DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31B-58

DIST. 8 REGION

W.P. No. 70-79-02

CONT. No. 82-90

W. O. No.

STR. SITE No. 16-111

HWY. No. 2

LOCATION Jones Creek Bridge

No of PAGES - ~

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

OVERSIZE DRAWING

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82 - 90

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 (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
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
Jones Creek Bridge
W.P. 70-79-02, Site 16-111
Hwy. 2, District 8, Kingston

INTRODUCTION

This report presents the factual information obtained from a foundation investigation program performed at the above-mentioned structure replacement site. The fieldwork for this program was carried out in two stages:

1) Initially, 4 sampled boreholes (Nos. 1 to 4) were advanced between 80 11 19 and 80 11 27.

2) The second stage included 2 additional sampled boreholes carried out between 81 05 26 to 81 05 28.

These borings were advanced to a maximum depth of 16 metres with bedrock being cored in two boreholes for runs of 1.5 and 1.6 metres.

SITE DESCRIPTION

The site is located where Highway 2 crosses Jones Creek approximately 13 km west of Brockville. The area surrounding, with its shallow overburden and frequent granite outcrops, is typical of the physiographic region referred to as Leeds Knobs and Flats. Jones Creek at the time of the investigation was 5 to 7 metres in width and less than a metre in depth. It flows in a narrow valley frequently bordered by rock outcrops exhibiting very steep slopes which, it may be assumed, are typical of the subsurface rock slopes.

The existing 12 metre single span structure which was constructed in 1921 and reinforced in 1968 is in poor condition. Plans show that the full height abutments of this structure are supported by timber piles. The stream channel in the area is lined with random rip rap.

SUBSURFACE CONDITIONS

General

Subsoil under the stream channel and approach embankments consists of 6 to 8 metres of compact silty sand. It is underlain by granite gneiss bedrock. The west approach fill is up to 6 metres thick and is constructed of silty sand immediately behind the west abutment with rockfill composing the rest of the embankment. The east approach consists of a shallow silty sand fill overlying rockfill composed of gravel, cobble, and boulder fragments.

Reference should be made to Drawing Number 707902-A which shows locations and elevations of all borings as well as an inferred subsoil stratigraphy. Record of Borehole sheets which show the boundaries between soil types as well as a record of all field and laboratory tests performed are contained in the report Appendix. A more detailed subsoil description follows.

Silty Sand

Silty sand containing a trace of gravel and clay extends from the bottom of the stream to the bedrock 6 to 8 metres below. Typical grain size distribution curves are shown in Figure 1. A 2.9 metre zone of cobbles and boulders was encountered in the most westerly boring at the base of the silty sand stratum. Standard Penetration Test 'N' values ranged from 9 to 47 blows/0.3 metres, but predominently between 10 and 20 indicating the silty sand stratum to be generally compact. Higher 'N' values are indicative of the presence of gravel, cobbles and boulders.

Approach Fills

Overlying the west and east bank of the creek and encountered for depths of approximately 1.5 metres is a surficial fill material consisting of a silty sand with gravel, generally loose to compact in denseness with

'N' values ranging from 9 to 13 blows/0.3 m. This upper fill material is underlain by cobble and boulder rock fill ranging in thickness from 3.2 to 4.2 metres. In view of the presence of rock fill, rock drilling techniques using BXL core barrels were employed.

In one boring, immediately behind the west abutment, the free-draining wedge of granular backfill composed of loose to compact silty sand with a trace of gravel and clay was encountered.

Underlying the rock fill at the east side is a 1.7 metre concrete slab which is part of the existing footing and is founded on the natural silty sand deposit.

Bedrock

Bedrock location was proven in two borings using BXL rock coring techniques for runs of 1.5 and 1.6 metres. Rock surface was encountered at depths of 13.9 and 11.0 metres below existing profile grade corresponding to elevations of 72.3 and 75.2. Based on this data and probable bedrock location where refusal to penetration was encountered in 3 of the other borings, bedrock surface appears to dip easterly in an irregular manner.

Bedrock outcrops in the area frequently have very steeply sloping surfaces. It may be assumed that the subsurface slopes are similar with locally very steep sections.

Groundwater

Groundwater levels will be at or slightly above the creek level within the highly permeable silty sand, approximating elevation 80.0 ±.

T. J. Kazmierowski, P. Eng.,
Project Foundations Engineer

M. Devata, P. Eng.,
Senior Foundations Engineer

APPENDIX

Ministry of Transportation and Communications Ontario

RECORD OF BOREHOLE No 1

METRIC 7

W P 70-79-02 LOCATION Sta.17+740.2 1.25 m RT C/L ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY P.J.S.

DATUM Geodetic DATE 80 11 19 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.1	Ground Level						86				
85.6	Asphalt										
0.5	Fill		1	SS	10				○		7 60 27 6
	Silty Sand										
	Trace of Gravel and Clay		2	SS	4		84				
			3	SS	17						
	Loose to Compact		4	SS	6		82				
			5	SS	7				⊟		7 41 45 7
80.3											
5.8			6	SS	43		80		○		11 73 11 5
	Silty Sand										
	Trace of Gravel and Clay		7	SS	11		78		○		10 65 21 4
	Compact to Dense										
			8	SS	9		76				
			9	SS	10						
73.9											
73.5	End of Borehole						74		Hammer Bouncing		
12.6	End of Cone Test										
	Probable Bedrock										
	Water Level Not Recorded.										

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

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications

RECORD OF BOREHOLE No 2

METRIC 8

W P 70-79-02 LOCATION Sta.17+757.2 1.25 m LT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY P.J.S.

DATUM Geodetic DATE 80 11 19 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						
86.2	Ground Level										
0.0	Gravel Cobbles and Boulders Rock Fill		1	SS	20/	100 mm	86	Rods Bouncing			
83.7							84				
2.5	Refusal to Augers End of Borehole Borehole Dry										

+3, x5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications

RECORD OF BOREHOLE No 3

METRIC 9

W P 70-79-02 LOCATION Sta. 17+752.3 1 m LT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE B Casing COMPILED BY P.J.S.

DATUM Geodetic DATE 1980 11 20 CHECKED BY

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.2	Deck Level						86				
85.7	Concrete										
0.5											
							84				
							82				
80.3	Ground Level					▼					
5.9			1	SS	16		80		○		11 70 (19)
	Silty Sand		2	SS	18		78				
	Trace of Gravel										
	Compact		3	SS	18		76				
			4	SS	9						
			5	SS	12		74		○		0 74 24 2
72.3											
13.9	Granite Gneiss Bedrock		6	BXL RC	87% REC		72				RQD 50%
70.8											
15.4	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC 10

W P 70-79-02 LOCATION Sta. 17+745.5 1 m RT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE B Casing COMPILED BY P.J.S.

DATUM Geodetic DATE 1980 11 27 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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
86.1	Deck Level						86				
85.6 / 0.5	Concrete										
							84				
							82				
80.3	Water Level					▼					
5.8	Creek Bottom						80				
79.8	Boulder		1	SS	12						
			2	BAL RC	60%						
			3	SS	15		78				
	Silty Sand Compact		4	SS	10						
			5	SS	10		76		o		0 71 28 1
73.3	Gravel		6	SS	22		74				
12.8	Refusal to Casing Probable Bedrock End of Borehole										

$+^3$, $\times^5$: 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 5

METRIC

W P 70-79-02 LOCATION Sta.17 + 734.1; O/S 2.1 m LT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing COMPILED BY NS

DATUM Geodetic DATE 81 05 26 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 (○ 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
86.2	Ground Level						86				
0.0	Silty Sand Some Gravel Compact (Fill)		1	SS	13						
84.7			2	SS	50/10 mm						
1.5	Cobbles and Boulders (Rock Fill)		3	BXL RC	50% Rubbling		84				
81.5			5	BXL RC	42%		82				
4.7	Silty Sand Some Gravel Traces of Clay Dense to Very Dense		6	SS	35						
			7	SS	32/100 mm	▼	80				
			8	SS	47						
78.1							78				
8.1	Cobbles and Boulders Very Dense		9	BXL RC	33% REC						
			10	BXL RC	36% REC		76				
75.2	Bedrock poor quality Bard		11	BXL RC	100% REC		74				
11.0											
73.6											
12.6	End of Borehole										

Note: Ground Water Level Reflects Creek Water Level

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

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

12

W P 70-79-02 LOCATION Sta. 17 + 761.2; 0/S 2.0 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing COMPILED BY NS

DATUM Geodetic DATE 81 05 27 to 28 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
86.2	Ground Level					
0.0	Silty Sand with Gravel Loose (Fill)		1	SS	9	
85.0			2	BXL		
1.2	Gravel, Cobbles and Boulders (Rock Fill)		3	BXL		
			4	BXL		
			5	BXL		
			6	SS	8	
80.7			7	BXL	30%	
5.5	Concrete Footing		8	BXL RC		
79.0						
7.2	Fine Silty Sand, Traces of Gravel Loose to Compact		9	SS	5	
			10	SS	12	
			11	SS	12	
73.7			12	SS	-	
12.5	End of Borehole					
70.2						
16.0	Refusal to Cone Probable Bedrock					

ELEVATION SCALE: 86, 84, 82, 80, 78, 76, 74, 72

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

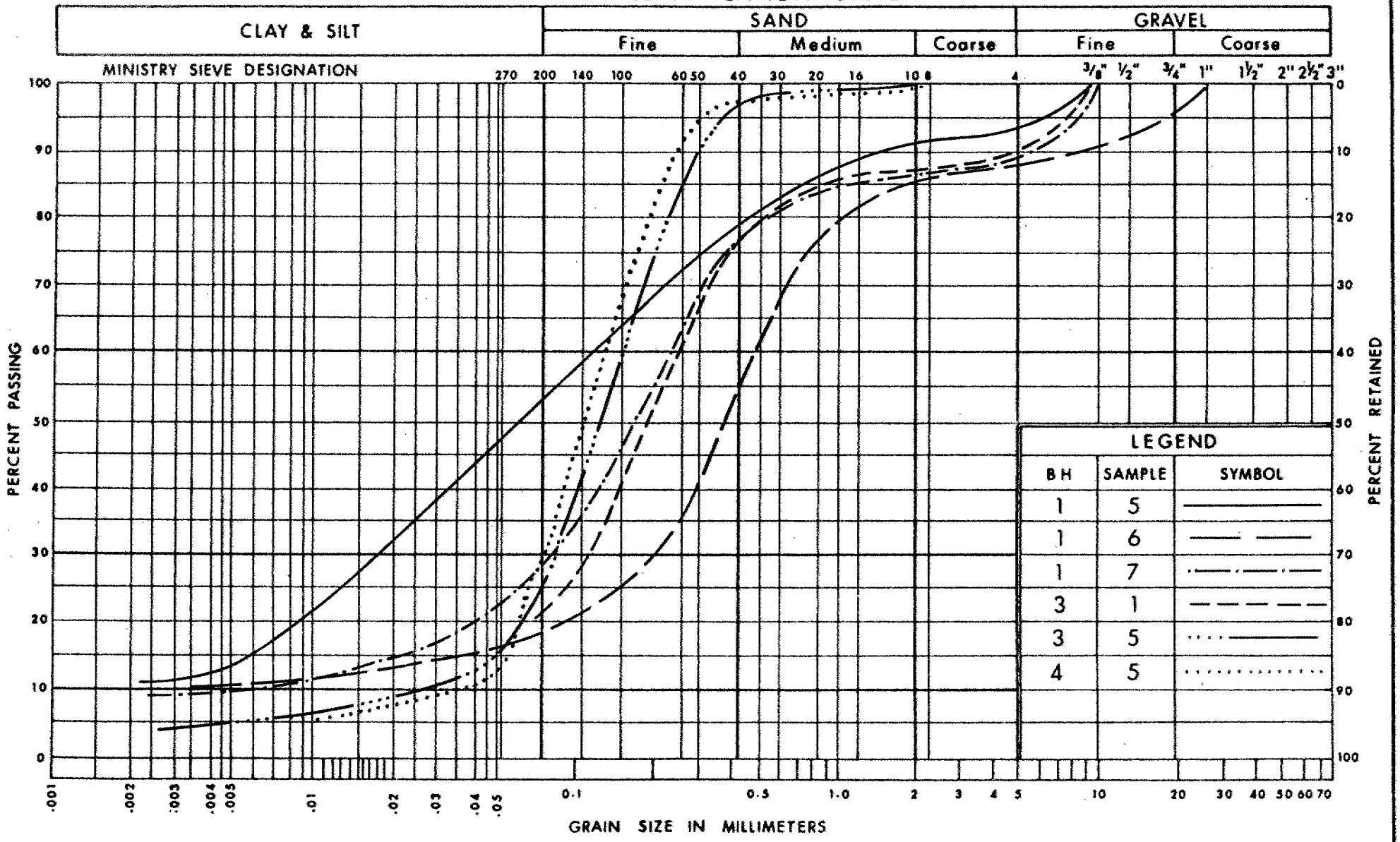
Note: Ground Water Level Reflect Creek Water Level

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE OF GRAVEL & CLAY

FIG No 1
W P 70-79-02

FOUNDATION INVESTIGATION REPORT

For

MacIlhennys Creek Bridge
W.P. 70-79-03, Site 16-112
Hwy. 2, District 8, Kingston

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural replacement site.

The fieldwork for this program was carried out in two stages:

1) Initially, the fieldwork consisted of 4 sampled boreholes (B.H. 1 to 4) advanced during the period November 20 to December 1st, 1980. A truck mounted CME 75 auger operating from the road surface was employed. The 2 boreholes through the east approach (B.H. 1 & 2) were advanced with hollow stem augers while 'N' and 'B' size casings were employed for the boreholes through the structure deck. Bedrock was proven in the 2 boreholes through the deck by recovering BXL size rock cores.

2) The additional fieldwork consisted of a combination of 9 sampled boreholes and probeholes carried out during the period of May 28th to June 3rd, 1981. Hollow stem augers were advanced to refusal at which time BX size casing, and in one particular case NX size casing, was drilled ahead using a muskeg mounted CME 55 auger machine. In some locations rock core samples were also obtained using BXL and NXL core barrels.

SITE DESCRIPTION

The site is located where Highway 2 crosses MacIlhenny Creek some 10 km west of Brockville. The surrounding area with its shallow overburden and frequent granite outcrops is typical of this physiographic region which is referred to as Leeds Knobs and Flats.

Sand, Gravel, Cobbles and Boulders

The silty clay deposit is underlain by a 1 to 4 metre thick granular layer consisting of sand, gravel, cobbles and boulders. Diamond coring was employed to penetrate this layer because of the presence of cobbles and boulders. As a result, only 1 Standard Penetration Test, which gave an 'N' value of 19, was carried out. The relative density is assessed as compact to dense.

Approach Embankments

In the immediate vicinity of the structure the approaches are constructed with rockfill consisting of cobbles and boulders. In view of the presence of the rockfill, rock drilling techniques using NXL and BXL core barrels were employed, however, the lower boundary of the rockfill was not established.

Generally, the rockfill is overlain with granular fill material ranging in depths from 1.8 metres to 3.3 metres. This material can be described as loose to dense, fine silty sand to sand with gravel, with 'N' values ranging from 5 to 41 blows/0.3 m. It can be inferred that this material is part of the road base course or granular backfill to the existing structure.

At the east creek bank both on the north and south sides of the road the casing was drilled to refusal. Refusal was met on the hard angular fragments of the rockfill.

Bedrock could be seen from the surface approximately 5 metres below the road surface just north of the east bank and possible bedrock was located with a probehole approximately 3 metres below the road surface just south of the east bank.

MacIlhennys Creek at the time of the initial investigation was 7 to 15 metres in width and up to 2 metres in depth. It flows in a narrow valley bordered by frequent rock outcrops exhibiting very steep slopes which, it may be assumed, are typical of the subsurface rock slopes.

The existing structure is a 14 metre single span bridge supported on full height abutments. The opening is skewed at 45 degrees. It was constructed in 1921 and reinforced with extra steel beams in 1968 due to the deterioration of the original girders. The river channel in the area is lined with rip rap.

SUBSURFACE CONDITIONS

General

Subsoil beneath the rip rap lined stream channel consists of about 4.5 metres of stiff to hard silty clay overlying a 1 to 4 metre thick granular layer consisting of sand, gravel, cobbles and boulders. This layer in turn overlies sound bedrock.

The immediate approaches consist of a thin veneer of granular fill overlying rockfill on the east side and rockfill and/or bedrock on the west side.

Reference should be made to Drawing 707903-A which shows the location and elevation of all borings as well as an inferred subsoil stratigraphy. Record of Borehole sheets which show the boundaries between soil types as well as a record of all field and laboratory tests performed are contained in the report Appendix. A more detailed subsoil description follows.

Silty Clay

The stream channel is underlain by a layer of silty clay having a thickness of approximately 4.5 metres. It's consistency is stiff to hard based on the undrained shear strength measured by field vane which ranges from 50 to in excess of 100 kPa. Results of Atterberg Limit testing are shown in Figure 1.

At the west creek bank two different subsurface conditions were found. On the north side of the west bank, sound bedrock was encountered 0.2 metres below ground elevation; on the south side of the west bank, a surficial fill material consisting of compact silty sand with occasional stiff silty clay zones, with a typical 'N' value of 13 blows/0.3 m was encountered. This upper fill material is underlain by a cobble and boulder rockfill.

At approximately 10.5 metres west of the west creek bank a 0.4 to 1.8 metre sand and gravel base course material intermingled with some cobbles and boulders was encountered. By obtaining BXL core barrels at B.H. #10 and by lowering probeholes #11, 12 and 13 the rock surface was delineated and was found to vary from 1.8 m below the road surface at B.H. #10 to 0.4 m below the road surface at B.H. #13.

Bedrock

Sound metagabbro bedrock was encountered within the creek limits at elevation 67 and 70 some 7 to 10 metres below the river surface. Bedrock geology maps show frequent dykes of similar material in the area. It is therefore assumed that a gabbro dyke was intruded into the surrounding granite bedrock. Since the dyke was softer than the surrounding rock it weathered more rapidly thereby forming the channel of MacIlhennys Creek. Bedrock outcrops in the area frequently have very steeply sloping surfaces. It may be assumed that subsurface slopes are similar with locally very steep sections.

Groundwater

Groundwater levels in the immediate vicinity of the proposed structure can be expected to reflect creek water levels, which approximated elevation 77.1 at the time of the initial investigation. These levels are expected to fluctuate accordingly.

T.J. Kazmierowski, P. Eng.,
Project Foundations Engineer

M. Devata, P. Eng.,
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC 19

W P 70-79-03 LOCATION Sta. 20+462.8, 2.3 m Lt. ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PJS

DATUM Geodetic DATE 1980 11 20 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						
83.0	Ground Level										
0.0	Sand and Gravel Some Silt Compact to Loose						82				
			1	SS	12						
			2	SS	8			Spoon Bouncing			
79.8			3	SS			80				
3.2	Refusal to Auger End of Borehole										

$+^3$, $\times^5$: 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 2

METRIC 20

W P 70-79-03 LOCATION Sta. 20+454.2, 1.5 m Lt. ℄ ORIGINATED BY RB

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PJS

DATUM Geodetic DATE 1980 11 21 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						
83.0	Ground Level										
0.0	Silty Sand Loose		1	SS	7		82				
81.0											
2.0	Refusal to Augers End of Borehole						80				

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications

RECORD OF BOREHOLE No 3

METRIC 21

W P 70-79-03 LOCATION Station 20+445.8, 1.5 m Lt. ℄ ORIGINATED BY RB

DIST 8 HWY 2 BOREHOLE TYPE B Casing COMPILED BY PJS

DATUM Geodetic DATE 1980 11 21 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, × LAB VANE; 50 100)	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
82.9	Deck Level										
82.5 / 0.4	Concrete						82				
							80				
							78				
77.1 / 5.8	Creek Level					▼					
75.9 / 7.0	Creek Bottom						76				
75.3 / 7.6	Rock Rip Rap		1	BXL RC	10%						
	Silty Clay Stiff to Hard		2	SS	5		74	4	o		
			3	TW	PH		72	4.5	o		
71.0 / 11.9			4	TW	PH						
70.0 / 12.9	Sand and Gravel Compact		5	SS	19		70				
68.4 / 14.5	Sound Metagabro Bedrock		6	BXL RC	95% REC						RQD = 85
	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications

RECORD OF BOREHOLE No 4

METRIC 22

W P 70-79-03 LOCATION Sta. 20+437.2, 2.3 m Rt. ℄ ORIGINATED BY RB

DIST 8 HWY 2 BOREHOLE TYPE N Casing COMPILED BY PJS

DATUM Geodetic DATE 1980 12 01 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ 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
82.9	Deck Level									
82.4 / 0.5	Concrete						82			
							80			
							78			
77.2 / 5.7	Water Level					▼				
76.2 / 6.7	Creek Bottom									
75.5 / 7.4	Rock Rip Rap						76			
	Silty Clay Stiff to Hard		1	SS	15			+ 6		
			2	TW	PH			○ + >100		
			3	TW	PH					
			4	SS	17		74			
71.0 / 11.9			5	TW	PH			+ >100		
	Sand, Gravel Cobbles and Boulders Compact to Dense		6	BXL RC	25% REC		72			
			7	BXL RC	25% REC					
66.9 / 16.0							70			
	Sound Metagabro Bedrock		8	BXL RC	95% REC		68			RQD = 65
65.6 / 17.3	End of Borehole						66			

+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 23

W P 70-79-03 LOCATION Sta. 20+462.5 O/S 2.5 m LT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing, BXL Rock Core COMPILED BY NS

DATUM Geodetic DATE 81 05 28 to 29 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						
83.0	Ground Level										
0.0	Fine Silty Sand With Gravel		1	SS	5		82				
81.2	Loose Fill		2	SS	69						
1.8	Gravel, Cobbles and Boulders		3	BXL RC			80				
			4	BXL							
	Rock Fill		5	BXL RC							
			6	BXL			78				
77.2			7	BXL RC							
5.8	Refusal to Drill 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 24

W P 70-79-03 LOCATION Sta. 20+455.0, O/S 2.4 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE NX and BX Casing, NXL Rock Core, BXL Rock Core COMPILED BY NS

DATUM Geodetic DATE 81 06 01 to 02 CHECKED BY

SOIL PROFILE 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
83.0	Ground Level										
0.0	Fine Silty Sand Some Gravel		1	SS	41		82				
79.7	Dense Fill		2	SS	50/80 mm		80				
3.3	Gravel, Cobbles and Boulders Rock Fill		3	NXL RC							
77.8			4	BXL			78				
5.2	Refusal to Drill End of Borehole										

+3, x5 : 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 7

METRIC 25

W P 70-79-03 LOCATION Sta. 20+457.6 , 0/S 11.3 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Continuous Flight Augers COMPILED BY NS

DATUM Geodetic DATE 81 06 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W_L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)				GR SA SI CL
80.6	Ground Level												
80.6	Topsoil						80						
0.6	Refusal to Auger Probable Bedrock End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ S (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC 26

W P 70-79-03 LOCATION Sta. 20+429.4, 0/S, 5.2 m LT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing, BXL Rock Core COMPILED BY NS

DATUM Geodetic DATE 81 06 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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						
83.0	Ground Level										
0.0	Topsoil										
	Bedrock Good Quality		1	BXL RC	33% REC		82				
	Hard		2	BXL RC	100% REC						
79.9							80				
3.1	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 9

METRIC 27

W P 70-79-03 LOCATION Sta. 20+421.5, 0/S 2.8 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing, BXL Rock Core COMPILED BY NS

DATUM Geodetic DATE 81 06 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (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						
83.0	Ground Elevation										
0.0	Compact Silty Sand With Occasional Stiff Silty Clay Zones						82				
			1	SS	13						
80.6	Fill										
2.4	Cobbles and Boulders Rock Fill		2	BXL RC	58%		80				
			3	BXL	77%						
4.8	Refusal to Drill 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 10

METRIC 28

W P 70-79-03 LOCATION Sta. 20+412.8, 0/S 3.3 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing, BXL Rock Core COMPILED BY NS

DATUM Geodetic DATE 81 06 03 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						
82.9	Ground Elevation										
0.0	Sand and Gravel Fill						82				
81.1	Cobbles and Boulders										
1.8	Bedrock Good Quality Hard		1	BXL RC	97%						
			2	BXL RC	100%		80				
78.9											
4.0	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF PROBE HOLES NO. 11, 12 & 13 METRIC

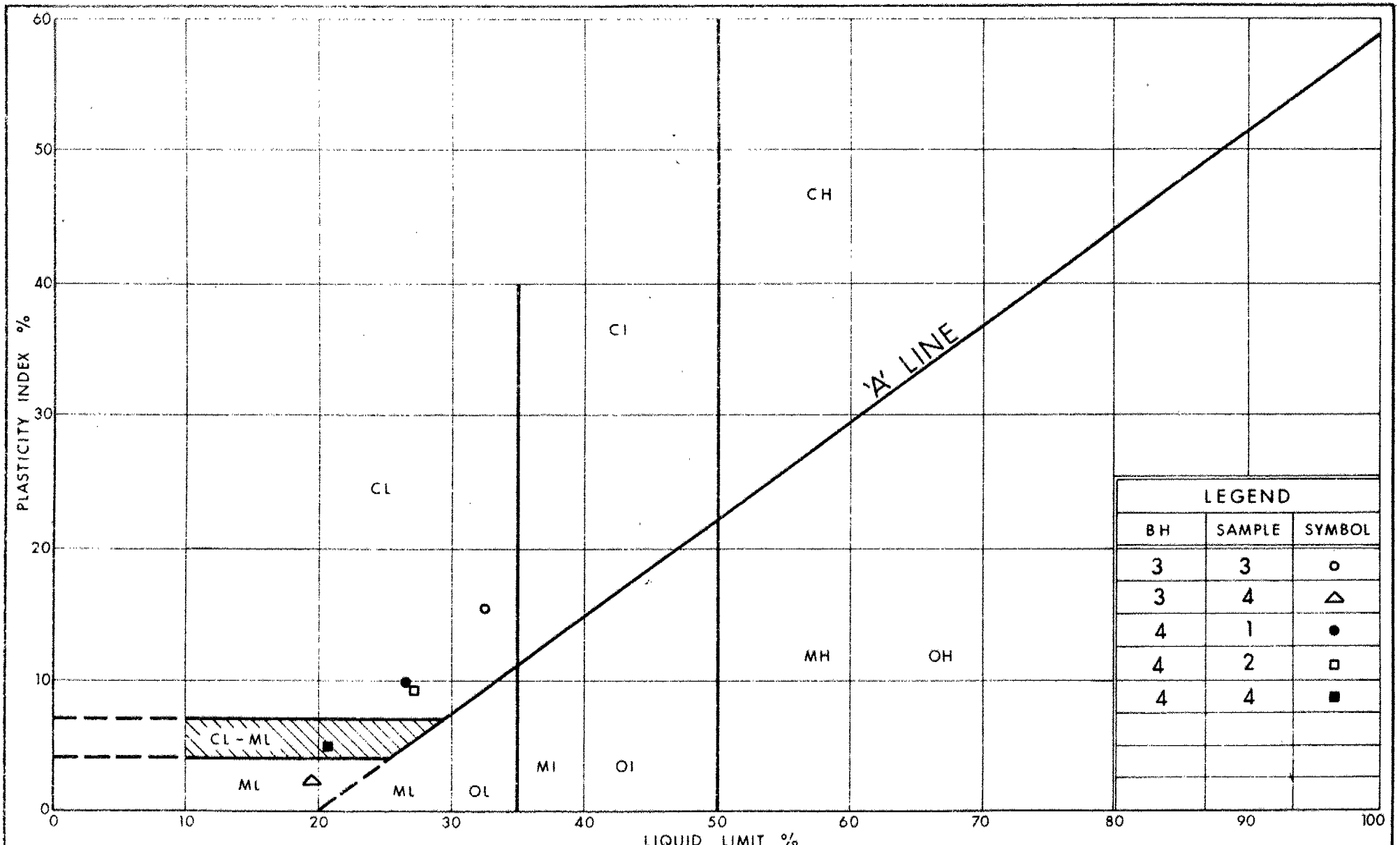
W P 70-79-03 LOCATION See Below ORIGINATED BY NS
DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Continuous Flight Augers COMPILED BY NS
DATUM Geodetic DATE 81 06 03 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	# 11 Sta. 20+408.5,		0/S	3.4 m RT		℄ Hwy. 2					
83.0	Ground Level										
0.0	Sand and Gravel Occasional Cobbles and Boulders Fill						82				
81.1											
1.9	Refusal to Auger Probable Bedrock End of Borehole										
	# 12 Sta. 20+416.7,			℄ Hwy. 2							
83.1	Ground Level										
0.0	Sand and Gravel Fill										
82.3											
0.8	Refusal to Auger Probable Bedrock End of Borehole						82				
	# 13 Sta. 20+422.6		0/S	5.2 m LT		Hwy. 2					
83.0	Ground Level										
82.6	Topsoil										
0.4	Refusal to Auger Probable Bedrock End of Borehole						82				

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10



Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
SILTY CLAY

FIG No 1
W P 70-79-03

30

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 70-79-02 DIST 8

HWY 2 STR SITE 16-111

Jones Creek Bridge

DISTRIBUTION

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

R. Hore

L. Saulnier
J. Anderson
T.J. Kovich
} cover only

Files

FOUNDATION INVESTIGATION REPORT

For

Jones Creek Bridge
W.P. 70-79-02, Site 16-111
Highway 2, District 8, Kingston

INTRODUCTION

This report contains the results of a foundation investigation for the above site. Fieldwork consisted of 4 sampled boreholes advanced during the period of November 19th to 27th, 1980. A truck mounted CME 75 auger operated from the road surface. Hollow stem augers were used for the 2 boreholes through the approaches and B size casing for the 2 boreholes through the bridge deck. Bedrock was proven in 1 borehole by obtaining BXL size rock core.

SITE DESCRIPTION

The site is located where Highway 2 crosses Jones Creek approximately 13 km west of Brockville. The area surrounding with its shallow overburden and frequent granite outcrops is typical of the physiographic region referred to as Leeds Knobs and Flats. Jones Creek at the time of the investigation was 5 to 7 metres in width and less than a metre in depth. It flows in a narrow valley frequently bordered by rock outcrops exhibiting very steep slopes which it may be assumed are typical of the subsurface rock slopes.

The existing 12 metre single span structure which was constructed in 1921 and reinforced in 1968 is in poor condition. Plans show that the full height abutments of this structure are supported by timber piles. The stream channel in the area is lined with random rip rap.

SUBSURFACE CONDITIONS

General

Subsoil under the stream channel consists of 6 to 8 metres of compact silty sand. It is underlain by granite gneiss bedrock. The west approach fill is up to 6 metres thick and is constructed of silty sand. The east approach consists of gravel, cobbles and boulders and is probably shot rock from nearby cuts.

Reference should be made to Drawing Number 707902-A which shows locations and elevations of all borings as well as an inferred subsoil stratigraphy. Record of Borehole sheets which show the boundaries between soil types as well as a record of all field and laboratory tests performed are contained in the report Appendix. A more detailed subsoil description follows.

Silty Sand

Silty sand containing a trace of gravel and clay extends from the bottom of the stream to the bedrock 6 to 8 metres below. Typical grain size distribution curves are shown in Figure 1. Standard Penetration 'N' values vary from 9 to 43 but are mostly between 10 and 20 indicating the stratum is generally compact.

West Approach Fill

The west approach fill consists of silty sand containing a trace of gravel and clay. The fill is considered to be loose to compact with Standard Penetration 'N' values ranging from 4 to 17.

East Approach Fill

A borehole was augered to a depth to 2.5 metres in this fill where refusal was met. Augering was very rough with the augers grinding and chattering on rock fragments. One Standard Penetration Test was attempted with refusal met after only 200 mm penetration. It is therefore concluded that this fill consists primarily of shot rock from a rock cut located 25 metres east of the structure.

Bedrock

Sound granite gneiss bedrock was encountered at approximate elevation 72 some 8 metres below the stream bed. Bedrock outcrops in the area frequently have very steeply sloping surfaces. It may be assumed that the subsurface slopes are similar with locally very steep sections.

Groundwater

Groundwater levels will be at or slightly above the creek level in the highly permeable silty sand.

PROPOSAL AND RECOMMENDATIONS

Proposal

It is proposed to replace the existing structure with a new structure of similar hydrologic capacity. Recommendations are to be provided for a bailey bridge on the same alignment to carry the traffic during the construction period.

RECOMMENDATIONS

Concrete Box

The replacement structure may consist of a concrete box founded at approximate elevation 79. Assuming an allowable settlement of 25 mm the serviceability limit state loading would be 70 kPa, and the ultimate limit state loading 250 kPa.

Timber Piles

The replacement structure may be supported on number 36 timber piles driven to bedrock at approximate elevation 72. A factored capacity of up to 440 kN per pile may be employed. If the piles extend above the creek low water level treated piles should be employed. All rip rap or bouldery fill should be removed from the area of the pile cap prior to pile driving.

'H' Piles

As an alternative steel 'H' piles driven to bedrock at approximate elevation 72 may be employed with design loads equal to their structural capacity. The piles should be fitted with reinforced tips to prevent damage due to boulders overlying the bedrock. All rip rap or bouldery fill should be removed from the area of the pile cap prior to pile driving.

Earth Pressure

For structures designed to deflect under load active earth pressures will apply. A value of 8.0 kPa/m should be used for ultimate limit state conditions and 6.5 kPa/m for serviceability limit states. If the structure is rigid, allowing little or no movement, the at rest condition will apply and design values of 10 kPa/m should be used for ultimate limit state conditions and 8.5 kPa/m for serviceability limit state conditions.

Unwatering

Unwatering an excavation extending below the groundwater level in the permeable silty sand will present problems of loosening of the soil due to an unbalanced hydrostatic head. If a footing is to be placed below the prevailing groundwater level the contract should contain an unwatering item and a special provision requiring that the soil in the base of the excavation not be disturbed during construction. The most practical way of achieving this would be through the use of perimeter steel sheeting. It would have to be driven below the base of the excavation for a depth equal to the height of the prevailing groundwater level above the base of the footing.

To avoid unwatering problems consideration should be given to a single span structure supported on abutments perched above the creek level.

Bailey Bridge Support

When the existing abutments are removed a forward slope of 1.5 horizontal to 1 vertical is acceptable provided it is protected from scour and erosion by a layer of rip rap. If the front edge of the bailey bridge footing is 3 metres horizontally from the top of the 1.5:1 slope a serviceability limit state loading of 100 kPa and an ultimate limit state loading of 150 kPa may be used. If the horizontal distance is reduced to 1.5 metres the loading should be reduced to 75 kPa for the serviceability limit state loading and 120 kPa for ultimate limit state loading.

Consideration should be given to shifting the new structure so that one of the existing abutments can be used for support of the bailey bridge.

MISCELLANEOUS

The base of all pile caps or spread footings should be protected from frost action by a minimum of 1.8 metres of cover.

If the new structure is shifted so that a footing is over the existing footing, provision should be made for cutting off or removing existing timber piles to at least 1 metre below the base of the new footing.

P.J. Stuart, P. Eng.
Foundations Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 70-79-02 LOCATION Sta. ~~7+742.0~~ 742.2 1.25 m RT C/L ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY P.J.S.

DATUM Geodetic DATE 80 11 19 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 (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.1	Ground Level						86				
85.6	Asphalt										
0.5	Fill Silty Sand Trace of Gravel and Clay Loose to Compact		1	SS	10				o		7 60 27 6
			2	SS	4						
			3	SS	17		84				
			4	SS	6						
			5	SS	7		82		●		7 41 45 7
80.3											
5.8	Silty Sand Trace of Gravel and Clay Compact to Dense		6	SS	43		80		o		11 73 11 5
			7	SS	11		78		o		10 65 21 4
			8	SS	9						
			9	SS	10		76				
73.1											
73.5	End of Borehole						74		Hammer Bouncing		
12.6	End of Cone Test Probable Bedrock Water Level Not Recorded.										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W P 70-79-02 LOCATION ~~Sta. 7+759.0~~ 757.2 1.25 m LT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY P.J.S.

DATUM Geodetic DATE 80 11 19 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						
86.2	Ground Level										
0.0	Fill Gravel Cobbles and Boulders		1	SS	~~20/~~	100 mm	86	Rods Bouncing			
83.7							84				
2.5	Refusal to Augers End of Borehole Borehole Dry										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

W P 70-79-02 LOCATION Sta. 7+754.1 1 m LT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE B Casing COMPILED BY P.J.S.

DATUM Geodetic DATE 1980 11 20 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.2	Deck Level						86				
85.7	Concrete										
0.5											
							84				
							82				
80.3	Ground Level										
5.9			1	SS	16		80		○		11 70 (19)
	Silty Sand		2	SS	18						
	Trace of Gravel						78				
	Compact		3	SS	18						
							76				
			4	SS	9						
							74		○		0 74 24 2
			5	SS	12						
72.3											
13.9	Granite Gneiss Bedrock		6	BXL RC	87% REC		72				RQD 50%
70.8											
15.4	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

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

W P 70-79-02 LOCATION Sta 7+747.2 (745.5) 1 m RT ℄ ORIGINATED BY R.B.

DIST 8 HWY 2 BOREHOLE TYPE B Casing COMPILED BY P.J.S.

DATUM Geodetic DATE 1980 11 27 CHECKED BY

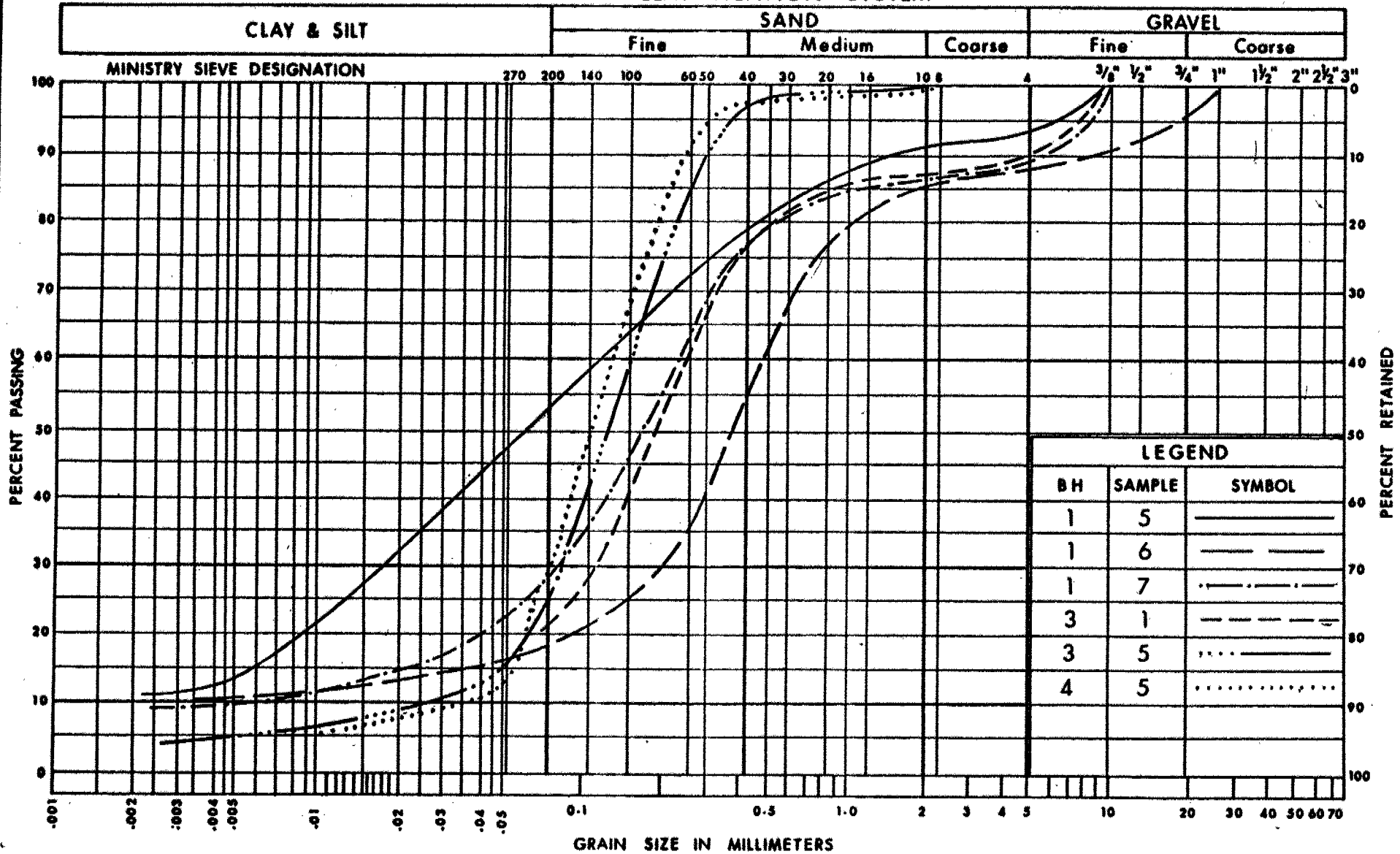
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
86.1	Deck Level						86				
85.6 / 0.5	Concrete										
							84				
							82				
80.3	Water Level										
5.8	Creek Bottom						80				
79.8	Boulder		1	SS	12						
			2	RC	60%						
	Silty Sand Compact		3	SS	15		78				
			4	SS	10						
							76				
			5	SS	10				o		0 71 28 1
73.3	Gravel		6	SS	22		74				
12.8	Refusal to Casing Probable Bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE OF GRAVEL & CLAY

FIG No 1
W P 70-79-02

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

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 05-MT-306M 6-78

METRIC

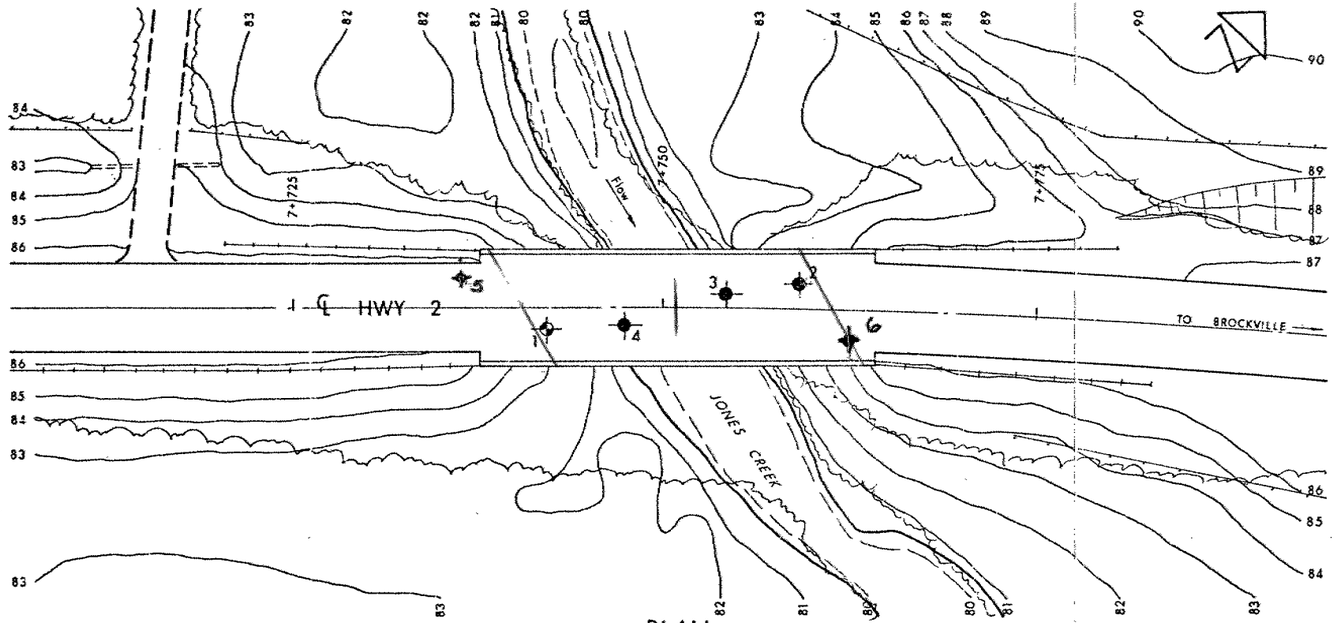
NOTE:
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

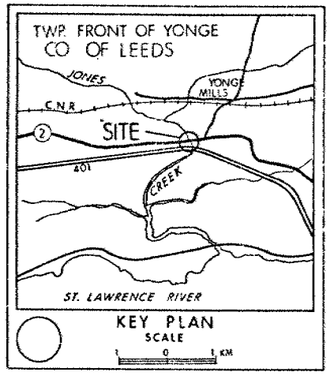
CONT No
WP No 70-79-02

JONES CREEK BRIDGE

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

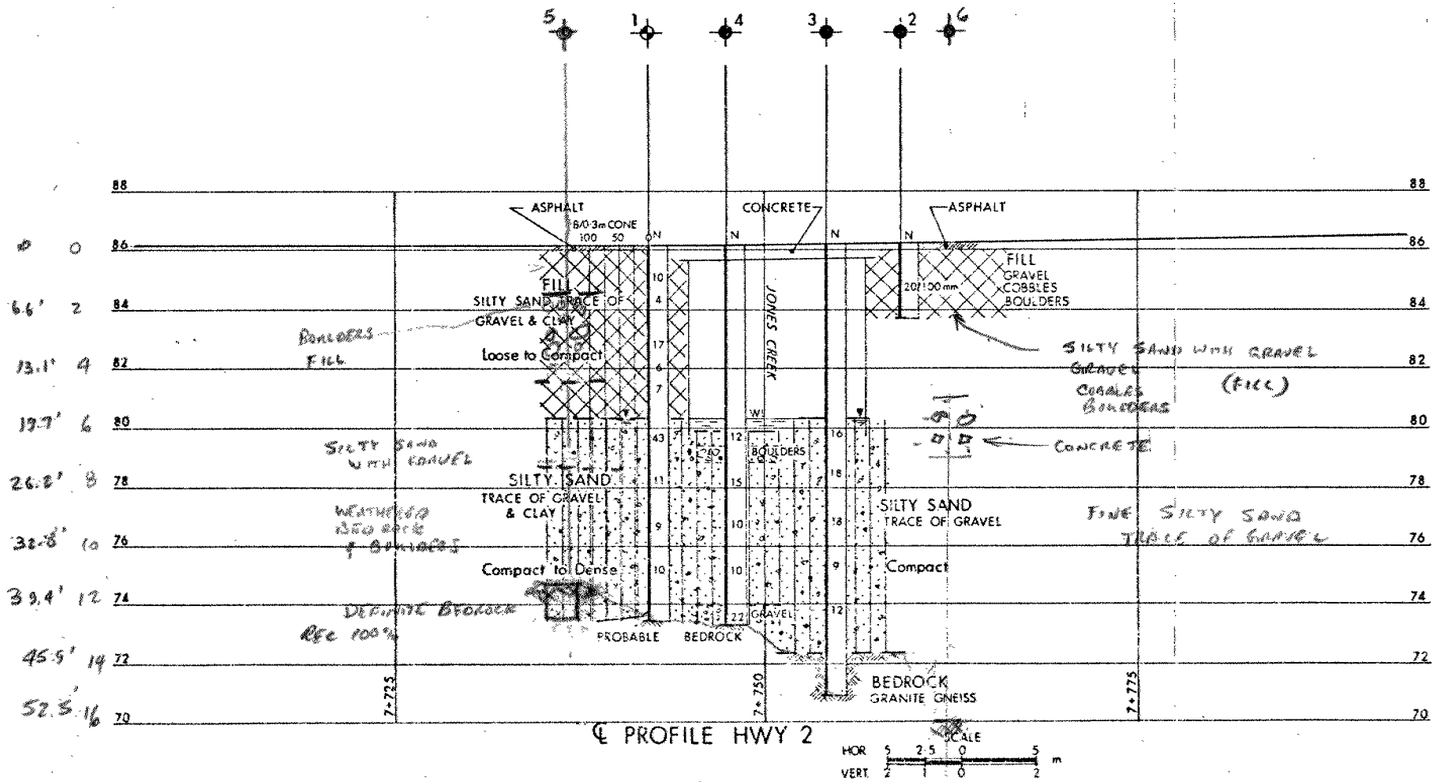




Sand pierced during wash boring completed

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 80 11 19



No	ELEVATION	STATION	OFFSET
1	86·1	7+742·0	1·25 RT.
2	86·2	7+759·0	1·25 LT.
3	86·2	7+754·1	1·0 LT.
4	86·1	7+747·2	1·0 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.

REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No 31B-58

HWY No 2			DIST 8
SUBMOD S	CHECKED	DATE 81 02 20	SITE 16-111
DRAWN OL	CHECKED	APPROVED	DWG NO 9G7-A

memorandum

Ontario

To: Mr. T. K. Kingsland,
Head,
Structural Section,
Eastern Region

Date: 81 12 24

ATTENTION: Mr. E. C. Lane,
Senior Structural Engineer

From: Pavement & Foundation Design Section
Room 315, Central Building

Re: W. P. 70-79-02, Site 16-111
Jones Creek Bridge
Highway 2, District 8, Kingston

We have reviewed the footing drawing and general plan for the above-mentioned structure and provide the following comments.

1. Further to our conversation of 81 12 23, we are in agreement with you that excavation below the pile cap should be maintained to a minimum. Since the pile cap excavation will be carried into the silty sand stratum which, when exposed to conditions of unbalanced hydrostatic head, is highly susceptible to 'boil', it will be necessary to provide a positive dewatering scheme in order to prevent boiling of the base material. For this reason it is recommended that the contract contain an unwatering item and that this fact be brought to the attention of the contractor.

2. Modified Granular 'C' should be described as Modified Granular 'C' having a maximum gradation of 75 mm.

3. The structure should be founded on steel 'H' piles equipped with 'Oslo" tips and reinforced flange plates. Please make a note of the reinforced flange plates on the drawings.

4. The pile lengths should be recalculated and should reflect the average estimated tip elevations as follows:

West Abutment (i. e. South Abutment on your drawings) pile tip elevation approximately 73.

East Abutment (i. e. North Abutment on your drawings) pile tip elevation approximately 72.

N. Stea, P. Eng.,
Project Foundations Engineer

For

M. Devata,
Senior Foundations Engineer

NS/bd

1318 (10/78)

memorandum

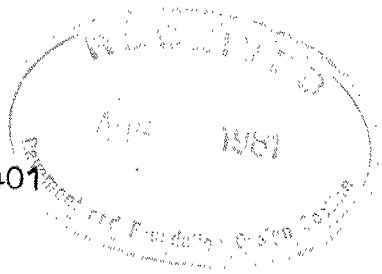
Ontario

To: Mr. T.C. Kingsland
Head, Structural Section
Eastern Region, Kingston

Date: 81-08-05

From: Structural Section
Eastern Region, Kingston

Re: Addendum to Structural Planning Report
Jones Creek Bridge, 6.1 km West of Hwy. 401
W.P. 70-79-02, Site No. 16-111, Hwy. 2
District 8 - Kingston, B.W. 7006



This addendum to the Structural Planning Report of 81-04-08 introduces new information concerning foundation soils, structure type and detour recommendations based on information obtained subsequent to the issue of the original report.

Foundations Information

At the request of this Section, the Pavement and Foundation Design Section has carried out further soils investigation at the site which is detailed in a memorandum to Mr. T.C. Kingsland dated 81-07-02. A copy is attached to this addendum.

Structure Alternatives

Two alternatives have been considered for the above structure. A discussion of these alternatives is given in the attached letter to Mr. J.W. Reid, Head, Planning and Design Section, dated 81-06-16. Further considerations are outlined in the attached letter to File dated 81-06-10.

A review of the alternative structures in conjunction with the most recent foundations information and cost estimates provides the following conclusions:

- There appear to be no advantages to staging the construction of this structure although a significant increase in costs would result.
- Difficult unwatering and stream diversion conditions preclude the use of rigid frame or a box type structure at this site.
- The most appropriate structures would appear to be skewed single span beam type structures supported on spill through type abutments founded on steel-H piles.
- Spans of 16 and 22 metres would be required for rockfill and earth fill, respectively.

2 .../

Recommendations

It is proposed to construct a 16 m single span precast beam structure supported on abutments perched in the approach fills and founded on steel-H piles as per Foundations' recommendations. The approach fills should consist of rock fill at maximum slopes of 1½:1 on side slopes and 1½:1 on the front slopes.

Detour

An on-site detour is considered necessary and would consist of a single span bailey bridge and approaches of rock fill constructed to the south of the new structure.

E.C. Lane
Sr. Structural Engineer

ECL:bd

Attachment

c.c. M. Devata ←
J.W. Reid
R.W. Oddson
K.G. Bassi
J. Harris
S.C.J. Radbone

memorandum

Ontario

To: Mr. T.C. Kingsland
Head, Structural Section
Eastern Region, Kingston

Date: 1981 07 02

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview

Re: Jones Creek Bridge
W.P. 70-79-02, Site 16-111
Highway 2, District 8, Kingston

This memorandum outlines the findings of a further soils investigation which was carried out at the above mentioned site and provides recommendations pertaining to the structure foundations and the related earthworks. A foundation investigation report has already been issued however, due to change in design geometry, an additional investigation was required. This memorandum should be read in conjunction with the previously issued foundation investigation report. Appended please find the additional borehole log sheets and a revised drawing with the updated subsurface information. No further report will be issued for this project except for the report and drawing required for contract purposes.

The additional fieldwork consisted of 2 sampled boreholes carried out during the period of May 26th to 28th, 1981. Hollow stem augers were advanced to refusal at which time 'B' size casing was drilled ahead using a muskeg mounted CME 55 auger.

Subsurface Conditions

The additional subsurface investigation confirmed data obtained previously, as well as providing more detailed information at both the west and east bank of the creek.

Overlying the west and east bank of the creek and encountered for depths of approximately 1.5 metres is a surficial fill material consisting of a silty sand with gravel, generally loose to compact in denseness with 'N' values ranging from 9 to 13 blows/0.3 m. This upper fill material is underlain by cobble and boulder rock fill ranging in thickness from 3.2 to 4.2 metres. In view of the presence of rock fill, rock drilling techniques using BXL core barrels were employed.

Underlying the rock fill at the west creek bank is a 3.5 metre layer of dense to very dense silty sand, some gravel and traces of clay with 'N' values ranging from 35 to 47 blows/0.3 m. Although tests indicate that this material is

cont'd.../2

dense to very dense, the observed 'N' values could be misleading due to the presence of cobbles and boulders. Based on the above information this layer should be considered as being loose to compact.

The silty sand overlies a 2.9 metre layer of cobbles and boulders which rests on sound bedrock which was encountered at approximate elevation 75.2.

Underlying the rock fill at the east side is a 1.7 m slab of concrete which is part of the existing footing. The concrete slab is underlain by an 8.8 m layer of loose to compact fine silty sand with traces of gravel having 'N' values ranging from 5 to 12 blows/0.3 m.

Sampling was terminated in B.H. #6 at a depth of 12.5 metres due to soil disturbance as a result of unbalanced hydrostatic head within the augers. For this reason a dynamic cone penetration test was driven through the fine silty sand to refusal on probable bedrock at approximate elevation 70.2.

Discussion and Recommendations

There are presently two schemes being considered for the Jones Creek Bridge.

Scheme 1 - a spill-through abutment beam type structure with a clear span of about 22.0 metres on skew.

Scheme 2 - a similar structure with a clear span of about 15.0 metres on the same alignment.

The following recommendations are specified directly for these two possible schemes.

In consideration of the layer of loose to compact silty sand at both the west and east abutment locations and the fact that full height abutments are not warranted, spread footing type foundations are not considered feasible at this site. The structure should be founded on steel 'H' piles equipped with reinforced flange plates and 'Oslo' tips to insure penetration of the cobble and boulder stratum and proper seating of the piles on sloping bedrock.

For design estimating purposes, the steel 'H' section piles driven to bedrock should be designed for an allowable compressive loading of 700 kN for a 310 HP 110 pile. In accordance with OHBDC the capacity at S.L.S. Type II is 700 kN, and the factored capacity at U.L.S. is 1600 kN.

The average estimated tip elevations are as follows:

Scheme 1 - West Abutment -
pile tip elevation will vary from 75 to 73.

cont'd.../3

East Abutment -
pile tip elevation approximately 70

Scheme 2 - West Abutment -
pile tip elevation approximately 73

East Abutment -
pile tip elevation approximately 72.

In order to facilitate pile penetration through the fill it is recommended that in the area of the piles all the cobble and boulder rock fill and the existing structure (i.e. the retaining wall and footings) be removed, backfilled and compacted with acceptable earth material having a maximum gradation of 75 mm.

In order to insure the stability of fills the following should be adhered to:

Rockfill slopes to be constructed with 1¼:1 slopes in the transverse direction, and 1½:1 slopes in the forward direction to ensure adequate protection against the scouring action of the creek.

Earth fill slopes to be constructed with 2:1 slopes with an adequate rip rap protection scheme to protect against river scour action.

We trust the information provided is sufficient in scope for your requirements. Please feel free to contact this Section if further discussion is required.

N. Stea
Project Foundations Engineer
For: M. Devata
Senior Foundations Engineer

NS:ea

cc: W.E. Blum
J.W. Reid
R.W. Oddson (2)
K.G. Bassi
B.J. Giroux
R. Hore

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 70-79-02 LOCATION Sta. 7 + 736.0; 0/S 2.1 m LT ℄ Hwy. 2 ORIGINATED BY NS
DIST 8 HWY 2 BOREHOLE TYPE BX Casing COMPILED BY NS
DATUM Geodetic DATE 81 05 26 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
86.2	Ground Level						
0.0	Silty Sand Some Gravel Compact (Fill)		1	SS	13		86
84.7			2	SS	50/10 mm		
1.5	Cobbles and Boulders (Rock Fill)		3	BXL RC	50% Recovery		84
81.5			4				
4.7	Silty Sand Some Gravel Traces of Clay Dense to Very Dense		5	BXL RC	42%		82
			6	SS	35		
			7	SS	32/100 mm	▽	80
			8	SS	47		
78.1							
8.1	Cobbles and Boulders Very Dense		9	BXL RC	33% REC		78
			10	BXL RC	36% REC		76
75.2							
11.0	Bedrock Good Quality Hard		11	BXL RC	100% REC		74
73.6							
12.6	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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

Note: Ground Water Level Reflects Creek Water Level

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

20
15 ◇ S (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 70-79-02 LOCATION Sta. 7 + 763.0; O/S 2.0 m RT ℄ Hwy. 2 ORIGINATED BY NS

DIST 8 HWY 2 BOREHOLE TYPE BX Casing COMPILED BY NS

DATUM Geodetic DATE 81 05 27 to 28 CHECKED BY

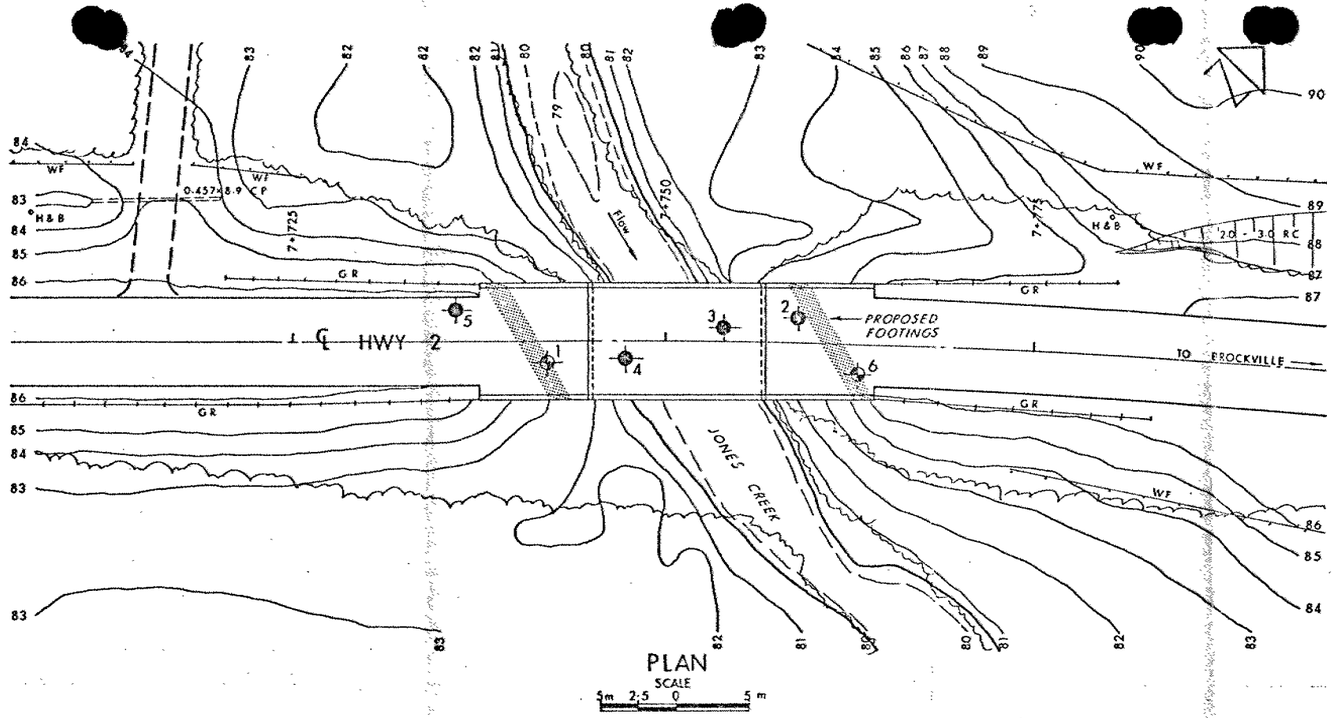
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.2	Ground Level										
0.0 / 85.0	Silty Sand with Gravel Loose (Fill)		1	SS	9		86				
1.2			2	BXL							
	Gravel, Cobbles and Boulders (Rock Fill)		3	BXL			84				
			4	BXL							
			5	BXL			82				
			6	SS	8						
80.7			7	BXL	30%						
5.5 / 79.0	Concrete Footing		8	BXL RC			80				
7.2			9	SS	5						
	Fine Silty Sand, Traces of Gravel Loose to Compact		10	SS	12		78				
			11	SS	12		76				
73.7			12	SS	-		74				
12.5 / 70.2	End of Borehole										
16.0	Refusal to Cone Probable Bedrock						72				
	Note: Ground Water Level Reflect Creek Water Level										

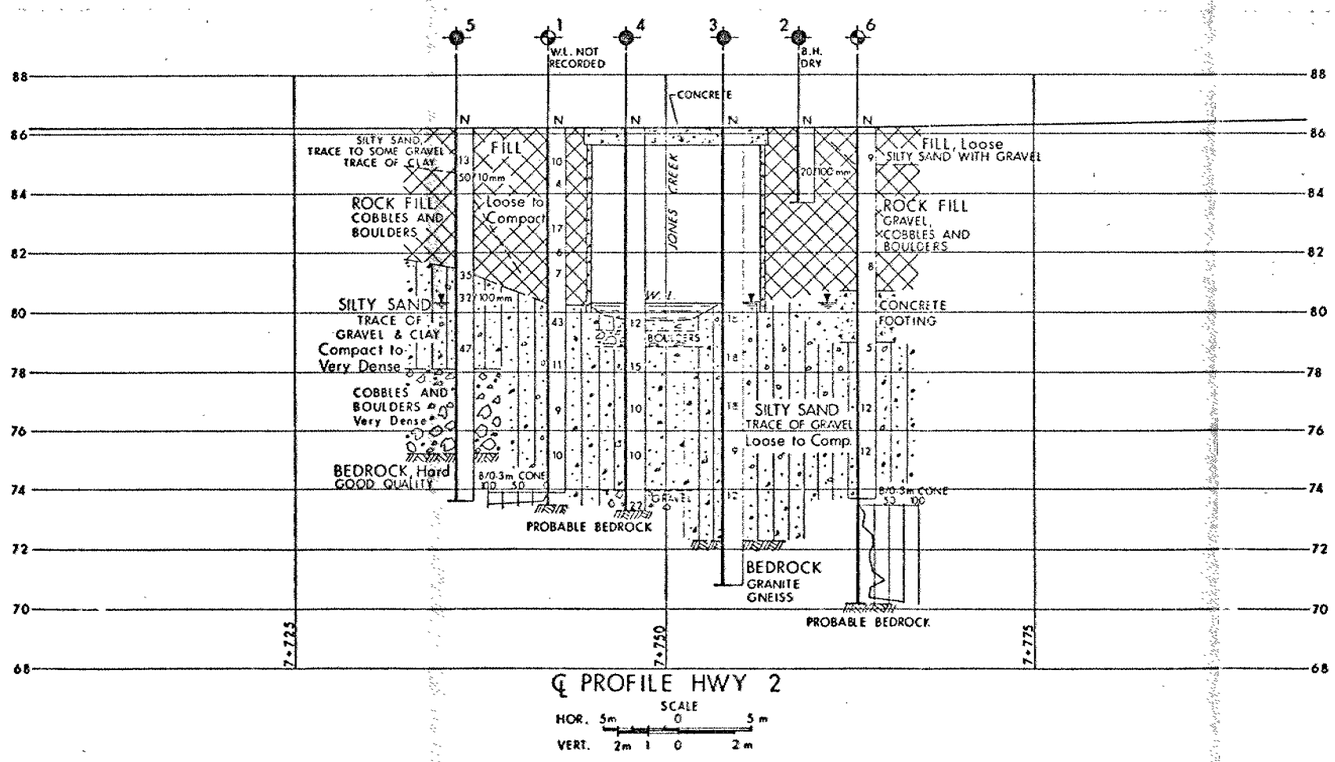
OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-306M 6/78





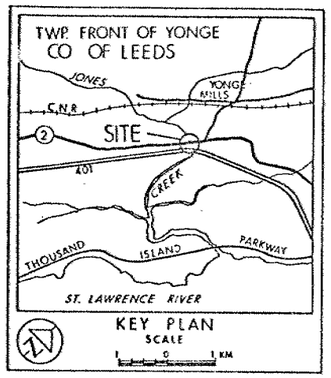
METRIC

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

CONT N[redacted]
WP No 70-79-02

JONES CREEK BRIDGE
(6.1 km West of Hwy 401)
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 80 11 19
  WL in BH#5 & 6 ; 1981 05 28

No	ELEVATION	STATION	OFFSET
1	86·1	7+742·0	1·25 RT.
2	86·2	7+759·0	1·25 LT.
3	86·2	7+754·1	1·0 LT.
4	86·1	7+747·2	1·0 RT.
5	86·2	7+736·0	2·1 LT.
6	86·2	7+763·0	2·0 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.

REVISIONS

DATE	BY	DESCRIPTION
81 07 03	G.P.	B.H. 5 & 6 ADDED TO PLAN & PROFILE

Geocres No 31B-58

HWY No 2			DIST 8
SUBM'D P.S.	CHECKED	DATE 81 02 20	SITE 16-111
DRAWN O.J.	CHECKED	APPROVED	DWG 70-79-02-A

REF No. E-5292-1 ; 1980 12

70-17-02

memorandum

Ontario

To: FILE Date: 81 06 10

From: Structural Section
Eastern Region, Kingston

Re: Jones Creek - MacIlhennys Creek Bridge
Review of Project

1. We have reviewed the sites for possible on-site detours and have found there to be feasible, without apparently being environmentally detrimental at either crossing site. The cost of such detours would be about $30,000. each.

   At each site the best location for a bailey bridge is the south side of the existing bridge. Only young growth is affected, mainly small poplars.

2. The foundation investigation which was carried out by consultants and was found to be unsatisfactory has been followed up by an extra in-house investigation. This is showing up poorer soils conditions than heitherto and will probably affect the chosen design for MacIlhennys Bridge. Field work is continuing and full results will be available shortly.

3. A study of possibilities for stage construction of a bridge at either site has been done (again) and found to be impracticable (as before).

4. Two possibilities for detours still remain, on site and off site. The off site routes are being investigated by Planning and Design Section. We traversed the County Road off site detours ourselves. These appeared to be good. The main factors appeared to be distance, school buses, Voyageur Colonial buses, (when running) and fire services. The latter problem could possibly be solved by a temporary agreement between adjoining townships.

T. C. Kingsland
Head, Structural Section

TCK:sh
c.c. R. W. Franks
J. W. Reid

Mr. J. W. Reid,
Head,
Planning & Design Section,
Kingston, Ontario.

81 06 16

Attention: Mr. P. A. Jones

From: Structural Section,
Kingston

Re: Jones and McIlhenny Creek Bridges,
W.P. 70-79-02, 03, Sites 16-111, 112,
Highway 2, District 8, Kingston.

We have investigated the alternatives for the structure types and detour arrangements for the above structures. Our comments are as follows:

Jones Creek Bridge

The use of staged construction at this site was considered but found to be of no advantage, though increasing the cost of the structure by approximately $20,000. The structure as suggested in the structural planning report is a spill-through abutment beam type structure with a clear span of about 22.0 metres on skew. The cost of this structure excluding removal of the existing structure and detours would be approximately $151,000. Further foundation work has been undertaken at this site. Pending the results it may be possible to construct a shorter structure of about 15 m span for about $115,000 utilizing steeper embankments constructed of rock fill. In either case, the existing alignment would be maintained. The construction of a box type structure is not considered practical as the presence of the existing structure and the foundation conditions make unwatering and stream diversions very difficult.

Based on a site visit and further investigations, a Bailey Bridge detour using a 100' span Bailey supported on rockfill embankments could be constructed to the south of the existing site. The cost of such a detour including rental of the Bailey Bridge would be about $30,000. The cost of removing the existing structure to the level of the top of the footings is estimated as $8,000.00.

McIllennys Creek Bridge

The use of staged construction is not considered practical for the reasons stated above.

The Structural Planning Report suggests a beam type structure supported on spill-through type abutments with a clear span of about 32 metres. The estimated cost for this structure is about $223,600.

...../2

Further foundation investigation is being carried out at this site and it may be necessary to lengthen this type of structure to a clear span of 39 metres increasing the cost to about $270,000.00.

An alternative type structure could be constructed at an estimated cost of $175,000 including dewatering although diverting the creek may prove more difficult than anticipated.

The most economical structure may now be a rigid fram bridge founded on piles with a clear span of about 18.5 metres. This could be constructed at a cost of about $147,000 including any necessary dewatering and utilizing rockfill for the approaches. The use of earth fill would increase the required length of the wingwalls and increase the cost by approximately $40,000.

A bailey bridge detour appears feasible at this site using a 160' span bailey and rock fill approaches. The cost of such a detour would be about $30,000. The cost of removal of the existing structure to the level of the top of footings would be about $8,000.00.

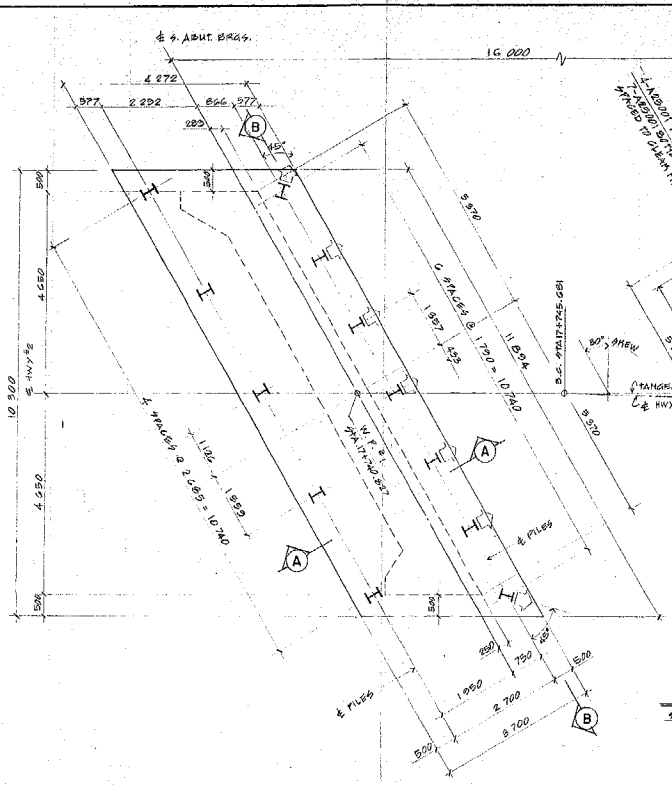
This information is preliminary only and could change subject to release of the additional foundations information.

E. C. Lane,
Structural Engineer

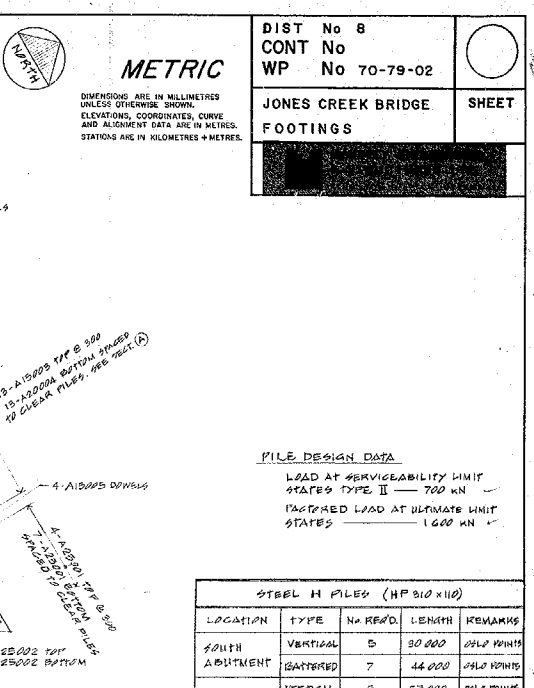
ECL/jtk

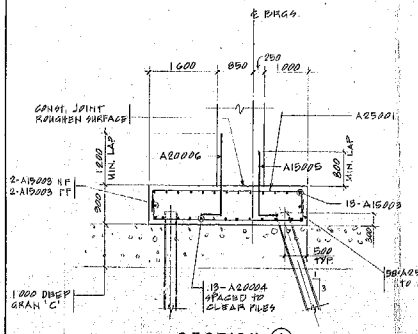
c.c. M. Devata
K. G. Bassi

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DS-BR 1341 79 05

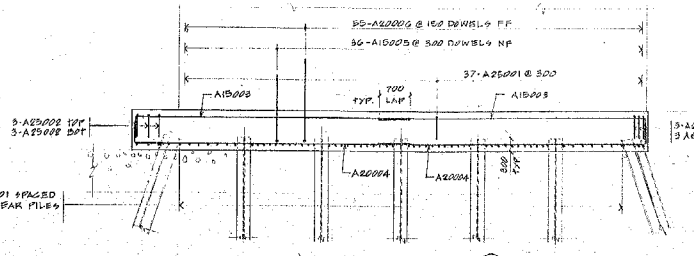


PLAN
SCALE 1:50





SECTION (A)
SCALE 1:50



SECTION (B)
SCALE 1:50

METRIC

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

DRAWINGS NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DIST No 8
CONT No
WP No 70-79-02

JONES CREEK BRIDGE
FOOTINGS

SHEET

[redacted]

FILE DESIGN DATA

LOAD AT SERVICEABILITY LIMIT STATES TYPE II —— 700 kN
FACTORED LOAD AT ULTIMATE LIMIT STATES —— 1 600 kN

STEEL H PILES (HP 310 x 110)

LOCATION	TYPE	No. REQ'D.	LENGTH	REMARKS
SOUTH ABUTMENT	VERTICAL	5	30 000	GOLD POINTS
	BATTERED	7	44 000	GOLD POINTS
NORTH ABUTMENT	VERTICAL	5	57 000	GOLD POINTS
	BATTERED	7	53 000	GOLD POINTS
TOTAL LENGTH OF PILING-IN PLACE = 1 621 000				

NOTES

1) PILE LENGTHS SHOWN ARE THE THEORETICAL BELOW CUT-OFF ELEVATIONS.
2) BATTERED PILES SHOWN THUS H▷ 1:3 TYPICAL UNLESS NOTED OTHERWISE.
3) PILES TO BE DRIVEN TO BEDROCK.
4) SEE ABUTMENT DRAWINGS FOR GEOMETRY OF WALLS ABOVE FOOTINGS.

S. T. ROGERS — PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO
D.K. McNEELY — PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN JJF	CHECK SSR	LOADING	DATE
DRAWING MNA	CHECK	SITE No 16-111	DWG 3

DIST. No. 8
CONT No
WP No. 70-79-02

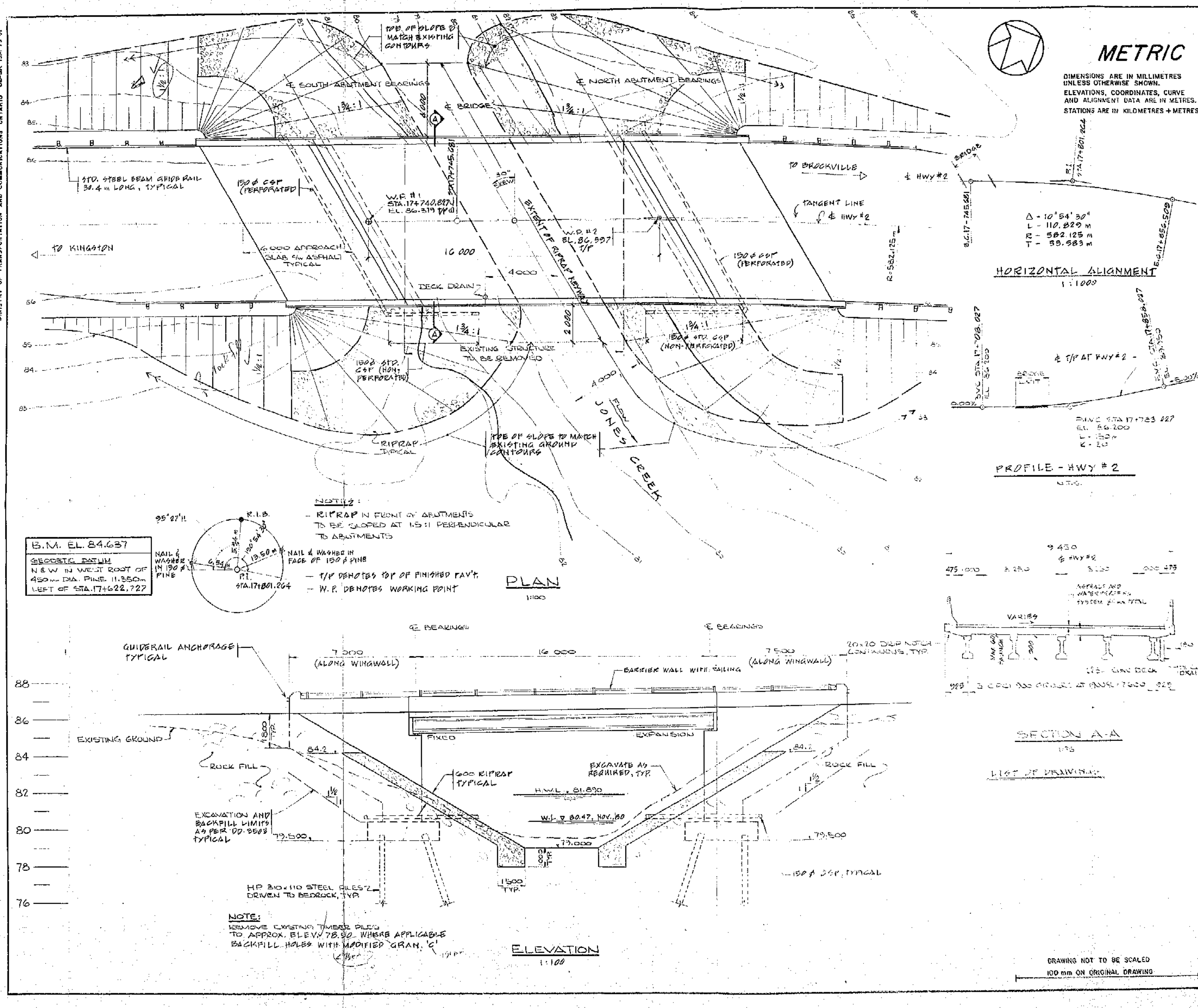
JONES CREEK BRIDGE GENERAL ARRANGEMENT

SHEET

McNEELY ENGINEERING & STRUCTURES LTD.
KINGSTON OTTAWA

METRIC

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



GENERAL NOTES:

1 - CLEAR COVER TO REINFORCING STEEL: (UNLESS OTHERWISE NOTED)

FOOTINGS	100 ± 25
ABUTMENTS AND WINGWALLS	70 ± 20
APPROACH SLABS	70 ± 10
DECK - TOP AND BARRIER WALLS	70 ± 20
DECK - BOTTOM	40 ± 10

2 - REINFORCING STEEL NOTATION:

NF - NEAR FACE   T - TOP
FF - FAR FACE   T&B - TOP & BOTTOM
EF - EACH FACE

3 - CLASS OF CONCRETE:

PRECAST PRESTRESSED GIRDERS	40 MPa
DECK, BARRIER WALLS, WINGWALLS AND ABUTMENTS	30 MPa
REMAINDER	20 MPa

4 - BEARING SEATS TO BE FINISHED DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3mm

5 - CONCRETE BARRIER WALLS ON WINGWALLS SHALL NOT BE CAST UNTIL THE WINGWALL BACKFILL HAS BEEN COMPLETED.

6 - ALL EXPOSED CONCRETE EDGES TO HAVE 20mm x 20mm CHAMFER UNLESS OTHERWISE NOTED.

7 - CONCRETE QUANTITIES:
CONCRETE QUANTITIES ARE LISTED FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS

ABUTMENTS & WINGWALLS	109 m³
DECK	42 m³
BARRIER WALLS	14 m³
APPROACH SLABS	26 m³

8 - REINFORCING STEEL SHALL BE C.S.A. G30.12M-1977 GRADE 400 UNLESS OTHERWISE NOTED. BARS MARKED WITH SUFFIX 'C' SHALL BE COATED BARS.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN J.O.F.	CHECK		LOADING OHBDC A79 · DATE 81-11
DRAWING	CHECK		SITE No 16-11 · DWG 1