DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31F-103

DIST. 9 REGION

W.P. No. 21-82-01

CONT. No. 84-23

W. O. No.

STR. SITE No. 15-59

HWY. No. 511

LOCATION Clyde River Bridge (Beaver Dam)

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

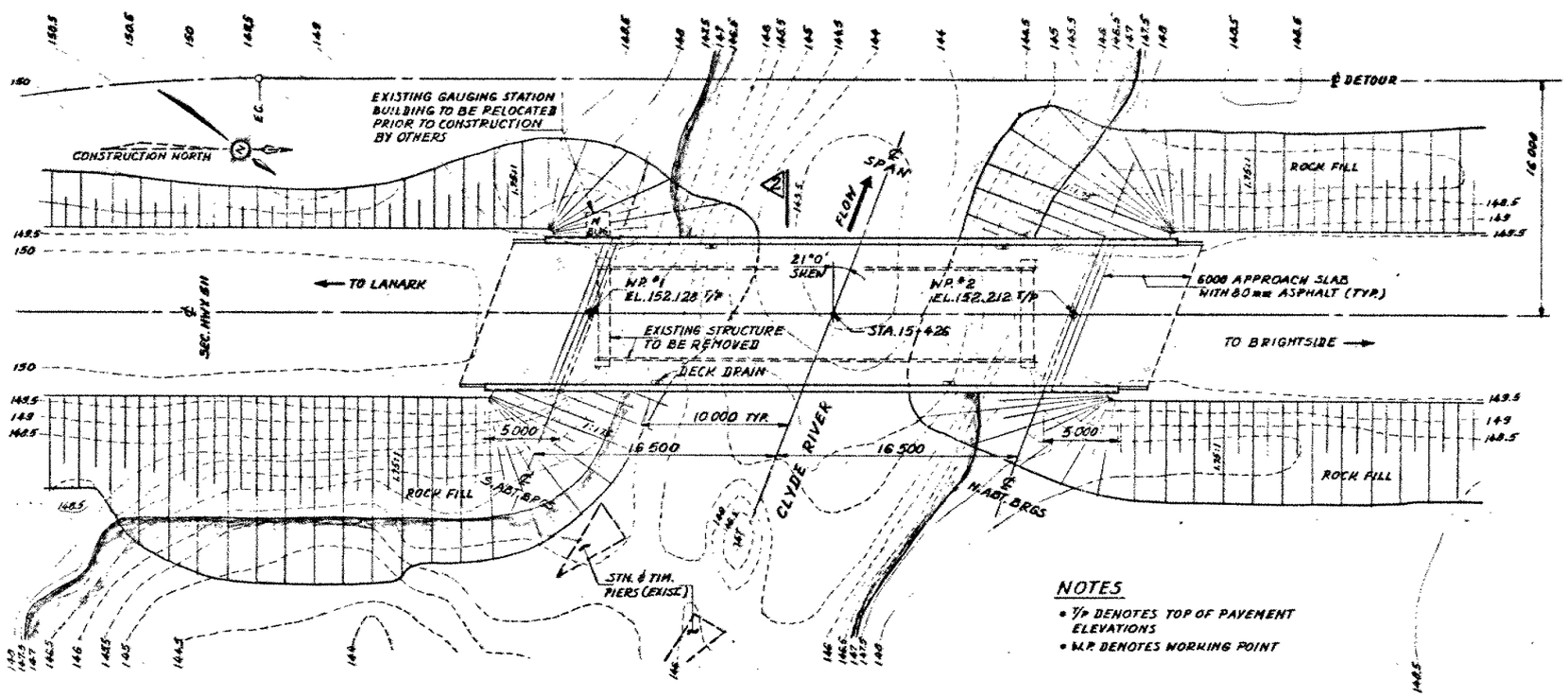
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DISTRICT No 9
CONT No
WP No 21-82-01

CLYDE RIVER BRIDGE
Approx. 5 km. North of Lanark
GENERAL ARRANGEMENT

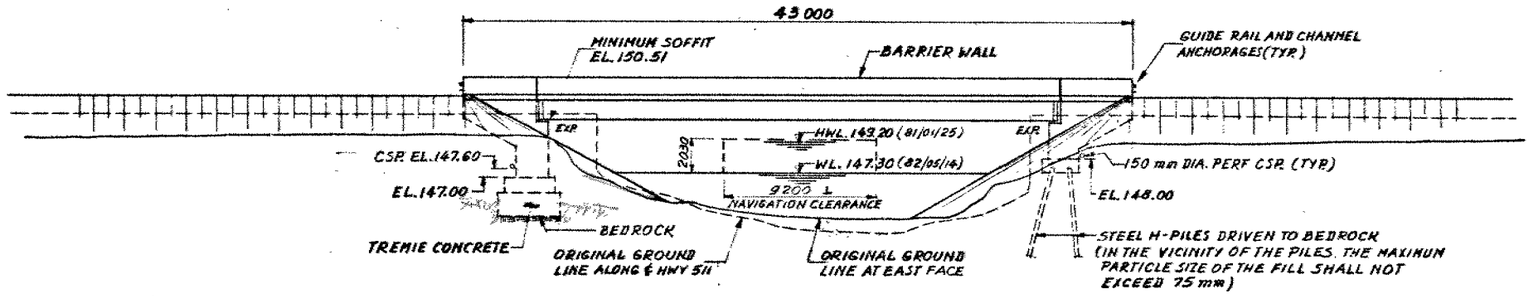
SHEET



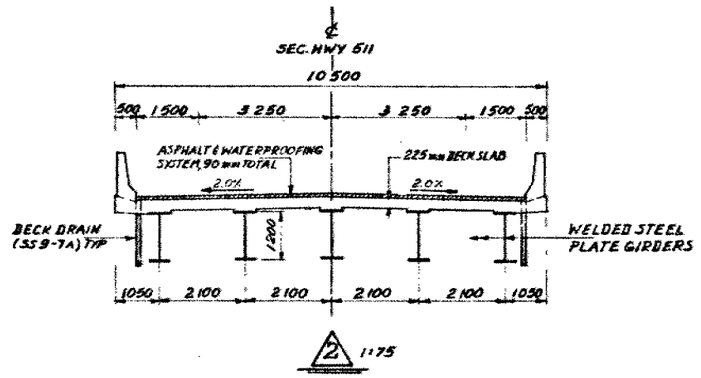
PLAN
1:200

NOTES

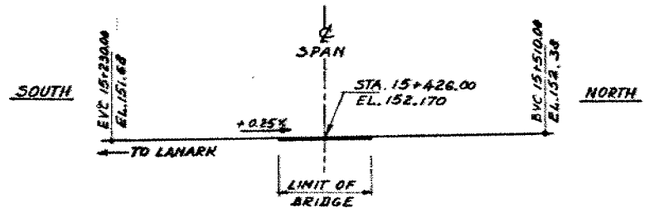
- T/P DENOTES TOP OF PAVEMENT ELEVATIONS
- W.P. DENOTES WORKING POINT



ELEVATION
1:200



2 1:75



PROFILE OF SEC. HWY 511
N.T.S.

NOTES

CLASS OF CONCRETE

DECK, BARRIER WALLS AND ABUTMENTS	30 MPa
REMAINDER	20 MPa

REINFORCING STEEL GRADE

GRADE 400, UNLESS OTHEWISE SPECIFIED
BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100±25 mm
ABUTMENTS, FRONT FACE	80±20 mm
BACK FACE	70±20 mm
DECK; TOP	70±20 mm
BOTTON	40±10 mm
REMAINDER; UNLESS OTHERWISE NOTED	70±20 mm

CONSTRUCTION NOTES

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

LIST OF DRAWINGS

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	
DESIGN J.S.	CHECK	LOADING OHBDC B-79		DATE DEC/83
DRAWING J.S.	CHECK W.H.	SITE No 15-59		DWG - 1

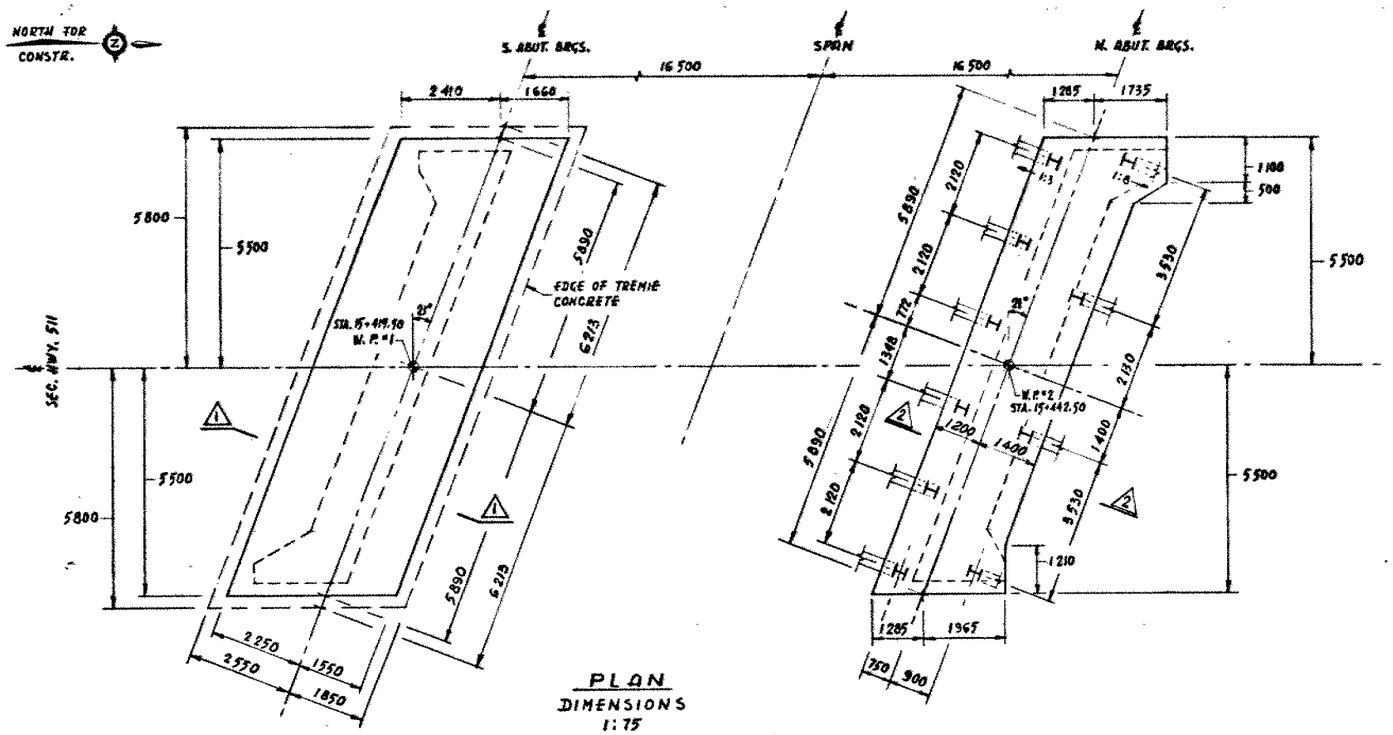
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
WP No 21-82-01

CLYDE RIVER BRIDGE
APPROX. 5 Km NORTH OF LANARK
FOOTINGS

SHEET



PLAN
DIMENSIONS
1:75

PILE DATA

LOCATION	BATTER	TYPE	No. REQ'D	LENGTH
NORTH ABUT.	1:3 FRONT	HP 310×79	6	5600
	1:8 BACK	HP 310×79	4	5400

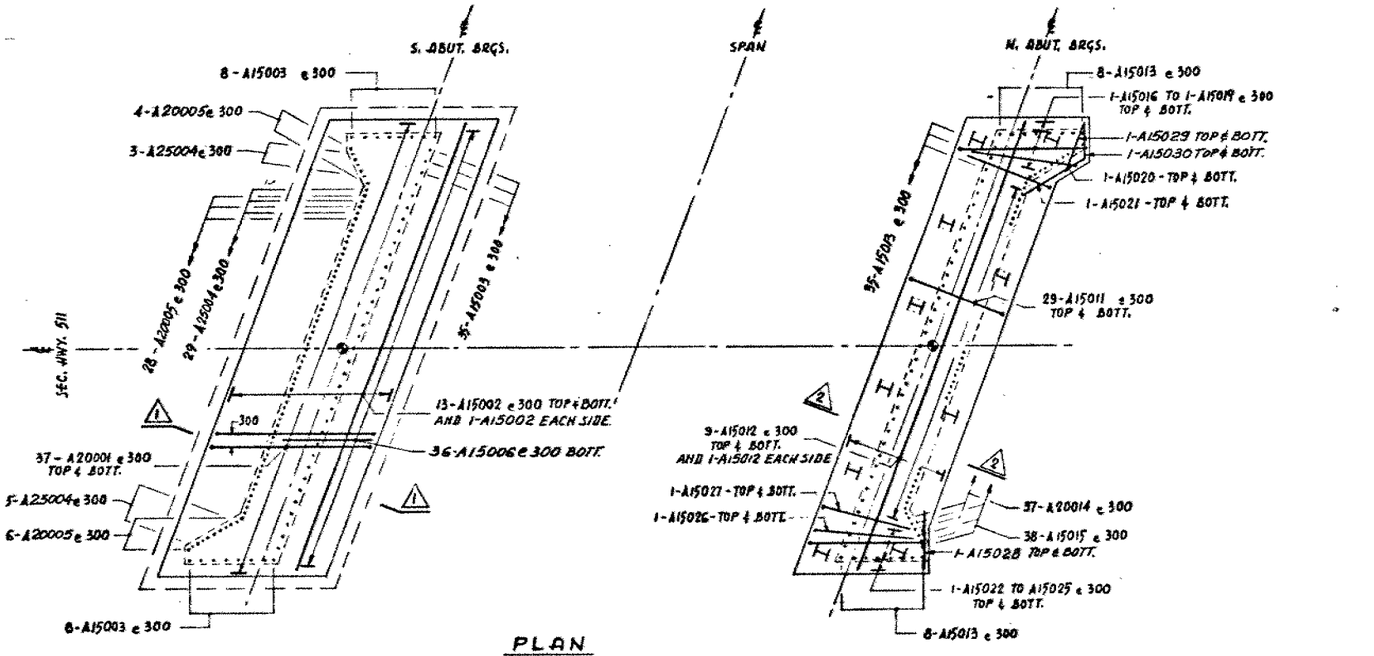
NOTES:

PILE CONSTRUCTION DATA

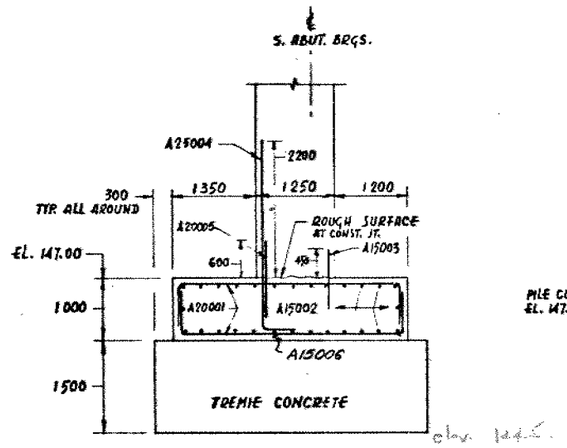
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF ABUTMENT FOOTING.
- PILES SHALL BE DRIVEN TO BEDROCK.
- PILE LENGTH SHOWN ON DWG. IS THE THEORETICAL LENGTH BELOW CUT-OFF.

PILE DESIGN DATA

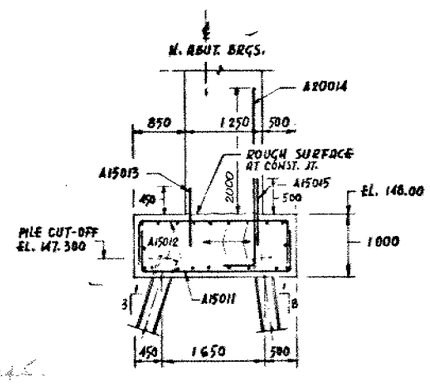
- DESIGN LOAD AT S.L.S. TYPE H = 820 KN
- FACTORED CAPACITY AT U.L.S. = 1150 KN



PLAN
REINFORCEMENT
1:75



1 1:50



2 1:50

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN J.C.Z.	CHECK	LOADING OHBDC-S-79	DATE OCT/83
DRAWING P.A.	CHECK J.C.Z.	SITE No 15-59	DWG 3

FOUNDATION INVESTIGATION REPORT

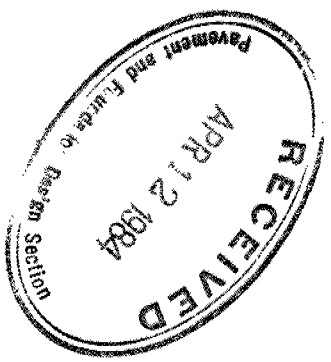
CONTRACT NO 84-23

Ontario

Ministry of
Transportation and
Communications

INDEX

NOTE: For purposes of the contract this report supersedes 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

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

FOUNDATION INVESTIGATION REPORT
For
Clyde River Bridge (Beaver Dam)
W.P. 21-82-01, Site 15-59
Hwy. 511, District 9, Ottawa

INTRODUCTION:

This report contains the results of a foundation investigation carried out at the above-mentioned site. Initial fieldwork was completed during December 9-10, 1982, and consisted of 3 sampled boreholes and one dynamic cone penetration test. Additional fieldwork was carried out during January 10-13, 1983, and consisted of 3 additional sampled boreholes. Borings were advanced to depths of up to 7-8 metres below the existing Hwy. 511 pavement surface by means of a continuous flight auger utilizing hollow stems. In addition, bedrock was proven in each of the six sampled boreholes by obtaining up to 3.1 metres of BXL size rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of the Clyde River and Hwy. 511, some 5.0 km north of the Village of Lanark, County of Lanark.

Topography in the vicinity of the site is rough. Land use may be described as rural residential with single residences established in the general vicinity. Uncultivated fields are located west of Hwy. 511, whereas east of the highway, the terrain is bush covered.

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

SUBSURFACE CONDITIONS

Subsurface conditions across the site are somewhat variable. North of the river, below 3.4 metres of highway fill material, is a layer of fine sand, approximately 0.6 metres in thickness. Underlying the fine sand layer is a stratum of 4.9 metres of very stiff silty clay. Immediately below the silty clay stratum is calc-silicate metasedimentary bedrock. South of the river, calc-silicate metasedimentary bedrock with solution cavities was encountered below 2.4 to 3.3 metres of highway fill material.

Reference should be made to the Record of Borehole Sheets contained in the Appendix of this report. These sheets contain the description of the soil and bedrock types encountered, and in summarized form, field and laboratory test results. The stratigraphical profile and sections shown on Drawing No. 2 of the contract drawings are based on this information and shows the location and elevation of the borings.

A detailed description of the various subsoils and bedrock types is given below.

Fill

Fill material was encountered in all boreholes and extends from the pavement surface to a depth of 2.4 to 3.4 metres. It is composed mainly of sand with a trace to some gravel. Boulders were encountered in three boreholes advanced south of the river. Based on the results of Standard Penetration Test 'N' values of 5 to 16 blows per 0.3 metres north of the river, and 4 to 100 blows/0.3 metres south of the river, it is estimated that the fill has undergone a moderate compactive effort.

Fine Sand with Organics, Some Silt

This deposit was encountered in the two borings advanced north of the river and is approximately 0.6 metres in thickness. The stratum is composed of fine sand with organics, some silt. Standard Penetration Test 'N' values of 6 blows/0.3 metres indicates the deposit is in a loose state.

Silty Clay, Trace of Sand

This deposit was encountered in both sampled boreholes advanced north of the river immediately below the roadway fill and fine sand strata. This layer is approximately 4.9 metres in thickness and comprised of silty clay, trace of sand. Results of Atterberg Limits Testing on representative samples are as follows:

		Range	Average
Natural Moisture Content	(W) %	25-30	30
Liquid Limit	(W_L) %	32-40	36
Plastic Limit	(W_p) %	17-21	19
Plasticity Index	(I_p) %	15-19	18

A plot of plasticity index versus liquid limit (Figure 1) indicates this material is silty clay of low plasticity. A typical grain size distribution for this deposit is shown on Figure 2.

The consistency of the deposit can be described as being generally very stiff throughout, based on one in-situ vane test and Standard Penetration Test results of 11 to 32 blows/0.3 metres.

Bedrock

Bedrock was proven in the six sampled boreholes by obtaining 1.5 to 3.0 metres of BXL size rock core.

Bedrock was encountered directly below the silty clay deposit north of the river at a depth of approximately 7.6 metres below the pavement surface corresponding to elevation 142.2±.

South of the river, bedrock was encountered directly below the fill material at a depth of 2.4 to 3.4 metres. This corresponds to elevation 147.6 to 146.6.

In general, the bedrock surface appears to be undulating and sloping down to the north.

Bedrock at this site consists of marble and calc-silicate rocks of the Precambrian Carbonate Metasedimentary Group, which in general consists of medium strong to weak marble overlying high strength calc-silicate rock.

The bedrock displays a marked gneissosity which dips at approximately 30 to 40 degrees easterly.

Evidence of solution cavities within the marble portion of the bedrock was encountered in borings south of the river, indicated by poor RQD and core recovery values at specific locations in the bedrock. In addition, associated drillwater losses as well as pitted and dissolved surfaces to the core indicate the existence of non-uniform solution cavities.

From borings advanced south of the river, the solution cavity zone in question below the location of the proposed south abutment appears to vary from about 0.1 to 1.0 metres in thickness with its lateral extent being unknown.

The solution cavity zone consists in part of cavities (high core loss) and in part of highly weathered rock. It also appears that the solution cavities may be entirely filled or partially filled by soil as shown by changes in drillwater level.

Directly above and below the cavity zone, bedrock is generally of high quality, with approximately 0.5 to 1.0 metres of rock overlying this zone.

Groundwater

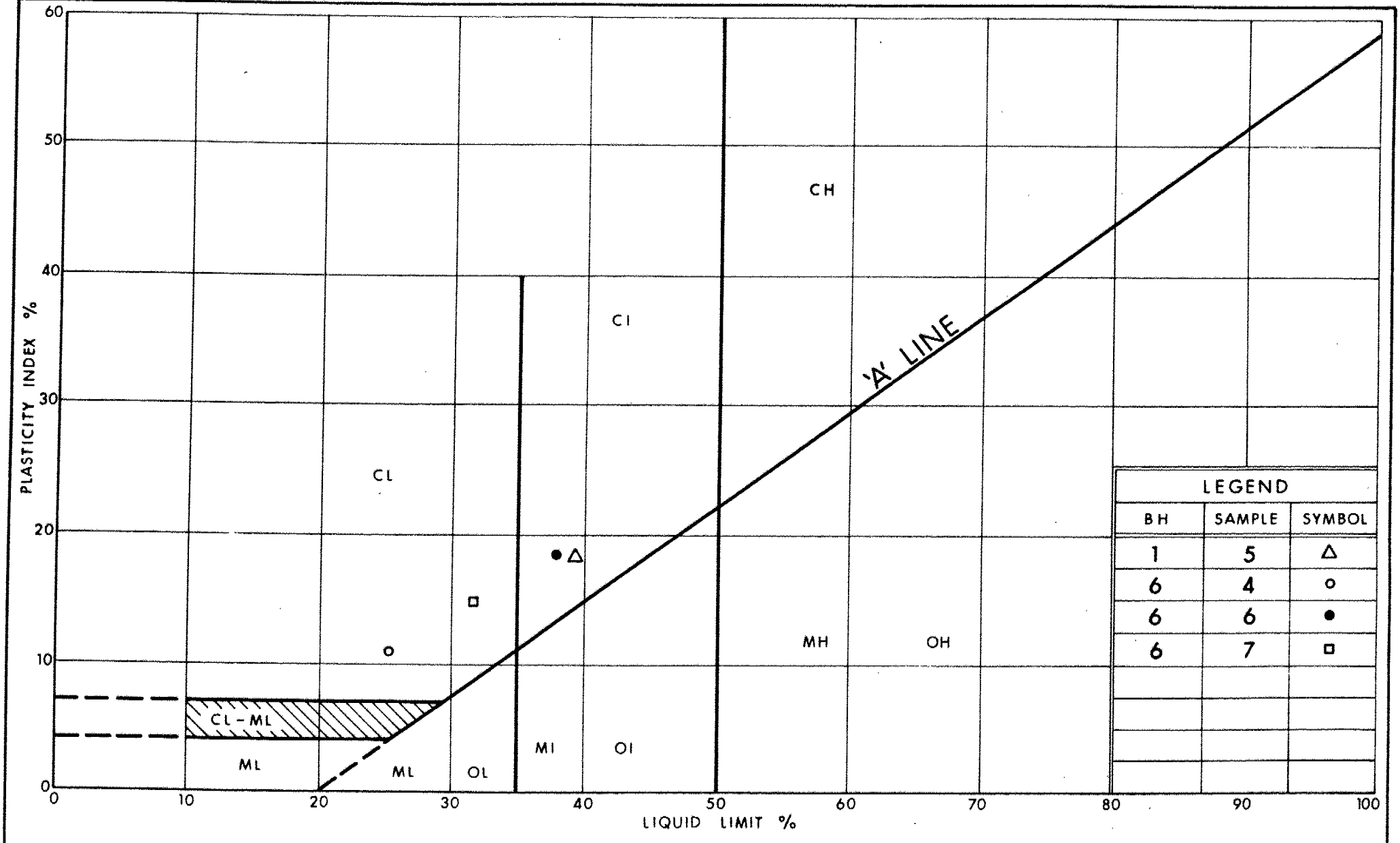
The groundwater level was determined by measuring in the open boreholes. Measurements indicate the groundwater corresponds to the free-water level of the Clyde River at elevation 147.6 in the vicinity of the river crossing, and in the general area has a very gentle gradient down to the river.

L. Politano
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer

APPENDIX

Oct 75, FF-S-21



Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

SILTY CLAY, TRACE OF SAND & GRAVEL

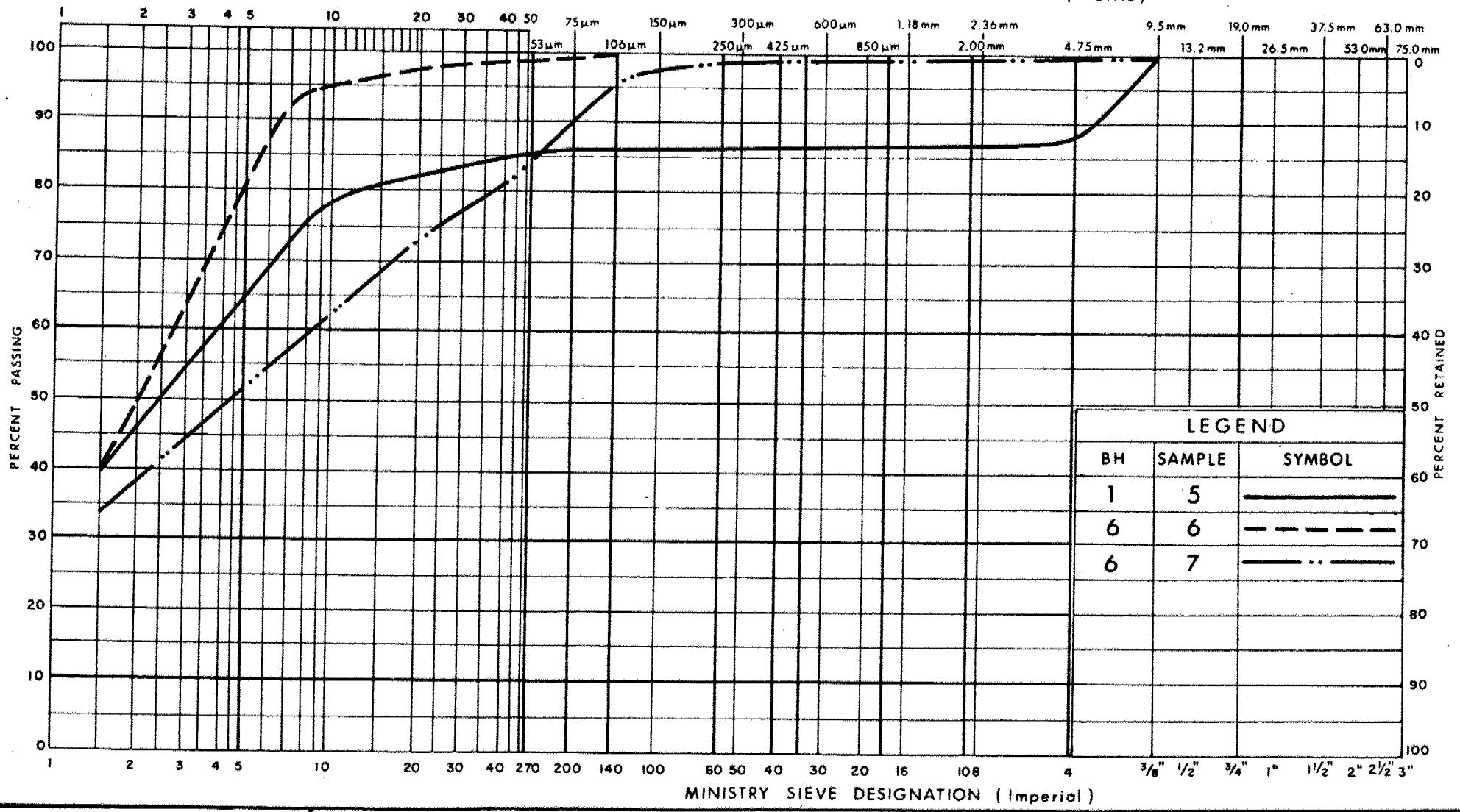
FIG No 1

WP 21-82-01

8

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, TRACE OF SAND & GRAVEL

FIG No 2

WP 21-82-01

6

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC 10

W P 21-82-01 LOCATION Sta. 15 + 443.5 o/s 3.6 m Lt. ℄ Hwy. 511 ORIGINATED BY KC

DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger, BXL Casing & Cone Test COMPILED BY KC

DATUM Geodetic DATE 82 12 09 CHECKED BY

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 kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE; 20 40 60 80 100)	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
149.8	Shoulder Surface										
0.0	Fill, Sand, Some Silt and Gravel, Trace of Clay Brown Compact		1	SS	11		149				
			2	SS	16		148		o		15 60 21 4
147.5											
2.3	Fine Sand with Org., Some Silt, Trace of Gravel, Black, Loose		3	SS	6		147		o		15 56 26 3
146.9											
2.9	Silty Clay of low Plasticity, Trace Gravel Grey Stiff to Hard		4	SS	11		146	+			
			5	SS	12		145		o—o		14 0 41 45
			6	SS	32		144				
142.3							143	100/15 cm			
7.5	Marble and Calc-Silicate Bedrock Light Grey		CR% 94	RQD% 92			142	Weathering: Slight to Unweathered; Strength: High			BXL Core
140.6							141	Jointing: Bedding, Cross joints, closely spaced, rough, oxidized			
9.2	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 11

W P 21-82-01 LOCATION Sta. 15 + 405.8 o/s 3.9 m Rt. ℄ Hwy. 511 ORIGINATED BY KC

DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC

DATUM Geodetic DATE 82 12 09 CHECKED BY

SOIL PROFILE			SAMPLES			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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
149.9	Shoulder Surface										
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense		1	SS	16		149				
			2	SS	20						
			3	SS	100/8cm	▼	148				
146.5			4	SS	65/8 cm		147				
3.4	Marble and Calc-Silicate Bedrock Light Grey		CRZ	RQD%				Weathering / Strength / Jointing			BXL Core
			93	60			146	Slight to Unweathered / High / Joints closely spaced, rough planar, oxidized			
	Core Loss							Moderate / Medium / Very Closely Spaced			
			96	77			145	Slight to Unweathered / High / Joints closely spaced, rough planar, oxidized			
144.2											
5.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC 12

W P 21-82-01 LOCATION Sta. 15 + 407.5 o/s 3.6 m Lt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 82 12 10 CHECKED BY

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 Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
149.9	Shoulder Surface										
0.0	Fill, Sand Some Silt and Gravel Brown Loose		1	SS	4	▼	149 148				
147.4											
2.5	Marble and Calc-Silicate, Bedrock, Light Grey		CRZ		RQD%		147	Weathering: Slight to Unweathered; Strength: High; Jointing: Bedding, very closely to closely, spaced			BXL Core
146.8			65		27						
3.1	Zone of High Core Loss 0.8 metre cavity (High Marble Content)	C						0.8 metre cavity, remaining rock moderately weathered, and of low strength			
146.0							146				
3.9	Marble and Calc-Silicate Bedrock Light Grey		94		90		145	Slight to Unweathered; High; Bedding, very closely to closely spaced			
144.4											
5.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC 13

W P 21-82-01 LOCATION Sta. 15 + 409.0 o/s 0.8m Lt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 83 01 11 CHECKED BY

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 W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
150.0	Road Surface										
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense						149 148				
147.3			CR% 100	ROD% 79			147	Weathering	Strength	Jointing	BXL Core
2.7	Marble and Calc-Silicate Core Loss Bedrock Light Grey		87	69			146	Unweathered	High	Bedding joints, Moderately spaced Rough Planar, Tight	
	Core Loss		92	70			145				
144.2											
5.8	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC 14

W P 21-82-01 LOCATION Sta. 15 + 408.5 o/s 1.3 m Rt. ℄ Hwy. 511 ORIGINATED BY KC

DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem, BXL Casing COMPILED BY KC

DATUM Geodetic DATE 83 01 12 CHECKED BY

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 W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_l — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
150.0	Road Surface										
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense					▼	149 148 147				
146.8											
3.2	Marble & Calc-Silicate Bedrock Light Grey		CRZ	RQDX			146	Weathering: Slight Strength: Medium to High Jointing: Closely spaced, Rough Planar, Oxidized			BXL Core
146.0											
4.0	Zone of High Core Loss, 0.9 metre cavity (High Marble Content)	C	78	28				0.9 metre cavity, remaining rock Moderately Weathered, and of low strength			
145.1							145				
4.9	Marble and Calc-Silicate Bedrock Light Grey							Unweathered High Bedding closely spaced Rough Planar, Tight			
143.9							144				
6.1	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 6

METRIC 15

W P 21-82-01 LOCATION Sta. 15 + 445.0 o/s 3.6 m Rt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 83 01 13 CHECKED BY GP

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
149.8	Shoulder Surface										
0.0	Fill, Sand, Some Silt and Gravel, Trace of Clay Brown Loose		1	SS	6		149				
			2	SS	5		148				
147.5											
2.3	Fine Sand, with Org., Some Silt, Trace of Gravel, Black, Loose		3	SS	6						
146.9							147				
2.9	Silty Clay of low Plasticity, Trace Sand Grey Stiff		4	SS	15						0 41 35 24
			5	SS	14		146				
			6	SS	13		145				0 2 49 49
							144				
			7	SS	14						1 9 53 37
142.0							143				
7.8	Marble and Calc-Silicate Bedrock Light Grey		CRZ 93 / 97	RQDZ 71 / 84			142	Weathering: Slight to Unweathered	Strength: High	Jointing: Bedding joints close to Moderately spaced Rough planar, oxidized	BXL Core
139.7							141				
							140				
10.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 21-82-01 DIST 9

HWY 511 STR SITE 15-59

Clyde River Bridge (Beaver Dam)
5.0 Kilometres North of Lanark

DISTRIBUTION

T.C. Kingsland
T. Murphy
J.W. Reid
R.W. Oddson (2)
K.G. Bassi
B.J. Giroux
R. Hore

L. Saulnier (Cover Only)
T.J. Kovich (Cover Only)

Files

GEOCRES 31F-103

DATE 23 MAR / 83

FOUNDATION INVESTIGATION REPORT

For

Clyde River Bridge (Beaver Dam)
5.0 Kilometres North of Lanark
W.P. 21-82-01, Site 15-59
District 9, Ottawa

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above-mentioned site. Initial fieldwork was completed during December 9-10, 1982, and consisted of 3 sampled boreholes and one dynamic cone penetration test. Additional fieldwork was carried out during January 10-13, 1983, which consisted of 3 additional sampled boreholes. Borings were advanced to depths of up to 7.8 metres below the existing Hwy. 511 pavement surface by means of a continuous flight auger utilizing hollow stems. In addition, bedrock was proven in each of the six sampled boreholes by obtaining up to 3.1 metres of BXL size rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of the Clyde River and Hwy. 511, some 5.0 km north of the Village of Lanark, County of Lanark.

Topography in the vicinity of the site is rough. Land use may be described as rural residential with single residences established in the general vicinity. Uncultivated fields are located west of Hwy. 511, whereas east of the highway, the terrain is bush covered.

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

.../2

SUBSURFACE CONDITIONS

Subsurface conditions across the site are somewhat variable. North of the river, below 3.4 metres of highway fill material, is a layer of fine sand, approximately 0.6 metres in thickness. Underlying the fine sand layer is a stratum of 4.9 metres of very stiff silty clay. Immediately below the silty clay stratum is calc-silicate metasedimentary bedrock. South of the river, calc-silicate metasedimentary bedrock with solution cavities was encountered below 2.4 to 3.3 metres of highway fill material.

Reference should be made to the Record of Borehole Sheets contained in the Appendix of this report. These sheets contain the description of the soil and bedrock types encountered, and in summarized form, field and laboratory test results. The stratigraphical profile and sections shown on Drawing No. 218201-A is based on this information and shows the location and elevations of the borings.

A detailed description of the various subsoils and bedrock types is given below.

Fill

Fill material was encountered in all boreholes and extends from the pavement surface to a depth of 2.4 to 3.4 metres. It is composed mainly of sand with a trace to some gravel. Boulders were encountered in three boreholes advanced south of the river. Based on the results of Standard Penetration Test 'N' values of 5 to 16 blows per 0.3 metres north of the river, and 4 to 100 blows/0.3 metres south of the river, it is estimated that the fill has undergone a moderate compactive effort.

Fine Sand with Organics, Some Silt

This deposit was encountered in the two borings advanced north of the river and is approximately 0.6 metres in thickness. The stratum is composed of fine sand with organics, some silt. Standard Penetration Test 'N' values of 6 blows/0.3 metres indicates the deposit is in a loose state of density.

.../3

Silty Clay, Trace of Sand

This deposit was encountered in both sampled boreholes advanced north of the river immediately below the roadway fill and fine sand strata. This layer is approximately 4.9 metres in thickness and comprised of silty clay, trace of sand. Results of Atterberg Limits Testing on representative samples is as follows:

		Range	Average
Natural Moisture Content	(W) %	25-35	30
Liquid Limit	(W_L)%	32-40	36
Plastic Limit	(W_p)%	17-21	19
Plasticity Index	(I_p)%	15-19	18

A plot of plasticity index versus liquid limit (Figure 1) indicates this material is silty clay of low plasticity. A typical grain size distribution for this deposit is shown on Figure 2.

The consistency of the deposit can be described being generally very stiff throughout based on one in-situ vane test and Standard Penetration Test results of 11 to 32 blows/0.3 metres.

Bedrock

Bedrock was proven in the six sampled boreholes by obtaining 1.5 to 3.0 inches of BXL size rock core.

Bedrock was encountered directly below the silty clay deposit north of the river at a depth of approximately 7.6 metres below the pavement surface corresponding to elevation 142.2±.

South of the river, bedrock was encountered directly below the fill material at a depth of 2.4 to 3.4 metres. This corresponds to elevation 147.6 to 146.6.

In general, the bedrock surface appears to be undulating and sloping down to the north.

Bedrock at this site consists of marble and calc-silicate rocks of the Precambrian Carbonate Metasedimentary Group, which in general consists of medium strong to weak marble overyling high strength calc-silicate rock.

The bedrock displays a marked gneissosity which dips at approximately 30 to 40 degrees easterly.

Evidence of solution cavities within the marble portion of the bedrock was encountered in borings south of the river, indicated by poor RQD and core recovery values at specific locations in the bedrock. In addition, associated drillwater losses as well as pitted and dissolved surfaces to the core indicate the existence of non-uniform solution cavities.

From borings advanced south of the river, the solution cavity zone in question below the location of the proposed south abutment appears to vary from about 0.1 to 1.0 metres in thickness with its lateral extent being unknown. The solution cavity zone consists in part of cavities (high core loss) and in part of highly weathered rock. It also appears that the solution cavities may be entirely filled or partially filled by soil as shown by changes in drillwater level.

Directly above and below the cavity zone, bedrock is generally of high quality, with approximately 0.5 to 1.0 metres of rock overlying this zone.

Groundwater

The groundwater level was determined by measuring in the open boreholes. Measurements indicate the groundwater corresponds to the free-water level of the Clyde River at elevation 147.6 in the vicinity of the river crossing, and in the general area has a very gentle gradient down to the river.

.../5

DISCUSSION AND RECOMMENDATIONS

The site is located at the crossing of Hwy. 511 and the Clyde River, approximately 5.0 kilometres north of the Village of Lanark.

The proposed structure will replace the existing steel truss bridge, with the structural proposal at present being a single 35 metre clear span structure with associated approach fill heights in the order of 1.5 metres above the present Hwy. 511 grade. Subsoil conditions at the proposed north abutment location consists of 3.4 metres of loose to compact fill material overlying 0.6 metres of loose fine sand, followed by 4.9 metres of very stiff silty clay. High strength matasedimentary calc-silicate bedrock is present immediately below the silty clay deposit, and shows no signs of severe weathering or solution cavities.

At the proposed south abutment location, subsoil conditions consist of 2.4 to 3.4 metres of loose to very dense fill overlying calc-silicate bedrock. The bedrock contains a solution cavity zone within the marble portion of the rock mass that may be filled entirely or partially with soil. Above and below the cavity zone, the bedrock is generally of a high quality, with approximately 0.5 to 1.0 metres of rock overlying in the solution zone.

Recommendations pertaining to the design and construction of the proposed structure as follows.

Scheme A:

North Abutment

The abutment footing can be supported on steel H piles equipped with reinforced tips driven to bedrock at elevation 142.0±. The following design values are recommended:

Pile Type	Factored Capacity at U.L.S.	Capacity at S.L.S. Type II
310 X 110	1600 kN (per pile)	1150 kN
310 X 79	1150 kN	820 kN

.../6

Front and side slopes of the approach embankments in the immediate vicinity of the abutment should be 2 horizontal to 1 vertical. All loose surficial fill material beneath the approach embankments in the abutment vicinity should be removed.

New fill material shall consist of free-draining granular backfill, with particle sizes of the fill directly beneath the pile locations not exceeding 75 mm to facilitate pile driving.

South Abutment

The south abutment footing can be founded on spread footings within the bedrock at elevation 144.5 in high strength unweathered rock below the solution cavity zone. This will require approximately 3.5 metres of fill and 2.5 metres of rock to be removed and excavated.

By excavating to high strength rock below the solution cavity zone at elevation 144.5±, the footing can be designed using a factored capacity at U.L.S. of 7500 kPa.

Provisions should be provided for in the contract to bring the excavated rock surface up to founding level by means of mass concrete.

A de-watering scheme will be required to construct the footing in dry conditions. Therefore, a cofferdam using either sheeting or a prefabricated box may be constructed. For sliding safety of the footing, a friction coefficient of 0.6 between the bedrock and footing should be used to achieve resistance to lateral forces.

For both the north and south abutments, earth pressures should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. Manual, assuming a non-yielding foundation condition with k_o=0.5 for granular backfill.

For frost protection purposes, earth cover should be greater than 1.7 metres.

.../7

Settlements of the abutments should be negligible.

Scheme B:

Both the north and south abutments can be founded on 76 cm Ø concrete caissons drilled into bedrock. Caissons should be keyed at least 1 metre into bedrock to elevation 141.0± at the north abutment location, and at least 1 metre into high strength bedrock below the solution cavity zone to elevation 144.0± at the south abutment location.

The 76 cm Ø caissons can be design to a factored capacity at U.L.S. of 3200 kN and capacity at S.L.S. Type II of 1800 kN.

Earth pressure against the abutment walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. Manual. For frost protection purposes, a minimum of 1.7 metres of earth cover should be provided.

Other Considerations

Rip-rap protection is recommended for the approach embankments. Erosion of the existing embankment along the southern approach is currently occurring, particularly in view of the fact that the embankment inhibiits the natural flow of the river.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. K. Chak, Trainee Engineer, and Mr. E. Magni, Engineering Geologist, using equipment owned and operated by F.E. Johnston Drilling Inc., Ottawa.

This report was written by Mr. Chak and reviewed by Mr. M. Devata, Senior Foundations Engineer.

K.D. Chak
Trainee Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

83 03 07

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 21-82-01 LOCATION Sta. 15 + 443.5 o/s 3.6 m Lt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem Auger, BXL Casing & Cone Test COMPILED BY KC
DATUM Geodetic DATE 82 12 09 CHECKED BY GR

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 kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	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
149.8	Shoulder Surface										
0.0	Fill, Sand, Some Silt and Gravel, Trace of Clay Brown Compact		1	SS	11		149				
			2	SS	16		148				15 60 21 4
147.5						▼					
2.3 146.9	Fine Sand with Org., Some Silt, Trace of Gravel, Black, Loose		3	SS	6		147				15 56 26 3
2.9	Silty Clay of low Plasticity, Trace Gravel Grey Stiff to Hard		4	SS	11		146	+			
			5	SS	12		145				14 0 41 45
			6	SS	32		144				
142.3							143	100/15 cm			
7.5	Marble and Calc-Silicate Bedrock Light Grey		CR% 94	RQD% 92			142	Weathering: Slight to Unweathered / Strength: High	Jointing: Bedding, Cross joints, closely spaced, rough, oxidized		BXL Core
140.6							141				
9.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 21-82-01 LOCATION Sta. 15 + 405.8 o/s 3.9 m Rt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 82 12 09 CHECKED BY

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 Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES					
149.9	Shoulder Surface									
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense		1	SS	16		149			
			2	SS	20					
							148			
			3	SS	100/ 8cm	▼				
146.5			4	SS	65/ 8 cm		147			
3.4	Marble and Calc-Silicate Bedrock Light Grey		CR%		ROD%			Weathering / Strength / Jointing		BXL Core
			93		60		146	Slight to Unweathered / High / Joints closely spaced, rough planar, oxidized		
	Core Loss							Moderate / Medium / Very Closely Spaced		
			96		77		145	Slight to Unweathered / High / Joints closely spaced, rough planar, ozidized		
144.2										
5.7	End of Borehole									

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 21-82-01 LOCATION Sta. 15 + 407.5 o/s 3.6 m Lt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 82 12 10 CHECKED BY GP.

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 WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
149.9	Shoulder Surface										
0.0	Fill, Sand Some Silt and Gravel Brown Loose		1	SS	4	▼	149 148				
147.4											
2.5	Marble and Calc-Silicate, Bedrock, Light Grey		CR% 65		ROD% 27		147	Weathering: Slight to Unweathered; Strength: High; Jointing: Bedding, very closely to closely, spaced			BXL Core
146.8											
3.1	Zone of High Core Loss 0.8 metre cavity (High Marble Content)	C						0.8 metre cavity, remaining rock moderately weathered, and of low strength			
146.0							146				
3.9	Marble and Calc-Silicate Bedrock Light Grey		94		90		145	Slight to Unweathered; High; Bedding, very closely to closely spaced			
144.4											
5.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 21-82-01 LOCATION Sta. 15 + 409.0 o/s 0.8m Lt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and BXL Casing COMPILED BY KC
DATUM Geodetic DATE 83 01 11 CHECKED BY GP.

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 (○ 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
150.0	Road Surface										
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense					▼	149 148				
147.3											
2.7	Marble and Calc-Silicate Core Loss Bedrock Light Grey Core Loss		CR% 100 87 92	ROD% 79 69 70			147 146 145	Weathering: Unweathered Strength: High	Jointing: Bedding joints, Moderately spaced Rough Planar, Tight		BXL Core
144.2											
5.8	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 21-82-01 LOCATION Sta. 15 + 408.5 o/s 1.3 m Rt. ℄ Hwy. 511 ORIGINATED BY KC

DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem, BXL Casing COMPILED BY KC

DATUM Geodetic DATE 83 01 12 CHECKED BY

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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
150.0	Road Surface										
0.0	Fill, Sand, Some Gravel Occasional Boulders Brown Compact to Very Dense					▼	149 148 147				
146.8											
3.2	Marble & Calc-Silicate Bedrock Light Grey		CR%		RQD%		146	Weathering: Slight; Strength: Medium to High; Jointing: Closely spaced, Rough Planar, Oxidized			BXL Core
146.0											
4.0	Zone of High Core Loss, 0.9 metre cavity (High Marble Content)	C	78		28			0.9 metre cavity, remaining rock Moderately Weathered, and of low strength			
145.1							145				
4.9	Marble and Calc-Silicate Bedrock Light Grey							Unweathered; Strength: High; Jointing: Bedding closely spaced Rough Planar, Tight			
143.9							144				
6.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 21-82-01 LOCATION Sta. 15 + 445.0 o/s 3.6 m Rt. ℄ Hwy. 511 ORIGINATED BY KC
DIST 9 HWY 511 BOREHOLE TYPE Hollow Stem and EXL Casing COMPILED BY KC
DATUM Geodetic DATE 83 01 13 CHECKED BY GP

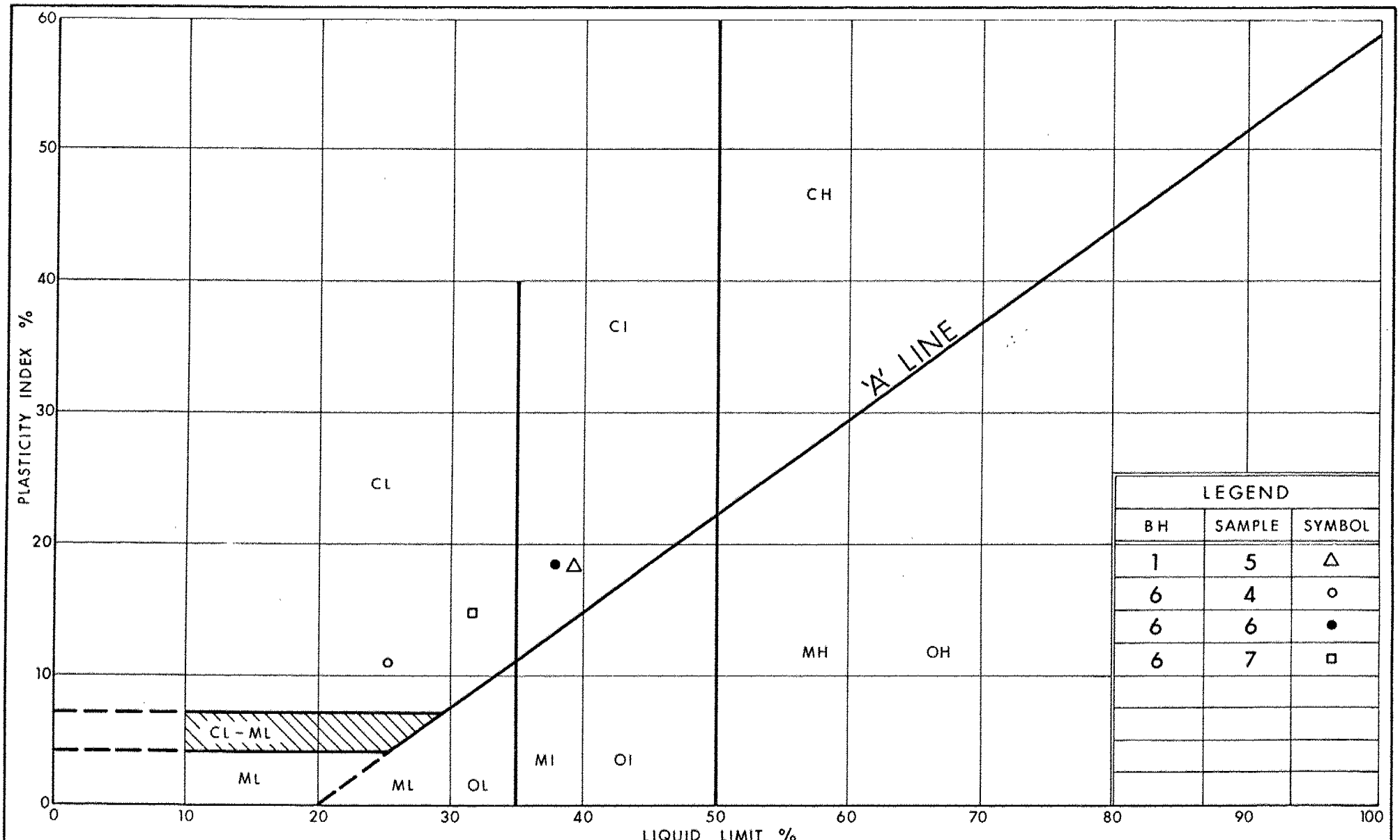
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.8	Shoulder Surface										
0.0	Fill, Sand, Some Silt and Gravel, Trace of Clay Brown Loose		1	SS	6		149				
			2	SS	5		148				
147.5						▼					
2.3	Fine Sand, with Org., Some Silt, Trace of Gravel, Black, Loose		3	SS	6		147				
146.9											
2.9	Silty Clay of low Plasticity, Trace Sand Grey Stiff		4	SS	15		146				0 41 35 24
			5	SS	14						
			6	SS	13		145				0 2 49 49
			7	SS	14		144				1 9 53 37
142.0							143				
7.8	Marble and Calc-Silicate Bedrock Light Grey		CR% 93 97		ROD% 71 84		142	Weathering: Slight to Unweathered Strength: High Jointing: Bedding joints close to Moderately spaced Rough planar, oxidized			BXL Core
139.7							141				
							140				
10.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Oct 75, FF-S-21



Ministry of Transportation and Communications
Ontario

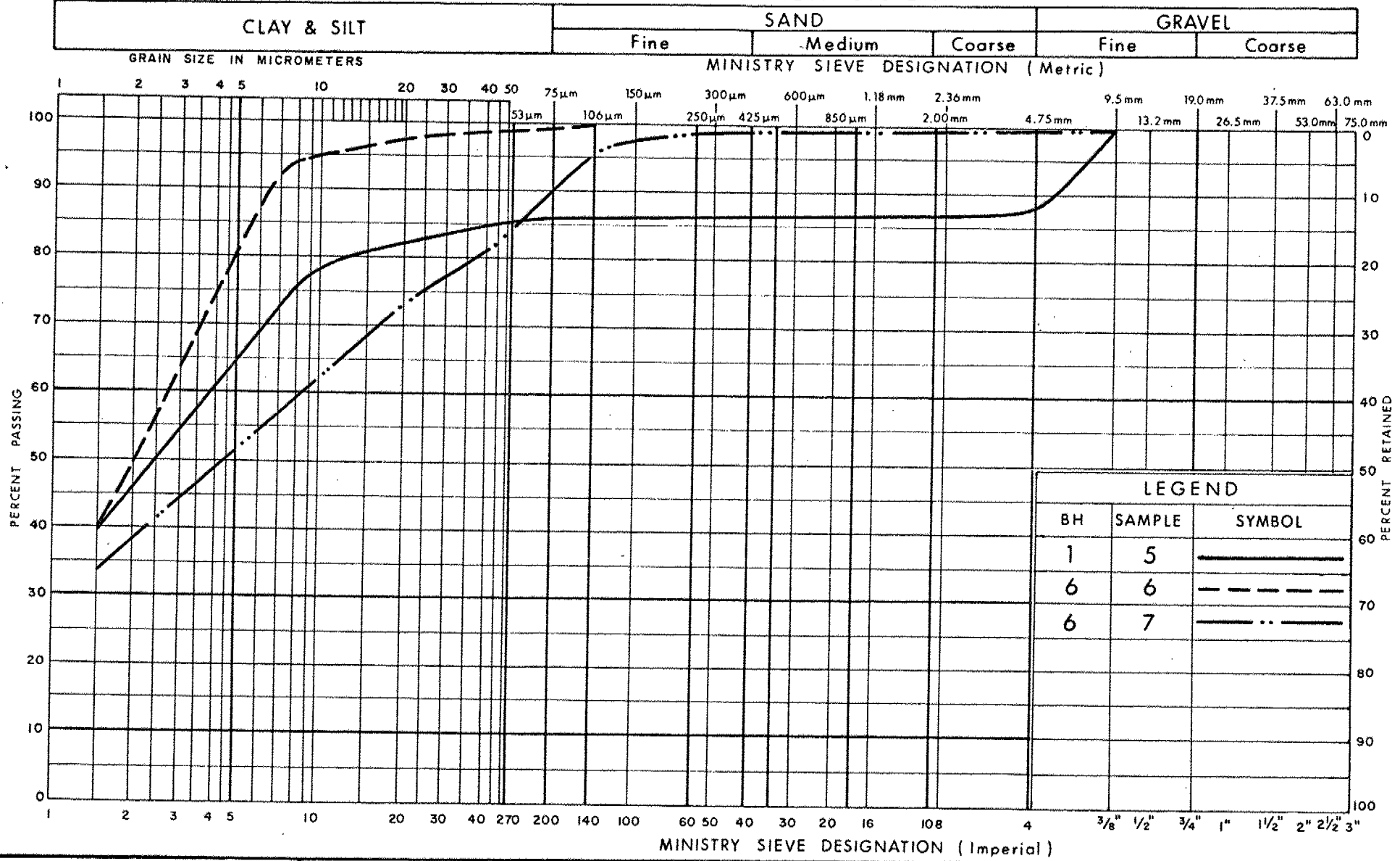
PLASTICITY CHART

SILTY CLAY, TRACE OF SAND & GRAVEL

FIG No 1

WP 21-82-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, TRACE OF SAND & GRAVEL

FIG No 2

WP 21-82-01

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 = $\frac{c_u}{\tau_r}$

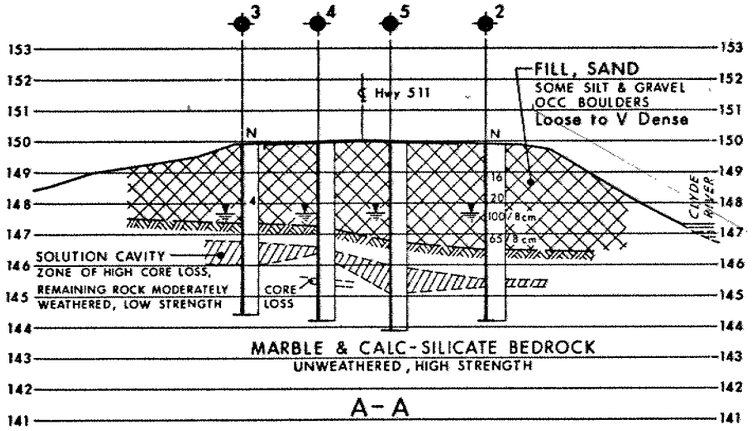
PHYSICAL PROPERTIES OF SOIL

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

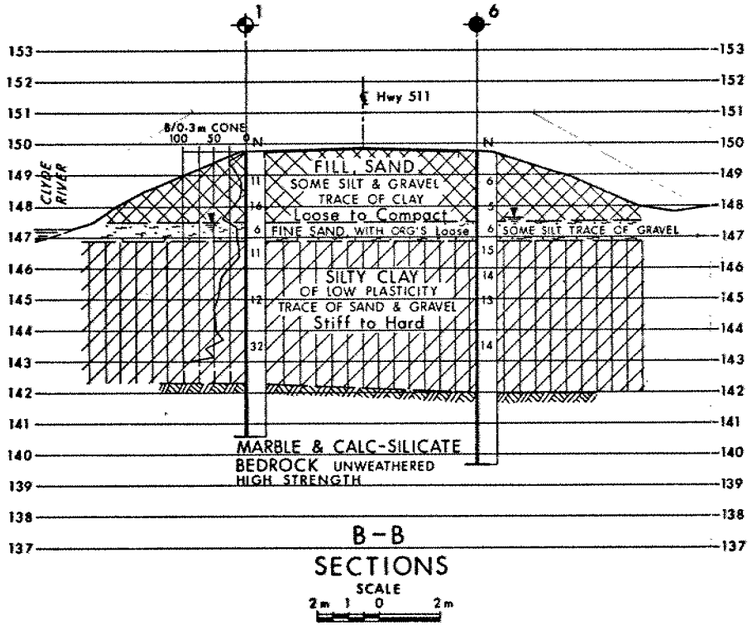
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04



A-A

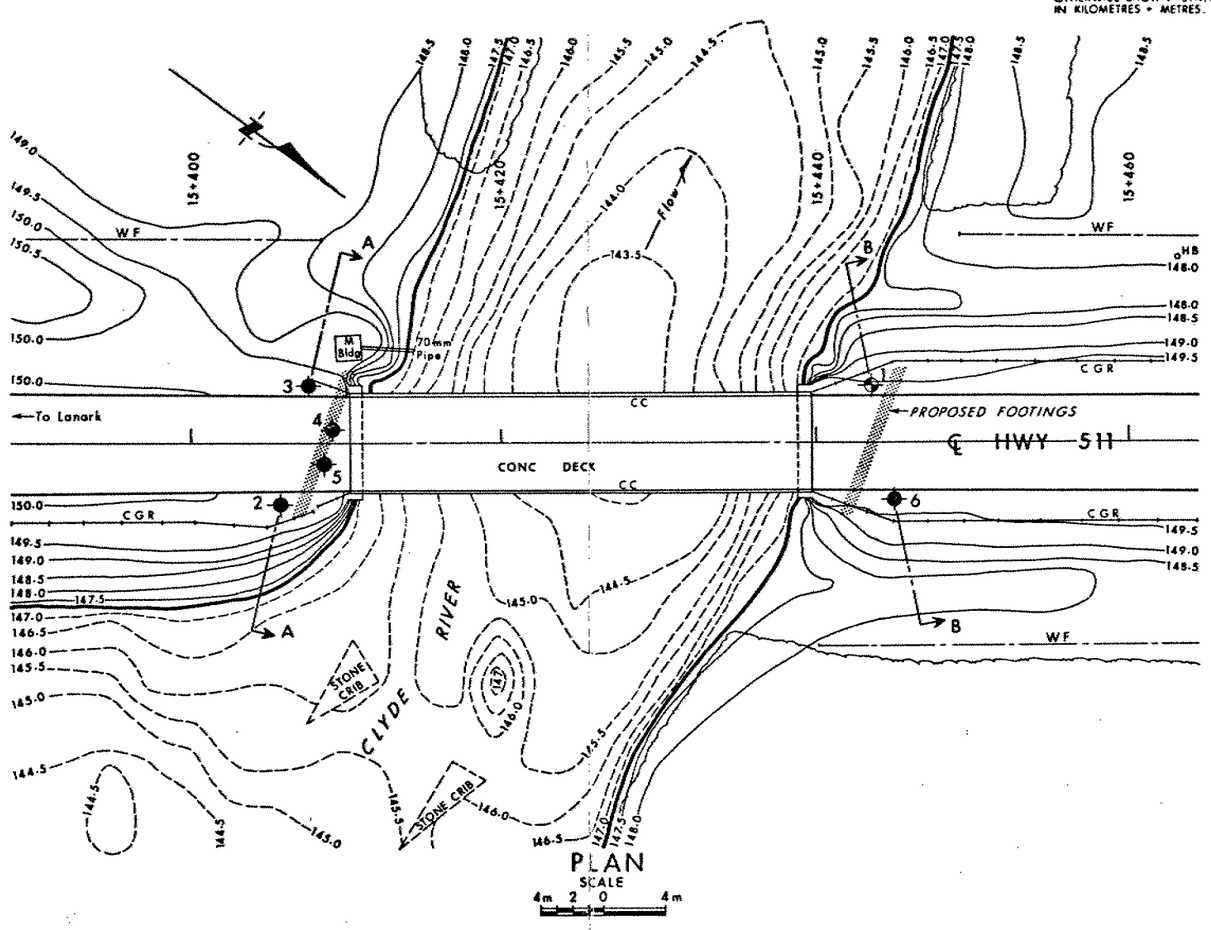


B-B

SECTIONS

SCALE

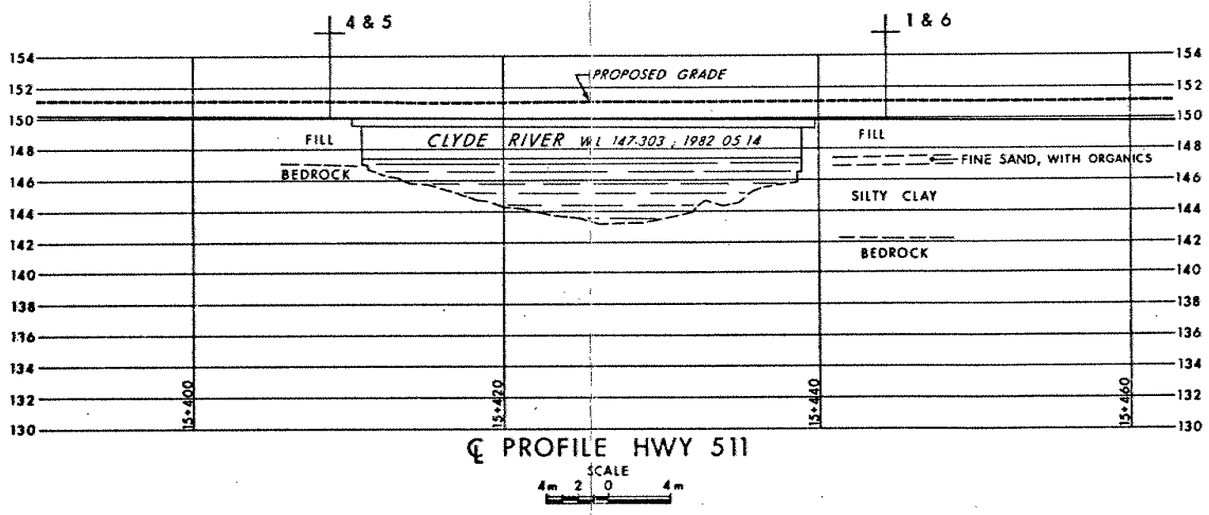
2m 1 0 2m



PLAN

SCALE

4m 2 0 4m



℄ PROFILE HWY 511

SCALE

4m 2 0 4m

METRIC

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

CONT No

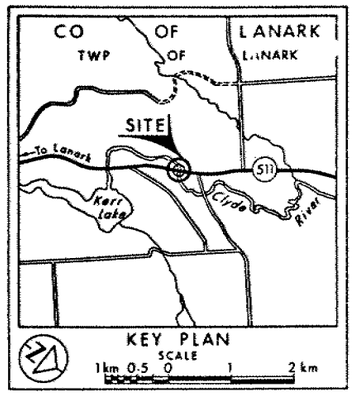
WP No 21-82-01

CLYDE RIVER (BEAVER DAM)

(5.0 km North of Lanark)

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN

SCALE

1km 0.5 0 1 2 km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1982 12 and 1983 01

No	ELEVATION	STATION	OFFSET
1	149.8	15+443.5	3.6m Lt
2	149.9	15+405.8	3.9m Rt
3	149.9	15+407.5	3.6m Lt
4	150.0	15+409.0	0.8m Lt
5	150.0	15+408.5	1.3m Rt
6	149.8	15+445.0	3.6m Rt

NOTE

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 31F-103

HWY No 511			DIST 9
SUBMTD K C	CHECKED	DATE 1983 03 11	SITE 15-59
DRAWN	CHECKED	APPROVED	DWG 218201-A

REF No E-7005-1 ; 1982 07