4		170.00							
167.90			2	SS	12									70 26 (4)
2.44	Clayey Silt Very Stiff		3	SS	11									
166.68			4	SS	14									
3.66	Sand, Some Gravel Compact - Very Dense		5	SS	Bouncing									
165.81			6	BX RC	Rec 100%		165.00							RQD = 50%
4.53	Dolomitic Limestone Bedrock Weathered Sound		7	BX RC	Rec 100%									RQD = 75%
			8	BX RC	Rec 100%									RQD = 95%
162.25														
8.09	End of Borehole													

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 5

METRIC

W P 45-71-02 LOCATION Sta. 10+940.0 of Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION *	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
173.30	Ground Surface																GR SA SI CL
0.0	Fill, Sand, Some Gravel																
171.80																	
1.50	Sand, Some Gravel																
169.42																	
3.88	End of Cone Test Refusal to Driving Cone Probable Bedrock																
	* Note: Description Based on Nature of Cone Test Correlated With Adjacent Sampled Boreholes																

RECORD OF BOREHOLE No 6

METRIC

W P 45-71-02 LOCATION Sta. 11+001.0 of Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 17 CHECKED BY *[Signature]*

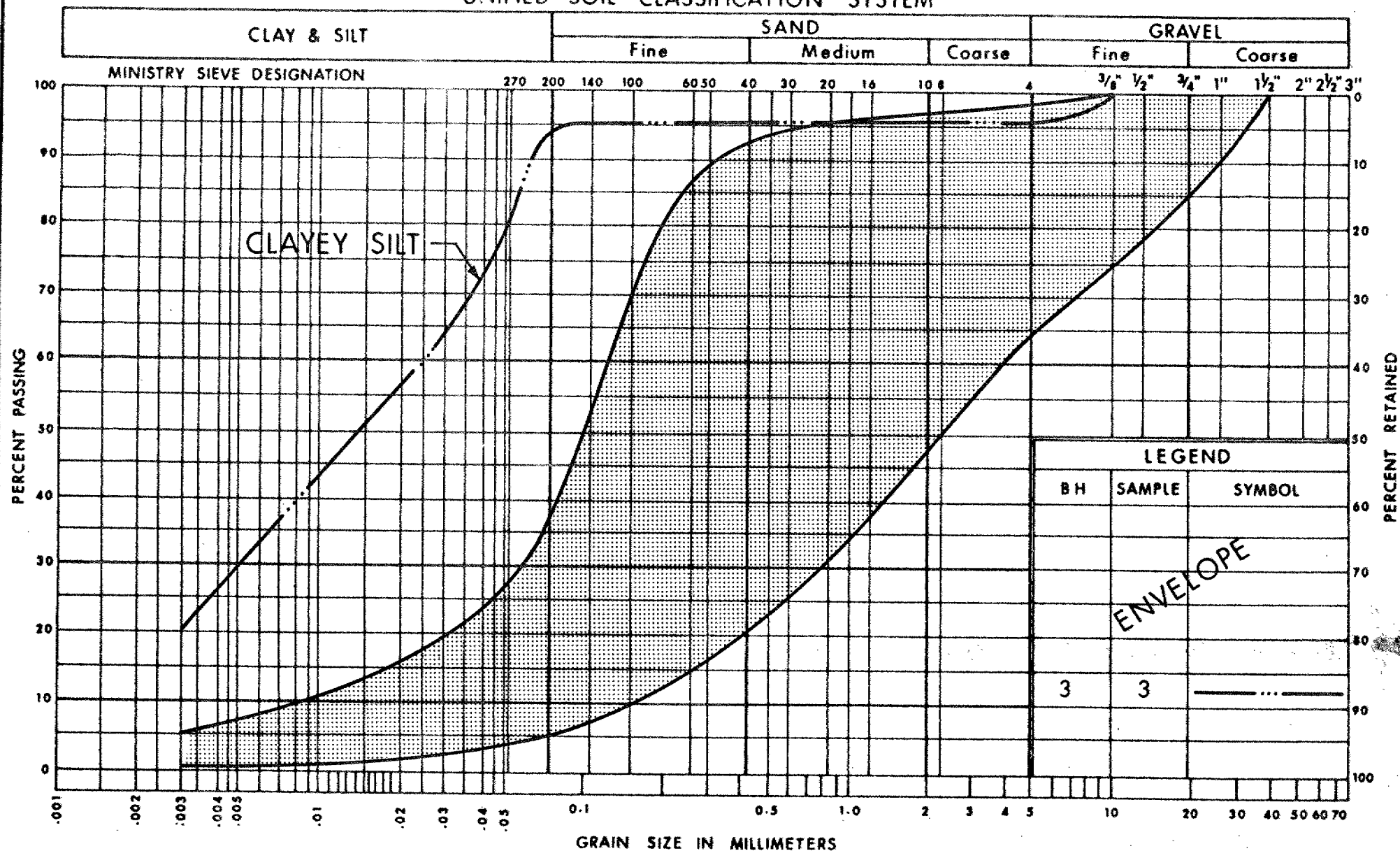
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION *	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.20	Ground Surface																GR SA SI CL
0.0	Organic Silt Some Sand																
168.30																	
167.10	Clayey Silt																
3.10	Sand, Some Gravel																
164.79																	
5.41	End of Cone Test Refusal to Driving Cone, Probable Bedrock																
	* Note: Description Based on Nature of Cone Test Correlated With Adjacent Sampled Boreholes																

+3, x5: Numbers refer to  
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SAND, SOME GRAVEL AND/OR FILL

FIG No 1

W P 45-71-02



ENGINEERING MATERIALS OFFICE  
SOIL MECHANICS SECTION

WP 45-71-02

DIST 9

HWY 511

STR SITE 15-10

Clyde River Bridge  
1 Kilometre North of Brightside

DISTRIBUTION

T.C. Kingsland  
W.E. Blum  
C.E. Pritchard  
R.W. Franks (2)

K.G. Bassi  
G.A. Wrong  
B.J. Giroux  
R.S. Pillar

R. Hore

R. Forest )  
J. Anderson ) cover only  
G. Sloan )

Files ✓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 11 15	M.D.
TUBES	-	-
ROCK CORES	the award of contract	M.D.

# FOUNDATION INVESTIGATION REPORT

For

Clyde River Bridge  
1 Kilometre North of Brightside  
W.P. 45-71-02, Site 15-10  
Hwy. 511, District 9, Ottawa

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## INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. Field-work was carried out during August 16 and 17, 1978 and consisted of 4 sampled boreholes and 6 dynamic cone penetration tests. The borings were advanced to depths of up to 4.9 metres below the existing ground surface by hollow stem augering. In addition, bedrock was proven in each of the sampled boreholes by obtaining up to 3.5 metres of BX size rock core.

## SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of Clyde River and Hwy. 511 some 1000 metres north of Brightside in the County of Lanark, Township of Darling.

The topography in the site vicinity is rough. Land use in the area may be described as rural residential with single residences established immediately south of the river and to the east and west of the highway. North of the river, pasture is located west of the highway, whereas east of the highway the terrain is bush covered.

Above this crossing the Clyde River drains numerous small lakes with a total catchment area some 600 square kilometers to the west of the highway. The water level at the time of the foundation investigation was about at elevation 170 metres with a depth of water of 0.3 to 0.6 metres. The creek banks are approximately 1 metre high and almost vertical on the north side and are in the order of 5 metres high to the south with slopes as steep as 2 horizontal to 1 vertical. The creek bed is strewn with sand, cobbles and boulders up to 1 metre in size.

The existing structure is comprised of a bailey bridge, center span, 20.9 m, with two concrete slab end spans, 6.6 m each. The proposed crossing is located some 10 to 25 metres east of the existing crossing.

Physiographically, the site is located within the region known as the Canadian Shield. This area is characterized by shallow till and rock ridges.

### SUBSOIL CONDITIONS

#### General

Subsoil conditions across the site are somewhat variable. North of the river the surficial deposit is composed of 2.4 metres of very soft to firm organic silt with sand overlying 1.2 metres of very stiff clayey silt. Immediately below this clayey silt deposit north of the river and extending from the ground surface south of the river is a compact to very dense granular deposit composed of sand with some gravel having a total thickness up to 2.7 metres. Adjacent to the highway this surficial granular stratum is overlain by up to 2.3 metres of well compacted roadway fill material composed of sand, some gravel and occasional cobbles. Immediately below the sand and gravel stratum is bedrock; gneiss bedrock to the south of the river, dolomitic limestone bedrock to the north of the river.

The boundaries between the various soil strata and bedrock are shown on the Record of Borehole Sheets. The locations and elevations of the borings, together with 1 stratigraphical profile and 2 stratigraphical sections based on the borehole data, are shown on Drawing No. 457102-A.

Following is a brief description of the encountered subsoil and bedrock types.

#### Fill

This deposit was encountered in 1 borehole put down south of the river adjacent to the highway and extending from the ground surface to a depth of 2.3 metres. The fill material is comprised of sand, some gravel with occasional cobbles. In addition,

exposed boulders, up to 0.5 metres in size, were observed within the face of the forward southeast approach slopes. The results of grain size distribution testing performed on representative samples obtained from this fill material are shown on Figure 1 in envelope form. Based on the results of Standard Penetration Test 'N' values of 5 to 18 blows per foot, it is estimated that the fill material has undergone a moderate compactive effort.

#### Organic Silt With Some Sand

This cohesive deposit was encountered in the two borings put down north of the river and extending from the ground surface to a depth of 2.4 metres below the ground surface. The stratum is composed of dark brown to black organic silt with some sand.

Based on Standard Penetration Test 'N' values ranging from 3 to 12 blows per foot this cohesive deposit is estimated to have a very soft to firm consistency.

#### Clayey Silt

This cohesive deposit was encountered in both sampled borings put down north of the river immediately below the stratum of organic silt with some sand. The thickness of this stratum is estimated to be 1.2 metres and is comprised of grey clayey silt. The results of Atterberg limit testings are as follows (2 samples tested).

		Borehole #3 Sample #3	Borehole # Sample #
Natural Moisture Content (W) %		25	29
Liquid Limit	(W <sub>L</sub> ) %	24	29
Plastic Limit	(W <sub>p</sub> ) %	19	19
Plasticity Index	(I <sub>p</sub> ) %	5	10

The limit testing indicates that the material is inorganic of low plasticity (CL to CL-ML zone).

The consistency of the deposit is estimated to be very stiff based on the Standard Penetration Test results of 11 and 14 blows per foot.

### Sand, Some Gravel

This granular deposit was encountered in all borings; south of the river it extends from the ground surface, whereas north of the river it is located immediately below the cohesive clayey silt stratum. The thickness varies from 0.9 to 2.7 metres and the material is comprised of sand with some gravel. The results of grain size distribution testing on samples from this deposit are shown in envelope form on Figure 1 in the Appendix.

Standard Penetration Testing gave 'N' values generally ranging from 14 to 58 blows per foot which indicates a compact to very dense relative density.

### Bedrock

Bedrock was proven in the four sampled boreholes by obtaining 1.5 to 3.5 metres of BX size rock core; elsewhere the bedrock surface was taken to be at the point of refusal to the cone test. Bedrock was encountered immediately below the sand with some gravel deposit at a depth of 2.7 to 5.4 metres below the ground surface which corresponds to an elevation of 164.8 to 169.4. The bedrock surface appears to be undulating and sloping slightly down to the north.

The type of the bedrock varies across the site; north of the river the bedrock is dolomitic limestone; south of the river the bedrock is gneiss.

The gneiss bedrock is grey to pink in colour and hard to medium texture with foliation at 45°. In one particular location the upper 0.7 metres of the gneiss bedrock appears to be in a weathered state with a corresponding RQD value of 40%; elsewhere the gneiss bedrock is generally sound with RQD values as high as 97%.

The dolomitic limestone (marble) bedrock is white grey in colour, coarse texture, hard, and partly weathered in zones of vugs and mineralization. The upper 1.4 to 1.6 metres of this bedrock contains some zones about 0.3 metres thick which are in a somewhat weathered state. Below these zones the rock is in a generally good condition with corresponding RQD values of 75 to 90%.

### Groundwater Conditions

The groundwater level was determined by measuring in the open boreholes. The measurements indicate that the groundwater varies between 0.6 and 2.4 metres below the ground surface which corresponds to elevation 169.4 to 170.3. The free water in Clyde River was at about elevation 170 during the field investigation. From the observations it is apparent that the groundwater has a very gentle gradient down to the river.

## DISCUSSION AND RECOMMENDATIONS

The site is located at the crossing of Hwy. 511 and the Clyde River some 1000 metres north of Brightside.

The proposed structure will replace the existing bailey bridge and will be located some 10 to 25 metres east of the existing crossing. At this time the structural proposal includes a single 40 metre clear span structure with associated approach fill heights in the order of 3 metres above the creek bed.

Following are our recommendations pertaining to the design and construction of the proposed structure and associated approach fills.

### Structure Foundations

South Abutment: Parent subsoil conditions here consist of 2.2 to 2.7 metres of compact to very dense sand with some gravel overlying gneiss bedrock. Roadway fill material consists of sand with some gravel and occasional cobbles.

The south abutment can be founded on spread footings within the sand, some gravel deposit. The base of the footings should be provided with a minimum of 1.7 metres of earth cover for frost protection purposes. Taking into account the frost protection requirements the abutment footing would be located at or below elevation 170.0 within the compact to very dense deposit of sand with some gravel. The subsoil conditions here are such that spread footings can be designed for a maximum allowable load of 200 kPa. Furthermore, if the footing founding level is below the groundwater level a temporary dewatering scheme may be required. If the footing level is approximately at the groundwater level a temporary dewatering scheme could be accomplished by constructing an oversize excavation and pumping from sumps. Alternatively, if the founding level is much lower than the groundwater, the dewatering scheme could be more practically accomplished by driving the sheet piling to a distance below the base of the excavation equal to the excess hydrostatic head. Furthermore, the sheeting could be left in place and incorporated in the scour

protection scheme. The recommendations for scour protection should be obtained from the Hydrology Office. The maximum settlement, total as well as differential, is not expected to exceed 25 mm for a footing designed and constructed according to the aforementioned recommendations.

Alternatively, the south abutment footing can be founded on spread footings placed on bedrock. According to the subsurface information in this area the upper 0.3 metres of this bedrock in certain locations is weathered. If the upper weathered bedrock is removed the footing could be designed using an allowable load of 1400 kPa. Alternatively, this weathered bedrock could be left in place and the footing may be designed for an allowable load of 650 kPa. Furthermore, the surface of the bedrock appears to be undulating with as much as 0.5 metres of relief and provisions in the contract should be made for bringing up the rock depressions to the founding level by means of mass concrete. In addition, the footing excavation will be below the groundwater level and due to the pervious nature of the subsoil a dewatering scheme will be required to enable construction of the footing to be carried out in the dry. Alternatively, the footing excavation could be carried out underwater to bedrock and the founding level brought up by means of tremie concrete.

North Abutment: Subsoil conditions here consist of 2.4 metres of very soft to firm organic silt and sand overlying 2.4 metres of very stiff clayey silt which in turn overlies up to 1.3 metres of compact to very dense sand with some gravel. Dolomitic limestone bedrock is present immediately below the sand with some gravel deposit. This bedrock has weathered zones up to 0.3 metres thick down to a depth of about 1.5 metres.

The subsoil conditions here are such that the north abutment can be supported on spread footings located within the clayey silt deposit. Footings designed in such a manner would require a minimum of 1.7 metres of earth cover for frost protection purposes. With the minimum earth cover provided the footing would be located at approximate elevation 168.0 within the deposit of clayey silt. This deposit is sufficiently competent to enable spread footings to be designed using an allowable load of 200 kPa. In order to



prevent softening of the foundation base 0.07 metres of mass concrete should be placed on the clayey silt founding level as soon as the excavation is completed. Alternatively, the footing could be founded on spread footings placed on the bedrock. The upper 1.5 metres of this deposit contain zones up to 0.7 metres thick of weathered rock. Since it may not be practical to remove the entire thickness of the weathered portion it is recommended that the footings constructed within this weathered zone may be designed for an allowable load of 650 kPa. As mentioned before, the surface of the bedrock appears to be undulating and in view of this, provisions in the contract should be made for bringing up the rock depressions to the founding level by means of mass concrete. In addition, the footing excavation will be below the groundwater level and due to the pervious nature of the overburden a dewatering scheme will be required to enable construction of the footing to be carried out in the dry. Alternatively, the footing excavation could be carried out underwater to bedrock and the founding level brought up by means of tremie concrete.

#### Other Considerations

To prevent the build up of hydrostatic pressures behind the abutment, free draining granular material should be used for backfill behind the retaining wall as per current M.T.C. Standards.

For estimating earth pressure a coefficient of active earth pressure of  $K_a=0.33$  may be used if some movement at the top of the wall is permitted, whereas if movement at the top of the abutment wall is restricted a coefficient of earth pressure at rest of  $K_o=0.5$  may be used for design purposes.

#### Approach Embankments

As mentioned earlier, the associated approach fills will be in the order of 3 metres above the creek bed. No stability problems are anticipated if the embankments are designed and constructed according to the following procedures.

- a) The organic silt on the north shore and the topsoil elsewhere is entirely removed to its full depth within the plan limits of the embankment for a minimum distance of 15 metres behind the abutments

- b) Widening where applicable is to be carried out in accordance with M.T.C. Standard Benching of Earth Slopes (DD-414)
- c) Side and forward slopes not steeper than 2 horizontal to 1 vertical slope
- d) The slopes are to be protected against river erosion as per recommendation of the Hydrology Office.

#### MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. M. MacLean, Project Engineer, using equipment owned and operated by Atcost Soil Drilling Inc., Toronto.

This report was written by Mr. MacLean and was reviewed by Mr. M. Devata, Supervising Engineer.

*M MacLean*

M. MacLean, P. Eng.  
Project Engineer



*M. Devata*

M. Devata, P. Eng.  
Supervising Engineer

September, 1978

## APPENDIX



RECORD OF BOREHOLE No 1

METRIC

W P 45-71-02 LOCATION Sta. 10+951.0 o/s 1.5 m Lt. Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
172.74	Ground Surface													
0.0	Fill, Sand, Some Gravel Occasional Cobble		1	SS	5									9 59 31 1
170.45			2	SS	18									
2.29	Sand, Some Gravel Compact to Very Dense		3	SS	14									2 64 (34)
168.24			4	SS	58									
4.50	Gneiss Bedrock	Weathered Sound	5	BX RC	Rec 79%									RQD = 40%
165.57			6	BX RC	Rec 100%									RQD = 97%
7.17	End of Borehole													

RECORD OF BOREHOLE No 2

METRIC

W P 45-71-02 LOCATION Sta. 10+960.4 o/s 4.5 m Rt. Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
171.35	Ground Surface													
0.0	Sand, Some Gravel Compact		1	SS	30									14 55 23 8
168.68			2	SS	16									36 59 (5)
2.67	Gneiss Bedrock	Sound	3	BX RC	Rec 100%									RQD = 90%
167.22														
4.13	End of Borehole													



## RECORD OF BOREHOLE No 3

METRIC

W P 45-71-02 LOCATION Sta. 10+993.8 o/s 6.0 m Lt. of Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 17 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.77	Ground Surface																
0.0	Organic Silt Some Sand Very Soft to Firm		1	SS	3		170.00										
168.33			2	SS	9												
2.44	Clayey Silt Very Stiff		3	SS	14												
167.11			4	SS	40												
3.66	Sand, Some Gravel Compact to Very Dense		5	SS	40/	0.15 m											
165.83			6	BX RC	Rec 100%		165.00										
4.94	Dolomitic Limestone Bedrock	Sound Weathered Sound	7	BX RC	Rec 100%												
162.75																	
8.02	End of Borehole																

## RECORD OF BOREHOLE No 4

METRIC

W P 45-71-02 LOCATION Sta. 11+000.4 o/s 4.0 m Rt. of Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.34	Ground Surface																
0.0	Organic Silt Some Sand Very Soft to Firm		1	SS	4		170.00										
167.90			2	SS	12												
2.44	Clayey Silt Very Stiff		3	SS	11												
166.68			4	SS	14												
3.66	Sand, Some Gravel Compact - Very Dense		5	SS	Bouncing												
165.81			6	BX RC	Rec 100%		165.00										
4.53	Dolomitic Limestone Bedrock	Weathered Sound	7	BX RC	Rec 100%												
162.25			8	BX RC	Rec 100%												
8.09	End of Borehole																



RECORD OF BOREHOLE No 5

METRIC

W P 45-71-02 LOCATION Sta. 10+940.0 @ Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 16 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION *	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
173.30	Ground Surface																
0.0	Fill, Sand, Some Gravel																
171.80																	
1.50	Sand, Some Gravel																
169.42																	
3.88	End of Cone Test Refusal to Driving Cone Probable Bedrock																
	* Note: Description Based on Nature of Cone Test Correlated With Adjacent Sampled Boreholes																

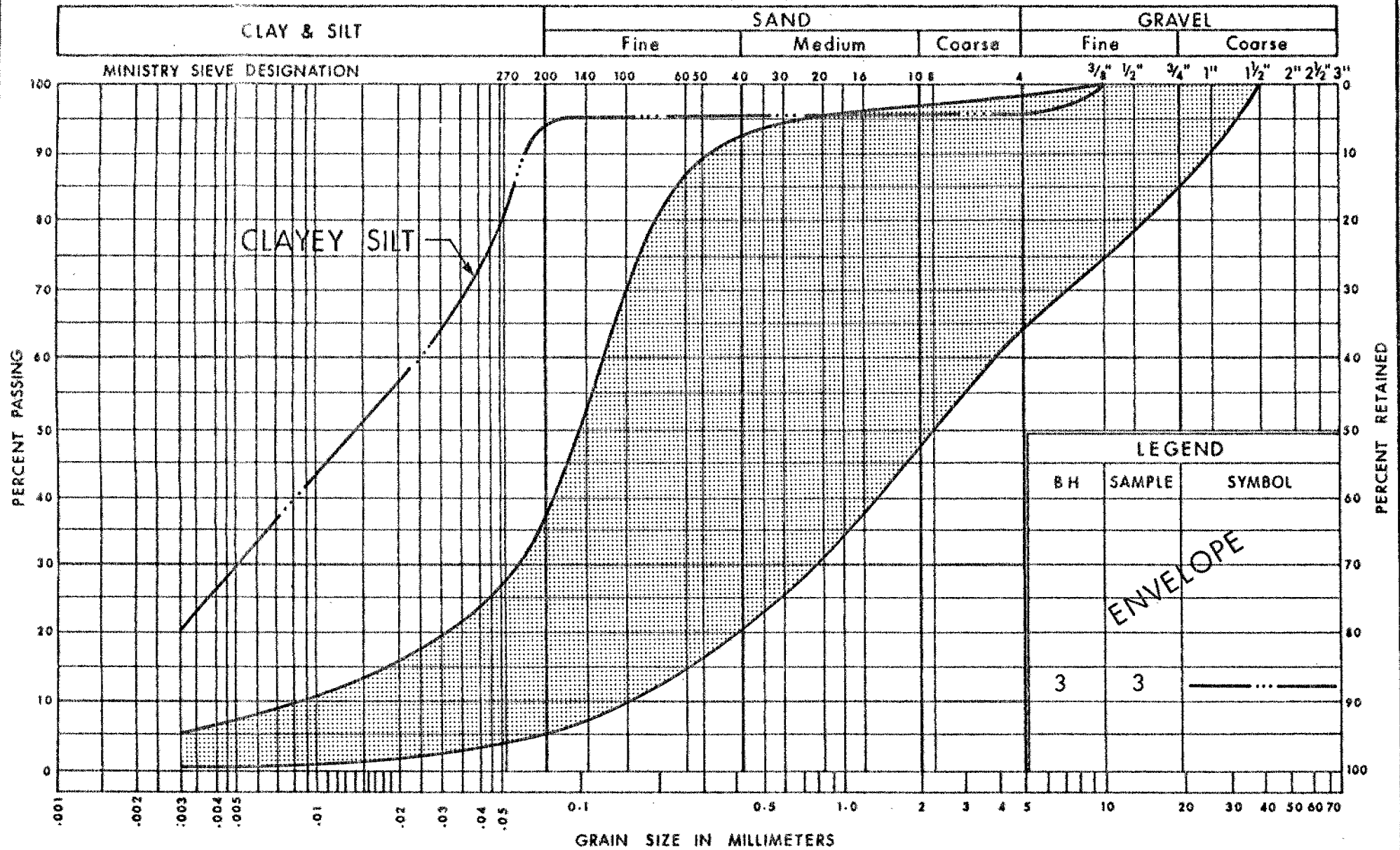
RECORD OF BOREHOLE No 6

METRIC

W P 45-71-02 LOCATION Sta. 11+001.0 @ Hwy. 511, Line 'C' ORIGINATED BY M.M.  
DIST 9 HWY 511 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY M.M.  
DATUM Geodetic DATE 1978 08 17 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION *	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.20	Ground Surface																
0.0	Organic Silt Some Sand																
168.40																	
1.80	Clayey Silt																
167.10																	
3.10	Sand, Some Gravel																
164.79																	
5.41	End of Cone Test Refusal to Driving Cone, Probable Bedrock																
	* Note: Description Based on Nature of Cone Test Correlated With Adjacent Sampled Boreholes																

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SAND, SOME GRAVEL AND/OR FILL

FIG No 1

WP 45-71-02

## 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

### MECHANICAL PROPERTIES OF SOIL

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

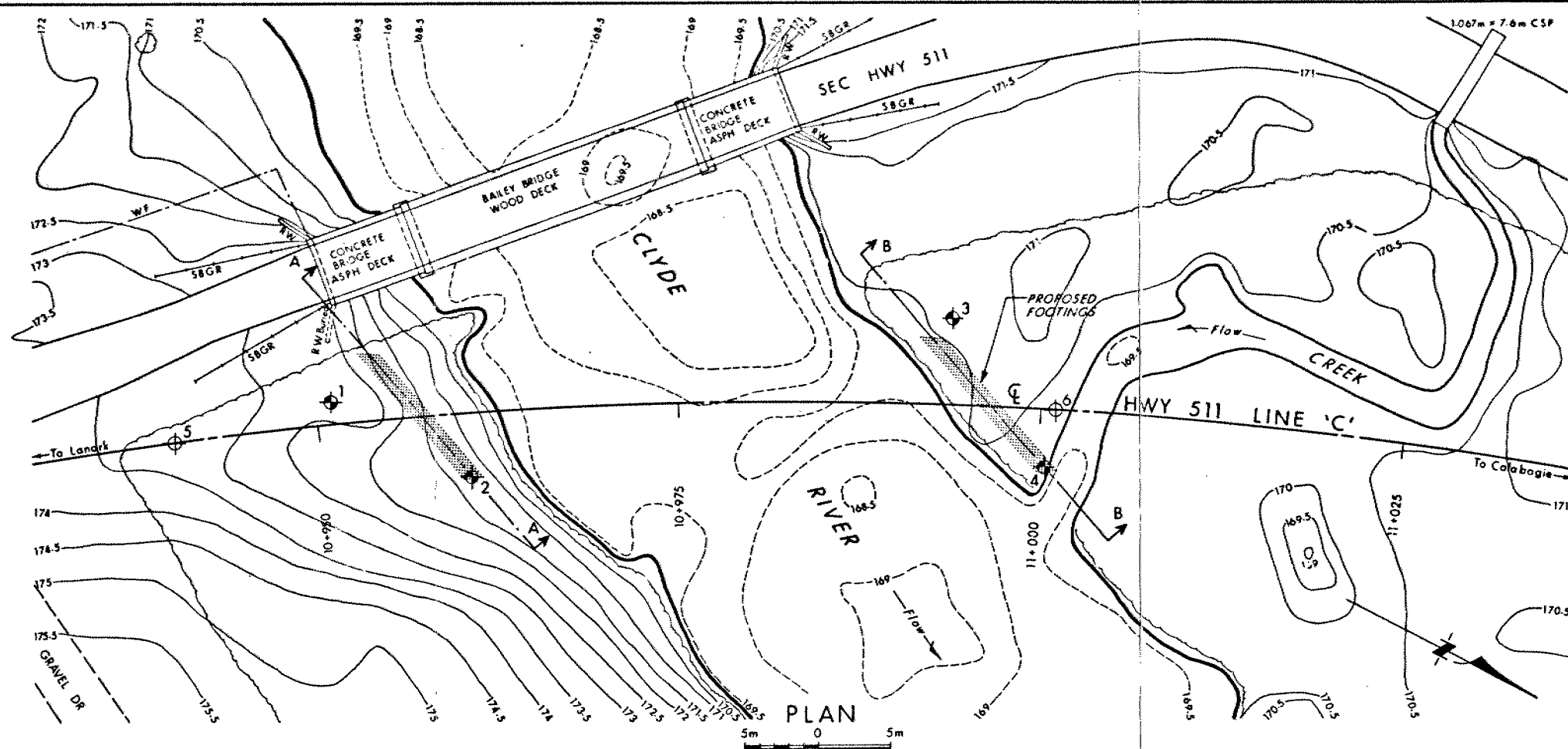
### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						



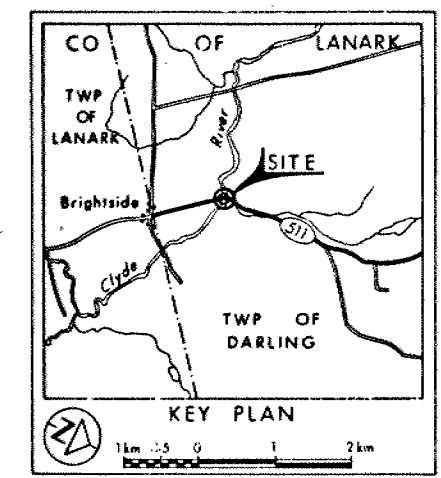


METRIC

CONT No  
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CLYDE RIVER BRIDGE  
(1.0 km North of Brightside)  
BORE HOLE LOCATIONS & SOIL STRATA

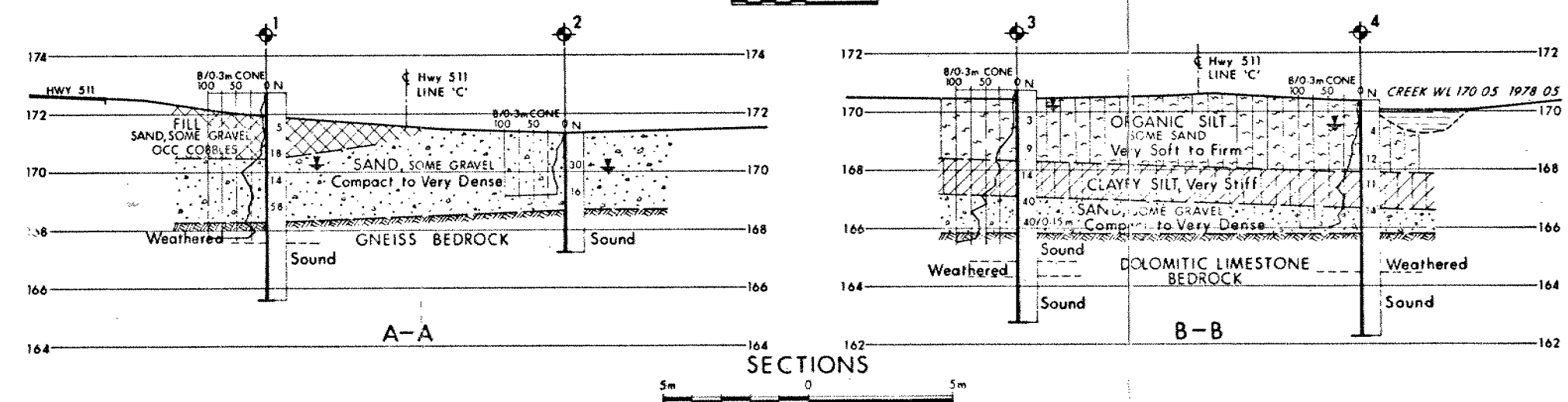
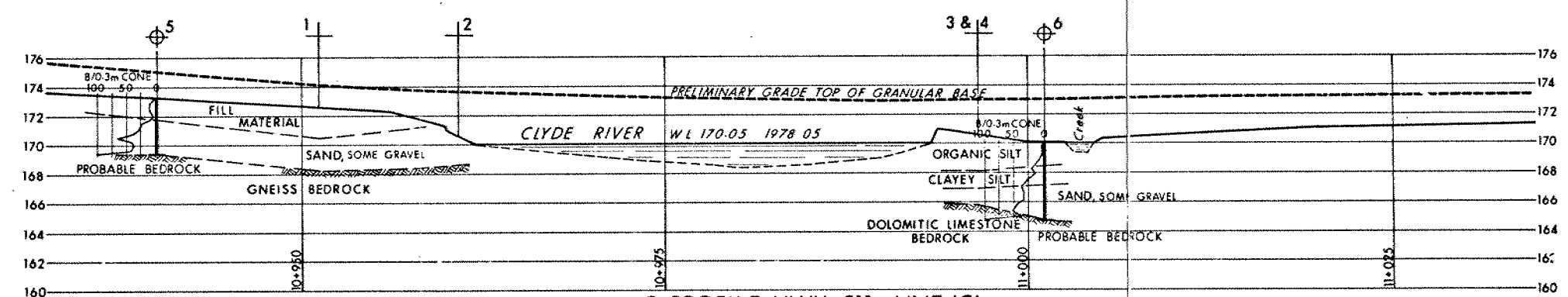
SHEET



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)
- WL at time of investigation 1978 05

No	ELEVATION	STATION	OFFSET
1	172.74	10+951.0	1.5m LT
2	171.35	10+960.4	4.5m RT
3	170.77	10+993.8	6.0m LT
4	170.34	11+000.4	4.0m RT
5	173.30	10+940.0	Q
6	170.20	11+001.0	Q



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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 31F-95

HWY No 511 LINE 'C' SITE 9  
 SUBMITTAL CHECKED DATE 1978 09 27 SITE 15-10  
 DRAWN CHECKED APPROVED DWG 457102-A